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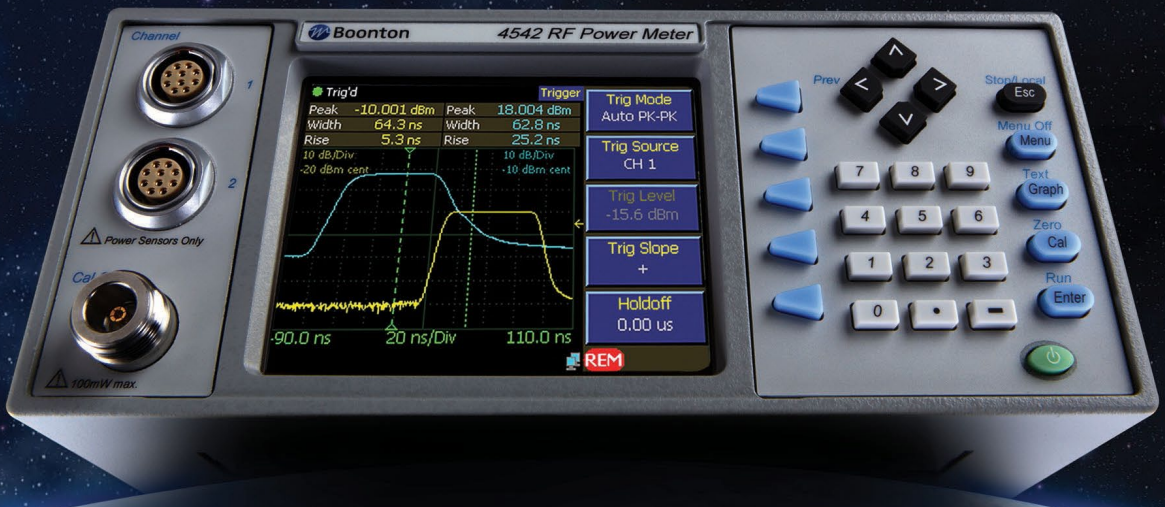

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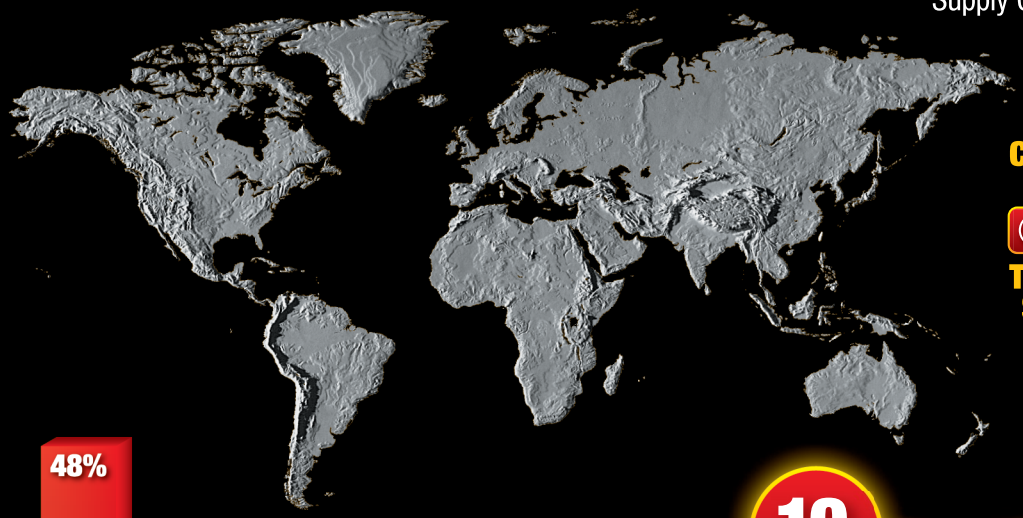

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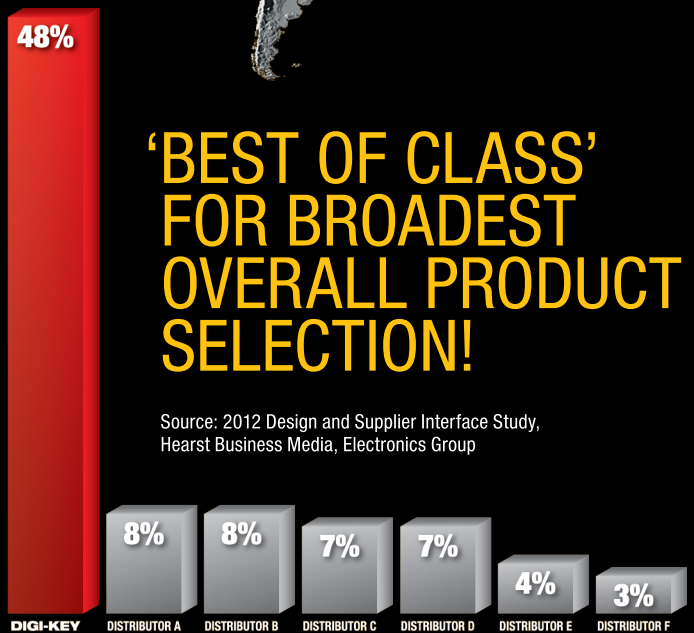

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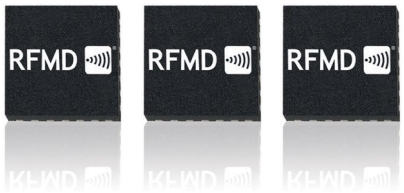

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Real-time oscilloscopes achieve 70 GHz performance

Tektronix has announced that lab testing has shown that its next generation performance oscilloscopes — due for availability in 2014 — will deliver real-time bandwidth of 70 GHz, with significant upside potential.

The oscilloscope platform will deliver the performance and signal fidelity needed for applications such as 400 Gbps and 1 Tbps optical communications and fourth generation serial data communications. Tektronix also announced an investment program that will give customers a cost-effective migration path to the new platform.

The extraordinary gain in bandwidth performance, with improved signal fidelity, is due in part to the development by Tektronix engineers of a patent pending signal processing architecture called Asynchronous Time Interleaving. The real-time oscilloscope platform will also include a number of other enhancements and refinements to improve overall performance and measurement precision.

Kevin Ilcisin, Chief Technology Officer, Tektronix, comments, "The development of the industry's first production-ready Asynchronous Time Interleaving architecture is a significant breakthrough that will improve signal-to-noise ratio beyond the frequency interleaving approach used by competing oscilloscope vendors."

The limitation of frequency interleaving approaches lies in how the various frequency ranges are added together to reconstruct the final waveform, a step which compromises noise performance. In traditional frequency interleaving, each analog-to-digital converter (ADC) in the signal acquisition system only sees part of the input spectrum. With Asynchronous Time Interleaving technology, all ADCs see the full spectrum with full signal path symmetry. This offers the performance gains available from interleaved architectures while preserving signal fidelity.

www.tektronix.com

Wireless charging for devices smaller than mobile phones

VTT Technical Research Centre of Finland is working with the industry's leading technological companies and standardisation bodies to expand the scope of application of wireless charging technology to other, smaller portable devices, such as mobile phone accessories, wrist devices, wireless mice and sensors.

This can be done by combining wireless power transmission with NFC connectivity technology, which enables cost-effective and compact design.

Consumer need to recharge the batteries of various kinds of portable devices, whenever and wherever, continues to grow. Over the next five years, wireless charging will be available for more and more mobile devices. The first mobile phones with wireless charging capability are already on the market. Examples include recent smartphone releases by leading mobile phone manufacturers, many of which have wireless charging either built in or available through a special cover accessory charging case.

The increase of features in mobile devices has caused cost pressures, increased power consumption, and created new challenges for keeping devices compact. Combining wireless charging with NFC technology makes it possible to design increasingly compact and cost-effective wireless charging circuits, which is essential especially for small devices. In the near future, NFC devices will be able to receive electrical power wirelessly, as well as acting as charging platforms capable of transmitting wireless electrical power. The challenges include, among others, current NFC antenna circuits which have not been optimised for efficient, wireless energy transfer.

www.vtt.fi

Vehicle to vehicle comms to reach 62% by 2027

Vehicle-to-vehicle technology based on DSRC (Dedicated Short Range Communication) using the IEEE 802.11p automotive W-Fi standard will gradually be introduced in new vehicles driven by mandates and/or automotive industry initiatives, resulting in a penetration rate of 61.8% by 2027.

Despite increasing momentum driven by both governments/regulators and the automotive industry, the deployment of V2V and even more so V2I will take time, as the real safety benefits of V2X only can be realized when a sufficiently large part of the installed vehicle base is connected. However, complimentary technologies such as ADAS on the low end and cellular connectivity on the high end will allow emulating some of the ITS functionality defined for V2X. In particular, the rapid emergence of LTE Advanced featuring very low latency is a good candidate for offering vehicle-to-vehicle communications awaiting the widespread availability of dedicated V2V technology.

www.abiresearch.com

ST and Ericsson agree to break up joint venture

STMicroelectronics NV and Ericsson AB have agreed to break up their 50:50 mobile phone chip joint venture. The two companies had been looking for a "strategic solution" for the joint venture for several months.

Ericsson (Stockholm, Sweden) will take back the LTE 2G-through-4G multimode modem technology while ST (Geneva, Switzerland) will take control of the existing ST-Ericsson products excluding the LTE multimode thin modem ICs and certain assembly and test operations.

The two companies have agreed to try and sell off the connectivity business separately, which employs approximately 200 people, and close down the remaining parts of ST-Ericsson.

ST said that the transfer of competencies from ST-Ericsson would strengthen its capabilities in application processors, RF, analog and power and help it address the fast-growing wireless semiconductor market.

www.st.com

NFC installed base to exceed 500m devices within 12 months

The number of NFC-enabled devices will exceed 500 million in 2014, according to a report from ABI Research — "NFC Devices, Strategies, and Form Factors". The report calculated that a minimum of 285 million mobile and consumer electronics devices will ship in 2013 as OEMs continue to drive the market for NFC as mobile operators struggle to gain control and bring their services to market.

Mobile manufacturers moved ahead with NFC in 2012 whilst MNOs were still largely focused on payments, where they have struggled to deliver tangible services. This has allowed predominantly Android OEMs to seize the initiative as they have delivered new services and features for connecting devices, sharing data and content, picking up information, and utilizing tags.

"NFC has reached the point of no return," commented John Devlin, practice director. "It all hinged on handsets; and next year we will see half-a-billion devices in the hands of consumers as it becomes more widely integrated. Up until this point banks and other service partners were holding back from committing to MNOs and it has always surprised me that they did not drive this forward themselves and invest to take charge of this market's potential."

Companies such as Blackberry and Samsung have developed and implemented clear strategies around NFC. They are differentiating themselves as they look to generate new service-based revenue streams utilizing NFC. Other brands, such as LG and Sony, are taking a different path as they horizontally integrate NFC across their broad product portfolios.

www.abiresearch.com

Arduino-compatible computer with Bluetooth low energy

Nordic Semiconductor has announced that wireless startup 'Open Source RF' has launched on KickStarter.com the world's first 'Arduino' compatible open-source micro-computer that can communicate wirelessly with any Bluetooth® v4.0 (which includes Bluetooth low energy as a hallmark feature) compatible smartphone (including the iPhone® 4S/5) or tablet (such as the 3rd and 4th generation iPad® or the iPad mini) and is based on a latest RFD51822 module, which in turn is based on the Nordic nRF51822 SoC developed by Nordic's long standing module partner and wireless specialist, RF Digital.

Called the 'RFduino' and making full use of the nRF51822's powerful on-board 32-bit ARM Cortex M0-based processor, this fully FCC and CE-compliant 2.4 GHz wireless coin-sized micro-computer is designed to allow both electronics makers and professional developers to develop thousands of miniaturized Bluetooth low energy applications controllable from a Bluetooth v4.0 compatible smartphone or tablet in a very short amount of time at very low cost.

Indeed, Open Source RF claims that the overriding focus of the RFduino is on building new wireless applications. Makers need go no deeper into the technical design aspects than high-level application design, while design engineers have the option to use standard Nordic Semiconductor nRF51 Series SDKs (software development kits) to fast track a successful prototype into production.

Application examples for which Open Source RF has already developed source code include wireless multi-color RGB LED lighting, iPhone controlled racing cars, temperature sensors, house plant watering sensors, proximity and motion sensors, relay switches, audio controls, robotics, theatrical props and special effects, sound, light or button-press detectors, and various home automation and control devices

wwww.opensourcerf.com

UltraCMOS® RFICs in Globalstar satellites

Peregrine Semiconductor Corporation has announced that its UltraCMOS® Phase Locked Loop (PLL) frequency synthesizer and prescaler devices are designed into six Globalstar mobile communication satellites that were launched into orbit on February 6.

Built by Thales Alenia Space in France, the low-Earth orbit satellites transmit audio and data communications for Globalstar's mobile voice and data customers worldwide. Peregrine's PLL and prescaler enable communication in sixteen C- and S-band transponders in the system, which connects end users with terrestrial communication networks via vehicle-mounted mobile devices, as well as fixed terminals, such as those used for rural telephony.

