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Cover Article:
How the latest spectrum analysers help engineers to troubleshoot Radio interference problems

The European journal for the microwave and wireless design engineer

www.mwee.com

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NASA uses commercial smartphone as control system to put three satellites into orbit

On April 21, NASA launched a novel project, putting into orbit three satellites that employ an off-the-shelf commercial smartphone as the control system. The satellites hitched a ride on the maiden flight of Orbital Science's Antares rocket from NASA's Wallops Island Flight Facility in Virginia. Each of the three "phonesats" was a 10-centimeter cube with a mass of about 1 kilogram. The trio operated in orbit for about a week, transmitting back down to Earth. The satellite orbits naturally decayed after about one week, as expected, and they re-entered Earth's atmosphere on April 27.

According to Chad Frost, chief of the Mission Design Division at NASA's Ames Research Center, the success of the mission was an important milestone. Building a spacecraft of any sort generally means using very expensive hardware and software, Frost said. But PhoneSat—comparatively very inexpensive—breaks the mold. According to Frost, this concept could be used to deploy groups of satellites to, for example, monitor space weather or conditions in various parts of the Earth.

"We were very intrigued by the notion that you could build a very low-cost spacecraft based entirely on a smartphone and other consumer electronics devices," Frost said.

According to Frost, the PhoneSat project—which won Popular Science's 2012 Best of What's New Award for innovation in aerospace—proved exactly what he and his colleagues at NASA had hoped for: "That you can build a spacecraft for orders of magnitude less" than what it typically takes.

Frost said NASA is now seriously looking at several PhoneSat concepts that could include hundreds or even thousands of spacecraft working in conjunction to provide, for example, a space weather early warning system or other such networks for monitoring. Since the PhoneSat project utilizes the Android operating system, it opens up the possibility of apps being created by the global Android developer community being used in space, Frost said. He called the concept "wide open and wildly exciting."

Advances in electronics

The idea of basing a satellite on a smartphone wouldn't be possible without advances made in smartphones over the past few years, Frost noted. "We've driven consumer electronics to the point where they are just amazingly capable little devices and ridiculously affordable for what they can do," he said.

Frost has been at the forefront of aerospace technology for more than 25
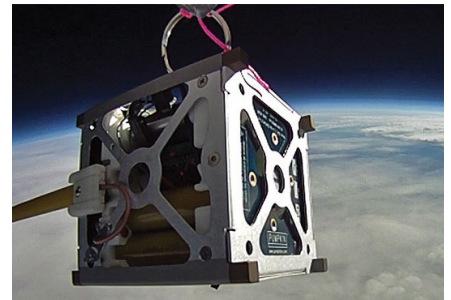
years. He joined the Army/NASA joint rotorcraft division in 1997. During these years at NASA, both electronics and spacecraft technology have come a long way.

"I'm part of the generation that first started to get their hands on the first computers," Frost said. He added that some of the earliest projects he worked on as an engineer still used analog control systems. The fundamental revolution, he said, beginning with Apollo, was the move to digital flight control.

The culmination of the digital revolution is "flying" these smartphones and other systems that have amazing computational power, ridiculously low power consumption, and are insanely inexpensive," Frost said.

By Dylan McGrath
Courtesy of EE Times

Indoor location applications expected to break 1 billion downloads by 2016

While there won't be an immediate surge in indoor location-enabled handsets and applications, the ecosystem necessary to drive mass adoption of indoor location applications will be in place by 2016.

According to ABI Research's report, "Indoor Location Smartphone Applications", the future adoption of a variety of indoor location and proximity technologies/hybrids are considered across a range of different application categories, such as retail, navigation, enterprise, personal tracking and social, while also enhancing services such as advertising, ambient intelligence, augmented real-

ity, photography, and local search. Even at this early stage, it is clear that indoor location will play a major part in the future of mobile.

"The market is still very nascent with a number of major handset vendors yet to decide on what technologies they will adopt," comments senior analyst Patrick Connolly. "In particular, any decision from Google will have huge repercussions, depending on whether it opens up the Android platform or not.

There are also issues around indoor maps, data ownership, and interoperability across technologies, buildings, and

OS platforms. By 2016, the ecosystem will have evolved sufficiently that ABI Research is forecasting strong adoption of indoor location applications, catalyzed by the increasing availability of in-store applications and services."

Practice Director Dominique Bonte adds: "As smartphones proliferate, and privacy barriers come down, location will become increasingly used to enhance existing and new services. Indoor/ubiquitous location is a natural extension of this inevitable trend."

www.abiresearch.com

AWR and James Cook University to offer eBook on RF design

AWR Corporation has announced a new eBook, RF Electronics: Design and Simulation, which is available free of charge to students, graduates, professors and industry professionals through AWR's Professors in Partnership™ web portal.

Developed by adjunct associate professor C. J. (Keith) Kikkert of James Cook University (JCU) School of Engineering and Physical Sciences, Townsville, Queensland, Australia, the book describes the use of AWR's Microwave Office® and AXIEM® software to design RF electronic devices for applications such as amplifiers, radar, mobile phones, Bluetooth, and WLAN.

This book is suitable for teaching RF and microwave electronic design in the final year of an undergraduate Bachelor Degree program or as a course in a postgraduate program. Chapter 2 can

be used at earlier years of a Bachelor Degree program to teach the principles of computer simulation and design of analogue electronic circuits. All the AW-RDE project files used for the material in the book are included with the eBook.

The eBook is the inaugural offering for AWR's Professors in Partnership program, which aims to provide engineering students, faculty, and graduates with access to ongoing microwave and RF educational content that enhances and promotes the use of AWR software solutions through e-books, textbooks, and videos. The eBook is the next-generation of Dr. Kikkert's popular RF and microwave electronic engineering course that has been widely distributed by AWR to universities worldwide over the past several years.

www.awrcorp.com

Skyworks, SMC Networks work on wireless for the smart home

Skyworks Solutions has announced that it is partnering with SMC Networks, a customer premise equipment manufacturer for multi-service operators (MSOs), to develop wireless connectivity for security, monitoring and automation (SMA) applications in the emerging connected home market. SMC is utilizing Skyworks' wireless networking and ZigBee® front-end solutions for security sensors, smoke alarms, motion detectors and touch pads.

"SMC is joining forces with Skyworks to deliver innovative solutions for the connected home," said Max Brogi, vice president of product management at SMC Networks. "With MSOs in the United States and Canada making full-scale deployments this year, SMC sought to collaborate with the industry leader in analog solutions to deliver best-in-class, energy efficient products. Together with Skyworks' front-end modules, SMC is creating platforms that integrate effortlessly with existing security systems and

devices, operate and back up wirelessly, are easy to install, and give MSOs a great opportunity to present revenue-generating services to their customers."

SE2432L is a 2.4 GHz, high performance, fully integrated RF front-end module for ZigBee® and smart-energy applications. Designed for ease-of-use and maximum flexibility, it contains integrated, fully matched input baluns, integrated inter-stage matching and harmonic filter, and digital controls compatible with 1.6 to 3.6 V CMOS levels.

SE5003L is a 5 GHz power amplifier offering high linear power for wireless local area network applications. Incorporating a power detector for closed-loop monitoring and control of the output power, the power amplifier contains high integration for a simplified design, providing quicker time-to-market and higher application board production yield.

www.skyworksinc.com

Anritsu receives PTCRB approval for its RF conformance test system

Anritsu Corporation has received the world's first PTCRB approval for its ME7873L RF conformance test system meeting the LTE Rel-10 carrier aggregation standard.

The latest 4G mobile LTE-Advanced standard supports the carrier aggregation function offering faster communication speeds than the LTE technology now being deployed worldwide. This carrier aggregation function uses multiple frequencies in one band to increase both the peak and average data speeds, reaching the 3GPP standards of 300 Mbps for downloads while targeting future speeds of 1 Gbps.

Network operators offering LTE services worldwide are now planning carrier aggregation rollout with the first North American services scheduled sometime this year. Development of commercial mobiles requires deployment of PTCRB and GCF approved tests systems for ensuring objective RF and protocol conformance tests meeting the 3GPP standards for terminal quality.

www.anritsu.com

Teseq EMC facility expands field probe calibration service

Teseq has expanded its capability in field probe calibration to deliver calibration data at all frequencies defined in the IEC 61000-4-3 standard.

The company can now offer field probe calibration data to 6 GHz, allowing customers to compensate for frequency variations within the probe with greater precision, through the reduction of measurement inaccuracies. In addition, probe linearity data can also be provided. The expansion marks the first step in a two year programme to install 18 GHz probe calibration capability.

Teseq's Wokingham facility offers full EMC calibration and repair services including two screened room antenna calibration chambers offering customers convenient and efficient indoor testing reducing test times and costs. Teseq has full UKAS approval.

www.teseq.com

Daimler uses smartphone for car-to-x technology

After years of discussion and development, Daimler has pressed ahead and announced its intention to equip serial vehicles with car-to-x communications capability before the end of the year. In order to speed the introduction, the technology will be implemented as a smartphone app along with an option kit. The kit also can be installed in stock vehicles as a retrofit solution.

The car-to-x technology enables motorists to virtually see around the corner or beyond obstacles, thereby helping to reduce blind spots and increase the overall traffic safety. "The technology's greatest potential lies in this expansion of the telematics horizon", said Thomas Weber, Member of the Board of Management of Daimer AG.

The car-to-x communications capability is provided by means of the Drive Kit Plus option which will be used in combination with a smartphone. On the latter, an app developed by Mercedes-Benz ("Digital DriveStyle") will be installed that carries the necessary functionality. The smartphone takes the part of the data transport over the air. Daimler regards the smartphone approach as the fastest way to deploy the technology and also the quickest way to "unlocking the safety potential of car-to-x technology".

www.daimler.com

Envelope Tracking modulator for handsets in volume production

Nujira Ltd recently launched the company's latest Coolteq.L envelope tracking (ET) power supply modulator chip for LTE handsets. Designated, NCT-L1300, the IC claims to deliver the best ET modulator performance on the market across all key metrics: system efficiency, noise, bandwidth, linearity and RF output power. The chip is now being geared up for volume production to support 4G smartphone shipments in 2014.

By delivering power conversion efficiencies in excess of 80%, the NCT-L1300 enables smartphone vendors to achieve 50% system efficiency (PA and ET) with LTE signals. It offers high bandwidth, high accuracy tracking over a wide voltage swing range of 0.5-4.5 V

Nujira's precise tracking and patented ISOGAIN technique linearizes the PA, demonstrating adjacent channel performance of better than 50 dBc without modem assistance or Digital PreDistortion.

The NCT-L1300 supports PA output powers of up to 29 dBm, enabling full power LTE transmissions and eliminating the need for maximum power reduction (MPR) - even for advanced RF front end architectures featuring MIMO, carrier aggregation and antenna tuning. The IC delivers ultra low noise performance: -135 dBm/Hz. It also supports for 20 MHz LTE channels, with minimal impact on efficiency.

The NCT-L1300 provides fast mode switching and low standby power to support both TD-LTE and FD-LTE waveforms in ET mode. It is equipped with industry-standard interfaces, compatible with a wide range of LTE chipsets and RF PAs from leading vendors.

Tim Haynes, CEO of Nujira said: "The NCT-L1300 has been designed to extend battery life, boost network coverage and data rates, and deliver a true 4G experience to users. The chip is a culmination of everything we have been working on for more than a decade. Breaking the 50% system efficiency barrier is a watershed and our new chip puts us in prime position to support OEMs in creating 4G products that meet users' expectations. With samples available next month we are now gearing up for a very rapid production ramp in 2014, when we expect to see ET technology heading towards a 100% attach rate in LTE smartphones."

www.nujira.com

Imec and Renesas claim first multi-standard RF receiver in 28 nm CMOS

Imec and Renesas Electronics have unveiled what the companies claim to be the world's first multi-standard RF receiver in 28 nm CMOS technology, and a 28 nm analog-to-digital converter (ADC) targeting wide-bandwidth standards such as LTE-advanced and next-generation WiFi.

