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July 2013



Microwave Journal

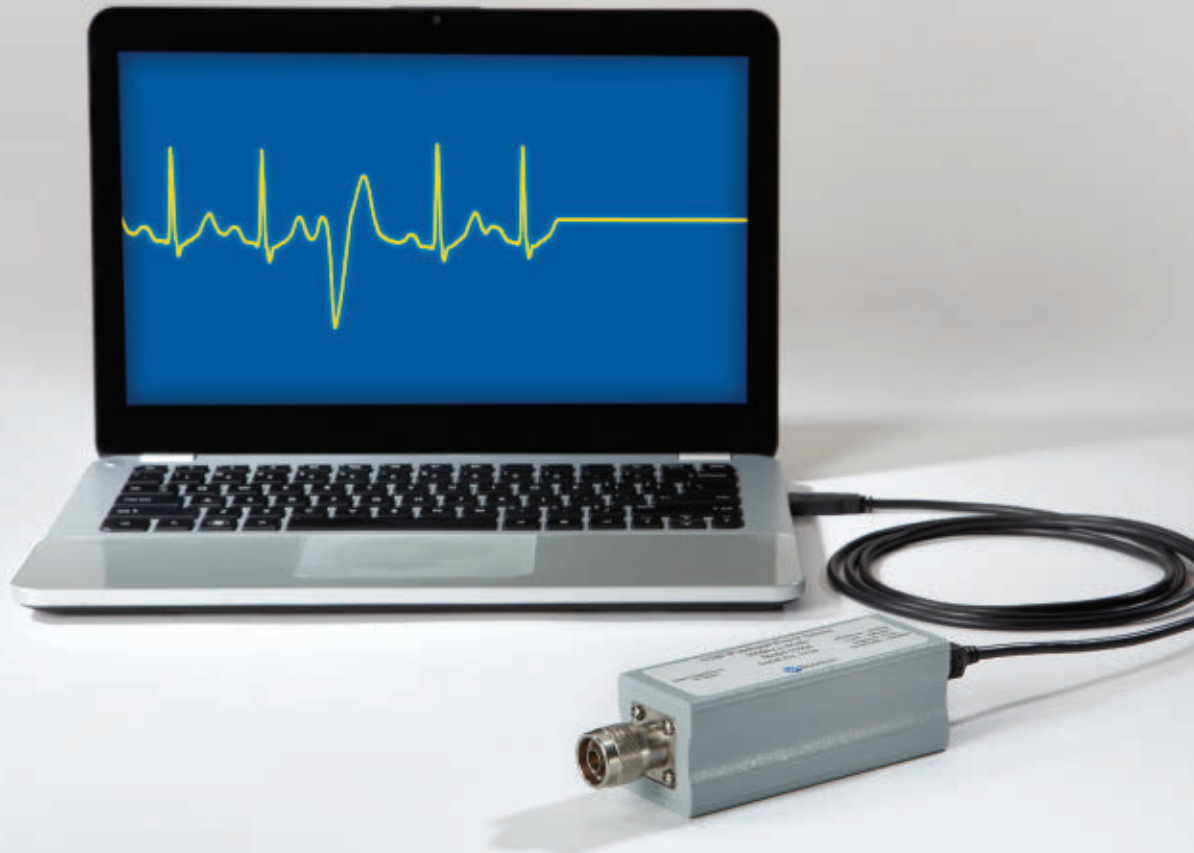
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2013 Design Software Review



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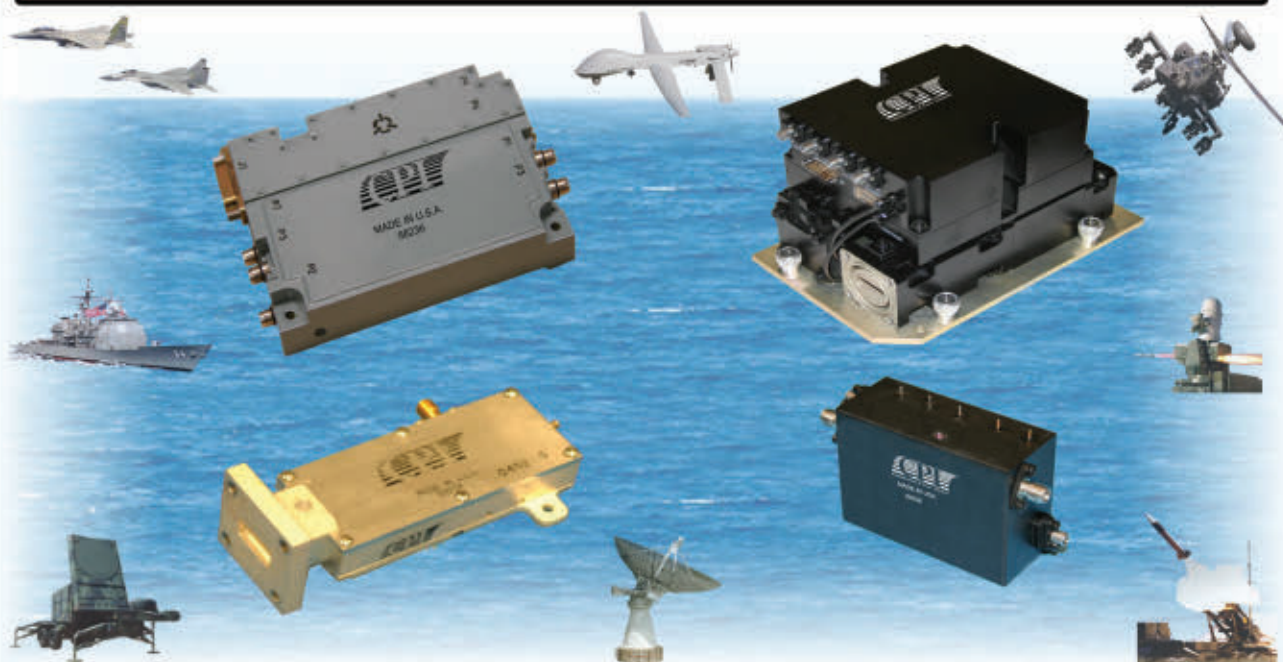
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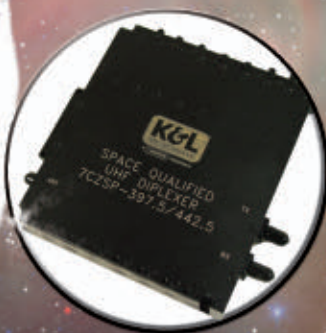
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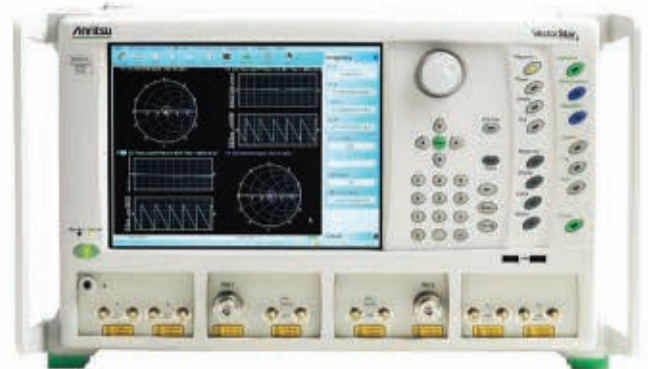
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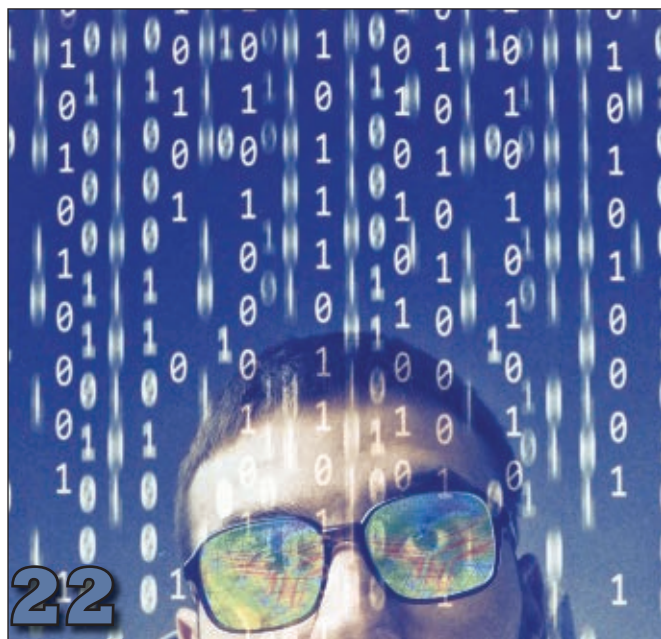
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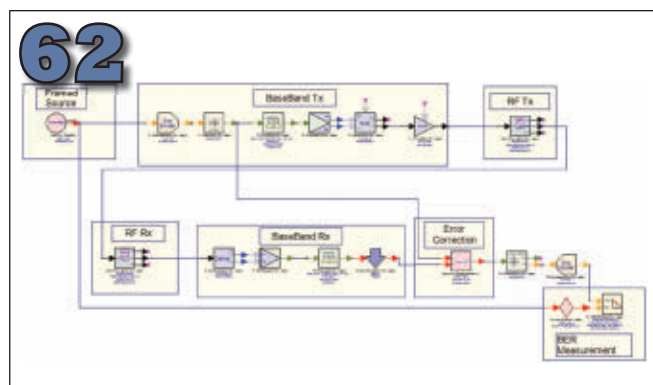
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Contributions from many of the industry's leading design software vendors as they reflect on the state of software tools in 2013. Contributors include: Agilent, ANSYS, AWR, Cadence, COMSOL, CST, FEKO, IMST, Intercept Technologies, Mician, MiG, Remcom, Sonnet and Tech-X.