The Peregrine devices feature extremely low phase noise and Single Event Effect (SEE) immunity—attributes enabled by the insulating properties of UltraCMOS process technology—as well as low power, small form factor, and light weight.

www.psemi.com

Lime wants a Raspberry Pi for RF

UK multimode RF chip developer Lime Microsystems wants to make its configurable RF hardware as ubiquitous as the Raspberry Pi low cost computer by making it open source.

The company has provided all the schematics and documentation for the board for an open source project called Myriad-RF, and is looking for partners to make more boards to bring the cost down. The board is currently made by Taiwanese distribution partner Azio but costs $300.

The Myriad-RF non-profit initiative aims to give both hobbyists and experienced design engineers a range of low-cost RF boards and free design files available for general use. The boards use field programmable RF (FP-RF) transceivers to operate on all mobile broadband standards - LTE, HSPA+, CDMA, 2G - including all regional variants; and any wireless communications frequency between 0.3 and 3.8 GHz.

www.myriadrf.org

Apple buys WiFiSlam for indoor WiFi geolocation technology

Apple has acquired a Silicon Valley startup, WiFiSlam, which makes mapping applications for smartphones based on the triangulation of WiFi signals. The Wall Street Journal reported Apple may have paid around $20 million for the company.

WiFiSlam develops technology that provides indoor tracking and similar services. The startup uses a combination of methods to get better indoor locations, such as using WiFi fingerprinting, or measuring the strength of the signal to get an idea of what the materials and construction of a particular building do to WiFi signals. With enough scans, users can get an accurate profile of a building that can be then be used to make a map. Slam stands for Simultaneous Localization and Mapping, at the core of WiFiSlam's way of gathering location and mapping information, without recording any data at all. WiFiSlam records 'trajectories' from the phone's sensors including the accelerometers, gyroscopes and magnetometers and combine them with WiFi signal strength data.

By aggregating the data of many paths walked by various users, a big database of paths and maps can be built for each building equipped with WiFi hotspots. Pattern recognition and machine learning algorithms are also blended-in to correlate the data gathered by all of the sensors in a device, and associate it with WiFi triangulation. Magnetometers can take magnetic field readings throughout a building, and again, the level of variance and details provided can be used to statistically map indoor locations together with the WiFi signals. All these sensors are already on-board Apple's iPhone 5 and iPhone 4S. This could turn any iPhone user into a remote anonymous data aggregator, adding precision to future Apple indoor mapping services.

TTP/Freescale team up for white space broadband basestation

The Technology Partnership (TTP) in Cambridge is using Freescale Semiconductor's RF devices and QorIQ base station-on-chip as the foundation of an innovative, low-cost high-speed broadband service over white space spectrum.

White space is license-exempt radio spectrum that exists between licensed TV transmissions. Globally, more than 100 MHz of prime UHF white space radio spectrum exists in many rural locations and is characterized by excellent propagation characteristics ideal for long-range communication. TTP sees the white space spectrum is ideal for providing fixed broadband internet services to locations where the routing of cables or optical fiber is neither practical nor economic.

TTP and Freescale are collaborating to develop low-cost terminals and base stations to support "last-mile" delivery of broadband service to consumers and small businesses. Similar in size to current-generation home routers, the TTP solution is engineered to deliver broadband over white space at speeds comparable to cellular LTE. By combining several TV channels and using directional antennas, data rates can be maximized.

Freescale's QorIQ Qonverge BSC9131 processor will handle the entire wireless stack from Layer 1 to transport and other processing duties for the TTP white space solution. The TTP solution additionally includes Freescale's gallium arsenide (GaAs) monolithic microwave integrated circuit (MMIC) amplifiers. The QorIQ Qonverge BSC9131 base station-on-chip is based on 45-nm advanced process technology. It includes multi-standard acceleration technology that adds flexibility and reduces costs for OEMs.

www.ttp.com

Alcatel-Lucent and China Mobile accelerate 4G TD-LTE across China

Alcatel-Lucent and China Mobile are to unveil an innovative new member of the lightRadio™ family that will help accelerate deployment of 4G TD-LTE technology across China, the largest mobile market in the world, as it continues to meet fast rising customer demand for mobile video and data.

Available now for large-scale commercial deployment in China Mobile's first trial TD-LTE network, which spans 13 cities in China, lightRadio Metro Radio will bring high-performance 4G services to residents in densely populated areas of Shanghai, Nanjing and Qingdao, three of the fastest growing cities in China and indeed the world. This will help to meet the ever-increasing demand for mobile Internet, video and data in the world's largest smartphone market. China Mobile itself has over 722 million subscribers - over half of the total mobile subscriptions in the country.

www.alcatel-lucent.com

Firefox OS launch with Firefox Marketplace

Mozilla has announced that Firefox OS will launch with Firefox Marketplace, and a new ability to discover one-time use and downloadable apps to give a powerful, personalized, and speedy smartphone experience while also enabling easy creation, distribution and discovery of HTML5 apps worldwide.

Firefox OS includes all the things people need from a smartphone out of the box – calls, messaging, email, camera and more – as well as the things you wish a smartphone offered, like built-in cost controls, social features with Facebook and Twitter, location-based services, Firefox Web browser, new ability to discover one-time use and downloadable apps, Firefox Marketplace and much more.

Firefox OS offers a deep contextual search that will take you to the exact content you want instead of just generic apps in the same category. It will allow far more sophisticated and deeper search capabilities as you can search both within apps and on the Web at the same time, which is not possible with native apps.

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Low mismatch UHF LNA for cellular infrastructure

By CHIN-LEONG LIM, Avago Technologies

The non-coincidence of noise Γopt and conjugate S11* matching points is the biggest hurdle in low noise amplifier (LNA) design. Because of this, the LNA design process inescapably entails trading off input match for noise figure and vice-versa. Unfortunately, this trade-off may be unavailable in cellular infrastructure application because of an aerial matching requirement; i.e. to achieve a 14 dB aerial mismatch when the LNA is preceded by a bandpass filter of -18 dB return loss (assumed lossless), the input return loss (IRL) has to be better than -23 dB. An isolator can cure the high reflectivity in the noise-matched amplifier but it is costly and heavy.

Cheaper and lighter than isolators is the balanced amplifier topology developed at Bell Labs in the 60's [1-2]. It channels the energies reflected from a pair of amplifiers to the quadrature 3 dB couplers (also known as the 90° or hybrid coupler) where self-cancellation can take place. Since the port match will be excellent regardless of the constituent amplifiers' actual reflectivity, the designer is free to tune the input networks for minimum noise. Additionally, the balanced configuration has better reliability, linearity and bandwidth than its single-ended counterpart and, most amazingly, it is inherently self-stabilizing; i.e. perfect stability, both in and out-band, can ensue even when it comprises two potentially unstable amplifiers [3].

On the negative side, the balanced LNA needs twice the current and the components of its single-ended counterpart. The quadrature couplers for signal splitting and combining also add cost and PCB area, especially for distributed implementations, and their insertion losses degrade RF performances. If commercial drop-in couplers are used, their RF performances are generally proportional to their size and cost. Furthermore, the confined space atop cellular towers, i.e. tower mounted amplifiers (TMA), disfavours balanced LNAs because they are roughly twice the weight and size of their single-ended counterpart. A reading of the literature reveals two broad approaches to solving the balanced LNA's size issue – shrinking the couplers [4-5] and higher circuit integration [6-7, 13-14]. At the same time, the TMA's need for cutting edge sensitivity and linearity hampers miniaturization.

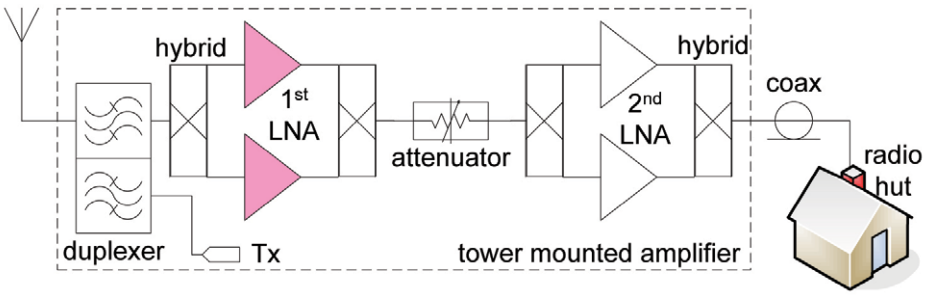

Figure 1: The balanced LNA provides an answer to the cellular tower mounted amplifier's need for low mismatch and low noise.

To improve on the size and component count of previous 900 MHz balanced LNA designs, we designed around miniature multilayer couplers and a MMIC that integrates dual amplifiers, biasing and shutdown functions. To our knowledge, this is the industry's first dual-amplifier MMIC with an integrated shutdown function. To enhance the design's usefulness, we target substantial size reduction while either equalling or exceeding the best noise and linearity performances recorded by the prior arts (see table 3). This article describes how the design accomplishes the conflicting size and performance goals and then summarizes the most important results.

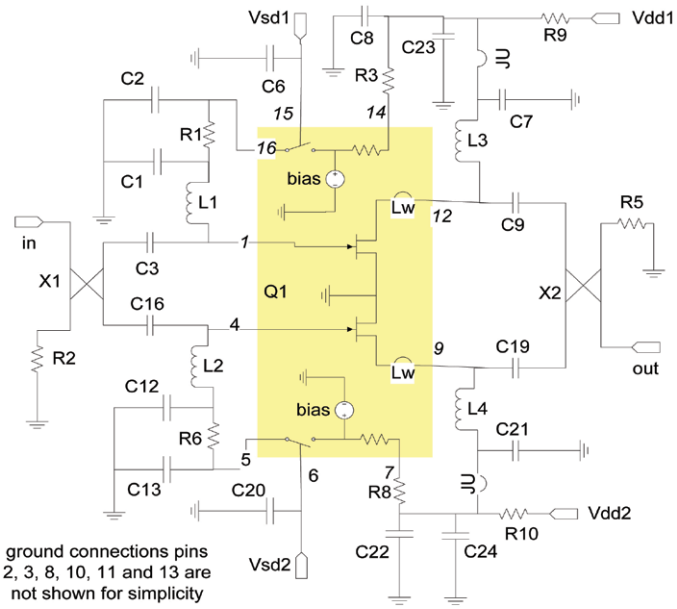

Figure 2: The MMIC (yellow area) integrates dual amplifiers, active bias and shutdown and therefore only impedance matching and hybrid couplers are required off-chip. Components labeled JU are 0Ω chip resistors used to bridge breaks in the PCB copper traces and are not essential to circuit operation.

Materials and methods

This section first describes the on-chip functions, then, the off-chip circuit, followed by the circuit modelling of the prototype balanced amplifier and finally, validates the designed source (Γ_S) and load (Γ_L) impedances against source and load-pull data.

As the first step to size reduction, a new MMIC that integrates dual amplifiers, electrostatic discharge (ESD) protection, active bias and shutdown functions (figure 2, inside yellow box) was designed. Aside from less external components, combining the bias circuits with the amplifier on the same chip also beneficially stabilizes the operating current against gate threshold voltage and temperature variations. The chip is fabricated using a 0.25 µm enhancement-mode pseudomorphic high electron mobility transistor (ePHEMT) on 6" wafer process because it

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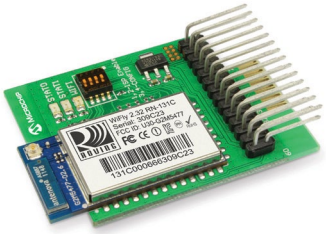

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has a suitable balance of cost and performance. Firstly, the process has previously enabled a single-ended LNA to attain 0.3 dB NF at 900 MHz [8], so a 0.5 dB NF in balanced mode might be reachable after factoring in coupler's loss. Secondly, the process' relatively high f_T and peak transconductance — >30 GHz and ~615 mS/mm, respectively — reduces the number of gain stages required to reach +17.6 dB gain to one. Lastly, this process is suitable for low voltage operation because its linearity does not drop appreciably until the Vds is reduced below 2 V [9]. The MMIC, which integrates 6 transistors, 26 diodes, 12 resistors and 2 capacitors, is epoxy encapsulated in a 16-pin 4 x 4 x 0.85 mm quad flat no-lead (QFN) package

The active bias circuits are connected to the voltage supplies Vdd1-2 via external resistors R3 and R8. Through these resistors, the gate bias voltages can be user controlled. Although each ePHEMT's nominal drain current Idd is 60 mA at 4.8 V Vdd, it can be varied 48-72 mA over the allowable range of values for these resistors. Inductors L1 & L16 and resistors, R1&6, serve as the gates' (pins 1 & 4) bias networks. Although on-chip spiral inductors can perform this function, this design opted for external inductors because they have lower losses, the smaller chip is more economical, and the chip can be used at other frequencies. Since NF is critical in this application, we specifically used wirewound chip inductors instead of multilayer ones. Beside bias insertion, the aforementioned inductors and series capacitors, C3 and C16, also form high-pass networks to roll off unneeded low frequency gain. The long bondwires, Lw, which connect the drain to the package leads also serve as pre-matching.