The 28 nm receiver is a linear software-defined radio (SDR) operating from 400 MHz up to 6 GHz and supporting reconfigurable RF channel bandwidths up to 100 MHz. Through novel design and architecture techniques, the receiver operates at a low standard supply of 0.9 V, while maintaining +5 dBm of out-of-band IIP3 and tolerating 0 dBm blockers. It achieves noise figures down to 1.8 dB, occupies an active area of 0.6 mm^2, and consumes less than 40 mW.

The ADC is a 410 MS/s dynamic 11bit pipelined SAR ADC in 28 nm CMOS. It achieves a peak SNDR of 59.8 dB at 410 MS/s with a power consumption of 2 mW. The ADC, including an on-chip calibration engine, occupies an active area of 0.11 mm^2.

www.imec.be
www.renesas.com

Silicon Labs to acquire Energy Micro

Silicon Labs has signed an agreement to acquire Energy Micro AS. Based in Oslo, Norway, the late-stage privately held company offers the most power-efficient portfolio of 32-bit MCUs and is developing multi-protocol wireless RF solutions based on the ARM® Cortex-M architecture. Energy Micro's energy-friendly MCU and radio solutions are designed to enable a broad range of power-sensitive applications for the Internet of Things (IoT), smart energy, home automation, security and portable electronics markets.

This strategic acquisition accelerates Silicon Labs' growth opportunities and positions the company as the foremost innovator in energy-friendly embedded solutions. Industry experts predict that the number of connected devices for the IoT will top 15 billion nodes by 2015 and reach 50 billion nodes by 2020.

www.silabs.com

DAS, small cells and WiFi fight for in-building wireless market

There is a fierce battle raging between Distributed Antenna Systems (DAS), Wi-Fi, and licensed small cells for coverage and capacity in enterprise wireless systems. Each type of system has its strengths and weaknesses with Active DAS systems the choice for large corporations which we define as over 100,000 square feet and with more than 100 employees. Small and Medium-sized Enterprises (SMEs) have the choice between Wi-Fi and small cells.

There are two business models for DAS in large corporations: neutral-host or carrier-led. "Neutral hosts are increasingly popular for multitenant situations since multicarrier DAS systems can add value with either carrier-led, venue-led or third party business models," says Nick Marshall, principal analyst.

Today, adding Wi-Fi is an attractive option for businesses since these systems are probably the lowest cost to deploy, however there is a risk of interference because the systems operate on unlicensed frequencies. With the promise of Next Generation Hotspot (NGH) well under way and many vendors including Wi-Fi in their equipment, Wi-Fi is becoming an essential part of the HetNet of the future.

Small Cells today are emerging as a viable alternative for enterprise coverage being less costly than DAS systems and much faster to deploy. "Unlike DAS, each small cell is a base station or eNo-deB and adds capacity directly where it is required," continues Marshall.

These findings come from a report entitled "The Battle for Enterprise Coverage – DAS, Wi-Fi, and Small Cells" which discusses this market and profiles 30 companies active in this area.

www.abiresearch.com

Ultra-low power wireless sensor technology

New battery-free, ultra-low power wireless sensor technology is being developed by TTP in Cambridge that will add connectivity and intelligence to everyday dumb objects such as medical implants, supermarket labels and engineering components.

The consultancy is working on applications that range from sensors embedded in smart orthopaedic implants for remote monitoring, to battery-free sensors for measuring highly-stressed components in F1 engines and active supermarket labels that are always up to date with real-time data. And the same technology is being used for displaying the balance on Oyster-type pre-pay cards, controlling home energy systems or street lights and intelligent security or postal tags. TTP expects many of these new sensors will connect to smartphones and tablets using ultra-low power Bluetooth technology or Near Field Communications (NFC) for close range transactions.

www.ttp.com

Antenna and device makers to benefit from LTE RF issues

Vendors are realizing that RF design is very important, and current design issues offers emerging antenna vendors opportunities to be more competitive in quality and price, according to the latest report from Heavy Reading 4G/LTE Insider.

The report identifies and analyzes key issues affecting the market for antennas and other RF components for LTE devices. It explores how vendors are responding to LTE's challenges with active antennas, tuning circuits and front-end products such as Qualcomm's RF360, which supports 40 bands.

Current challenges add up to major, emerging, long-term opportunities for antenna vendors and other RF companies to differentiate their products and compete on more than just price, says Tim Kridel, research analyst with Heavy Reading. "Consumers and enterprises are upgrading to LTE because device vendors and operators have convinced them that it's blindingly fast compared to 3G," he continues. "So when LTE fails to live up to that expectation, customers inundate operator call centers and social networks with questions and complaints. Antennas and other RF components are critical for meeting that expectation and avoiding the support costs, churn and brand hits."

Some findings incude:
• Band fragmentation and legacy fallback are two major challenges for LTE RF designers;
• Qualcomm's latest RF360 solution won't single-handedly enable LTE global roaming or solve fragmentation;
• LTE's unique requirements makes it easier for antenna vendors to escape the commoditization trap; and
• Digital cameras and other consumer electronics devices are adding LTE, but their OEMs often lack RF design experience.

www.heavyreading.com/research

Lime Microsystems and Europractice to bring flexible RF to universities

Lime Micro has just announced a deal with Europraxis that will see its open source Myriad RF platform and its field programmable transceiver put in front of all EU universities. Under the terms of the deal, Europractice will promote Lime's LMS6002D field programmable RF transceiver and associated boards for use in research and teaching of wireless technology to its member establishments throughout Europe.

The list of boards includes both Lime's Universal Wireless Communications Toolkit and Azio's Myriad RF-1, an open source board created for Lime's non-profit MyriadRF initiative, which seeks to increase access to RF hardware.

The products enable the creation of highly flexible wireless systems. The field programmable RF (FPRF) transceivers are software configurable for all major wireless communication frequency bands (300 MHz to 3.8 GHz) and standards (including LTE, HSPA+, CDMA and 2G).

http://myriadrf.org

How the latest spectrum analysers help engineers to troubleshoot radio interference problems

By Anritsu Company

The exploding growth of wireless services has made interference – once uncommon – a fact of life for wire-less and broadcast professionals. For example, a metropolitan area of approx-imately one million people may have 1,000 licensed two-way radios, 600 cell sites, and 100 broadcasters. Added to this mix are military, aeronautical, and emergency services, plus low-power unlicensed signals, such as Wi-Fi and wireless video cameras. All of this traffic in a crowded RF spectrum is reason enough for interference problems, but when you add the fact many of these services are expanding, being modi-fied, aging or failing, interference can become an epidemic.

A spectrum analyzer, such as the MS2720T (figure 1) from Anritsu, is typi-cally used to find and locate causes of interference. The first and best place to start looking for interference is at the antenna input to the receiver. If the receiver has a pre-filter, it's best to measure the signal after the pre-filter.

If it is a cellular issue and the base station has a high noise floor, the uplink channels should be checked. However, if the issue is device recep-tion in a given area, then the downlink frequencies need to be measured. Once an interfering signal is present at the receiver input, it affects the receiver's front end, causing a reduction in sensitivity. This will lower the effective carrier-to-interference ratio (C/I) and result in all the symptoms of a weak signal (noisy, waterfall effect, low data rate), except that the received signal strength measurements will be strong due to the high noise floor.

Characterizing the signal

Once an interfering signal is spot-ted, it should be characterized before disconnecting the spectrum analyzer from the receiver's signal. To char-acterize the signal, the user should adjust the spectrum analyzer to best view the signal by using the pre-amp, reference level, span, and resolution bandwidth controls. The signal's shape, bandwidth, and behavior should be observed. Users may also want to look for frequency drift, amplitude changes, and fre-quency hopping.

If the signal is intermittent, the Max-Hold feature of the spectrum analyzer can be used to create an envelope. If the spectrum analyzer has spectrogram capability, it can be used to check for periodicity. For signals that are intermittent with a long time between appearances, it can be helpful to use a "Save on Event" capability. This capability uses a mask automatically generated from the "normal" signal and only saves a trace when something unusual appears. Once saved, the traces can be exam-ined for time-of-appearance and signal characteristics. The burst detect feature in many Anritsu handheld spectrum analyzers is very useful when hunting for bursty signals, especially ones that occur with a low duty cycle.

While looking for signals that don't belong on the input to a receiver, it's important to know what signals are typically present in the bands, as well as what other legitimate signals may be present. This can save much time when hunting signals. If this is not possible, the signal can be demodulated so the user can listen for the station ID call sign.

Many interfering signals are not so easy to identify, so field engineers must find them by hunting. Possible interfer-ence causes to seek are on-channel interference, in-band interference, impulse noise, harmonics, passive intermodulation (PIM), or intentional interference caused by a jammer.

Figure 1: The MS2720T spectrum analyser from Anritsu is ideal for finding and locating causes of interference.

Locating the source of interference

Once an interfering signal has been spotted and characterized using the tower's antenna, the next task is to find the same signal using a ground level antenna. This will allow the field engineer to search for the signal, either by direction finding or seeking areas of higher signal strength. One issue is that signals that may be strong atop the tower may be weak at ground level.

Initially, it must be determined if the signal is visible near the tower base. If it is, the signal has been spotted at ground level and it's time to move to the next task, locating the source. If not, there are several things to attempt:
• Check other sectors for the interfering signal;
• Look for the interfering signal from a nearby rooftop or top floor. In an urban area, this may be the best way to direction find;
• Move to higher ground;
• Investigate nearby valleys, swales, or other low spots;
• Use in-instrument mapping tech-niques to plot signal strength versus location.

Once the signal has been spotted at ground level, the RF source needs to be located using the following method:
• Import a geo-referenced map onto your spectrum analyzer;
• Select an antenna;
• Setup the spectrum analyzer;
• Go to mapping mode;
• Find the signal direction;
• Repeat the direction finding process from several locations.

A Geo-referenced map has GPS latitude and longitude information embedded in it. This allows a GPS-enabled spectrum analyzer to locate the user's current position when plotting signals on the map.

Traditionally, a Yagi antenna is used for direction finding because it has good directivity, good front-to-back ratio, and generally low side lobes. Its biggest disadvantage is it usually has a fairly narrow frequency band. Other options include a Log Periodic antenna, which has broad frequency coverage but less directivity, a panel antenna (best to ward off reflections), or omni-directional (appropriate when seeking the strongest signal).

Anritsu has developed the MA2700A Handheld InterferenceHunter (figure 2) that accepts many types of antennas with standard N-(f) connectors. The handle also contains a magnetic compass and a GPS receiver, which report position and direction to the spectrum analyzer. This simplifies taking directional bearings. The InterferenceHunter also has a built in pre-amp to ease the process of getting a sufficiently strong signal to the spectrum analyzer.

Users then load the map into the spectrum analyzer and enter mapping mode. Next, the InterferenceHunter is installed and enabled. The spectrum analyzer will show the current location on the map and the direction that the antenna is pointing.

Once set up, rotate the antenna to find the direction of the strongest signal. When the direction of the strongest signal is located, the user presses the trigger on the antenna handle to place a record of the direction on the map. Next, the user moves to a new location and repeats the direction-finding process. It helps the triangulation effort if the moves are made at a right angle to the direction last plotted.