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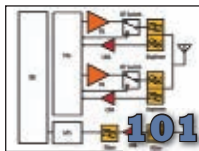
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- New GaN SSPAs
- Military Microwaves Supplement – UAVs Unleashed

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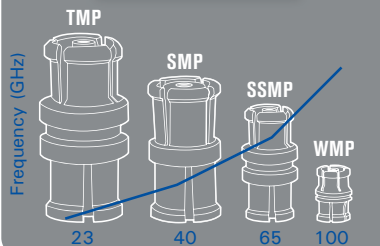
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Innovations in EDA

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Designing Custom RF and Analog Filters Through Direct Synthesis

8/1



May Survey

What frequency range do you mostly design for?

RF (under 700 MHz) [34 votes] (17%)

RF/Microwave (700 MHz-5GHz) [91 votes] (45%)

Microwave (5 GHz-30 GHz) [55 votes] (27%)

Millimeterwave (over 30 GHz) [19 votes] (9%)

Lightwave [5 votes] (2%)

Executive Interview

Microwave Journal talks to **Paul Blount**, president and CEO of **Custom MMIC** about the business and technology trends driving his company's product development efforts.



White Papers

Calculating VNA Measurement Accuracy

Anritsu

Overview of Tests on Radar Systems and Components

Rohde & Schwarz

Introduction to Radar System and Component Tests

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Fundamentals of Oscilloscopes Primer

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Synchronization for Next Generation Networks—The PTP Telecom Profile

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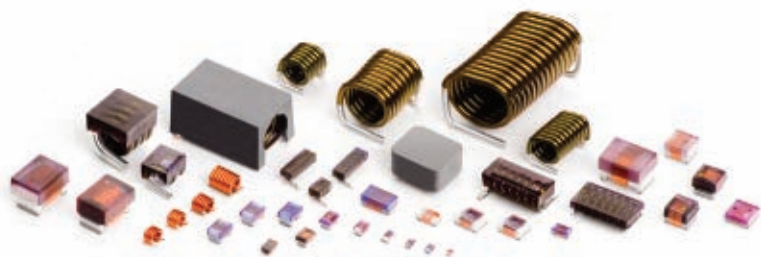
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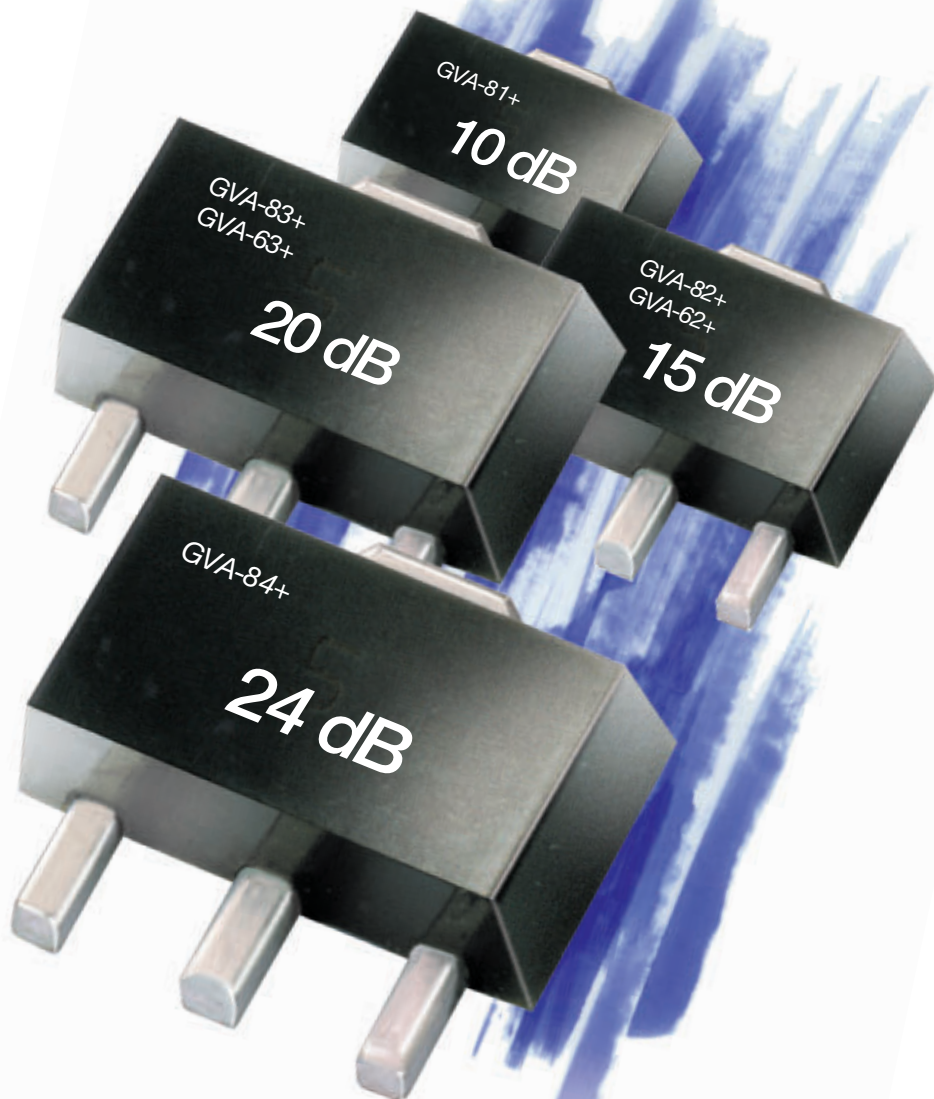
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US patent 6,943,629

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AUGUST 2013

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
28	29	30	31	1 Webinar: Designing Custom RF and Analog Filters Sponsored by  Agilent Technologies	2	3
4	5	6	7  EMC 2013 DENVER, COLORADO	8	9	10
		7  NATIONAL INSTRUMENTS NIWEEK 2013 Austin, TX				
11	12	13  AUVSI's Unmanned Systems 2013 WASHINGTON, DC • 12 - 13 AUGUST	14	15 Webinar: Innovations in Aerospace/Defense Sponsored by  Agilent Technologies	16	17
18	19	20 Webinar: PCB Design - Part 2 Sponsored by   LPMF Laser & Electronics	21	22 Webinar: Innovations in Wireless Communications Sponsored by  Agilent Technologies	23	24
25	26	27	28	29 Webinar: PIM Webcast Sponsored by  Agilent Technologies	30	31

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SOURCES UP TO 160GHz

SWITCHES UP TO 160GHz
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WAVEGUIDE PRODUCTS UP TO 325GHz

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ATTENUATORS(UP TO 160GHz)
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ELECTROMAGNETIC COMPATIBILITY
August 5–9, 2013 • Denver, CO
www.emc2013.org