The shutdown function block consists of transistor switch in series with the active bias. Shutdown is initiated by applying a high logic (≥2 V) at Vsd1/2 to open the switch. Conversely, a low logic, i.e. Vsd1/2 ≤500 mV, enables the amplifiers. Transitioning from normal to shutdown takes less than 50 ns if the large (≥0.1 µF) decoupling capacitors C6/8/20/22/23/24 are omitted. However, these capacitors are generally recommended because they aid low frequency stability and dampen supply transients.

The balanced amplifier's signal splitting and combining utilize commercially available multilayer couplers, X1-2, to save design effort and PCB area. A larger coupler measuring 6.4 x 5.1 mm is used at the input because of its lower loss, while a smaller (2.0 x 1.3 mm) coupler is used at the output to save space and cost. To ensure that the IRL ≤ -21 dB requirement can be satisfied without fail in volume production, the critical parameters are identified through a Monte Carlo analysis (figure 3). Subsequently, two controls were instituted: correlating the amplifiers' input match to |S11a-S11b| <0.025 and the input coupler's isolation must be >23 dB. The first control is satisfied by using adjacent chips while the second requires specifying a high isolation input coupler [10]. The output coupler is non-critical.

The PCB utilizes the mid cost Rogers RO4350 material (figure 4). The microstrip width is dimensioned for 50 Ω characteristic impedance wherever practical. However the traces next to the input coupler's mounting pads are necked down following the manufacturer's recommendations to compensate for the pads' parasitic capacitances. To the 10mil thick PCB, an FR4 layer is added to increase the stack height to 1.6 mm. The input and output microstrips are transitioned to coaxial using edge-launched SMA receptacles. All results are referenced to the coaxial ends.

To simulate in Agilent ADS2009, the circuit model is split into a two-level hierarchy (figure 5). The upper level consists of blocks representing the MMIC, the signal dividing/combining and the impedance matching functions. Each of the dual amplifier, Q1-2, is represented by an identical 2-port s-parameters (s2p). The s-parameters were previously extracted on a test fixture of similar material (10mil RO4350) and then applying the Thru Reflect Line (TRL) calibration to shift the reference planes to the package edges. Using the same test fixture, the device's noise and

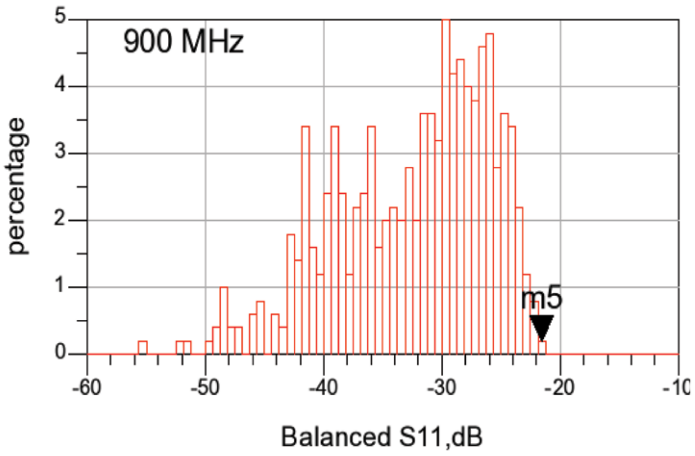


Figure 3: Tightening the intra-MMIC S11 difference and the coupler's isolation allow the design to meet the IRL<-21dB specification in volume production. The worst case value is -21.5 dB in 500 samples.

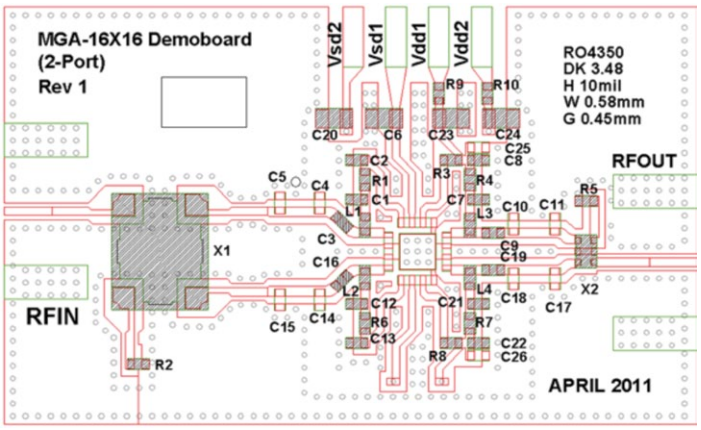
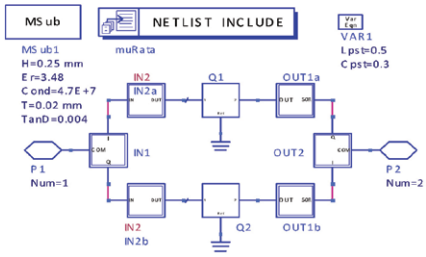


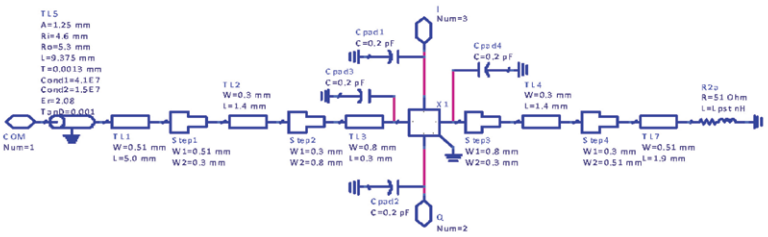
Figure 4: PCB layout and component placement drawing. Component positions are shown as grey-filled rectangles. All components fit a 30 x 15 mm square area (450 mm^2).

PART	Size	Value	Detail Part Number
C1,C12	0402	20 pF	GJM1555C1H200GB01
C2,C8, C13,C22	0402	0.1 uF	GJM1555C1HR10BB01D
C3,C9,C16,C19	0402	100 pF	GRM1555C1H101JD01E
C6,C20,C23,C34	0805	4.7 uF	GRM21BR60J475KA11L
C7,C21	0402	12 pF	GJM1555C1H120GB01
L1,L2	0402	68 nH	Murata LQW15AN68NG00
L3,L4	0402	120 nH	Murata LQW15ANR12J00
Q1	QFN4x4		Avago MGA-16116
R1,R6	0402	51 ohm	RK73B1ETTP510J
R3,R8	0402	1.5 kohm	RK73B1ELTP152J
R9,R10	0402	10 ohm	RK73B1ETTP100J
R2,R5	0402	51 ohm	RK73B1ETTP510J
X1	-	-	Anaren X3C09P1-03S
X2	-	-	Anaren C0810J5003AHF

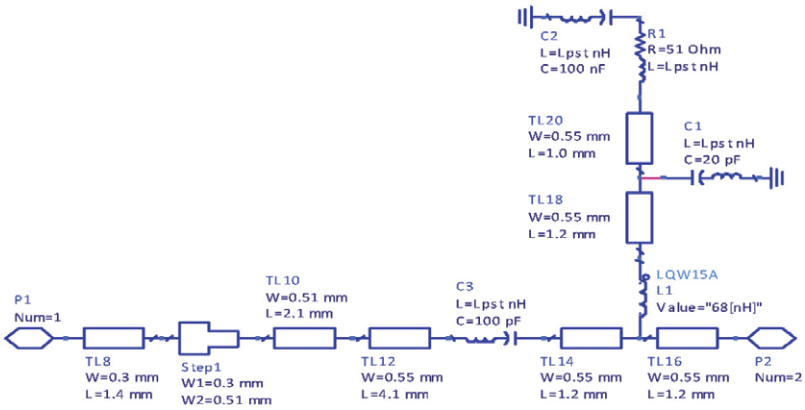
Table A: bill of material.



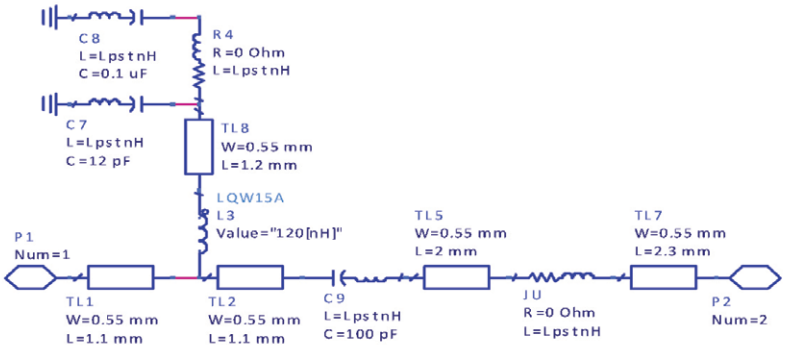
Top-level circuit model. Q1 and Q2 are s2p data files.



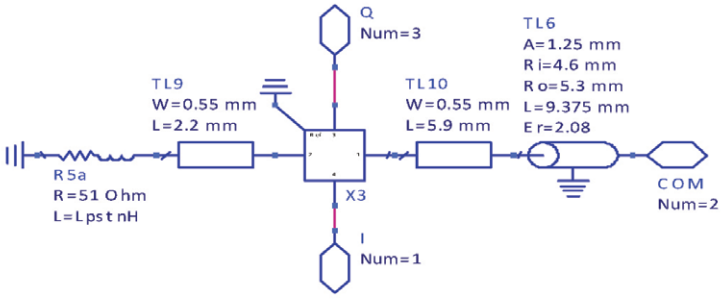
Sub-circuit of input combining section (IN1).



Sub-circuit of input matching network (IN2).



Output matching sub-circuit (OUT1a-b).



Output combining sub-circuit (OUT2).

Figure 5: Equivalent circuit models.

linearity parameters were extracted using automated source and load pull tuners (Focus). The ~0.2dB NF_{MIN} is particularly challenging to extract because it can be easily obscured by the combined losses of the mechanical tuner and the required connector adapter (APC7 to 3.5 mm). The inductors and hybrid couplers are modelled with the manufacturers' s2p data. Other passive components are modelled using their equivalent circuit including their lower order parasitic.

To validate the designed input and output matching networks, the modelled source (Γ_S) and load (Γ_L) impedances are compared with the previously measured source and load pull contours. Both Γ_S and Γ_L are obtained by simulating with ADS's "s-parameter probe" component. With this MMIC, it is easy to achieve good noise performance because the 0.3 dB constant NF circle is large and even encompasses the chart centre (figure 6). Because of this, the input networks comprising L1-C3 and L2-C16 are designed to function as bias-tees rather than as impedance/noise match. The absence of impedance tranformation in the input LC network means that the bandwidth does not have to be constricted by the network's loaded Q and the insertion loss is less sensitive to component Q. The Γ_S offset from the chart centre is unintentional and is due to the lumped component parasitics; the NF associated with Γ_S is 0.28 dB. Optimizing to the noise match Γ_{opt} will improve NF by an insignificant 0.03 dB and so, is not necessary.

The device has a third order output intercept point (OIP3) in excess of 42 dBm at optimum output match. The area encompassed by the 42 dBm constant linearity circle will require some impedance transformation to arrive at because it located away from the chart centre (figure 6 right). The next circle at 40 dBm readily includes the chart centre. Since a 40 dBm OIP3 is sufficient for this application, we designed the output network without impedance transformation; i.e. Γ_L=50Ω. However Γ_L is shown slightly offset from the exact centre because component parasitics.

Results and discussion

A: Size, component count and function integration

This design is probably the smallest and the most highly-integrated among balanced LNA designs for TMA application. Compared to previous designs, the PCB is 110% to 40% smaller (table 1). The part count is higher than the ulti chip on board (MCOB) design with integrated

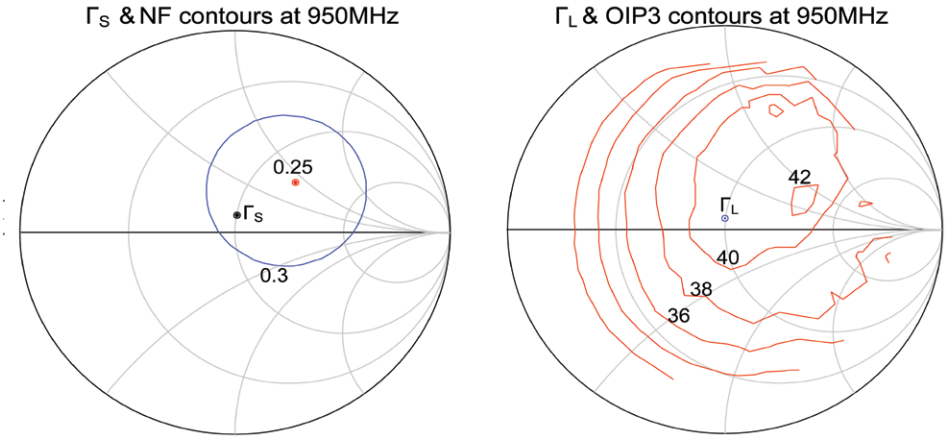


Figure 6: Good noise and linearity performances can be obtained without impedance matching because the Smith chart centre is encircled by the 0.3 dB constant noise figure circle (left) and at the output side, by the 40 dBm constant IP3 circle (right).