Sometimes a map is not required for signal hunting. In the simplest cases, it can be faster to take direction finding readings with a signal strength
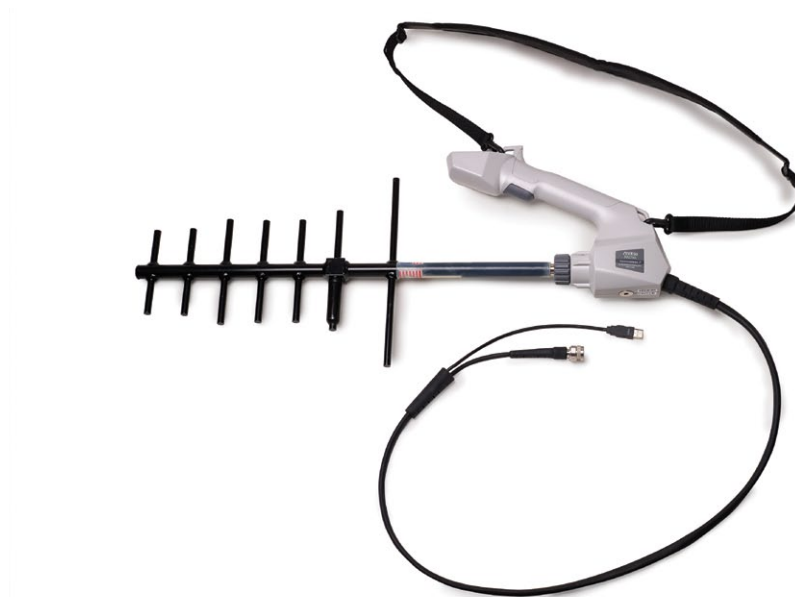

Figure 2: The MA2700A Handheld InterferenceHunter accepts many types of antennas with standard N-(f) connectors.

meter, use the tried-and-true Max-Hold method, or simply travel until the signal strength readings increase. A signal strength meter is available on many spectrum analyzers.

Selecting the right spectrum analyzer
Some spectrum analyzers are more capable than others when looking for interference. Handheld spectrum analyzers clearly have an edge over bench instruments, since they can easily go to where the signal is located. If you are going to be spending hours away from power sources, long battery life is helpful.

The ability to see small signals in the presence of large signals that may be nearby in the RF spectrum is important, as well. A spectrum analyzer with a dynamic range of >106 dB in 1 Hz RBW allows users to see a small signal 90 or 100 dB below a strong signal, while both signals are present.

Another key capability is a fast sweep speed with a low resolution bandwidth, so the spectrum analyzer can sweep fast while resolving sufficient detail to see the interfering signal. For many interference hunts, a 1 MHz span is

useful. A good spectrum analyzer can use a 1 kHz resolution bandwidth to create a noise floor at –126 dBm, with an update rate of 3 sweeps per second. Figure 3 shows a display of a handheld spectrum analyzer with a fast sweep speed and high resolution.

Conclusion
Tracking interfering signals is becoming increasingly difficult due to the proliferation of wireless services in the finite RF spectrum. Using the proper testing tools, such as handheld spectrum analyzers with wide dynamic range, fast sweep speed, and low resolution bandwidth, will help locate interfering signals faster and more efficiently.
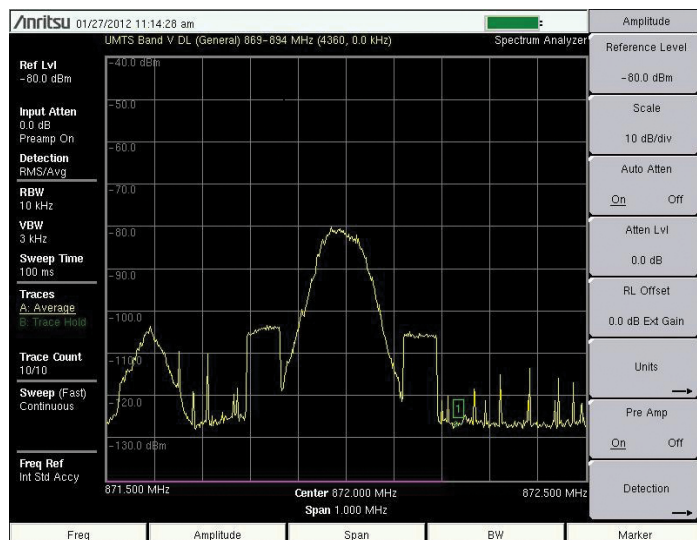

Figure 3: Handheld spectrum analyzer display with a fast sweep speed and high resolution.

Advancing the art of system design: next generation design flows for signal processing and communications systems

By Graham Reith, MathWorks

Introduction

Design-flow discontinuities are becoming increasingly disruptive and expensive in the development of complex signal processing and communications technologies. The drive to reduce the length of design and verification cycles is magnifying the impact of these discontinuities. This paper describes a few use cases–in algorithm design, system architecture, and hardware design–that illustrate significant recent advances in modeling, simulation, and code generation tools and methods.

Algorithm design for streaming systems

Many engineers begin the development of signal processing and communications algorithms in MATLAB using floating-point arithmetic. These algorithm developers can take advantage of the powerful signal acquisition and analysis capabilities of MATLAB as well as built-in algorithm libraries of several toolboxes. In some organizations, however, these algorithms are then rewritten in C code to refine them for implementation, conversion to fixed-point or integer arithmetic, or to integrate them with other design elements. This rewriting step is one example of a potentially costly and disruptive discontinuity in the design flow.

Several hundred new components for signal processing, communications, image and video processing are available for use with MATLAB as libraries of System objects. System objects are ready-for-use packaged implementations of algorithms in MATLAB – designed for designing real-time systems. They implicitly handle streaming, indexing, buffering, and state management – which makes the code much simpler to write, debug, and maintain.

As an example, Figure 1 shows a block diagram representation of a basic communication system with transmitter, channel, and receiver components.
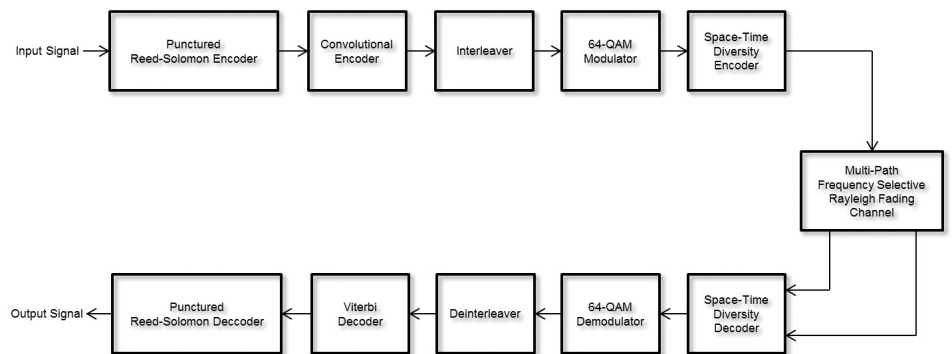

Figure 1: Block diagram view of the physical layer of a typical communication system.

```
%% Instantiate system objects to model wireless communications link
%% Transmitter
hRSEncoder = comm.RSEncoder(120,108);
hConvEncoder = comm.ConvolutionalEncoder(poly2trellis(7, [171 133]),...
    'TerminationMethod','Truncated',...
    'PuncturePatternSource','Property',...
    'PuncturePattern', puncture_pattern);
hInterleaver = comm.BlockInterleaver('PermutationVector', interleave_pattern);
hModulator = comm.RectangularQAMModulator(64,...
    'BitInput',true,...
    'SymbolMapping','Custom',...
    'CustomSymbolMapping',constellation_pattern,...
    'NormalizationMethod','Average power');
%% Channel Model
hAWGN = comm.AWGNChannel('NoiseMethod','Signal to noise ratio (Eb/No)', 'EbNo',10);
```

Figure 2: A portion of MATLAB code showing the use of System objects from DSP System Toolbox and Communications System Toolbox.

To model and simulate such a system, some engineers write many thousand lines of C code, and then look for ways to integrate the design with test equipment or analyze simulation results.

In contrast to the several thousand lines of C code that are typically written to implement this communication system, the MATLAB code shown in Figure 2 uses several available System objects from DSP System Toolbox and Communications System Toolbox. For example, to model the transmitter, an engineer can instantiate and call the Reed-Solomon Encoder, Convolutional Encoder, Block Interleaver, Rectangular QAM Modulator, and Orthogo-

nal Space-Time Block Coder System objects from Communications System Toolbox in sequence, as shown in Figure 2. The code structure enables engineers to easily compare it with the original specification or block diagram. Algorithm designers can rapidly combine this code with their existing MATLAB code and test the algorithms with live streaming data acquired from measurement instruments.

Combining MATLAB and C/C++

Algorithms coded using System objects facilitate code reuse in the system design process. Floating or fixed-point MATLAB code can be included

directly in a Simulink model as part of the system architecture, modeling, and design process. Engineers can also use MATLAB Coder to generate C code automatically from MATLAB code including System objects, and then use that C code for simulation or integration with other C/C++ design elements, after proper verification.

As shown in Figure 3, several important use-cases are enabled by the integration of MATLAB with C/C++ in engineering workflows. For example, engineers can directly invoke MATLAB from a C program to take advantage of MATLAB's signal processing libraries or visualization capabilities. Existing C/C++ designs can be directly used in MATLAB as external libraries. MATLAB Compiler can be used to deploy MATLAB algorithms – or alternately – MATLAB Coder can be used to automatically generate C code from MATLAB.

RF and digital system architecture

Static link budget calculations are a common first step in RF designs based on specifications for LTE, Bluetooth, ZigBee, Wi-Fi, or other technologies. These calculations provide a good starting point, but they do not account for input signal modulation, image effects, interferers and other real-world phenomena. To effectively model and simulate the effects of RF impairments on communication systems, system architects currently juggle multiple disconnected tools that support either digital or analog/RF designs, but not both.

SimRF is integrated with Simulink and provides a Circuit Envelope engine for the simulation of multi-frequency dynamics in RF transceivers. The SimRF component library includes behavioral models of nonlinear amplifiers, three port mixers, S-parameter blocks and other basic blocks for designing architectures with arbitrary topology and for simulating RF front ends at the system level. SimRF lets you simulate RF amplifiers to estimate gain, noise, even- and odd-order intermodulation distortion. The simulation of mixers enables you to predict image rejection, reciprocal mixing, local oscillator phase offsets, and DC conversion. You can also simulate frequency-dependent mismatches between linear and nonlinear components in the time and frequency domains.

SimRF and Simulink together provide a common environment for modeling and simulating RF and baseband subsystems in a unified design. Used in

combination, these tools enable system architects to perform realistic simulations early in the development process and make informed trade-off decisions in designs that include digital and analog/RF components.

Figure 4 shows the overall system model of an ISM band low IF receiver that includes both the digital signal processing components and the RF receiver subsystem. The details of the RF subsystem that implements a Hartley IF receiver are also shown. Unlike traditional modeling methods that use cascades of two-port elements and single-frequency approximations, the use of three-port elements simplifies the receiver model. The model also utilizes circuit envelope simulation technology and supports multi-frequency modeling to estimate the impact of a blocker and an image signal on a nonlinear receiver.