AUVSI's UNMANNED SYSTEMS 2013

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OCTOBER

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NOVEMBER



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2013 LOUGHBOROUGH ANTENNAS & PROPAGATION CONFERENCE

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DECEMBER

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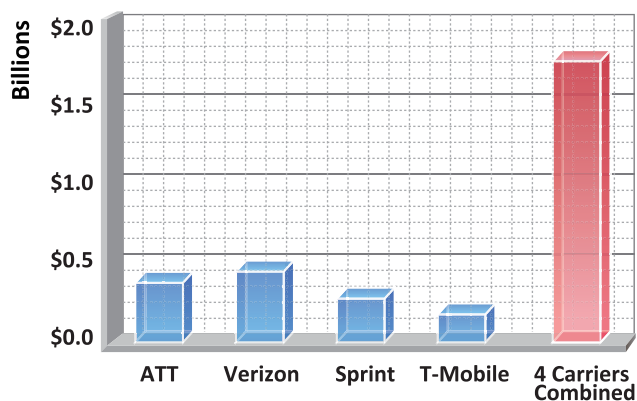


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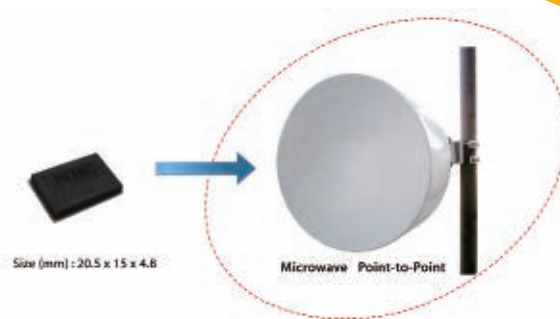
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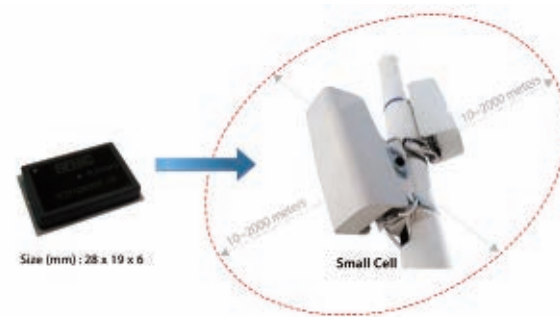
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COVER FEATURE
INVITED PAPER

RF/Microwave Design Software Review

Designing components and subsystems for use at RF and microwave frequencies is no longer achieved with a ball-peen hammer, epoxy filler and paint. Today's engineers are required to hit performance specifications in a smaller footprint, using new materials to reduce cost and weight and under significant time-to-market pressure. This new norm has led to the widespread use of RF/microwave centric design and EM analysis tools. These software products are under significant pressure to improve their speed, capacity, accuracy and time-saving automation. The following contributions from many of the industry's leading design software vendors reflect the state of software tools in 2013.

David Vye, Microwave Journal Editor

AGILENT

Engineers require design flow integration because today's RF/MW designs themselves have become more integrated. The RF modules inside popular wireless consumer products contain multiple ICs on a small printed circuit board (PCB) carrier or laminate connected to the ICs with wire bonds or solder bumps and are covered in a compound mold or package. When designing these RF modules, engineers use a variety of design software to simulate and fabricate the individual components, as well as the completed consumer wireless device. Each tool typically performs an individual function, such as schematic, IC layout, PCB/laminate layout, circuit simulation, layout verification, planar electromagnetic (EM) simulation, 3D EM simulation or packaging. While some Electronic Design Automation (EDA) vendors do offer tools with multiple functions, companies often purchase tools from several

vendors to have a complete RF module flow. In response, EDA vendors have developed design flow integration solutions based on point-to-point links between tools. This approach inherently has the potential to corrupt user design and make round trip design iteration an even bigger challenge.

A preferred approach would maintain the integrity of the users' design data by architecting the design software so that translation, migration or conversion of the data to another format is never necessary. This idea began several years ago with the concept of an open, industry standard database on which design software is built. Today, enterprise EDA vendors, like Cadence, Synopsys and Mentor Graphics, are using the same industry standard, open database structure for schematic and layout design data; they are also developing layout verification tools that operate on this customer design data.

While this concept was originally created

6GHz Mixer Delivers 32dBm OIP3

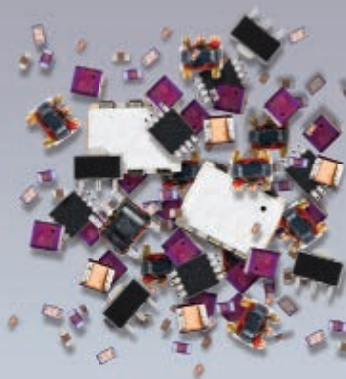
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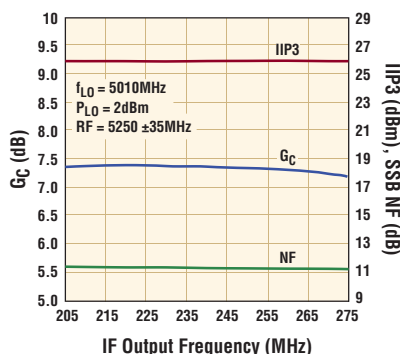
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for single technology ICs, Agilent extended it to multiple, heterogeneous technologies, including IC, laminate/PCB, packaging and 3D solid model technologies. With the help of several of its customers who are industry-leading RF and microwave suppliers, Agilent embarked on a multi-year effort to re-engineer its Advanced Design System (ADS) and EMPro software platforms to incorporate this expanded concept. The result is the next generation of these platforms—ADS and EMPro 2012.

A simple, but compelling example of the design flow integration now present in these tools is the ability for EMPro and ADS to directly share design data. A 3D solid model created in EMPro can be directly opened in ADS for Finite Element Method (FEM) simulation in a larger multi-technology design. Freescale Semiconductor took advantage of this concept to develop a new discrete design methodology, dramatically improving its power amplifier design flow. A webinar is available at mwjournal.com/ADSFreescaleWebinar.

ANSYS

The new 3D electrical layout interface for ANSYS HFSS allows engineers to easily create designs consisting of fully parametric planar stack-ups, via padstacks, transmissions lines and other planar structures and transitions with a few button clicks. In addition, the new interface has a simplified boundary assignment methodology and automated excitation assignments which reduce the engineering and simulation setup times. While the user interface and model creation has been greatly simplified, the solution is still generated by the trusted HFSS solver. This enables true 3D electromagnetic field analysis of key design parameters, including trace thicknesses, etching, bondwires, solder balls and solder bumps in a robust, reliable, and highly accurate design and simulation flow.

The new functionality integrates with existing ECAD design flows and can import geometry from Altium, Cadence, Mentor Graphics, Zuken, and ODB++ compatible databases allowing full or partial designs to be imported directly. Specialized integration with Cadence is also included so users of Cadence

software can set up ready-to-solve chip, package and PCB simulations directly from Allegro® Package Designer, Allegro PCB Designer, SiP Digital Layout, or Virtuoso® Analog Design Environment for analysis in HFSS. All the necessary HFSS set-up steps – geometry and net selection, material properties, excitations and boundary conditions – are completed in the Cadence software and transferred to HFSS for solving the electromagnetic field and S-parameters via a single click.

ANSYS also provides direct integration of Synopsys® HSPICE® through ANSYS Designer. Using ANSYS Designer and its tight integration with HFSS solver technology, engineers have a design platform where the ANSYS best-in-class electromagnetic field solver technology HFSS, Q3D Extractor, SIwave and the gold standard transient circuit simulator HSPICE can operate from a single interface. This results in the Gold Standard design platform for signal- and power-integrity analysis. With ANSYS Designer at the core of this platform high-speed component designers can analyze 3D EM behavior of advanced electronic systems, including gigabit communications channels and high-speed wireless systems. Users can combine S-parameters, w-elements, HSPICE, HSPICE encrypted, IBIS and IBIS-AMI models directly as schematic components allowing them to seamlessly integrate with behavioral, circuit and GHz-accurate interconnect models in a unified schematic desktop.