Ref.	year	PCB area, mm^2	Part count	device packaging	supplies, V	dual amp	bias	matching	shutdown
Piper* [1-2]	2002	945 (+110%)	34	SOT-343	5.0				
Lee [3]	2008	760 (+69%)	10	MCOB5x6	2.8, 5.0	•	•	•	
Avago [4]	2009	630 (+40%)	34	QFN4x4	0.6, 5.0	•			
Ommic [5]	2008	n. a.	27	QFN4x4	-0.5, 5.0	•			
Ommic [6]	2008	n. a.	27	QFN4x4	-0.9, 2.5	•			
This work	2012	450 (0%)	32	QFN4x4	4.8	•	•		•

Table 1: This work has the smallest PCB among 900 MHz balanced LNAs. Moreover its single 4.8 V saves on components that are otherwise required for the second supply's regulation and filtering. Its MMIC has one of the most integrated functions, including the never before integrated shutdown. *Although this design reports 1.9 GHz perfomances, it is included in this survey because it is readily adaptable to 900 MHz by swapping the drop-in multilayer couplers with another model.

Section	input	MMIC	output	total
NF (dB)	0.2	0.3	0.2	0.5
G (dB)	-0.2	18.4	-0.2	18

Table 2: Breakdown of gain & noise figure contributions from various LNA sections at 900MHz.

matching [13], but its external matching enables lower NF and its monolithic fabrication is cheaper. Additionally, its single voltage requirement can potentially save many more components that will be required for the second voltage supply's regulation and filtering. The MMIC also integrates as many functions as the best of the prior arts. To our knowledge, this is the first dual-amplifier MMIC that integrates the shutdown function.

B: RF performances

The gain and noise performances are not compromised by the substantial miniaturization. The experimental gain and noise figure are 0.5 dB and 18 dB, respectively at 900 MHz (figure 7). The experimental NF is comparable to competing designs which used more expensive processes or packaging (table 3). The NF result is also notable for being equal to our last design using 55% larger couplers [14]. The circuit model developed for this design has good predictive value - the maximum error for gain and NF are 0.2 dB and 0.1 dB, respectively. Assuming ideal input coupler and matching networks, the balanced LNA has similar NF to its constituent amplifiers [17]. Since the device-level NF is ~0.3 dB, a figure of 0.2 dB can be inferred for the combined loss of the coaxial connector, hybrid coupler and input matching (table 3). Over 600-1050 MHz, the NF changes less than a tenth of a decibel from the minimum, hence, the usable bandwidth is sufficient to serve existing and planned 3G/4G bands worldwide. The NF increases abruptly outside this frequency range due to the input coupler's characteristics.

In the event of one arm completely failing, the balanced LNA's midband gain remains a useful ~12 dB. To simulate the failure of one amplifier, the voltage supplies to each amplifier, Vdd1 and Vdd2, are disconnected alternately. With either one amplifier powered at a time, the midband gain is alternately 11.8 dB and 12.7 dB (figure 8). The gain in this semi-operational state is within tenths of a decibel from the 6 dB drop predicted by theory. Because there is no complete loss of gain when one amplifier completely fails, the balanced amplifier is more reliable than a single ended one; this is an important advantage for cellular applications because service outage is intolerable.

The experimental result surpasses the -21 dB input mismatch required by TMAs. Morever, the good matching is maintained over a wide bandwidth; i.e. the bandwidth equals 83% of centre frequency (fc) at IRL≤-20 dB (figure 9). The experimental IRL is best around the input coupler's centre frequency. Likewise, the output coupler determines the ORL response. The model has semi-quantitive agreement with the experimental result over most of the passband. However, the experimental ORL's unexpected dip at 500 MHz was not predicted by the model and this could be due to failure to model a component's parasitics. As previously mentioned, the quadrature couplers enable the extremely wide matched bandwidth. Both input and output RL are limited by the couplers' finite isolation and by the microstrip discontinuities.

The balanced LNA is unconditionally stable even when its constituent amplifiers are not. Both modelled and measured mu stability factor exceed unity over 50 MHz to 20 GHz (figure 10). Therefore, the balanced topology's self-stabilizing promise is validated because the individual amplifiers are potentially unstable (mu <1) at several frequencies over the evaluated range. The calculated stability factor has the same general trend as the experimental result but the peaks do not converge exactly; the errors are probably caused by oversimplification of the passive component models.

The design's gain compression and linearity performances are best-in-class; its IIP3 is 5.6 dB higher than the nearest competitor (table 3). The 1 dB gain compression, P1dB, measures ~24 dBm at midband and is relatively constant over frequency, varying less than a dB over a 1 GHz span (figure 11). Using -20 dBm tones spaced 1 MHz apart as the test stimuli, the third-order input intercept point IIP3 measures ~21.6 dBm at midband. But unlike the flat P1dB response, the IIP3 exhibits a pronounced peak (21.9dBm) at the approximate centre of the couplers'

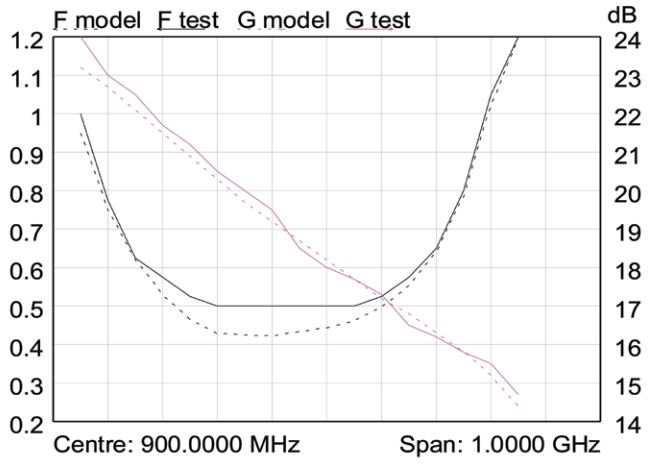


Figure 7: Modelled and tested noise figure (F) and gain (G) show good agreement over a wide swatch of frequencies. The experimental NF is among the best for balanced LNAs.

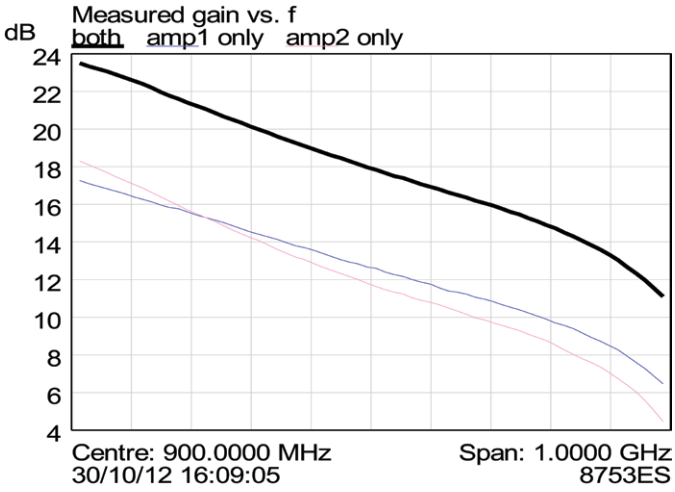


Figure 8: Gain versus frequency when both amplifiers are functioning (BOTH) and when only either one of the amplifier is functioning (amp1/amp2 only). Hence, useable amplification is assured even when one amplifier completely fails.

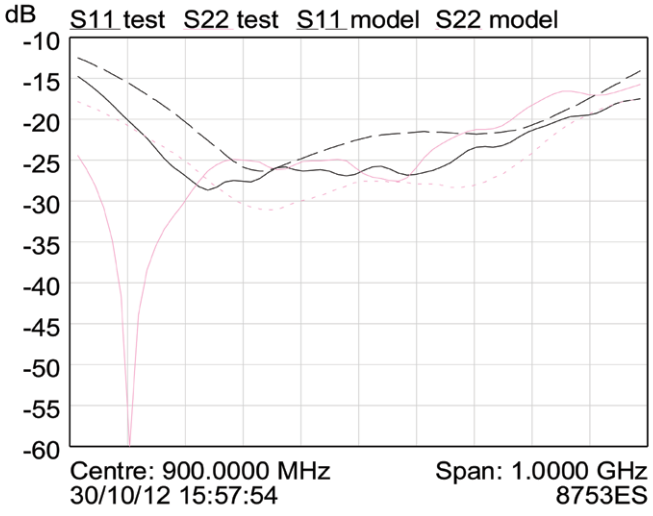


Figure 9: Modelled and measured input and output return loss versus frequency.

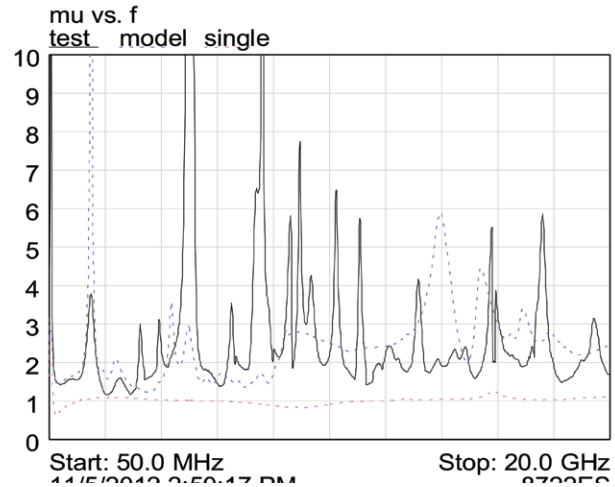


Figure 10: The balanced LNA's modelled and tested mu stability factors point to unconditional stability. To demonstrate the balanced amplifier's self-stabilizing property, the constituent amplifiers' poorer stability factor is also shown for comparison.

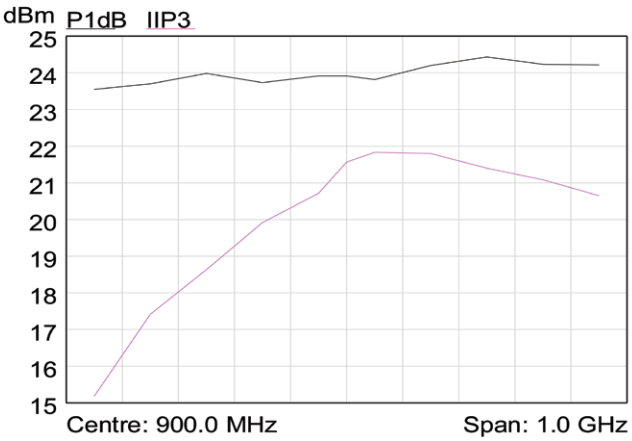


Figure 11: The ~24 dBm P1dB and 21.6 dBm IIP3 are the highest among 900 MHz balanced LNAs.

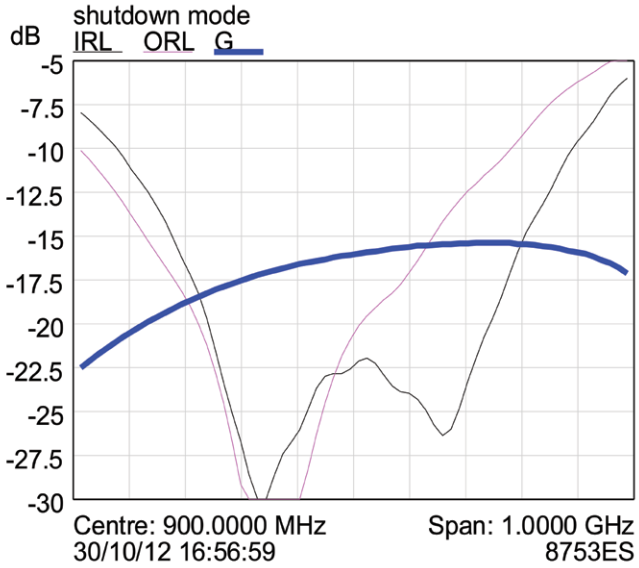


Figure 12: The good match (RL≤-20 dB) during shutdown can obviate the need for external bypass.

author / ref.	year	Process & gate length, um	package	NF, dB	IRL, dB	IIP3 dBm
Woestenburg [1]	1997	GaAs HEMT 0.15	Ceramic	0.45	-15	-20.0
Lee [**Error! Bookmark not defined.**]	2008	GaAs HEMT 0.5	MCOB5x6	0.8	-28	15.0
Wang [2]	2008	SiGe HBT	SOT-343	0.7*	-10*	n. a.
CGY2106XHV [**Error! Bookmark not defined.**]	2008	GaAs HEMT 0.13	QFN4x4	0.45	-27	16.0
Avago [**Error! Bookmark not defined.**]	2009	GaAs HEMT 0.25	QFN4x4	0.5	-28	15.9
Osman [**Error! Bookmark not defined.**]	2012	GaAs HEMT 0.5	SOT-343	1.03	-18	14.3
This work	2012	GaAs HEMT 0.25	QFN4x4	0.5	-27	21.6

Table 3: Among 900 MHz balanced LNA designs, this work has the best linearity (IIP3). Its input return loss and noise figure are among the best.

passband. Referred to the output, the third order intercept point OIP3 is ~39.6 dBm at mid-band. The linearity figure of merit based on the ratio of OIP3 (linear) to DC power is 9.12/0.58 or approximately 15.7. High values of 1 dB gain compression (P1dB) and input third-order intercept point (IIP3) imply greater immunity to blocking and spurious mixing, respectively and so, are desirable in TMA applications which are usually co-located with other services on the towers.