System architects can also explore the feasibility and relative merits of alternate approaches for image rejection such

as super heterodyne or direct conversion architectures in the unified environment. In addition to simulating the effects of RF impairments, system architects can
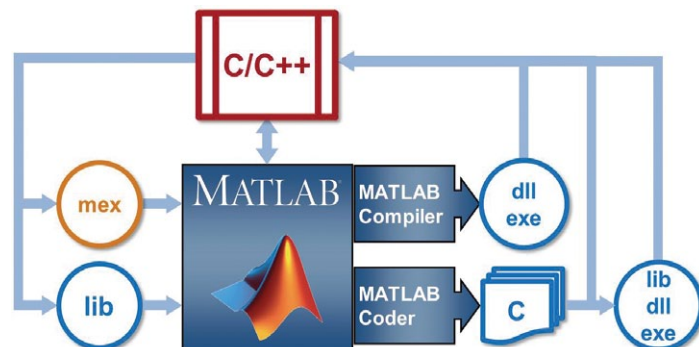

Figure 3: Combining MATLAB with C/C++ provides a powerful and flexible algorithm and system design platform for signal processing applications.
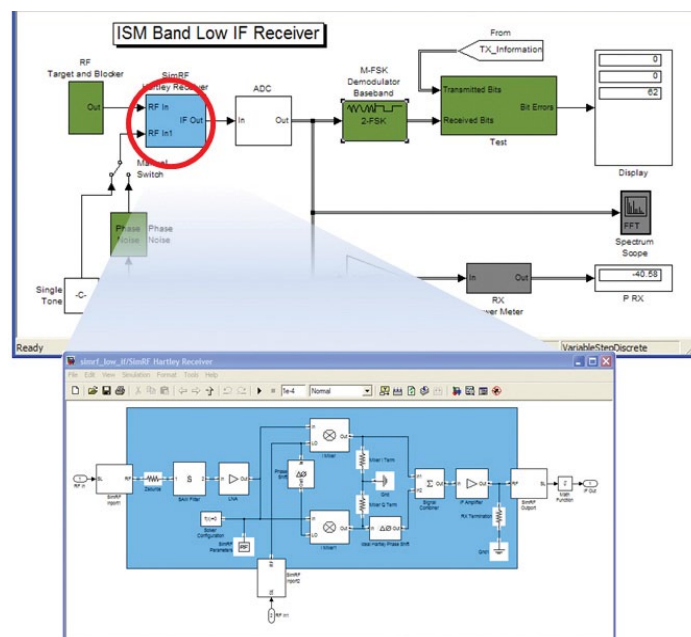

Figure 4: ISM band low IF receiver with digital and RF subsystems in one unified model (above) and detail of the Hartley receiver RF subsystem modeled in SimRF (below).
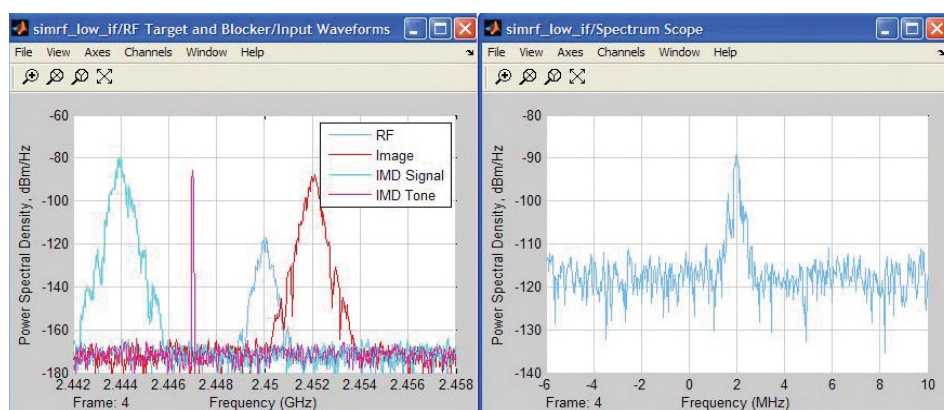

Figure 5: Input (left) and output (right) power spectral density plots showing the results of low IF image rejection.

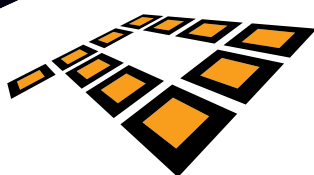use the same system models used for design to perform the verification tasks in simulation that would normally be done on the lab bench.

Hardware design

After the algorithm design and system architecture are completed, the next step in many development cycles is FPGA implementation and verification of the digital portions–sometimes en route to final deployment as ASICs. Among the primary sources of inefficiency in FPGA prototyping and implementation are the time-consuming design iterations that are required to find the proper balance of power consumption, performance, and area.

Figure 6 shows a symmetric FIR filter implemented in fixed-point arithmetic. To realize such a filter in hardware, engineers must carefully balance the throughput and latency, and monitor the amount of hardware resources used. Critical path highlighting is a new capability that provides actionable information on potential bottlenecks in the system. Using the post-synthesis information generated by the synthesis tool, HDL Coder annotates the critical path timing in the Simulink model. Engineers can utilize this information together with pipelining techniques to partition their designs, reduce the critical path latencies, and infer the use of dedicated DSP resources available on many FPGAs. Figure 7 shows the same filter design, with the critical paths automatically highlighted, along with estimated latency for each path segment.

As mentioned above, pipelining is one of the key techniques that engineers utilize to address critical path latencies. One of the well-known challenges with pipelining is that parallel paths may have unmatched latencies, which can lead to unexpected or unwanted system behavior. Distributed pipelining–a technique employed often to address this problem–can now be automated. By choosing this option, engineers can automatically retime the model and balance the latencies introduced by pipeline registers across relevant parallel paths.

In the past, these types of design iterations and trade-off evaluations have required a significant amount of time and effort. Recent enhancements include a Workflow Advisor console that enables engineers to go through design iterations much more quickly and in an intuitive manner. This is especially helpful to those that are not experts in HDL

programming, but need to take advantage of FPGA processing. In addition to using critical path highlighting and distributed pipelining, engineers can also examine an automatically generated resource utilization report to monitor the type and number of critical hardware components being used and determine the best architectural choice for a given situation by quickly iterating through several viable design options.

Accelerating design across teams

Today's engineering managers face the challenge of coordinating geographically dispersed teams that are working on different parts of an overall system using different disconnected tools. In many cases, system-level designs are best done in graphical environments, while some lower level details are best expressed as text in MATLAB or C. This paper presented some key recent developments that improve efficiencies across various stages of the design flow.

For algorithm design, System objects are a key new development in modeling and simulating signal processing and communications systems. Several hundred ready-to-use signal processing and communications System objects are now available in MATLAB. Further, System objects support fixed-point arithmetic, and they can be integrated with Simulink or used for automatic generation of C code.

SimRF-featuring circuit envelope simulation technology- is an important new tool for more efficient system architecture flows. It enables engineers to model RF and baseband system components in a unified environment and perform true multi-frequency simulations.

To improve the design iteration cycle times for hardware design, there

are several recent developments in HDL Coder, including workflow advisor, critical path highlighting, distributed pipelining, back annotation, and resource utilization reports, which provide critical actionable information on system performance and a streamlined workflow framework and for hardware developers.

Whether the teams are small or large, geographically distributed or located in the same office, engineering organizations can apply some of these technologies to remove discontinuities in their workflow, and by so doing, streamline and accelerate the development of complex signal processing and communications systems.
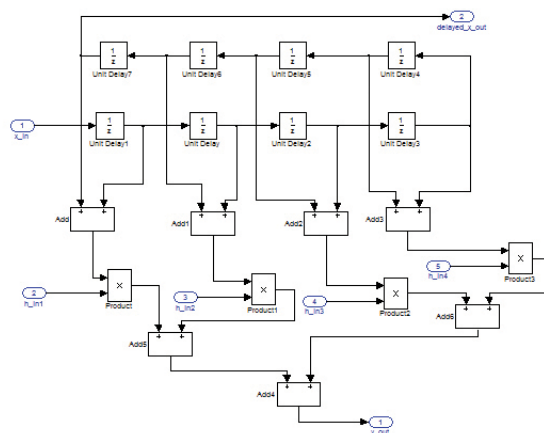

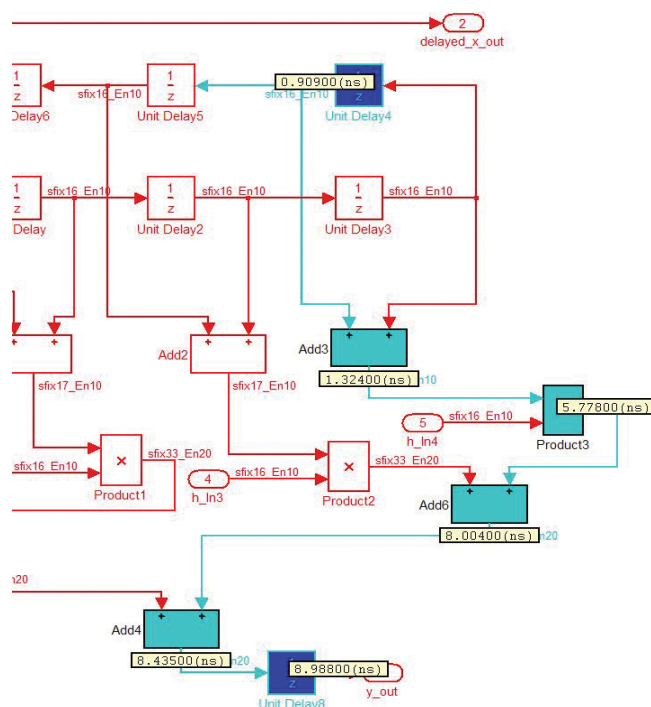**Figure 6: A symmetric fixed-point FIR filter modeled in Simulink.**

Figure 7: Symmetric fixed-point FIR filter showing critical paths and estimated latencies.

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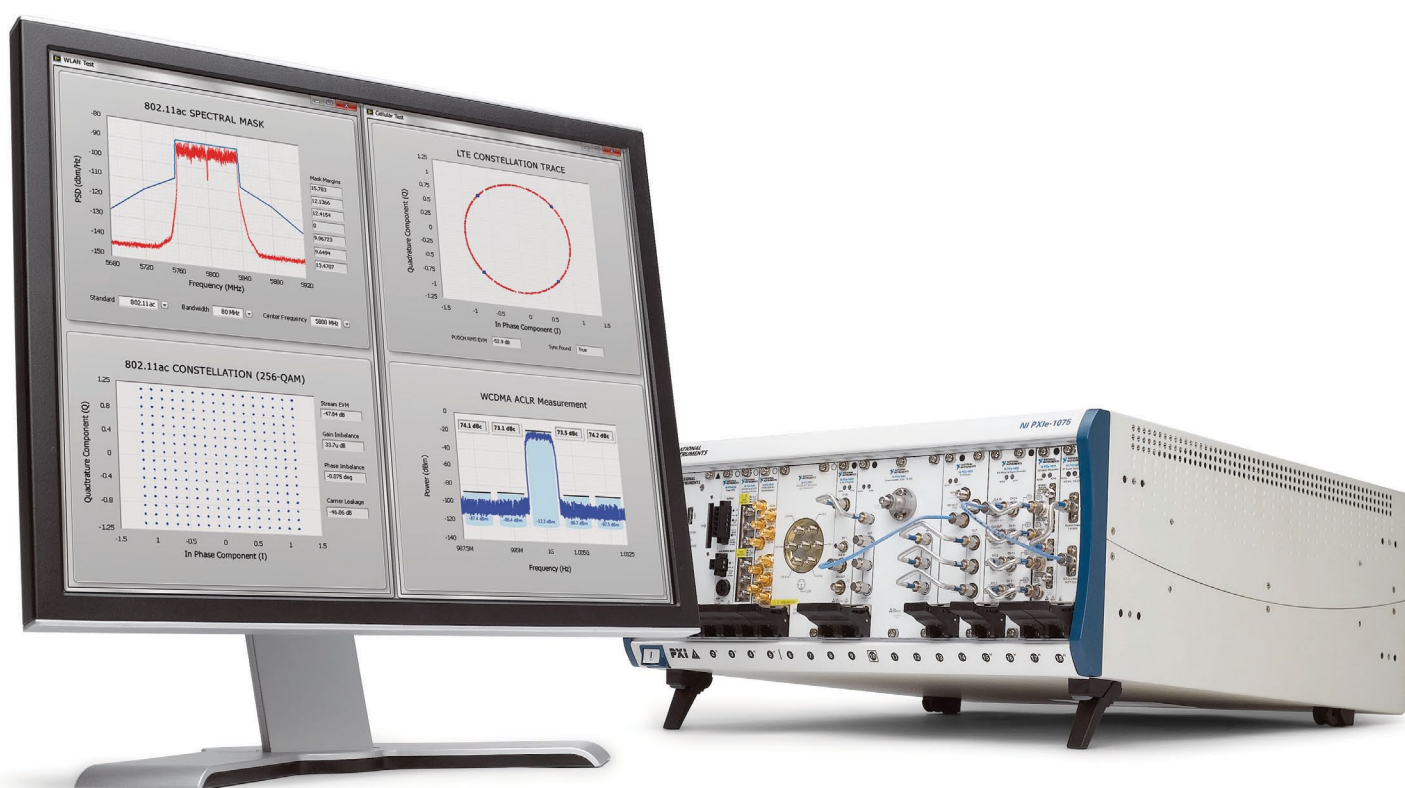
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NATIONAL INSTRUMENTS™

PIM testing in modern base station infrastructure

By Reinier Treur, Livingston

The phenomena known as passive inter-modulation (PIM), and it relates to wireless communication systems, up to this point was thought to be of a fairly inconsequential nature. However, as IP-based next generation networks that support a much wider range of data-intensive services are rolled out, its impact on overall system performance is destined become more pronounced. The mobile sector must therefore take decisive action.