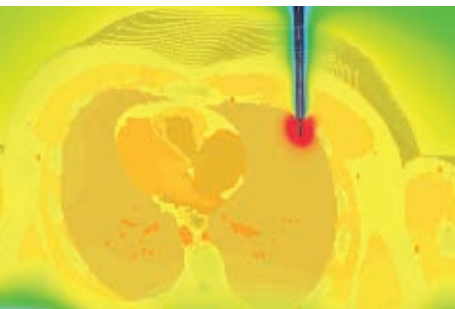
AWR

AWR's EM simulation software tools, like Analyst™ 3D finite element method (FEM) EM simulator, AXIEM® 3D planar EM simulator and EM Socket™ technology introduced in 2003, are now seamlessly integrated within their Microwave Office® (MWO) circuit design software to address RF/microwave and wireless systems that are being designed into shrinking footprints and/or alternative processes such as GaAs and GaN. This allows MWO circuit designers to directly access EM simulation within a single design environment. This integration allows designers to easily transition from system to



Make the Connection

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Simulation of cancer treatment
by RF thermoablation

Components don't exist in electromagnetic isolation. They influence their neighbors' performance. They are affected by the enclosure or structure around them. They are susceptible to outside influences. With System Assembly and Modeling, CST STUDIO SUITE helps optimize component and system performance.

Involved in biomedical applications? You can read about how CST technology was used to simulate biomedical devices at www.cst.com/biomed.

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 - 10 dBm
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 - 0 dBm
 - + 5 dBm
- **Removable connectors for circuit board assembly**
- **Ideal for LNA Protection**

MODEL	FREQ. RANGE (GHz)	NOMINAL ¹ LEAKAGE LEVEL (dBm)	TYPICAL ² LEAKAGE LEVEL (dBm)	TYPICAL ³ THRESHOLD LEVEL (dBm)
LL00110-1	0.01 - 1.0	-10	-	-11
LL00110-2		-5	-	-6
LL00110-3		0	-	-1
LL00110-4		+5	-	+4
LL0120-1	0.1 - 2.0	-10	-	-11
LL0120-2		-5	-	-6
LL0120-3		0	-	-1
LL0120-4		+5	-	+4
LL2018-1	2 - 18	-	-10 TO -5	-10
LL2018-2		-	-5 TO 0	-5
LL2018-3		-	0 TO +5	0

Notes:

1. **DC Supply required: +5V, 5mA Typ.**
2. **Typical and nominal leakage levels for input up to 1W CW.**
3. **Threshold level is the input power level when output power is 1dB compressed.**

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circuit to EM analysis automatically, addressing design functions such as drawing 3D shapes, extrusions, port setup and meshing/convergence tweaks, not to mention importing and exporting either CAD and/or resulting S-parameter files across vendor environments.

The AXIEM tool addresses 3D planar applications such as RF printed circuit boards (PCB) and modules, low temperature co-fired ceramic (LTCC), monolithic microwave integrated circuit (MMIC) and RFIC designs. By delivering EM analysis as an integral part of the design flow, Ax-iem benefits designers by helping to diagnose issues early, thereby shortening the design process. It does this by pulling from the schematic/layout and automatically understanding the circuit hierarchy and nuances necessary from EM so that ports, frequencies, convergences criteria, etc. are all pre-set for the user such that a single button click runs the EM simulation and analysis. Analyst provides similar functionality for EM analysis of 3D interconnect in chip/board/module designs. Analyst eliminates the need to launch a third party drawing and simulation tool, operating directly from Microwave Office with a single mouse click. Layout setup and drawing are simplified through automatic simulation settings and preconfigured 3D parametric cells (Pcells) that eliminate manual setup and drawing tasks.

What AXIEM and Analyst really have in common goes beyond the fact that they are both powerful yet easy to use and intuitive EM simulators. They embrace the modular approach that AWR has built from day one within its AWR Design Environment™ framework using the EM Socket interface. The concept is, quite simply, the ability to use one or multiple EM tools, from method-of-moments (MoM) to finite difference time-domain (FDTD) to full FEM or even FIT as an integral part of the design flow. This is a critical requirement for circuit designers (MMIC, MIC, RFIC, RF PCB, microwave modules, et al) and yet the essence of what methodology would be best for each individual design task (fastest, most accurate, etc.) is left to the discretion of the user or customer or industry.

CADENCE

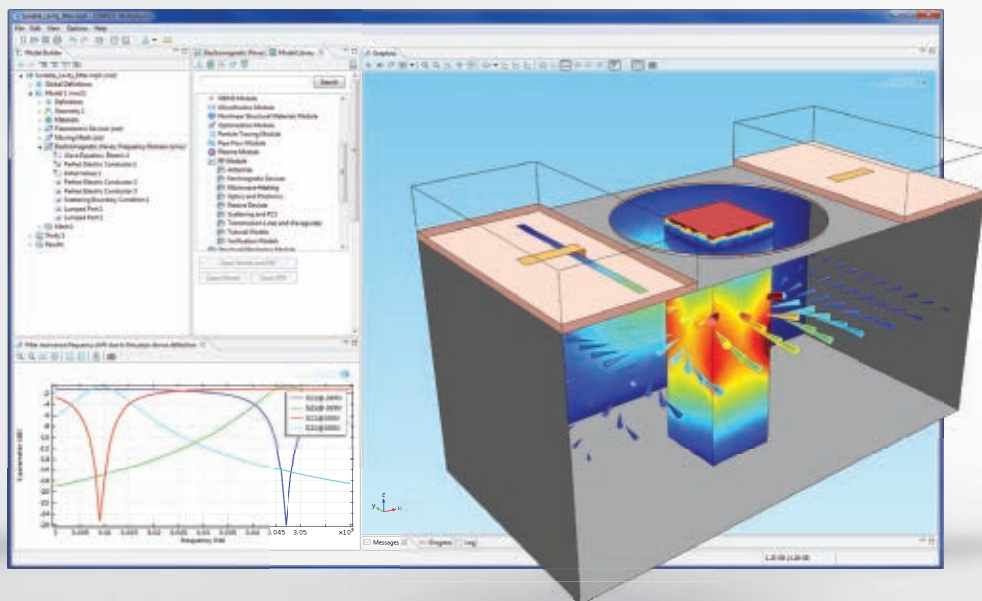
The Allegro Sigrity® signal integrity (SI) product integrates advanced EM analysis for PCB and IC package design in a constraint-driven design environment. The Allegro physical implementation tools enable PCBs, single die packages or stacked die packages to be designed and prepared for manufacturing.

Many products are being implemented using lower voltages with faster data transfers. In years past, SI tools focused on the signal path and assumed that the current would return on an ideal power/ground return path. At slower speeds and larger voltage swings, it was relatively safe to assume ideal power and ground, and to build in a small amount of margin for noise on the planes and timing push-out due to simultaneous switching output (SSO) noise. Today, however, assuming ideal power and ground is a risky proposition as the ground plane discontinuities and simultaneous switching noise (SSN) effects now consume a much larger portion of both the signal quality and timing budgets.

Allegro Sigrity SI products provide a power-aware signal integrity environment for multi-gigabit SerDes and DDR interface design. The SI tool suite is constructed such that base level analysis using 2D boundary element method (BEM) and finite element method (FEM) field solvers provides quick results using first-order analysis techniques such as ideal power and ground and uncoupled via modeling. Later in the design process, engineers can call on detailed power-aware SI analysis. The power-aware technology includes advanced field solvers for modeling interconnect used in high-frequency signaling. The hybrid (2D/3D) and full-wave solvers model signal, power and ground in a fully coupled manner. A SPICE-based simulator provides transient circuit-level analysis results from circuits that span across chip, package and board. All the effects of SSN are considered. The highly automated post-analysis waveform processing and report generation verify timing closure on DDR interfaces and ensure electrical specification compliance on SerDes interfaces.

The die-to-die system-level analysis is largely enabled through the in-

TUNABLE CAVITY FILTER: A piezo actuator is used to tune the resonant frequency of a cavity filter used in a miniaturized satellite. Other applications include broadcasting and wireless communication.