Activating the MMIC's shutdown function transforms the amplifier into a non-reflective attenuator which can be used to prevent the overloading of subsequent stages. Signals passing through the shutdown amplifier are attenuated by ~16 dB at midband , while the IRL and ORL measure better than -20 dB (figure 12). Good match is retained during shutdown because reflected energies are self-cancelled in the couplers. In contrast, an unpowered single-ended amplifier is highly reflective and must be bypassed to prevent detuning of aerial and filter. To our knowledge, this is the first time this favourable property is reported and proposed for eliminating the customary LNA bypass switch. The current consumption is a negligible ~176 µA per channel during shutdown.

Conclusion

The size and component count of 900 MHz balanced LNA designs can be significantly reduced by integrating multiple functions into a MMIC. The TMA's ultra low mismatch requirement can be met by controlling for the amplifiers' S11difference and the coupler's isolation. Despite the aggressive miniaturization, including a 55% smaller input coupler, state-of-the-art results are achieved for noise and linearity. The shutdown mode's good match has the potential to eliminate the need for LNA bypassing. We anticipate this new design will enable smaller and better performing tower-mounted balanced LNAs.

Recently, balun-less connections of balanced aerials with balanced LNAs have been demonstrated [20-21]. Because eliminating the balun can beneficially cut cost and RF losses, one tantalizing question is what performance and cost benefits this work's highly integrated MMIC can bring to such application?

Acknowledgement

The author thanks Zulfa for the insightful discussions, M. D. Suhaiza and S. Punithevati for fabricating the prototype, S. A. Asrul for reviewing the draft, and the management of Avago Technologies for approving the publication of this work. Anaren Communications (Suzhou) provided the couplers at no charge.

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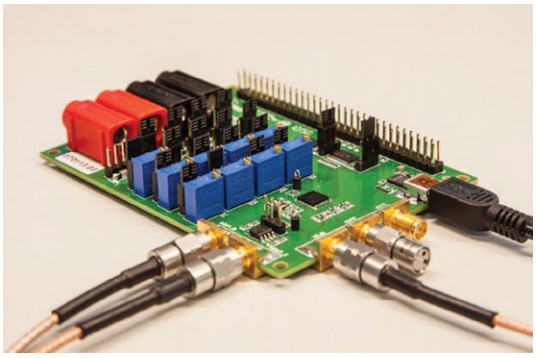
Ultra-low power 2.4 GHz multi-standard radio

Imec and Holst Centre have presented an ultra-low power multi-standard 2.3/2.4 GHz short range radio. The 1.9nJ/b radio is compliant with three wireless standards: Bluetooth® Low Energy (BLE), ZigBee (IEEE802.15.4) and Medical Body Area Networks (MBAN, IEEE802.15.6). A proprietary 2 Mbps mode is also implemented to support data-streaming applications like hearing aids. The radio is 3-5 times more power-efficient than current Bluetooth Low Energy solutions.

The radio significantly reduces the power consumption of the overall sensor system compared to off-the-shelf radios. As a result, the autonomy of the device is increased, or more functionality can be added to the sensor device, increasing its quality, functionality and/or performance. Or, the battery size can be reduced, resulting in a smaller device, which in case of wearable systems, adds to the comfort of the user.



The 2.4 GHz radio is implemented in 90-nm CMOS technology. Using a highly energy efficient architecture and optimizing the most power hungry building blocks, resulted in a 2.4 GHz radio with world-class energy efficiency while supporting the most common standards for mobile sensor networks (BLE®, ZigBee® and IEEE802.15.6).

The energy-efficient radio architecture has a suitable LO frequency plan and several efficiency-enhancement techniques for the critical RF circuits. As a result, the radio achieves a DC power of only 3.8 mW at 1.2 V supply for the receiver and 4.6 mW for the transmitter. This is 3 to 5 times more power-efficient than the current state-of-the-art Bluetooth Low Energy solutions. The measured RX noise figure is 6 dB, resulting in an excellent sensitivity in each standard (-100/-98/-96.5 dBm for Zigbee/BLE/MBAN). With a measured IIP3 of -19 dBm at the maximum front-end gain, the RX can accommodate the BLE intermodulation test level to -40dBm (the specification is >-50 dBm).

These results were presented at the 2013 IEEE International Solid-State Circuits Conference (ISSCC) in San Francisco.

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Designing a universal SDR platform

By Aleksandr Kondratiev

Today, SDR technology enjoys a very different status than it had back in 1984 when the term software radio (software defined radio) was first coined in the E-Systems laboratory. Until recently this technology was reserved mostly for enthusiasts and the military. SDR has beome one of the priorities in the development of wireless communications and it is supported by international and national programs and associations such as Wireless Innovation Forum, French CONTACT Programme, Italy's Forza NEC Battlefield Command System, ESSOR, EULER, and the US military's Joint Tactical Radio System (JTRS).

Many experts believe that this technology will become a new standard for the telecommunications market. A number of successful commercial projects using SDR-based and cognitive radio equipment have already been implemented. Examples include projects by equipment manufacturers Harris and Alcatel Lucent; Firetide, a developer and integrator of hardware mesh networking; xG Technology (a startup that implements cognitive radio in wireless networks); and Promwad Innovation Company (an independent electronics design centre), the developer of a universal SDR platform.

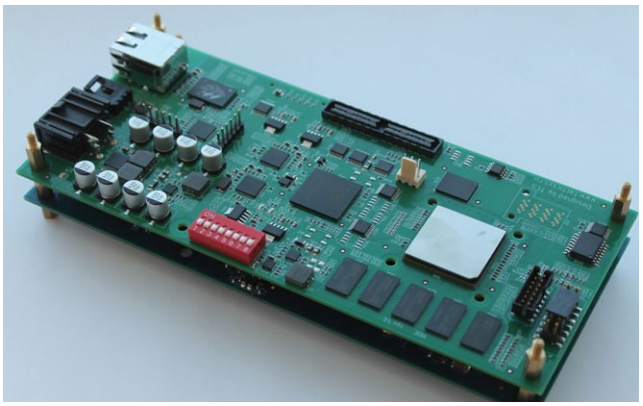
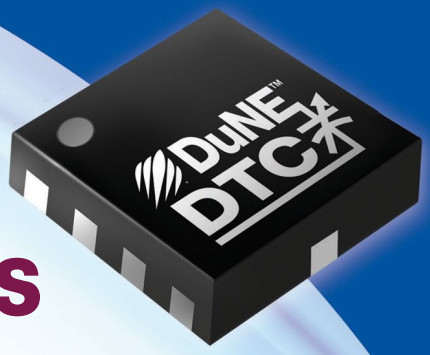


Figure 1: Open SDR platform.

This rapid change is explained by several factors. The primary factor is the interest of the major manufacturers and consumers of telecommunications equipment since the introduction of devices with SDR support helps improve efficiency, reduce upgrade costs and reduce

Peregrine Semiconductor



RF Tuning Solutions

DuNE™ DTC

Peregrine's DuNE™ Digitally Tunable Capacitors (DTCs) provide a monolithically integrated solid-state impedance tuning solution for today's demanding RF applications.

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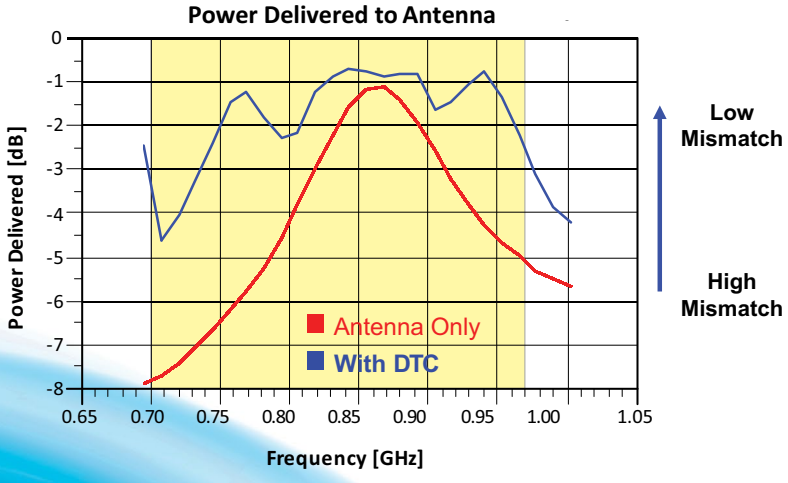

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dtc.psemi.com

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the cost and the time of introducing new communication standards. Another factor is the development of a modern element base: ADCs / DACs providing high speed and good dynamic performance, multi-standard broadband transceivers with programmable features, high-performance communication processors with integrated specialized accelerators, etc.

Unfortunately, the Russian market of SDR-based products is closed due to its specificity. However, Promwad Innovation Company has had some valuable experience in this field. In 2011, Promwad experts started a project for designing a rather unique product for the Russian market, an open SDR platform for the development of multi-standard wireless communication devices (Figure 1). This article will discuss this particular product.

What is so unique about this project? First of all, it is open for developers. It is a platform which companies can build their products on, using both supplied software and their own developments. This platform can be used for developing transmitters for standards such as DVB-T, DVB-T2 (470–862 MHz); access points and base stations for the standards 802.22 (470–862 MHz), LTE (791–862 MHz, 1710–1880 MHz, 1710–1880 MHz and 2.5–2.7 GHz); radar stations, debug and laboratory stands in educational institutions and more.

From the developer's perspective, a state-of-the-art SDR platform is basically a fully configurable system including an antenna, a digital processing unit with a minimum number of analog high-frequency components, low power consumption and, ideally, an unlimited frequency range. This architectural solution allows the developer to adapt and customize the device according to the problem to be solved, eliminating unnecessary elements and adding necessary ones. In this case all efforts will focus on improving the software, while the hardware remains unchanged.

From the customer's perspective, an SDR platform is a multi-standard device which is capable of working in any network with minimal settings, without the user's help. The developer's and customer's interests meet in a multi-standard device which works in different communication networks and helps programmatically change a variety of features, from RF parameters to supported communications standards and protocols.

When creating a device which would meet all of the criteria, Promwad developers had to face the problem of finding a balance between the performance and cost of the platform. The problem was that the selected functionality and the tasks of the device set a high bar for resources needed. In this case, an assessment of the system resources was based on the need to implement digital signal processing methods: direct and inverse Fourier transformations, the Reader-Solomon codes, LDPC, Viterbi transformations, linear prediction, etc., as well as software support for various standards. So the analysis and selection of an elements base was performed simultaneously to the engineering of the device architecture.

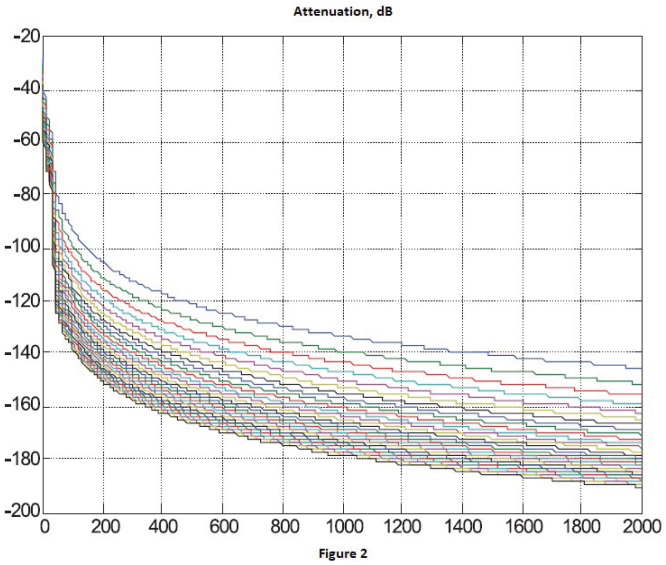

Figure 2: Signal attenuation over distance.