PIM is basically a type of interference. It arises when there is an interaction between RF wireless signals being transmitted by base stations and a mechanical or functional nonlinearity of some description. New frequencies are generated which cause interference. PIM sources can manifest themselves in all manner of different ways, such as poorly connected cabling, faulty RF components, damaged antennas, etc. In modern mobile networks PIM has the potential to significantly contribute to the base station's overall signal integrity, bringing the noise floor into closer proximity with the receiver sensitivity and thereby making it more difficult to differentiate the base station's transmit/receive signal from the background interference present. This will have a detrimental effect on the quality of service (QoS) that a telecom operator's network is able to deliver to its subscriber base.

Current concerns about PIM stem from the fact that, mobile communication is now starting to migrate to complex 4G infrastructure that will allow much larger data capacities to be supported. As networks evolve and begin to employ new high data rate, multi-channel technologies such as LTE, HSPA+ and LTE-Advanced, the increased noise floor that PIM creates will have a far greater effect. Telecom operators need to ensure the functional robustness of their mobile network infrastructure. Cutting corners here is likely to compromise network performance and thereby result in churn – with subscribers joining rival operators that can offer better QoS. In addition, human resources will need to be allocated to troubleshoot PIM issues after base station installations have been completed. This will accrue costs that could easily be avoided.

PIM testing

Normally dynamic testing is needed for PIM - with the particular component being tested having light mechanical stress applied to it. If the component happens to generate a level of PIM that is above the pre-defined threshold deemed to be acceptable, then the component will need to be repaired or replaced.

Standard PIM tests would usually rely on equipment transmitting two high power signals at fixed frequencies into the hardware under test. If these signals then came across a non-linearity, PIM would be witnessed. The size of the PIM signal generated would then be assessed, with large spikes indicating that there was a major fault. This fault could then be taken care of, as soon its exact location could be confirmed. The drawback of this technique has always been pinpointing the fault's exact location.

Mobile test equipment manufacturer Kaelus has developed an innovative solution through which it is possible to more accurately locate where faults are situated. This can be done through the translation of frequency data into time domain plots utilising complex mathematical functions and enhancement algorithms. The company's proprietary Range to Fault (RTF) technology transmits two test frequencies, as with standard PIM tests, but here just one of these frequencies is fixed and the other sweeps across a wide frequency range in so as to produce inter-modulation events in the receive band of the system being tested. Using RTF, an engineer can systematically remove the largest PIM source found on the line and repeat the process until all significant PIM sources have been dealt with. Each time a PIM source is dealt with the accuracy for locating the next largest one will be improved.

Tackling PIM's impact on mobile communication will be crucial to telecom operators as the move to next generation IP-based networks continues. Carrying out PIM testing will ensure that this next generation base station hardware can deliver the levels of operational performance and build quality that are now needed to serve operators' data hungry customers.

Field operatives need to be able to acquire precise PIM test data, so they can determine the reasons for its presence and locate where the source is, then effort can be made to rectify the situation. Operators and their contract partners are demanding advanced analysis tools via which they can complete thorough appraisals of the base station infrastructure in their networks. The high degree of uncertainty in the global economy means that the risks involved in purchasing test equipment are more acute than ever. As well as finding the funds for the initial outlay, there are the ongoing costs to consider too. Furthermore, if test requirements suddenly changed, expensive items of purchased equipment might become redundant - offering no feasible way of generating the revenue to pay for the investment that has been made on it. Working with test sourcing companies, such as Livingston, they can get immediate access to the test hardware necessary for carrying out the procedures that will alleviate PIM. By renting, as opposed to direct purchase, it is possible to get access to the desired items of equipment without being exposed to risk. Should this equipment at any stage become surplus to requirements then it can be returned - so that there is only a cost associated with it while revenue is being generated by its use.

Moving forwards PIM is likely to have a major impact on mobile communication systems. As this sector continues to progress and next generation, IP-based mobile networks start to come online, the presence of PIM will need to be fully addressed so that installation and maintenance activities are totally effective. Equipment manufacturers and their rental/distribution partners are, in reaction to this, ensuring that operators and their subcontractor can specify and source more sophisticated testers, so that they will be able to deal with the challenges of PIM.

Targeting PIM testing —
a cost-effective approach

By K&L Microwave
www.klmicrowave.com

As the electromagnetic spectrum becomes increasingly crowded, regulatory agencies focus on enforcing existing regulations and establishing new ones to ensure that communications and radio location systems remain operational. In this environment, it is of paramount importance to monitor spurious emissions of systems at the design, type approval testing and production stages. K&L Microwave and sister company Dow-Key Microwave have developed a series of products to make such testing more accurate and efficient. Bandpass/bandstop (BP/BS) and lowpass/highpass (LP/HP) diplexers meeting rigid Passive Intermodulation (PIM) specifications are the essential building blocks of innovative testing system architectures. By integrating these filers with Dow-Key's switch matrices, an OEM can construct a single automated test system capable of covering a variety of frequency bands. Test systems of this kind can be further expanded to accommodate injection of interfering signals, monitoring ports or other customer requirements.

Traditionally diplexers are used to separate two frequency bands. K&L Microwave has designed a series of high Q cavity BP/BS diplexers to perform this function. The diplexer design features one bandpass and one bandstop filter sharing a common port. The two filters are at the same center frequency and have the same, or very similar, bandwidths in order to perform two important functions during testing. First, this arrangement provides a broadband match at the common port, maximizing performance of the device under test (DUT). Second, the two filters separate the fundamental carrier from any spurious emissions that may be created by the DUT. The DUT is connected to the common port of the diplexer, and the bandpass port can be terminated or used to test the output at the DUT's fundamental frequency. The bandstop port is connected to a spectrum analyzer to measure the spurious emissions generated by the DUT. High Q cavity bandstop filters, by their nature, are re-entrant at approximately twice center frequency; therefore, the BP/BS diplexer cannot be used to test spurious emissions beyond that point. To measure those frequencies, an LP/HP diplexer is needed.

K&L Microwave has designed LP/HP diplexers with crossovers useful for the major cellular bands. By connecting the DUT to the common port, as with the BP/BS diplexer, the far out-of-band emissions can be measured at the highpass port. These diplexers contain highpass filters that extend as far as 13 GHz to cover all of the known regulations regarding cellular spurious emissions. To simplify measurements, the LP/HP diplexer can be cascaded with a BP/BS diplexer. In this case, the lowpass port of the LP/HP diplexer is attached to the common port of the BP/BS diplexer, as shown in Figure 1.

When cascading the two diplexers together for testing, the customer will select a LP/HP diplexer with a crossover slightly below two times the center frequency of the BP/BS diplexer. Once assembled, the DUT is attached to the open common port, the bandpass port can be terminated, and spurious measurements are made at the band-stop and highpass ports, as in Figure 1. In this way, the spurious emissions of a device can be accurately determined. Of course, it is critically important that the filters used for the testing do not cause false readings. In cases where multiple high power carriers are transmitted by the DUT, one has to consider PIM that may be generated by the filters.

In order to provide the most cost-effective solution while maximizing performance, K&L Microwave offers BP/BS and LP/HP diplexers for bands of interest in three variations. Each of the variations has a guaranteed level of PIM performance allowing the customer to select filters best suited existing needs. The base part number, and lowest-cost option has guaranteed PIM of -100 dBc when subjected to two input tones of +43 dBm. For situations where somewhat better PIM performance is needed, a "-1" is added to the end of the part number, denoting PIM of -130 dBc with the input powers noted above. For the most stringent testing requirements, "-2" versions are guaranteed to meet -156 dBc PIM at the same input powers. For example, the three variations of a GSM900 BP/BS are WSD-00491, WSD-00491-1, and WSD-00491-2.

In addition to testing OEM transmitters as noted above, these diplexers can be used to test stand-alone passive devices for their PIM performance. In stand-alone cases, there are two basic configuration options that allow the
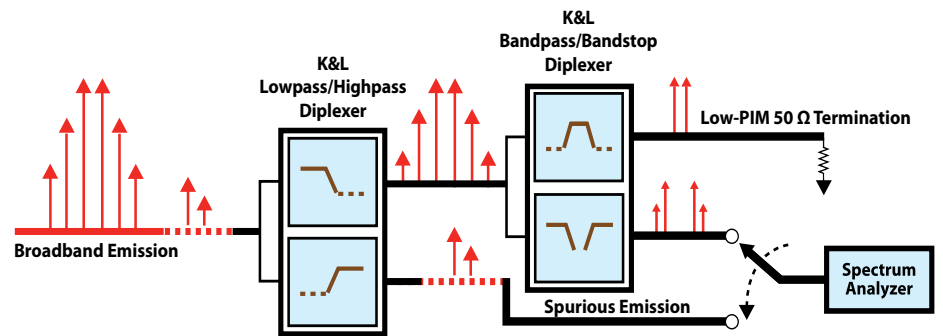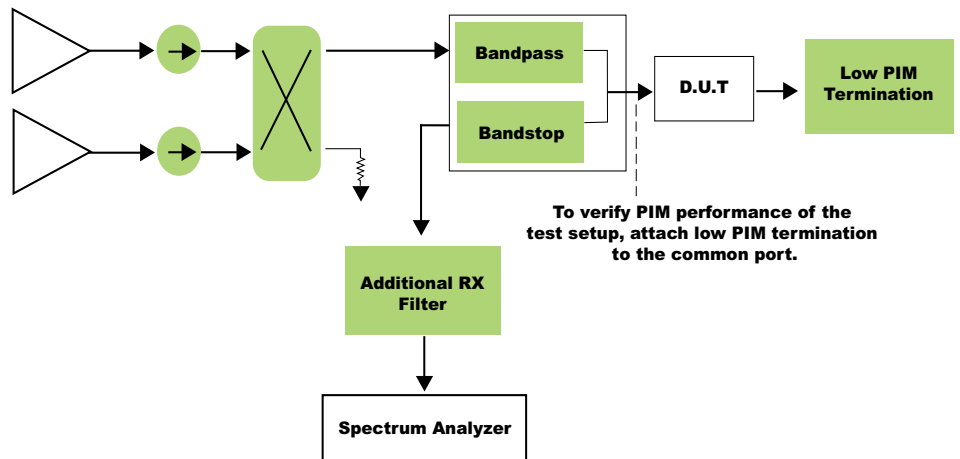
Broadband PIM Monitoring

Figure 1: To simplify measurements, the LP/HP diplexer can be cascaded with a BP/BS diplexer.

Figure 2: Option 1 — the tones sweep the entire Tx; Option 2 — the tones are in the narrow portion of the Tx.

PIM Testing

Option 1 Tones Sweep Entire TX Band

Bandpass/Bandstop Diplexer

K&L Bandpass/
Bandstop Diplexer

TX Filter → D.U.T

Bandpass → Low PIM Termination

Bandstop

Additional RX Filter

Spectrum Analyzer

Option 2 Tone Sweep Limited to Diplexer Bandwidth

K&L Low PIM Diplexer

TX 1 Filter

TX 2 Filter

D.U.T

K&L Bandpass/Bandstop

Bandpass → Low PIM Termination

Bandstop

Additional RX Filter

Spectrum Analyzer
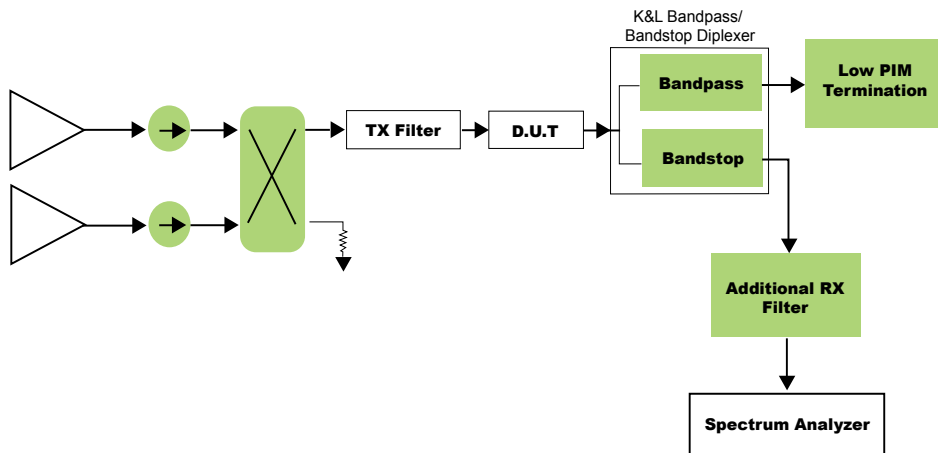
Figure 3: Option 1 — tones sweep entire Tx, Option 2 — tone sweep limited to diplexer bandwidth.