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Multiphysics tools let you build simulations that accurately replicate the important characteristics of your designs. The key is the ability to include all physical effects that exist in the real world. To learn more about COMSOL Multiphysics, visit www.comsol.com/introvideo

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telligent combination of circuit analysis and EM analysis. Circuit-level analysis is used to connect the interconnect models. The models can be an extraction of individual pieces such as traces, vias, pads and wirebonds, or they can be S-parameter data that is collected from a test bench using test and measurement equipment such as a vector network analyzer (VNA). EM analysis (both 2D and 3D) is applied during the extraction of signal

interconnect while 3D EM analysis handles power planes and shapes. The circuit and the 3D EM analyses are merged into one fully coupled model. All local and global SI and PI effects are considered by this combined circuit/EM analysis approach.

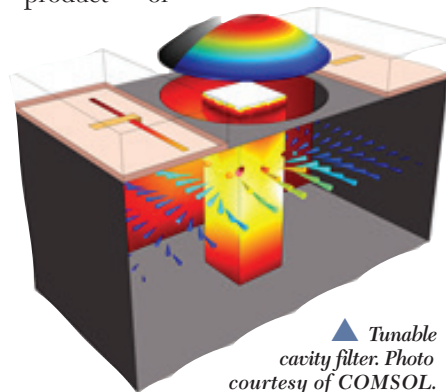
For ultra-high-frequency designs, extraction of interconnect is commonly accomplished with 3D full-wave EM techniques. To enhance accuracy, the hybrid solver technology is

supplemented with a 3D FEM field solver within Allegro Sigrity SI tools. 3D EM is commonly used to extract interconnect of multi-gigabit channels, breakout regions for dense packages and connectors or for high-density interconnect (HDI) via technology commonly used in high-end consumer devices.

COMSOL

COMSOL Multiphysics software provides 38 application-specific modules in the electrical, mechanical, fluid and chemical disciplines so that COMSOL users can simulate their applications with a multiphysics approach. The six modules developed for the electrical engineering discipline include: the AC/DC Module, RF Module, Wave Optics Module, MEMS Module, Plasma Module and Semiconductor Module. The RF Module models the propagation of electromagnetic waves in and around structures. The new Wave Optics Module accurately simulates optical systems with geometric dimensions much larger than the wavelength. When analyzing electrical devices and circuits, the AC/DC Module allows users to go beyond conventional analysis by providing a simulation for a mixed system of lumped and high-fidelity models.

A particular strength of COMSOL Multiphysics is its ability to combine any physics effect with any other, such as RF heating, mechanical stress and deformation effects – all crucial components in electrical applications. In addition to its multiphysics capabilities, COMSOL simplifies the design process with a single, intuitive modeling and simulation environment. From within this interface, the design flow process of a product or



▲ Tunable cavity filter. Photo courtesy of COMSOL.

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Anticipate — Accelerate — Achieve



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design can be integrated with COMSOL Multiphysics using the Live-Link™ products, which allow for interfacing between COMSOL and other simulation and CAD software.

For example, a Tunable Cavity Filter includes a piezo actuator that is used to control the size of a small air gap in a cavity filter which tunes the resonant frequency. Results show the S-parameter as a function of the frequency and total displacement of

the actuator. Cavity filters are used in wireless products, RF and satellite applications.

In a second example, a Self-Focusing Laser Beam uses a model of a self-focusing Gaussian beam developed using the Wave Optics Module (this is important in the design of high-power laser systems). The simulation demonstrates 3D nonlinear wave propagation and the distribution of the index of refraction within the lens.

CST

CST STUDIO SUITE® provides a smooth workflow for the whole product design cycle including tools for importing and exporting CAD and EDA files in numerous industry standard formats. However, since models used in field simulation have to fulfill special requirements, models created with CAD software are often not suitable for simulation directly, perhaps because they are too detailed or contain flaws and corrupted elements. These are dealt with using shape-healing tools to convert CAD data into a simulation-ready model. To process data, which are often layered, 2-dimensional structures, from EDA software, CST can create 3D models based on stack-up, via and bondwire information. The ability to parameterize imported models enables optimization and sensitivity analysis even if the geometry was not originally generated in CST STUDIO SUITE.

CST STUDIO SUITE provides a template-based post-processing system which automates using simulation results to calculate additional user-relevant data. Built-in optimizers are included as a standard feature of the software. The software also includes links to a number of specialist products, such as Optenni Lab for matching circuit tuning and EMIT for co-site interference analysis. These additional products can read models and fields from CST STUDIO SUITE simulations and use them as the basis of further calculations, without the need to start from scratch. Engineers can also use their own VBA macros or MATLAB code to fully control the software and analyze the data to support their own unique requirements.

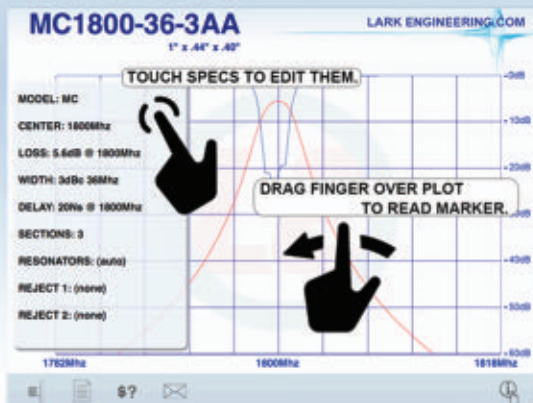
Complex systems may contain several elements that are each suited to a different solver. One such example is a satellite dish, where the feed network is well suited to a frequency domain solver, the feed antenna is best simulated with a time domain approach and the reflector dish needs an integral equation solver. CST's "Complete Technology" approach offers on demand access to all these simulation methods in a single design environment. System Assembly and Modeling (SAM) allow users to build their own simulation flow within CST STUDIO SUITE. Rather than using a single 3D



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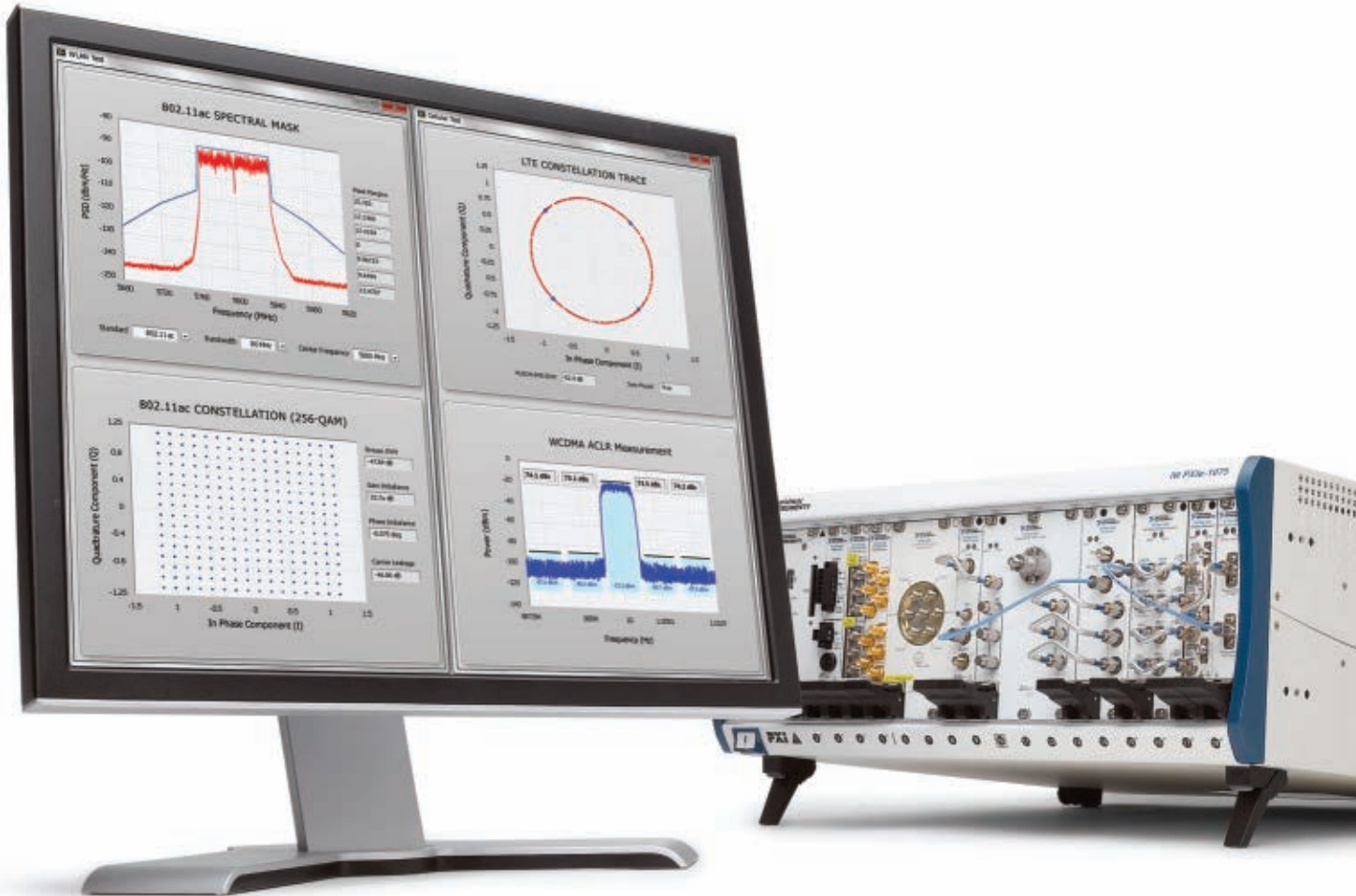