As a base model, developers considered the classic architecture of a SDR device including a transceiver which outputs I/Q signals, and a digital processing unit. RF path requirements were created on the basis of an analysis of existing communications standards, digital TV and radio frequency identification. Hardware support for the 802.11 standard was purposefully not implemented because its implementation on the platform does not make commercial sense. In addition, an important consideration in frequency range shift to the lower part of the range is the best signal propagation in urban areas, as well as long range, compared to high-frequency signals. Figure 2 shows a relationship between the attenuation of the signal and its distance for the frequency range of 300 MHz (top) to 3000 MHz at a step of100 MHz, which shows that the signal attenuation difference at a distance of 2,000 m is about 40 dB for the frequencies of 300 and 3000 MHz.

Based on the required bandwidth, the experts selected a two-channel ADC by Texas Instruments (14 bit, 250 MSPS), which features excellent dynamic performance, high speed and low power consumption. Inverse transformations are performed by the DAC3283 (two-channel, 16-bit, 800 MSPS). The function of primary signal processing and controlling the RF parameters of the transceiver tract is performed on the FPGA. Also, after an analysis of resource distribution in the system, PHY-level tasks were transferred to the FPGA, according to the OSI model.

The developers also analyzed the application of both a GPP processor (ARM DSP) and a high-performance DSP processor, to provide support for the MAC level of the stacks of various communication protocols, as well as support for peripherals and traffic flow generation. In addition to TI processors, specialized Freescale solutions were also considered. Finally, the developers selected the four-core DSP processor TMS320C6674c, each core with a frequency of 1.25 GHz, which was explained by the excellent performance of the processor, as well as a good level of technical support on the part of the developer company. It should be noted that the TMS320C6674 processor supports the high-speed SRIO interface, which provides the best solution to the problem of inter-board connection and integration with FPGA, as well as Secure Accelerator Engine, part of the KeyStone processor architecture. The communication channel can be tightly closed on this architecture, which is extremely important for transmitting confidential information over wireless networks.

MESH, SMARTGRID, SMARTANTENNA, MIMO, RFID, WRAN, DVB, DRM and LTE is a short list of areas where SDR technology is now being effectively introduced. The platform developed by Promwad will also find applications as it will help solve major problems related to equipment upgrade. It used to take two to three years to design and manufacture products of such a class from scratch, while now it can take six months to one year to design a new device based on the SDR platform.

Aleksandr Kondratiev is Head of Wireless Development Center at Promwad Innovation Company (Moscow) — www.promwad.com.

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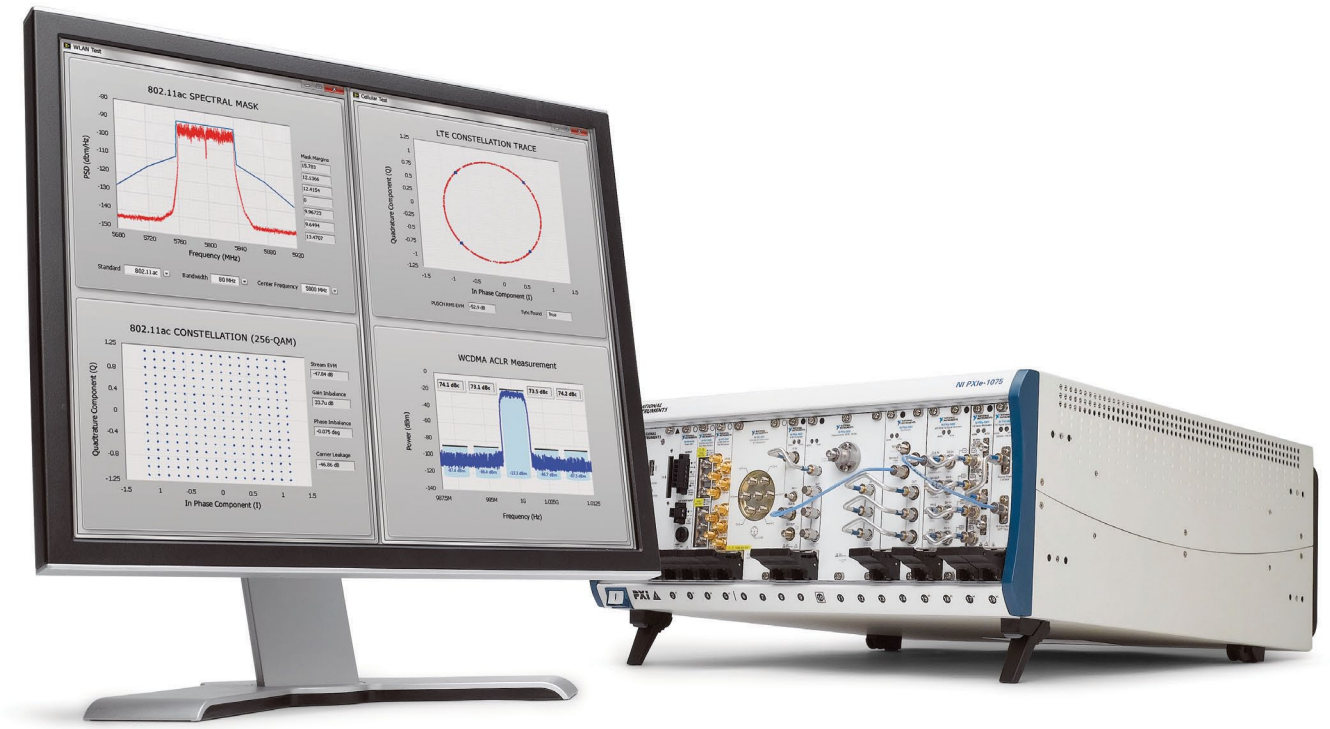

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NATIONAL INSTRUMENTS™

Energy harvesting wireless — the secret to M2M's success

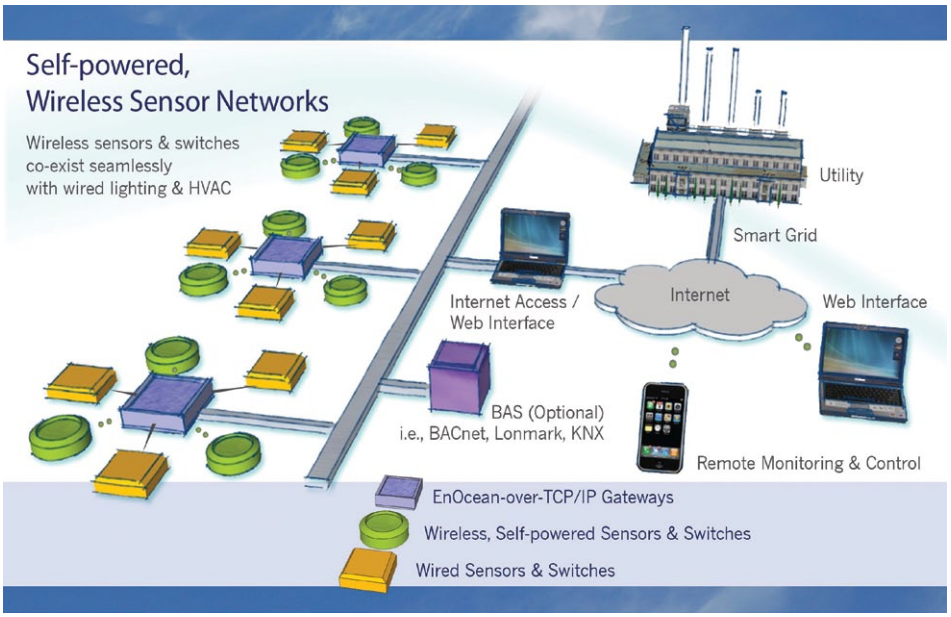
By Frank Schmidt, Chief Technology Officer and Co-Founder of EnOcean

A few years ago, M2M communication was an expensive niche application that required complex networking. But with technological developments and the flexible capabilities of cloud services, both the infrastructure and the products have made it possible to provide a great deal of information for M2M applications cost-effectively, using wireless modules. The deeper the interconnection of these devices, the more flexibility is demanded of the technologies. That's a major reason why energy harvesting wireless technology is increasingly being adopted within M2M devices, products and building automation systems.

Today, M2M is considered a future-oriented growth market with high expectations. The predictions range from over 300 million by 20171 to 50 billion devices connected to the Internet by 20202. Deploying the millions of distributed devices lead to a challenge: How should they be powered and how will they communicate? One solution is energy harvesting wireless technology. Wireless sensors and relay receivers enable simple deployment of intelligent nodes, however, wireless devices require power – historically this meant pulling a lot of wires or installing and replacing batteries. Devices powered by energy harvesters are maintenance-free and independent of batteries or other external energy sources, paving the way to a simpler installation of millions of devices connected to each other and the Internet.

Energy from the surroundings

Due to the energy harvesting principle the wireless modules gain their power from the surrounding environment and therefore work without batteries. In the process, an electrodynamic energy converter uses mechanical motion or a miniaturised solar module generating energy from light. Combining a thermo-electric converter with a DC/DC converter taps heat as an energy source. Even these small amounts of harvested energy are sufficient to transmit a wireless signal. The addition of a capacitor can ensure adequate power storage to bridge intervals when little or no energy can be harvested.



For optimal radio frequency (RF) effectiveness, the radio protocol, standardised as ISO/IEC 14543-3-10, uses sub 1 GHz frequency bands. This provides a safeguard against other wireless transmitters, whilst offering fast system response and elimination of data collisions. In addition, sub-GHZ radio waves have twice the range of 2.4 GHz signals for the same energy budget, and better penetration within buildings. As a reference point, duplicating the energy harvesting wireless system at 2.4 GHz system requires about four times more receiver nodes to cover the same area. That increases its cost compared to a sub-GHz solution, for example. RF reliability is assured because wireless signals are just 0.7 milliseconds in duration and are transmitted multiple times for redundancy. The range of energy harvesting wireless sensors is about 300 meters in an open field and up to 30 meters inside buildings.

Building automation as a model for M2M

Energy harvesting devices are particularly attractive as replacements for batteries in low-power electronic systems such as wireless sensor networks, because of the logistics involved in the time-consuming tasks of acquiring, installing, and changing the batteries. Today, energy harvesting wireless technology is very well established providing M2M solutions in the building automation sector, bridging the control of light, HVAC and other fields of building technology to smart home, smart metering and energy management systems.

Wireless and batteryless technology significantly eases energy monitoring and control in buildings with only little intervention into the existing systems. The wireless devices are highly flexible to install so that individual components, wall switches, sensors and relay receivers can be easily networked to form an intelligent system without complex cabling. In addition, dispensing with batteries eliminates the burdensome need to maintain the devices' energy supply in a regular time period, which can be up to each year.

An example for such a flexible automation system is HVAC control. Here, a thermostat, VAV (Variable Air Volume) or fan coil controller receives information related to occupancy, temperature, humidity, window position or CO2 from the respective batteryless sensors and controls the opening and closing of

valve actuators for radiators, or dampers for VAV systems. At the same time, the controller sends status information to a central building automation system, and receives control messages from the BAS system. This enables the building to be monitored from a central location, that can be remote from the building itself, and to implement building wide settings, such as holiday shutdown, for example.

Self-powered intelligence for heating

Enormous progress is also being made on the product side, leveraging advancements in energy harvesting: revolutionary self-powered radiator valves, from Kieback&Peter for instance, generate energy from the difference in temperature between the hot water and the surrounding air. This energy powers both the communication with a controller or BAS system, and to turn the valve itself. Without cables or batteries, these wireless devices are especially easy to install, and they require no maintenance.

In further optimised systems, central equipment such as boilers or air handling units are integrated into the wireless communication system enabling scalable HVAC generation on demand, visible and controllable over the Internet on a PC, tablet or smart phone.

Secure monitoring instead of battery failure

Alarm systems, such as water detectors for example, are a second field, which batteryless wireless technology is opening up, due to its specific features. Here, the reliability requirements are a lot more stringent than those required for lighting controls. A system failure not only means a malfunction but can cause much more serious consequences for other systems that depend upon the equipment being monitored. It's a fact that more malfunctions are caused by battery failures than by the electronics, especially in large systems. Energy harvesting overcomes this issue.

From everywhere into the Cloud

Via gateways, the standard-based energy harvesting technology can also communicate with Ethernet, WiFi, GSM/UMTS/CDMA and other networks for integration in cloud services. Here, all data collected by batteryless wireless sensors is encrypted and transmitted to a cloud service over the Internet. The data packages are encrypted with an AES-Algorithm with 128 bit-keys. Furthermore, every telegram comes with its own rolling code. A forever changing authentication code is generated, based on the rolling code and the AES encrypted data package, and then validated by the receiving system. The same proven mechanism also takes place by locking or unlocking a car with a wireless key. For even higher requirement of data security, application-specific encryption mechanisms can be integrated, too.

The gateways connected to a control and visualisation software by TCP/IP can be used to control all relay receivers and sensors bidirectional offering energy management as-a-service. Therefore facility managers, building owners and businesses can monitor important inventory, equipment, assets and energy related information from anywhere at any time, via the cloud. Critical building related data is automatically pushed to the cloud, freeing owners and managers from the often-challenging coordination and expense of hosting onsite servers.