Small Signal Broadband Carrier

Bandpass

Common Input

Bandpass

Common Input

Bandreject

Bandpass

Common Input

Bandreject

Bandpass

Common Input

Bandreject

Common Input

Bandreject

Bandreject

Figure 4a: Typical layout for small signal testing applications.

www.microwave-eetimes.com

Automated PIM

Figure 4b: Typical layout for automated PIM testing applications.

utilization of existing lab equipment to verify the PIM performance of parts. Measurement can be made using the Reflection Mode or Through Mode; see Figures 2 and 3. With the system configur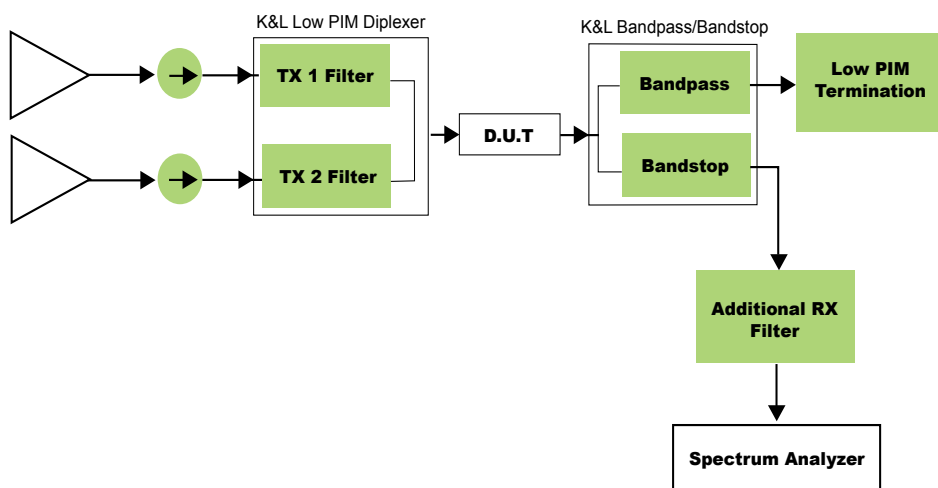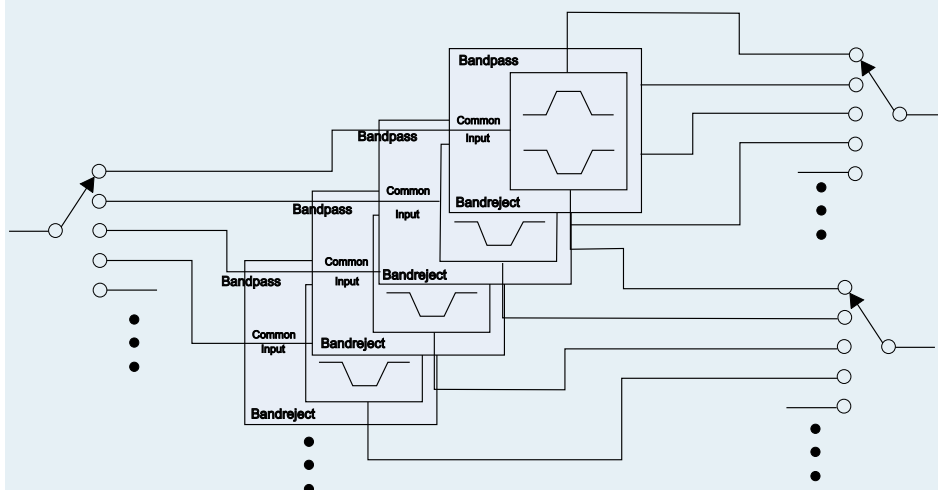ed as shown, the PIM performance of a passive DUT can be measured at any frequency supported by the available equipment. This approach makes it unnecessary to purchase expensive equipment that can only measure PIM performance in one frequency band.

Ultimately, taking advantage of the Switch Matrix expertise of Dow-Key Microwave, these filters can be integrated into a system that allows testing of multiple functionalities over multiple frequency bands. PIM testing can be performed using broad band amplifiers, combiners, and spectrum analyzers. In applications where PIM performance is not as stringent, such as the testing of cellular chipsets, spurious out-of-band measurements can be made and coupler ports can be supplied to allow the injection of interfering signals for performance testing under simulated adverse environments. These custom test soluti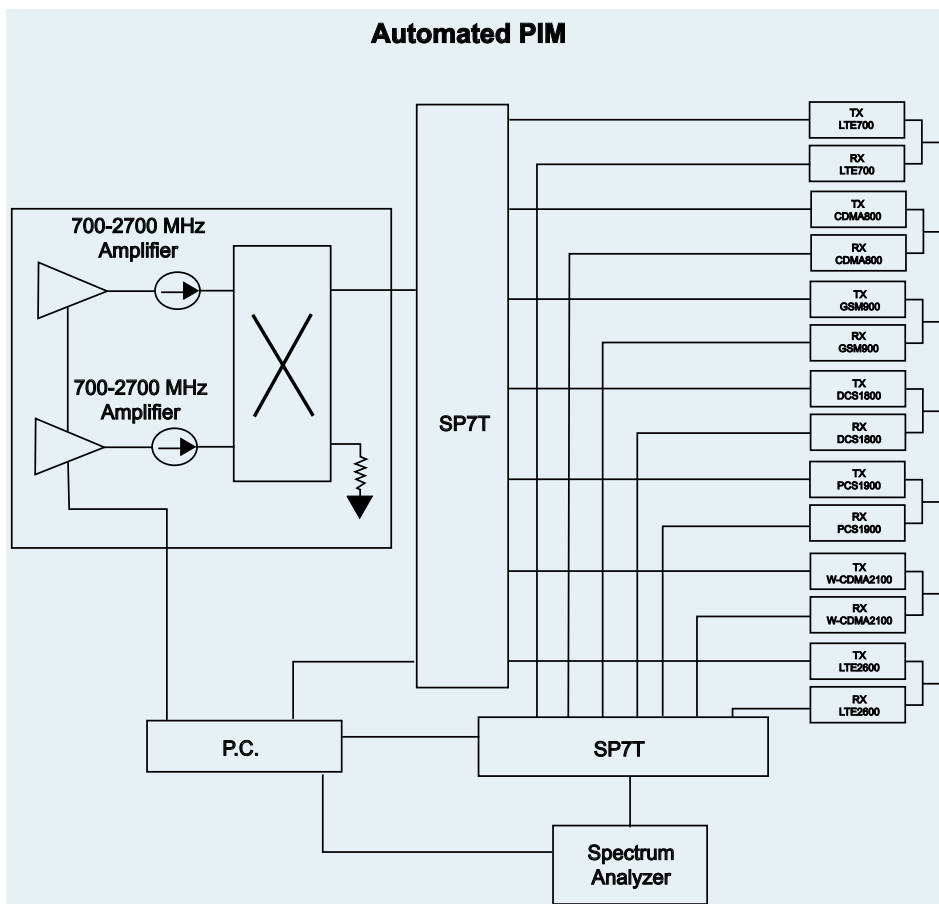ons can be designed to meet the exact requirements of a type approval test lab or for performance testing of production hardware. Figure 4a and 4b show typical layouts for both small signal and PIM testing applications respectively. Ease of calibration is an additional advantage inherent to test systems realized in this way.

This product feature provides an overview of a scheme for assembling affordable and flexible broadband emission monitoring test systems from high-performance building blocks. Dow-Key Microwave and K&L Microwave supply cost-effective test solutions tailored to customers' specific needs.

Telematics test platform addresses in-vehicle testing requirements

With cars increasingly incorporating telematics functions and features, testing of telematics devices becomes an issue for OEMs and tier ones. RF testing expert company IZT GmbH has developed IZT RecPlay, a platform for RF receiver design validation of analog and digital radio, video and global navigation satellite systems.

The platform features a portable monitoring RF recorder for mobile and telematics applications for accurate phase-synchronous recording of diversity signals from multiple antennas. Customers benefit from the lightweight recorder with a 30-cm high-resolution

touch screen as a turnkey solution for in-vehicle testing. The integrated GPS receiver serves as a highly robust time and location reference. RecPlay's signal generator IZT S1000 combines 31 virtual signal generators in a single platform for testing radio receiver and for creating complex mixed signal RF scenarios.

The system receives, records, and replays up to 20 MHz bandwidth in a frequency range from 9 kHz to 3000 MHz. It supports practically all radio broadcast standards such as FM-RDS, DVB-T, DAB, DAB+, DMB-Audio, Sirius and XM, including DRM/DRM+ and HD radio receivers.

www.izt-labs.de/en/home

CPRI and DAS

By John Spindler, Director of Product Management, TE Connectivity

One of the enduring challenges in matching up a distributed antenna system (DAS) with a mobile base station has been the need to use RF as the method of interface. Using RF as the interface adds complexity and cost to the deployment, but to date, DAS equipment has not been able to use the Common Public Radio Interface (CPRI) that has been defined for base stations. Now, DAS equipment is emerging that does use the CPRI interface, and this development solves several key problems.

CPRI defines the publicly available specification for the key internal interface of radio base stations between the Radio Equipment Control (REC or base station) and the Radio Equipment (RE, or radio head). The companies cooperating to define the CPRI specification now include Ericsson, Huawei, NEC, Nokia Siemens Networks and Alcatel-Lucent. (Nortel contributed as member of the CPRI cooperation to CPRI Specification versions 1.4, 2.1, 3.0 4.0 and 4.1 and left the cooperation in December 2009.) The CPRI specification has gone through several revisions, and today is at version 5.0.

The idea behind CPRI was to create an open standard for interfacing base stations with radio heads, but in reality, CPRI is neither Common nor is it Public, as it is not truly an open standard. Instead, similar to what happened with the Integrated Services Digital Network (ISDN) for PBXs, each
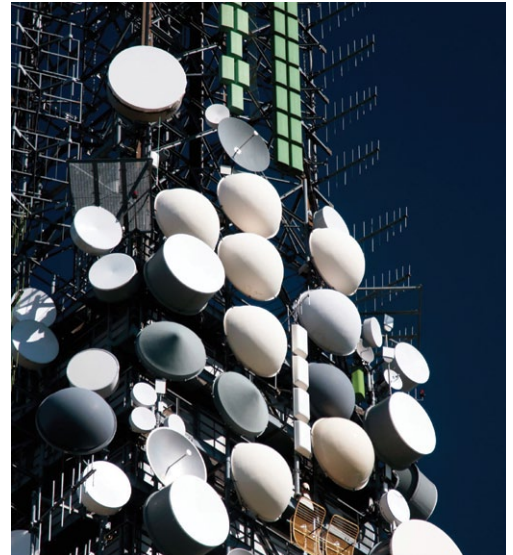
manufacturer developed its own flavour of CPRI that works only when interfacing its own base stations with its own radio heads. Since the major base station manufacturers don't make DAS equipment, DAS systems supplied by third party OEMs until now haven't been able to interface the DAS head end equipment directly with base stations through CPRI because each BTS manufacturer's CPRI interface is unique.

Instead, the DAS head end interfaces with base stations through the RF signal. This has been true since the inception of DAS over twenty years ago. However, there is a significant power mismatch between base stations and DAS head ends that must be accommodated for this interface to work. A typical base station puts out about 40 watts of power, and a DAS head end takes in roughly ¼ watt of power. Feeding 40 watts into a DAS will destroy the head end. As a result, the base station's power must be severely reduced before it can interface with the DAS.