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model, the antenna can be built as a series of components linked using either S-parameters or near or far field sources. The simulation sequence can be set up to run automatically, with the result calculated at each step being used as the basis for the next.

Another use of SAM is in multiphysics analysis. Field losses generate heat and this heat can damage materials or detune the structure by causing thermal expansion. Investigating this effect

means carrying out four simulations: an initial full-wave electromagnetic (EM) simulation to calculate the field losses, a thermal simulation to calculate the heating effect of these losses, a structural mechanics simulation to calculate the thermal expansion and a final EM simulation to calculate field behavior in the new, deformed structure. These tasks can be set up as a sequence and evaluated automatically to speed up such multiphysics flows.

FEKO

Ever-increasing component and trace densities compounded with higher clock speeds result in electromagnetic interactions that may be difficult to predict. With the 3D electromagnetic simulator FEKO, design engineers have access to a host of numerical technologies that enable them to avoid problems before they occur. For example, the geometry of a design layout can be imported (e.g., using DXF or Gerber formats) into FEKO, where the various 3D solvers can be applied to calculate cross talk and radiated fields. R, L and C elements can be included as lumped elements, while more complex circuits and networks are added using the schematic editor. By including circuits in the electromagnetic simulation, the design engineer performs a more comprehensive analysis in FEKO than in a stand-alone simulator. The Spice co-simulator is included with FEKO at no extra cost. Many design parameters are obtained from FEKO, including voltages, currents and S-parameters. The latter can be exported in Touchstone format for inclusion in system simulators. Alternatively, measurement data can be imported directly into FEKO for comparison purposes.

FEKO is especially valuable to investigate optimum strategies for component placement, cable routing, shielding, and to design antennas, including on-chip and on-package antennas. Inherent parametric modeling capabilities are available, enabling geometry to be created and defined in terms of variable dimensions. These variables are passed to an automated optimization engine so that the geometry can be modified to achieve specific performance goals. Different optimization technologies are available including the Generic Algorithm (GA) method. GA is well suited to solve multiple-variable, multiple-goal problems, as it is renowned for finding the best configuration. Automated optimization is ideal for both coupling and radiation applications.

Integration of third-party tools further simplifies antenna design: Antenna Magus offers antenna synthesis capabilities for a large number of antenna types, while Optenni Lab offers

The advertisement features a blue background with a grid of images showing various applications: an aircraft, a satellite, a ship, a 4G network, and a radar. Text elements include the company logo, event information, a slogan, and product images.

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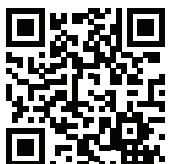
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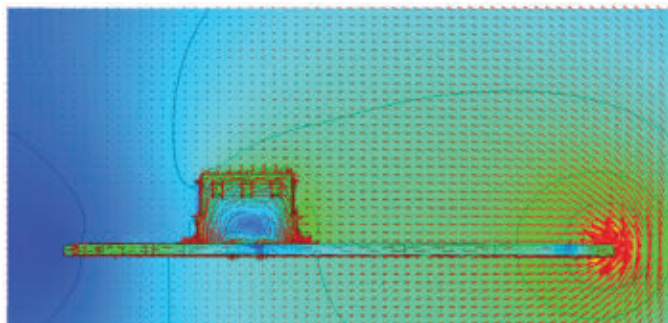
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▲ Magnetic fields coupling to a connector on a mobile device PCB.
Photo courtesy of FEKO.

fast matching-circuit design, including broad-band, multi-band and multi-port matching.

Magnetic fields coupling to a connector on a mobile device PCB and the induced currents

that flow on PCB. The increased coupling can be visualized in between the battery and PCB.

IMST

IMST develops RF components in combination with its EMPIRE XCell 3D EM field solver. Based on the 3D Finite Difference Time Domain method, the software offers an easy-to-use graphical user interface with extensive layout capabilities, yield analysis and smart optimization algorithms as well as intelligent remote control to distribute simulation jobs efficiently in LAN-networks. In addition, EMPIRE has been highly optimized with respect to simulation speed in order to achieve fast results using off-the-shelf workstations. By using a state-of-the-art software controlled workflow algorithm for distributing the simulation job among various CPUs, a speed of 5 GCells/s can be achieved today on a standard dual CPU machine. Such speeds enable the designer to run a huge number of parameter variations of planar circuits or to analyze highly complex multi-layered modules in almost no time at all.

The extreme high speed is also the key for the next level of design integration. Up to now the conventional design flow was to embed full 3D EM simulation results of passive components and small circuit parts in co-simulations using a separate circuit simulator. This causes inaccuracies due to the limited modeling validity, especially if the components are spaced closely together. However, today it is possible with 3D EM simulations to analyze whole passive circuits for a specified frequency range within minutes.

In order to account for active devices, RLC-Elements and S-parameter files can be embedded into the 3D EM simulation. This is done using a schematic entry of symbols and defining virtual connections to the internal ports. The figure shows a design example of an LNA using EMPIRE where two transistor measurements are included as 2-port S-parameters set. SMD elements are modeled as 3D structures with internal ports to allow tuning of the element values. Such a design can be carried out without using an ad-

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2.0-6.0	±10.0°	±1.5dB	12.0dB	1.90:1
6.0-18.0	±10.0°	±1.5dB	12.0dB	1.90:1
12.0-22.0	±15.0°	±3.50dB	17.0dB	2.20:1
2.0-18.0	±22.0°	±3.00dB	16.0dB	2.20:1