One of the major advantages of such a cloud-based solution is that the management system arrives completely pre-commissioned from the manufacturer and ongoing device commissioning is expertly done on behalf of the client and pushed out from the cloud. The users are granted unlimited access to their remote, dedicated virtual server with their own IP address, accessible from a desktop or smart phone.

Future power of energy harvesting

Today the need for wireless applications with ultra-low power consumption and the advancements in establishing communication standards offer M2M providers new opportunities to innovate and evolve their products and devices. Already the acceptance of international standards is accelerating the development and implementation of energy-optimised wireless sensors and wireless sensor networks associated with M2M environments. In addition to the already established markets for home and building technology, there seems to be a natural progression in its use in smart homes, smart metering and the smart grid as well as solutions for industry, logistics and transportation.

By Frank Schmidt, Chief Technology Officer and Co-Founder of EnOcean - www.enocean.com

Scenario-based RF signal generator for interactive test environments

IZT and LOG.IN have jointly announced EXERCISE-RF, a scenario-based RF signal generator designed for interactive radio frequency testing environments and can generate a real-time radio frequency spectrum.

The generated spectrum can be fed into a receiver such as the IZT R3000, a radio monitoring system, and even a geo-localization system based on multi-channel direction finders or TDOA (Time Difference of Arrival) sensors, such as the LOG.IN RMS-DF-5-R3000 with IZT R3000 receivers. Moreover, the generated RF spectrum can be transmitted through a signal amplifier and an antenna.

EXERCISE-RF from LOG.IN allows the creation of complex tactical scenarios with user-defined entities, such as fighters, UAV, ships or soldiers, high resolution 3D terrain, environmental effects and propagation models. The user programs the entities' behavior via mission doctrines and artificial intelligence and can control its attitude and behavior at all times. A tactical 2D and 3D map with MIL-STD-2525B symbology, a joystick and a throttle are at the user's disposal.

Within the scenario, one of the entities takes on the role of the DUT (Device Under Test), thus virtually representing the entity on which the system to be tested is installed. EXERCISE-RF drives the IZT S1000 to ensure that the DUT is fed with an RF spectrum, which is coherent with the surrounding tactical scenario. To develop the scenario, EXERCISE-RF computes in real time the distance, RF inter-visibility, azimuth and elevation of each of the entities with respect to the DUT. These parameters and the mission doctrines allow EXERCISE-RF to drive the IZT S1000 and decide which signal has to be transmitted on which frequency and with which signal-to-noise ratio. EXERCISE-RF can drive multiple IZT S1000 generators at the same time.

A key feature of this scenario-based RF signal generator is the capability to stimulate multi-channel DFs and TDOA sensors, thereby computing the correct phase and time correlation of each signal in accordance with the DUT and the other entities' positions.

EXERCISE-RF is designed for the radio monitoring sector with a focus on validation and testing rigs, mission planning and mission rehearsal systems, such as validating the COMINT and SIGINT operative capability of a mission platform. It can be also used for EW, COMINT, SIGINT or ISTAR training.

With EXERCISE-RF, the user can play, pause, and resume the scenario. He can also record the scenario and play from any given point. The scenario-based RF signal generator is fully DIS (Distributed Interactive Simulation) and HLA (High Level Architecture) compliant, which means that it can be integrated into larger distributed-simulation environments.

EXERCISE-RF covers a frequency range of 9 kHz to 3 GHz with an instantaneous bandwidth of 120 MHz. Features include multi-channel 3D direction finder testing and a TDOA location-finding platform.

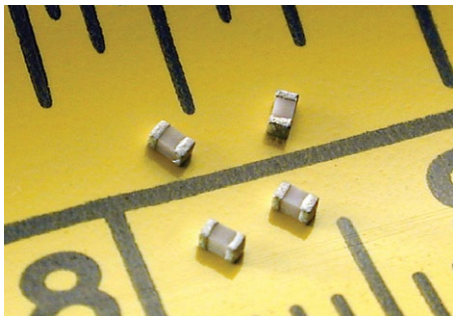
www.izt-labs.de

AEC-Q200-qualified RF chip capacitor

targets automotive applications

AVX Corporation has introduced a series of AEC-Q200-qualified RF chip capacitors for automotive applications.

Available in 0402 and 0603 case sizes, the C0G (NP0) dielectric Automotive "U"



series capacitors exhibit ultra-low ESR, high Q, and lot-to-lot uniformity that meets or exceeds the requirements of AEC Q200. Lead-free and RoHS compliant, the RF chip capacitors are ideal for use in automotive WiFi, collision avoidance, vehicle communications, and traffic alert system applications.

The company's latest Automotive "U" series RF chip capacitors are rated for use in temperatures ranging from -55°C to +125°C and feature lead-free, plated Ni/Sn terminations. Capacitance values and tolerances for the series' 0402 case size capacitors range from 0.2 pF to 22 pF at 1 MHz. For the 0603 case size capacitors, capacitance values and tolerances span 1.0 pF to 100 pF at 1 MHz.

www.avx.com

MEMS oscillatorsr

boast 100 fs typical phase jitter

Differential 4H MEMS oscillators from Integrated Device Technology (IDT) feature a 100 femtosecond typical phase jitter performance and integrated frequency margining capability.

The very low phase jitter and adaptable output frequency of these oscillators significantly reduce bit error rate (BER) in 10 gigabit Ethernet (10GbE) switches, routers, and other related networking equipment.

The 4H MEMS oscillators feature a differential LVDS / LVPECL output and the lowest phase jitter in their product class (100 fs at 1.875 to 20MHz and sub-300 fs at 12 kHz to 20 MHz), satisfying the low-jitter chipset requirements of high-performance networking applications.

Integrated frequency margining capability enables customers to fine-tune the oscillator frequency during operation in the application by up to ±1000 ppm, minimizing BER and facilitating margin testing. Unlike competitive MEMS devices that only offer fixed frequencies, IDT's device allows hundreds of offset frequencies that can be generated after the selection of any base frequency up to 625 MHz – even on final production systems.

www.idt.com

USB-compatible signal generators

fill popular bands through 4 GHz

In response to customer demand for defined frequency bands through 4 GHz, Vaunix Technology has added eight models to its LMS series of signal generators. The Lab Brick LMS series of USB-compatible, synthesized signal generators target specifically the 70-450 MHz, 250-1500 MHz, 600-3200 MHz, and 1000-4000 MHz bands.

They feature low noise, fast 100-microsecond switching time, and fine 100 Hz frequency resolution, requiring no additional DC supply voltage. Advanced features include phase-continuous linear-frequency sweeping; selectable internal/external 10 MHz reference; optional pulse modulation; ability for GUI software to track and control several connected

signal generators, simplifying multiple-signal test setups; and device storage of settings in internal memory, allowing it to power up in a specific instrument state. All instruments come in a robust aluminium construction.

www.vaunix.com

ZigBee transceivers

offer deep packet inspection and wake-on-LAN capabilities

GreenPeak Technologies has introduced a generation of ZigBee transceivers that contain a coexistence scheme that allows Wi-Fi, Bluetooth and ZigBee chips to work side by side in the same device.

The GP501 also contains Deep Packet Inspection allowing deep sleep modes of set-top boxes and other host devices by means of Wake-on-LAN messages.

ZigBee shares the 2.4 GHz frequency band with other Wi-Fi equipment. The GP501 has a coexistence interface to allow optimized and co-located ZigBee/Wi-Fi radios to work in the same device, successfully avoiding RF interference when operating simultaneously. The coexistence interface enables arbitration over the shared radio frequency medium to prevent contention, signal degradation and data loss.

A key feature of the GP501 ZigBee transceiver chip is the Deep Packet Inspection for ZigBee applications. Deep Packet Inspection (DPI) enables advanced packet management, allowing the host processor to go into a deep-sleep mode to conserve power.

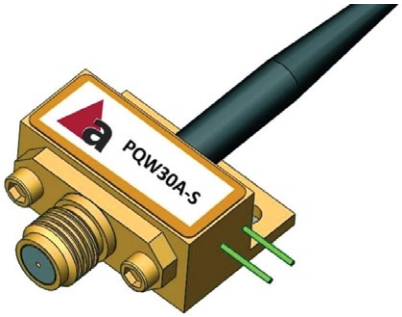
The DPI engine is also security aware, blocking unauthorized packets without involving the host processor and ensuring the system does not waste energy analyzing non-compliant packets. The DPI feature can be used for Wake-on-LAN functionality, where ultra-low power ZigBee is used to wake up the main processor from its sleep mode to enable Wi-Fi networking.

www.greenpeak.com

30 GHz short wavelength photodetector

hermetically packaged

Albis Optoelectronics has released the PQW30A-S, a hermetically packaged, short wavelength, 30 GHz RF photodetector.



The small sized pigtailed device is used for the detection of RF-modulated optical signals and combines a number of unique features such as an integrated bias-T, a high responsivity GaAs photodiode as well as a hermetic enclosure. The combination of these features makes this a one-of-a-kind device that hasn't been commercially available so far.

www.albisopto.com

Ultra wideband omni antenna

for DAS applications

Cobham Antenna Systems, Microwave Antennas (formerly European Antennas Ltd) has developed an ultra wideband and compact omni-directional antenna.

Originally developed for an airport application, the antenna is required to support DAS applications covering PMR, TETRA, cellular, wireless LAN and WiFi communications systems.

This omni-directional antenna, model OA-0.4-6.0V/2028, covers 380 MHz to 6000 MHz. It features vertical polarisation and -1 to +5 dBi gain across the band. The omni pattern has very low ripple, and unlike other similar antennas does not require any additional ground-plane to be able to operate across its full band.

Dimensions are 352 mm (14 inches) diameter by 182 mm (7 inches). Being light weight (0.97 kg), the antenna can be ceiling mounted using a variety of optional mounts. The protective radome is manufactured from fire retardant material and the unit has been SAR tested.

Further variants are planned which will have high impact radomes and can tolerate high power for applications in potentially hostile environments where RF counter measures may be necessary.

www.cobham.com

Low phase noise master crystal oscillator

space-qualified

Spectratime,has announced its latest space-qualified LNMO low phase noise master crystal oscillator.

The LNMO builds on the success of the model MO master crystal oscillator by offering the lowest noise performance in a very low profile, lightweight package for advanced satellite applications. Its ultra-low noise option features -110 dBc/Hz at 1 Hz from the 10 MHz carrier. Environmentally robust and designed with high reliability and long lifecycle, its hardened radiation rates less than 100 kRad.

It also extends the limits of several other key performance characteristics, including an ultra small profile and footprint of 50 x 50 x 30 mm, lightweight package coming in at 100 g, low power consumption of 1.5 W nominal and fast warm-up time of 10 minutes. The device has high frequency stability over a wide temperature range of $\pm 1E^{-9}$ over -30 °C to +70 °C) and low aging of $\pm 1E^{-10}$/day. Long-term stability is $\pm 1E^{-8}$/year, while short-term stability is $1E^{-12}$ from 0.1 to 10 s.

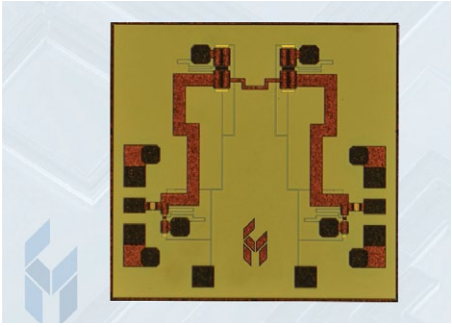
www.spectratime.com

18 to 40 GHz MMIC die

features ultra wideband and low insertion loss

Custom MMIC has introduced the CMD172, a voltage-variable attenuator (VVA) in die form operating from 18 to

40 GHz. Fabricated in GaAs with a small footprint, the CMD172 is a wideband absorptive VVA die that uses a single DC control voltage between -3 V and 0 V to vary the RF signal level over a 37 dB dynamic range. The insertion loss of the CMD172 is only 1.6 dB. The GaAs MMIC also offers full passivation for increased reliability and moisture protection.



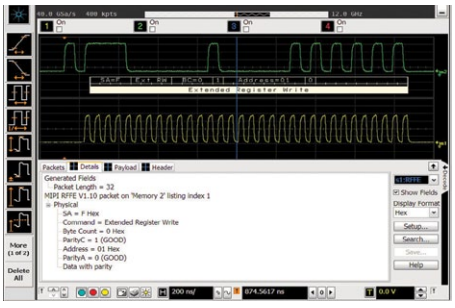
Ideal applications for the CMD172 include point-to-point and VSAT radio systems, microwave sensors, test instrumentation, and military and space applications.

www.CustomMMIC.com

MIPI RFFE protocol-decoding software

available for Agilent oscilloscopes

Agilent Technologies claims the industry's first software for decoding MIPI Radio Frequency Front-End (RFFE) protocol packets on oscilloscopes. The protocol decoder provides design and validation engineers with a fast, easy way to validate and debug their RFFE interfaces.