There are several challenges with reducing base station power output.

Complexity - Base station power is reduced with racks of passive equipment called attenuators. All of this external "plumbing" between the base station (which can also include splitters, combiners, circulators, etc.) and the DAS head end adds to the complexity and cost of the deployment.

Space – Racks of attenuators take up floor space, making a DAS deployment much larger than it needs to be. In many cases, there may not be enough floor space at the intended facility to accommodate the entire deployment, so a separate, off-site facility must be built. This added expense can be a deal-killer for many mobile operators.

Heat – RF attenuators generate a lot of heat, making it necessary to spend more on air conditioning in DAS deployment areas.

Cost – The need for attenuators (and the rest of the aforementioned "plumbing"), and the need to invest manpower resources in designing and deploying all this RF "plumbing" adds Capex and Opex to the overall deployment, worsening the DAS business case for mobile operators.

Inefficiency – Mobile operators invest in large, hot, power-hungry amplifiers for their base stations, only to have their power substantially reduced in the actual deployment. Amplifiers are one of the biggest cost drivers in a base station.

By interfacing directly with a base station via CPRI instead of RF, the need for all this "plumbing" is eliminated, thereby saving space, power, and cooling costs in the DAS deployment. All of these elements are critical when evaluating the viability of a DAS deployment, both the practical and financial aspects.   DAS manufacturers' ability to use CPRI interfaces vs traditional RF will greatly improve deployment time and the business cases for mobile operators, thereby increasing DAS' market reach. Obviously, this will require direct cooperation from the base station manufacturers, as custom CPRI interfaces will need to be developed to work with each major base station manufacturer.

At the end of the day, with all of the challenges currently facing mobile operators in terms of providing focused coverage and capacity, supporting CPRI interfaces to the DAS head end will make it easier and more cost-effective to deploy DAS and help meet those challenges economically. CPRI interfaces are clearly the way forward for DAS and its continuing role as a critical element of the small cell ecosystem.

## WLAN/Bluetooth transceiver modules
based on WiLink™ 8.0

Murata has announced the LBEP series of wireless modules providing wireless LAN, Bluetooth® and Bluetooth low energy (BLE) connectivity.

Based around the WiLink™ 8.0 solutions from Texas Instruments, the miniature modules measure just 8.8 x 9.9 x 1.3 mm and offer a complete low cost, highly integrated approach to providing wireless connectivity to a wide range of consumer, industrial and commercial applications. The modules include an integrated crystal and require no additional external components. Host connectivity, antenna and power are the only connections required. A slow clock input can be used to support a deep sleep mode.

The LBEP5CLWMC module provides both 2.4 GHz (IEEE802.11 g/b/n and Bluetooth 4.0) and 5 GHz (IEEE802.11a) connectivity. This module uses the TI WL1803/1833 combo connectivity solution. Host interfaces of SDIO are used for the wireless LAN and UART or PCM for Bluetooth.

The LBEP5CLWTC module provides 2.4 GHz IEEE802.11b/g/n connectivity and uses the TI WL1831/1801 devices.

www.murata.eu
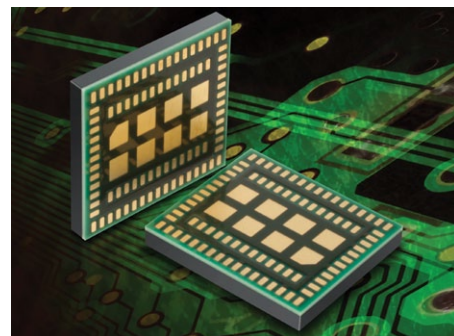
Radar chipset
makes advanced driver assistance systems more affordable

In the automated driving scenarios of the future and in many other safety-oriented advanced driver assistance systems (ADAS), Radar is one of the central sensor technologies. Chipmaker Freescale has introduced the Qorivva MPC577xK microcontroller (MCU) and MRD2001 77 GHz radar transceiver chipset to provide the embedded technology necessary for affordable radar based ADAS solutions with fewer components, helping increase the adoption of such features in mainstream vehicles.

The Qorivva MPC577xK MCU, built on Power Architecture technology, provides high-level digital and analog integration in a single-chip solution for radar applications, removing up to four additional major printed circuit board (PCB) components and reducing system-level cost, PCB space and software complexity. The MCU also provides high performance for intense computational tasks with key integrated digital accelerators and features a state-of-the-art signal processing toolbox that contains all of the hardware modules required for processing sampled signals from short-, medium- and long-range radar applications.

Performance data from the European New Car Assessment Programme (Euro NCAP) suggests that safety systems, such as Autonomous Emergency Braking (AEB), can reduce accidents by up to 27% and can lead to a considerable reduction in road injuries. Euro NCAP plans to incorporate the AEB assessment for cars sold in Europe into its five star rating scheme beginning 2014.

www.freescale.com

Broadband DC Block
for automated test and production

Response Microwave has announced the availability of its broadband DC block for use In automated test and production applications.

The RMDC.26500SMA27mf covers the 5 to 26.5 GHz band offering typical electrical performance of 0.8 dB insertion loss and 1.25:1 VSWR. Working voltage is 50 V and the unit is operational over the -55 to +85°C range. The mechanical package is 1.18 x 0.354 inches in diameter. The DC block is made from SUS303F passivated stainless steel and connectors are Super SMA male to female.

www.responsemicrowave.com

High-precision 12-bit PCIe digitizer
delivers multi-GHz real-time processing

Agilent Technologies's U5303A is a compact dual-channel PCIe digitizer with 12-bit resolution, sampling up to 3.2 GS/s, and on-board real-time processing.

The board has a DC-to-1.8 GHz bandwidth, features 9.1 ENOB at 100 MHz and a 58 dB signal-to-noise ratio together with very high data-transfer rates from an eight-lane PCIe 2.0 interface.

The U5303A gives users the ability to integrate advanced real-time signal processing within the embedded Xilinx Virtex-6 field-programmable gate array. This is made possible by the Agilent FPGA development kit for high-speed digitizers. This software kit provides interfaces that leverage the full density and speed of the FPGA while ensuring the digitizer's outstanding level of performance at multi-gigasamples per second.

www.agilent.com

Low-noise timing chipset
ideal for cellular infrastructure

Integrated Device Technology, (IDT) has announced a low-noise timing chipset for use in wireless base transceiver station (BTS) radio cards, enabling solutions phase noise-related challenges in wireless systems

The 8V19N4xx chipset is a flexible JESD204B-compliant radio frequency phase-locked loop (RF PLL) and clock synthesiser, designed to meet both the high frequency and low phase noise requirements for 2G, 3G and 4G LTE wireless infrastructure.

Using the company's FemtoClock NG technology, the low phase noise characteristics enable the system's analogue-to-digital and digital-to-analogue converters to function with high precision and very low distortion levels. This results in improved signal integrity on transmission and enhanced signal sensitivity on reception, increasing data throughput via lower bit error rates (BER). Reduced noise in the RF signal path enables base-station developers to decrease cost and complexity by relaxing the system's filter requirements.

The IDT 8V19N4xx chipset generates synchronised and highly-configurable clock and SYSREF signals as required by JESD204B applications. This allows designers to use a standard, cost-effective timing chipset with a high degree of flexibility instead of multiple PLLs, synthesisers, and buffers. In addition, the devices feature integrated clock jitter attenuation to simplify system design, and support a low-cost, low-frequency external VCXO to reduce system cost.

www.idt.com/go/timing

500-W GaN L-Band amplifier
suitable for radar applications

RF Micro Devices has introduced the RFHA1027, a gallium nitride (GaN) matched power transistor (MPT) that will deliver industry-leading pulse power performance of 500 W in a compact flanged package at L-Band.

The amplifier is optimized for pulsed power applications requiring efficiency and compact size. It operates from 1.2 GHz to 1.4 GHz and provides 500 W of pulsed RF power from a 50 V supply. It also offers high gain of 16.5 dB and high efficiency of 55 percent. The RFHA1027 is housed in a small form factor package of 24 mm by 17.4 mm, and is input and output matched to 50 ohms, efficiently minimizing external components. In addition, the package leverages RFMD's advanced heat-sink and power-dissipation technologies to deliver excellent thermal stability and conductivity.

The RFHA1027 targets new and existing radar architectures requiring ruggedness and reliability. The introduction of RFHA1027 follows the previous release of RFHA1020 (280 W L-Band) and RF3928 (280 W S-Band).

www.rfmd.com

Cavity duplexer
for indoor and outdoor wireless infrastructure

The Model AD772-802D363 cavity duplexer from Anatech Electronics is designed for indoor and outdoor wireless infrastructure applications.

The cavity duplexer has a Band 1 passband of 769 to 775 MHz and Band 2 passband of 799 to 805 MHz with insertion loss of 1 dB or less, ripple of less than 0.5 dB, return loss of at least 25 dB, and power handling of 50 W CW. It has an operating temperature range of -20 to +70°C and uses Type-N female connectors.

www.amcrf.com

Switches cover DC to 6 GHz
for applications up to 50 through to 200 W

KCB Solutions, an ITAR compliant and AS9100 certified microwave design and manufacturing center, has announced a suite of SPST through SP6T switches designed to meet high power-handling requirements from 50 to 200 W.
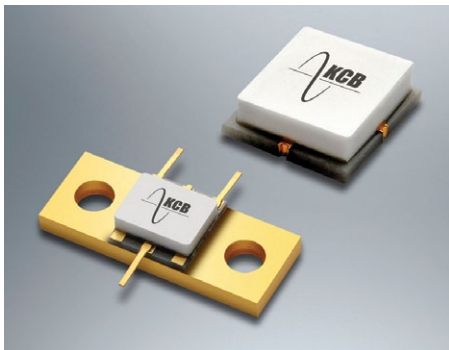
These switches are available in QFN-style packages and thermally conductive flange-mount packages. As an added feature, they are shipped to order in your choice of a variety of factory-configured ports. Designed and manufactured with PIN diode technology, they are 100 percent RF tested (small signal), have robust carrier construction, and are manufactured with thick deposition thin film traces.

For power levels up to 50 W, KCB offers these high power switches in surface mount packages. They offer low-loss performance from DC to 6 GHz and robust construction. They're ideal for today's demanding portable military communications.

To address the need for switches that can handle powers in excess of 50 W, KCB has developed a flanged-based package. By utilizing an AlN carrier with a CuW sub-mount, the construction of these products offers superior heat spreading which allows for CW incident power levels up to 200 W. This, coupled with larger minimum breakdown voltages, provides the designer with a switch that is ideally suited for higher powered radios, radar and counter IED systems. These models are available in configurations up to SP3T.

KCB offers several off-the-shelf configurations as well as dozens of possible configurations that can be quickly realized using off-the-shelf components. In addition, the designer can choose from a menu of diodes that provide optimal linearity for the application.

www.kcbsolutions.com

6 port entrance panels
enable cost-effective protection of base station equipment

Times Microwave Systems has added two 6 port entrance panels to its offering of the Times-Protect Smart-Panel, series, claiming to be the most revolutionary concept in shelter and base station entrance panels to come along.

Intelligently designed to eliminate traditional entrance panel shortcomings and vastly improve the protection of expensive base station equipment, the Smart-Panel® is truly a product for 21st century needs.

The Smart-Panel® provides for highly desirable single point grounding while eliminating the expense and potential incorrect installation of external grounding kits. The Smart-Panel® design provides for bulkhead mounting of the surge protectors directly on the panel for superior surge performance. Also eliminated are the traditional internal lightning protector "trapeze" as well as the external copper master ground bar so there's nothing to steal outside the shelter!

The Smart-Panel® is completely weatherized, accommodates any shelter wall thickness and is supplied with all the necessary installation hardware including an inside copper master ground bar and low inductance ground plate. The 6 port panels are especially suited for applications requiring fewer feeder cables such as public safety, SMU, 2-way land mobile radio, energy, utilities, SCADA, and so on.

www.timesmicrowave.com

Low power wireless modules
enable products for the "Internet of Things"

NXP Semiconductors has announced a range of small-footprint modules based on the ultra-low-power JN5168 wireless microcontroller. Supporting multiple network stacks including ZigBee® Home Automation, ZigBee Light Link, ZigBee Smart Energy, JenNet-IP™ and RF4CE, the JN5168 wireless modules are a mere 16 x 21 mm and offer very low transmit and receive power consumption.