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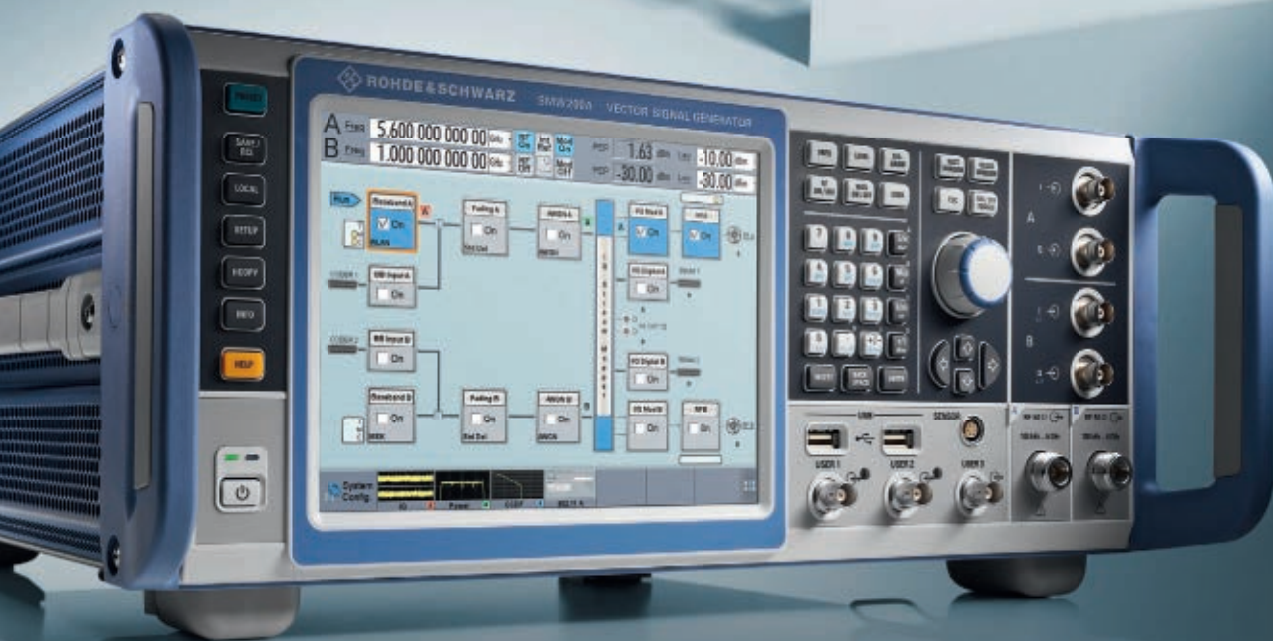
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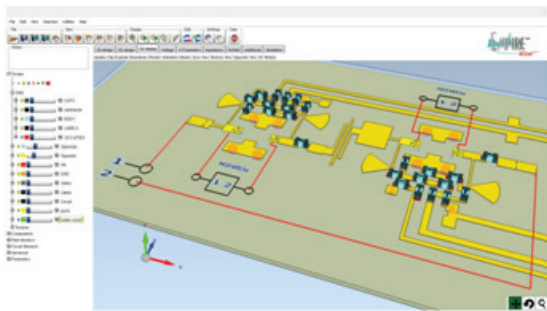
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▲ PCB design. Photo courtesy of IMST.

ditional circuit simulator within a very short time frame. All parameters of the design can be tuned and used as input for different optimizers in EMPIRE. The final layout can be checked (e.g., automatic connectivity check) directly before exporting it to a variety of formats (DXF, Gerber, GDS).

INTERCEPT TECHNOLOGIES

In contrast to the “all-in-one” solution that tries to span the entire design cycle, Intercept favors a multi-vendor approach to integrate PCB design flow with simulation and analysis software. Whenever possible, Intercept’s interfaces are made bidirectional so that data can pass freely to and from design, layout, modeling and simulation. The company’s Pantheon product currently offers bidirectional interfaces to and from AWR’s Microwave Office, HFSS and ANSYS Designer.

Taking the customers’ needs a step further, Intercept is currently developing a method by which vendor-approved RF models can be created and modified parametrically using a direct link to Microwave Office and Agilent ADS library models. This allows models placed into Intercept’s Pantheon layout software to be simulation-ready at all times. By offering enhanced communication between RF and PCB layouts, there are fewer steps to design completion and fewer interruptions in the work being done in either application. In line with this, Intercept is working toward future developments with RF simulation and modeling vendors that will provide the simulation directly within Pantheon, eliminating the need for data transfer and further error-proofing processes for designers and engineers.

MICIAN

Advanced RF simulation software is a substantial investment and an exact computer model of an RF component is expected to generate exact results, just as measured. For more accurate results, better models need to be built using full wave EM simulation software based on various techniques. FEM, MoM and FDTD are versatile methods with virtually no limitations in complexity but they require fast computers with a substantial amount of RAM. Large, complex structures significantly increase CPU time, making optimizations almost impossible. Mode Matching has low CPU and RAM requirements and simulates complex structures fast and accurately, provided eigenvalues for all geometries are known. Boundary Contour Mode Matching (BCMM) has proven to be a suitable replace-

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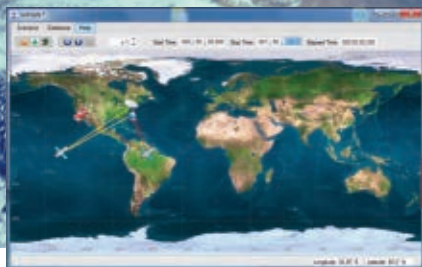
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Software showing mobile link setup

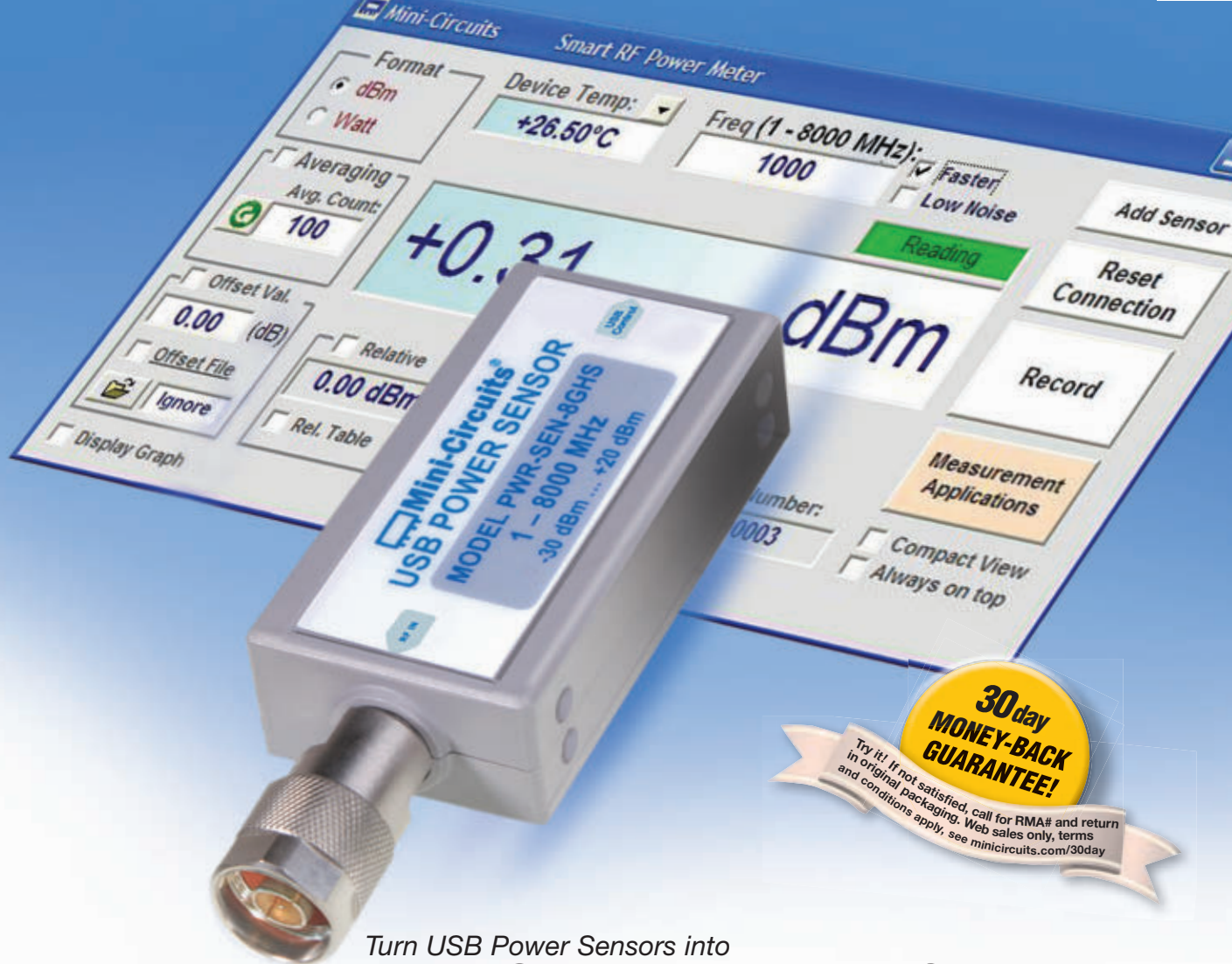


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IF/RF MICROWAVE COMPONENTS

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ment for certain 3D FEM applications.

Hardware and software advancements support accurate simulation of highly complex assemblies, but there is no all-in-one design software on the market. Modeling requires in-depth knowledge of drafting or model building tools and solver settings. The more flexibility and options the product offers, the more familiar the user needs to be with the product or its strength

will become a weakness. GUI's become overwhelming for the novice and the casual user.