RFFE is a specification that offers a common method for controlling RF front-end devices, namely power amplifiers, switches, power management modules, antenna tuners and sensors. RFFE provides point-to-multipoint connectivity for control of the RF front-end and is able to scale to dozens of slave devices, which are connected to a single master device.

Many radio applications need accurate timing control. To address this challenge, RFFE uses a relatively high bus-clock frequency of 26 MHz and introduces accurate triggering mechanisms to allow control of timing-critical functions in multiple devices.

The N8824A MIPI RFFE protocol decoder is designed to run on Infiniium 9000A and 9000 H-Series oscilloscopes as well as the 90000A, 90000 X- and 90000 Q-Series. It decodes protocol packets for the MIPI RFFE v1.10 specification. R&D design and validation teams can use the software to address their startup debugging and to examine the traffic between RF front-end devices. Using the decoder with an oscilloscope also allows engineers to meet accurate timing requirements associated with the RFFE packets.

www.agilent.com

60 GHz WR-15 circulator

minimizes loss with maximum isolation and bandwidth

The HMC15-385-60.0-2.0 ferrite junction circulator utilizes a low loss H-plane structure in a modified Y-junction format to provide minimum loss with maximum isolation and bandwidth.

The circulator is commonly employed as a signal duplexer on transceivers having a single antenna. The in-line port orientation makes the mechanical interface more convenient than standard Y-junction types. Access pockets on the top and bottom allow for blind flange mating, eliminating the need for interconnecting waveguide in many cases.

The HMC series of broadband circulators is available from 18 to 120 GHz across eight waveguide sizes from WR-42 to WR-8. Standard bandwidth is 2 GHz, but wider bandwidths are available in select units.

www.rec-usa.com
www.hxi.com

Wideband power meters

do not require directional couplers or power attenuators

Bird's latest Wideband Power Sensor (WPS) series of USB Thruline power meters feature five models each suited to a particular application.

All capable of measuring True Average Power, Peak Power and Duty Cycle, as well as VSWR/Return Loss, Average Burst Power and CCDF, the WPS series

will work with any modulation scheme. Bird Technologies are one of the few manufacturers to offer RF enquirers equipment capable of measuring "real world" transmitter power levels without the need to use directional couplers or high power attenuators.

These USB power meters for "real world" RF power measurements cover; 350 MHz to 4 GHz (150 mW to 150 W); 350 MHz to 4 GHz (25 mW to 25 W); 25 MHz to 1 GHz (500 mW to 500 W); 150 MHz to 4 GHz (100 mW to 25 W) and 25 MHz to 1 GHz (100 mW to 100 W).

Insertion loss is less than 0.1 dB (typically 0.05 dB) with a VSWR of 1.1:1 maximum (typically 1.05:1), plus a directivity specification of typically 30 dB. These parameters contribute to an average power accuracy for all models of ±4% of reading, or 0.17 dB, over the full power range at +15 to +350 °C.

www.aspen-electronics.com

Low PIM cable assemblies

for test and equipment applications

AtlanTecRF offers low PIM cable assemblies, which are designed specifically for applications where it is essential to have a low level of passive intermodulation products. The ASF-LP series of high performance and low intermodulation cable assemblies are available in two convenient diameters and a large range of lengths.

In order to achieve the low intermodulation level of -155 dBm at 6 GHz with 2 tones of +26 dBm, the cable material consists of a silver plated copper centre conductor with PTFE dielectric and a copper/tin composite outer conductor. Connector bodies are of tri-metal plated brass with no ferrous parts.

The standard SMA male connectors also feature the anti-torque hex to prevent cable twisting and distortion as the connectors are tightened.

The ASF-LP series are available in lengths from 2 to 60 inches in both 0.141

and 0.086 sizes with frequency capability to more than 18 GHz and are formable and reformable in situ according to customer requirements. They also featue high RF shielding of 100 dB minimum.

www.atlantecrf.com

Outdoor, sub-6 GHz, LTE-ready, microwave system

targets rural/private networks

DragonWave has introduced Harmony Radio Lite, which is specifically tailored to provide reliable and affordable connectivity to vertical markets, such as public safety, education, healthcare, oil and gas organizations and utilities, as well support growing mobile backhaul demand in rural and suburban communities.

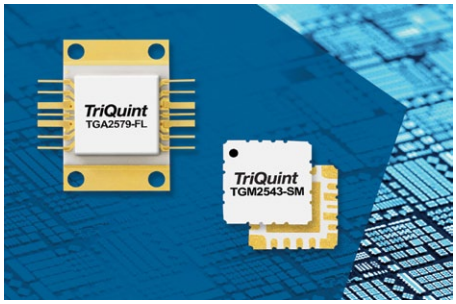
With a form factor of only 7.5 inches square including antenna, the sub-6 GHz point-to-point microwave radio supports both licensed and unlicensed spectrum and is ideally suited for non-line-of-sight (NLOS) scenarios where obstructions are found between link endpoints. The unit offers full scalability and is designed within rugged outdoor specifications to ensure reliable performance and longevity in the field.

The Harmony Radio Lite is a single, all-outdoor unit and includes standard Ethernet interfaces and an integrated antenna, making it easy to install and bring online. With DragonWave's comprehensive network management system, the Harmony Radio Lite can easily be configured and monitored remotely, helping lead to a quick return-on-investment for operators. Streamlined functionality is further complimented by low power consumption (under 15 W), PoE compatibility, reduced cabling requirements and low delay. Synchronization through 1588v2 and SynchE eliminates the need for an external synchronization source. The high capacity and low latency capabilities of the Harmony Radio Lite make it one of the first LTE-ready NLOS systems.

www.dragonwaveinc.com

GaN Ku-band PA and broadband amplifier

TriQuint Semiconductor has released a broadband integrated packaged device that combines a limiter with a low-noise



amplifier (LNA) for use in radar and electronic warfare along with a 25 W Ku-band gallium nitride (GaN) RF power amplifier for satellite communications. Both products deliver unique advantages for commercial and defense systems.

The 25 W TGA2579-FL power amplifier is placed in a ground-signal ground (GSG) package so it can be mounted on the top or underside of multi-layer circuit boards, giving designers the greatest possible flexibility. The device's high gain and extremely wide operating bandwidth (4-20 GHz) provides broad versatility. It integrates limiting and LNA functions in a single package.

The TGA2579-FL 13.75 to 15.35 GHz (Ku-band) GaN RF power amplifier delivers 25 W (+44 dBm) saturated output power; +48 dBm OIP3; 32 dB small-signal gain; 30 % power-added efficiency; and features ground-signal-ground RF transitions for interfacing with coplanar waveguide circuit boards.

The TGM2543-SM is a 4 to 20 GHz integrated limiter/LNA with RF input limiting of 4 W CW (+36 dBm). It offers +17 dBm mid-band gain; 2 dB noise figure; +28 dBm (OIP3); adjustable gain control; 5-V/100-mA DC bias; and comes in an hermetically-sealed 22-lead 7x7mm ceramic QFN package.

www.triquint.com

Micro miniature SMA switch

excellent electrical performance through 26.5 GHz

RLC Electronics' Micro Miniature SMA switch is a single pole two position type. It incorporates SMA connectors to allow high density packaging and excellent electrical performance through 26.5 GHz. The switch is available in failsafe and pulse latching configurations with a choice of three different frequency ranges and three different coil voltages of 5 V, 12 to 15 V, and 24 to 28 V.

For the frequency ranges of DC to 8 GHz, 8 to 12.4 GHz, 12.4 to 18 GHZ and 18 to 26.5 GHz, the switch respectively features insertion loss of 0.3 dB, 0.5 dB, 0.7 dB and 0.8 dB maximum with VSWR of 1.35, 1.6, 1.7, 1.8 maximum and isolation of 70 dB, 60 dB, 60 dB and 50 dB minimum.

The single pole two position switch features 1,000,000 operations life, a switching time of 15 milliseconds maximum and meets MIL-DTL-3928 environmental conditions.

www.rlcelectronics.com

ETSI standard compliant test system

for certification testing in the 2.4 GHz band

Diverse radio services such as WLAN and Bluetooth® as well as radio remote controls and wireless devices share the 2.4 GHz band, which is unlicensed and being more and more widely utilized. Since radio channels interfere with each other to an increasing extent, the ETSI EN 300 328 standard has been revised. Existing scenarios have been modified, and special tests for verifying improved coexistence behavior have been introduced. On December 31, 2014, the standard will become mandatory for all devices using this frequency band and being sold in the European Union.

The TS8997 test system from Rohde & Schwarz claims to be the first solution on the market that can perform certification tests in line with the new ETSI EN 300 328 V1.8.1 standard for wireless devices in the 2.4 GHz band. During development and certification, device manufacturers and test houses can now verify whether new products meet the upcoming certification requirements.

Version V1.8.1 of the ETSI standard specifies a special type of power measurement. Thanks to the test system's four antenna ports and integrated OSP switching module, the TS8997 can perform this measurement fully time-synchronized and in compliance with the

standard on up to four channels, allowing it to characterize devices with MIMO and beamforming capability. Via menu control, the user first selects the radio technology implemented in the device under test. The EMC32 software, which is a standard solution in EMC test labs, guides the user through the individual test cases, which are run fully automatically. The test system saves all samples taken and subsequently evaluates them.

The test system meets the requirements of the ETSI standard. This is due, among other things, to the system's high sampling rate greater than 1 Msample/s with a measurement time of up to 32 seconds.

www.rohde-schwarz.com

Radio test set adds POCSAG testing option

includes transmitter capabilities

Aeroflex Incorporated has announced the POCSAG testing option for the 3920 series digital radio test set, enabling engineers and technicians to verify the operation of POCSAG pagers and paging systems. This option adds the capability of both sending and decoding POCSAG encoded messages to the 3920 Series.

With a full set of POCSAG receiver testing tools, the operation includes user control of the modulation deviation, bit rate and the message format. The user can select from a list of pre-defined messages to transmit or they can create their own custom defined messages. The pages can be sent to a user selected radio identification code (RIC) or to a sequence of RIC's. The user also has full control of the RF frequency and power level, so that receiver sensitivity testing can be performed on any POCSAG receiver.

This option also includes the capability of testing POCSAG transmitters.

www.aeroflex.com

Coaxial-based VCO

with an internal frequency doubler

Crystek's latest CVCO55CXT-5270-5375 coaxial resonator oscillator (CRO) is a coaxial-based VCO with an internal proprietary frequency doubler. The oscillator family's frequency doubling, 2x fundamental technology offers higher performance levels of lower phase noise

and much lower harmonics over the competition, while achieving lower current consumption in the process.

The CVCO55CXT-5270-5375 operates from 5270 to 5375 MHz with a tuning voltage range of 0.3 Vdc to 4.7 Vdc. This coaxial VCO features a typical phase noise of -102 dBc/Hz at 10 kHz offset and has good linearity. The CRO exhibits an output power of 0.0 dBm typical into a 50 ohm load with a supply of +5.0 Vdc and a current consumption of 30 mA (maximum).

www.crystek.com

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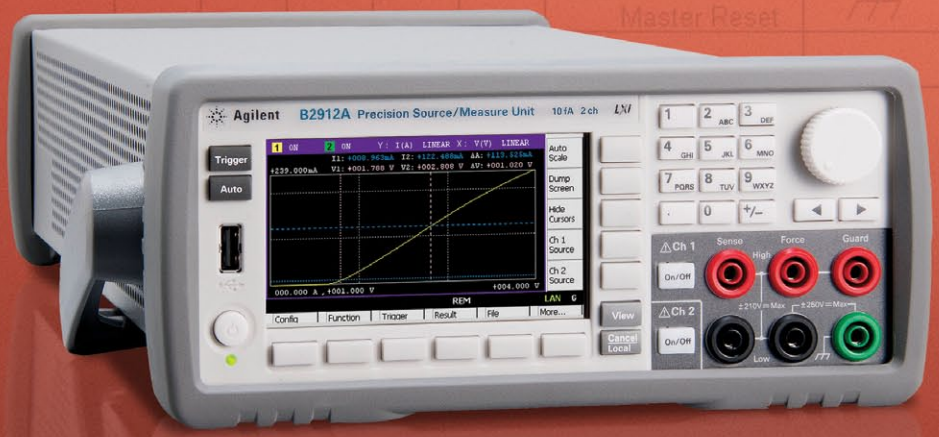

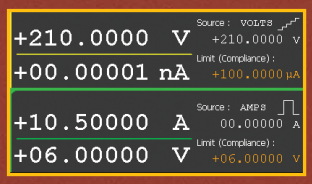

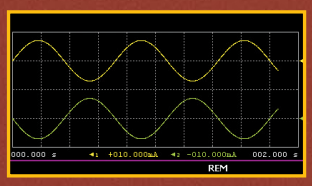

The superior GUI on the new Agilent bench-top source measurement unit (SMU) is the first in the industry to display your measurement results graphically. It also provides best-in-class output range and source/measurement resolution. For the testing speed and efficiency you need to deliver smart technologies to market faster, the choice is clear.

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