All modules have 256 kB flash memory, 32 kB RAM and 4 kB EEPROM, as well as best-in-class low-power sleep modes. An SPI interface allows the connection of additional external flash memory for applications that require Over-the-Air firmware updates, and all other main functions and I/Os of the chip, such as I2C, ADCs, UARTs and PWMs, are accessible. Easily surface-mounted on motherboards, the JN5168 wireless modules come in a range of formats and output power levels, and are FCC, ETSI and CA approved.
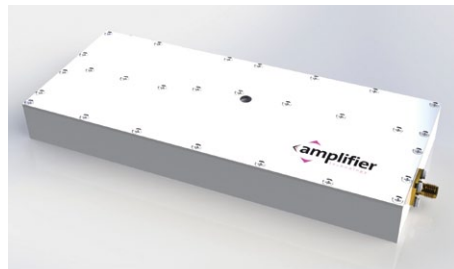
www.nxp.com

High linearity power amplifiers
boost cellular base station effectiveness

Amplifier Technology has introduced two power amplifiers for cellular base station

and telecoms applications, providing extremely linear output power to ensure the clean and consistent transmission demanded for reliable cellular service.

The 8860 power amplifier covers the frequency range 1.3 to 1.5 GHz, while the 8862 power amplifier covers the frequency range 2.3 to 2.7 GHz. Both deliver a minimum linear output power (P1) of 19 W, with high gain, ±1 db gain flatness and excellent phase linearity across the whole frequency range.

Today's base station amplifiers must be able to cope with multicarrier signals, high data rates and a wide range of wireless standards. With their high linearity, the 8860 and 8862 power amplifiers provide excellent error vector magnitude (EVM) with even the most complex waveforms to meet the demands of the latest generations of digital systems, ensuring reliable cellular coverage even under rapidly changing conditions.

The 8860 is built on GaN technology while the 8862 is designed using laterally diffused metal-oxide semiconductor (LDMOS) technology in a Doherty configuration. Both deliver high efficiency power in a compact form factor. Measuring 180 x 75 x 20 mm and weighing 400 g, the 8860 and 8862 power amplifiers provide an SMA RF connector and a 9-way D-type connector for control and monitoring.

Suitable for ambient temperatures from -40 °C to +55 °C and relative humidity up to 95 percent, the 8860 and 8862 power amplifiers are vibration resistant to IEC 68-2-6 and shock resistant to IEC 68-2-27.

www.amplifiertechnology.com

Quad-core HSPA+ processor
with 5G WiFi, NFC, GPS and indoor positioning

Broadcom Corporation has announced a quad-core HSPA+ processor designed for high-performance, entry-level smartphones. The BCM23550 is the company's latest smartphone platform optimized for the Android 4.2 Jelly Bean operating system (OS).

The BCM23550, and its turnkey design, are powered by a quad-core processor running at 1.2 GHz, VideoCore multimedia and an integrated HSPA+ cellular baseband that provides enhanced, power-efficient features for entry-level smartphones.

The BCM23550 supports "dual HD," allowing users to simultaneously share high-definition content from a small hand-held screen to a larger, Miracast-enabled display. It includes leading VideoCore technology for fluid, responsive graphics and incorporates power management techniques to optimize battery life and reduce power consumption without compromising the user experience. The platform provides an integrated Image Signal Processor (ISP) that supports up to 12-megapixel sensors with advanced imaging capabilities such as blink and smile detection, face tracking, red eye reduction, fast shot to shot (burst capture), zero shutter lag, and best picture selection. It also integrates NFC with native support for simplified connectivity and mobile payments systems like Quick-Tap from China UnionPay.

The quad-core processor is coupled with Broadcom's connectivity suite, which includes the comapny's leading 5G WiFi technology, multi-constellation GNSS support, and advanced indoor location capabilities to enable ubiquitous positioning both indoors and outdoors.

www.broadcom.com

4G/LTE backhaul in a single box
in an all-outdoor "zero footprint" format

Wireless Excellence has announced their CableFree FOR2 microwave transmission product for 4G/LTE and 3G backhaul, as well as telecom, ISP, government and other types of wireless network. FOR2 provides high capacities in an all-outdoor "zero footprint" format and can be deployed without indoor components, racks or space. Timing, IP network intelligence and resilience are all included in the unit.

CableFree FOR2 uses the licensed frequency bands from 7 to 38 GHz, and offers 400 Mbps full duplex per channel (800 Mbps aggregate) scaling up to 800 Mbps (1.6 Gbps aggregate) or higher

using multiple channels. It comes with advanced features such as Adaptive Coding and Modulation and Automatic Power Control to ensure maximum uptime and stability of links even in harsh conditions such as tropical rainfall.

Important synchronisation features for 3G/4G base stations and support for Synchronous Ethernet and IEEE 1588v2 are included to simplify direct connection to cellular infrastructure.

At the network level, it offers native support for 2+0 aggregation for 800 Mbps full duplex capacity as well as 1+1 resilience within the radios, and Ethernet Ring Protection and Rapid Spanning Tree, to build resilient city networks with all types of topology.

Integrated Radio Link Aggregation allows a simple "pay as you grow" model, adding extra channels or components as needed to meet rising bandwidth demands. The systems are MEF9 and MEF-14 (Metro Ethernet Forum) compliant.

www.wirelessexcellence.com

RF front-end amplifiers and filters
target small cell base transceiver station applications

Avago Technologies has announced two RF power amplifiers, the MGA-43728 and MGA-43828, and a WiFi FBAR filter, the ACFF-1024, designed specifically for small cell base transceiver station (BTS) applications.

Expanding upon Avago's proven MGA-43x28 PA family, the MGA-43728 and MGA-43828 are respectively new UMTS/LTE Band 7 and Band 8 power amplifiers featuring high linearity, gain and power-added efficiency (PAE) with integrated power detector and shutdown function.

The ACFF-1024 is a miniature band-pass filter optimized for use in

the 2.4 GHz ISM band. Designed with Avago's innovative FBAR technology, the ACFF-1024 enables concurrent operation of WiFi and Bluetooth applications that coexist with other wireless standards such as PCS and LTE Bands 7, 38, and 40 without performance degradation due to interference.

The MGA-43728 features a linear Pout of 27.3 dBm at 48 dBc ACLR (LTE, 10-MHz/50RB), gain of 38.3 dB, and PAE of 13.7 percent. The MGA-43828 has a linear Pout of 27 dBm at 50 dBc ACLR (UMTS, 5 MHz), gain of 33.0 dB and PAE of 15.0 percent.

The ACFF-1024 offers WiFi and Bluetooth coexistence with LTE Bands 7, 38, and 40, as well as 57 dB minimum attenuation in LTE Band 7, 55 dB minimum attenuation in LTE Band 38, and 50 dB minimum attenuation in LTE Band 40.

www.avagotech.com

TVS diodes
protect the antenna in wireless devices from ESD strikes

Infineon's latest transient voltage suppressor (TVS) diodes protect antennae and front-end devices from transient voltage events. The latest ESD101x and ESD103x diodes absorb dangerous electrostatic discharges (ESD) to prevent damage to the antenna system while maintaining signal integrity.

Optimised features for antenna protection include a symmetrical bidirectional configuration with a very low capacitance of only 0.1 pF to avoid mismatch and insertion loss. ESD101x and ESD103x offer high linearity as required by TX and RX systems. In order to be compliant with various regulations regarding electromagnetic compatibility (e.g. ETSI EN 300 328), harmonic generation is minimised. Furthermore, intermodulation distortion is kept low to avoid in-band interference and jamming of the other radio services.

Due to their minimal power consumption – with typical leakage current below 0.1 nA at working voltage in normal operating mode – the new diodes help to prolong battery life in portable electronic systems.

www.infineon.com/esdprotection

Signal and spectrum analyser
delivers 320 MHz analysis bandwidth

Rohde & Schwarz has doubled the analysis bandwidth of its high-end FSW signal and spectrum analyser from 160 MHz to 320 MHz, asserting that it is currently the only signal and spectrum analyser on the market able to process signals in this bandwidth.

This analysis bandwidth gives the analyser a competitive edge in a variety of applications related to wideband digital communications and radar systems, Rohde & Schwarz says, for users who need to analyse radar signals with very short pulses of less than 10 ns or wideband signals in radar systems. Analysing automotive radar signals (FM CW radar or pulsed radar) requires at least 200 MHz, for example. The instrument is also suitable for performing interference analysis on radar signals and digital communications signals and for testing multistandard radio base stations.

In addition, the analyser can be used for carrying out modulation analysis on radio links with a channel bandwidth of 250 MHz. During measurements for determining the digital predistortion required for amplifier linearisation, signals with a wider bandwidth than that of the actual signal have to be captured.

In the past, measuring these kinds of wideband signals required complicated test setups consisting, for example, of a digital oscilloscope and a downconverter. The FSW not only simplifies the test setup. It also offers significantly wider dynamic range and is easier to calibrate than other solutions. Users can upgrade their FSW from 160 MHz to 320 MHz by entering a key code.

www.rohde-schwarz.com

Tiny broadband mixer for radar applications
in a plastic TDFN package for cost-effective requirements

M/A-COM has released a broadband sub-harmonic pumped mixer for cost sensitive applications covering the 14 to 32 GHz frequency range and IF frequencies from DC to 7 GHz.

The MAMX-011009 comes in a 1.5 x 1.2 mm TDFN surface mount package, it has a single RF port, requires no biasing and has excellent 2xLO and 3xLO isolation eliminating the need for extra filtering. The device requires +15 dBm of LO power that can be easily attained by implementing the MAAM-011101, which is a single bias low cost 4-20 GHz buffer amplifier offered by MACOM.

The part can be used for up or down frequency conversion. The mixer integrates an 180° balanced diode topology that allows the LO to be injected at ½ the LO mixing frequency, which improves isolation and simplifies system requirements for the customer.

www.macomtech.com

Small thin-film 10-W 3-dB directional couplers

AVX Corporation claims to offer the smallest thin-film 10-W 3-dB directional couplers available. Based on the company's proven thin-film technology, the 0603 3-dB 90° couplers exhibit excellent high-frequency performance in ranges spanning 800 to 6000 MHz and are currently unique in their ability to provide 10 W continuous power handling.

Utilizing Land Grid Array (LGA) packaging technology, the 10-W 3-dB directional couplers feature an inherently low profile, low parasitics, excellent solderability, and improved heat dissipation in addition to self-alignment during reflow. Surface mountable and RoHS compliant, the DB0603N couplers also feature low loss, high isolation, and rugged construction for reliable automatic assembly.
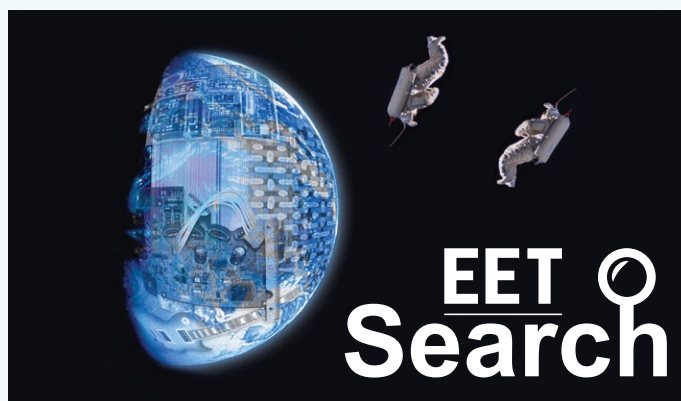
Supplied on tape and reel, these 10-W 3-dB directional couplers are ideal for a broad range of wireless communications applications, including: mobile communications, satellite TV, GPS devices, vehicle location systems, and wireless LANs, among others.

www.avx.com

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