Hybrid solvers such as MICIAN μ Wave Wizard™ combine different solvers for increased simulation efficiency, overcoming the limitations and shortcomings of single solvers. The modal port concept of μ Wave Wizard facilitates dissecting complex structures into more fundamental sub-structures. The program assigns each

sub-structure to the most suited of the built-in solvers (MM, 2D FEM or 3D FEM), allowing it to operate within its comfort zone with little need for user interference. Homogeneous cylindrical structures of finite length will only be treated as multimode transmission lines, leading to a drastic reduction of computation time. Afterward, results from individual solvers are cascaded multimodal to generate S-parameters of the composite structure.

By breaking complex structures down into basic sub-circuits or components such as irises, geometries can be parameterized for optimization or tolerance studies. Sub-circuits excluded from optimization are only simulated once and their respective S-parameters temporarily stored for subsequent cascading with those of the optimized circuits. Additional advantages are break-point analysis capability, allowing for separate S-parameter analysis of components or subsystems within a complex assembly and ease of use through convenient composition of complex structures either by drafting tool or through use of parameterized library elements.

MiG

Converting synthesized prototype values reliably into actual physical filters is often a challenge. MiG's latest hybrid electromagnetic (EM) computer-aided design (CAD) technology implemented in its CAD and optimization tool WASP-NET meets this demand by streamlining the filter design flow and reducing overall design time. As the first step in advanced filter design flow integration, the coupling (or M-) matrix approach supports synthesis of practically any kind of filter characteristics on a prototype level and selection of the appropriate topology for adequately placing the important cross-couplings. In this way, the best suited topology for a given filter problem can be found.

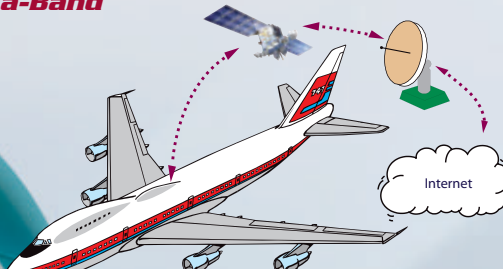
In the second design step, synthesized M-matrix parameters are converted into an initial approximation of physical dimensions by applying 3D EM simulations stepwise for isolated structure parts – e.g., for inter resonator couplings between two resonators, for external couplings between in-/output ports and for cross-couplings between two resonators.

In the commonly used filter design

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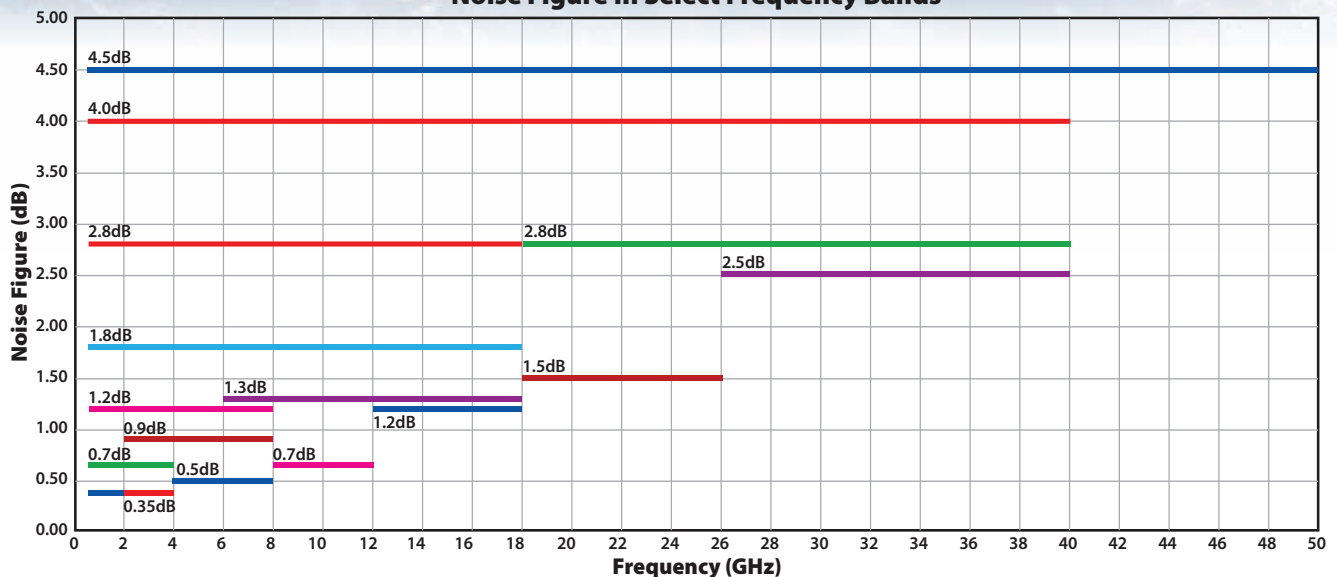


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flow, a third design step is applied, during which lookup tables or parameter plots are generated from the EM data of step 2, relating isolated physical dimension data to circuit level parameters. The design of the total filter is then commonly carried out by optimization on this circuit level based on different modeling techniques, such as lumped element, distributed line, neural network or space mapping approaches, and by executing sporadic

correction loop calculations applying EM simulators. The last design step applies EM solvers to analyze the total filter, making some final stepwise corrections. Direct EM level optimization – though very desirable – is still judged hitherto taking an enormous amount of time and is therefore considered impractical.

MiG's filter design flow includes a new integrated M-matrix designer that makes step 3 unnecessary

and carries out design steps 1 and 2. Recent advances in the fast hybrid mode-matching/multi-solver 3D EM CAD engine of WASP-NET enable filter designers to apply the last, final EM level in filter design flow directly and efficiently after design step 2. The filter design flow is drastically simplified and reduced concerning both design time and complexity. No time consuming, and often cumbersome, interim circuit level mapping is necessary, and the filter can be optimized directly on the EM level.

RECOM

In its most recent release, Remcom offered users a breakthrough in FDTD-based electromagnetic simulation performance with MPI + GPU technology and unlimited memory support for the company's XFDTD® Electromagnetic Simulation Software (XF7). By combining Message Passing Interface (MPI) technology with XStream® GPU Acceleration, multiple high-performance graphical processing units (GPU) in separate computers can be linked together, resulting in tremendous increases in processing speed and available memory. Complementing this technology with unlimited memory support gives XF7 the robustness to simulate massive problems exceeding billions of cells.

The new speed performance enables users to simulate increasingly complex scenarios in a reasonable timeframe. A growing number of designers have exhausted the amount of GPU RAM available for use in a single machine but still wish to grow the complexity of their models. Extending the GPU capabilities to leverage additional cards through clustering creates a solution with limitless potential. The MPI + GPU can dramatically cut your simulation times by orders of magnitude.

SONNET

The Blink™ passive device modeling system automates the Sonnet planar electromagnetic (EM) simulator setup and design flow in the Cadence Virtuoso environment to easily simulate spiral inductor, balun, transformer, and capacitor designs on silicon. In these design flows, Blink and Sonnet can work with process design kit (PDK) specific information, such

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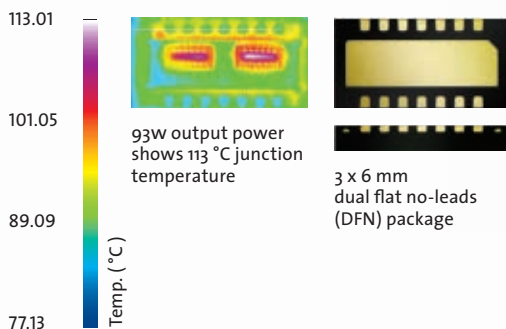
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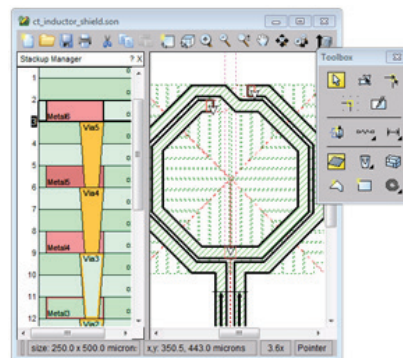
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as stack ups, metal properties, and via properties. Starting from operation completely within Cadence, users can export Sonnet EM simulations outside of the Cadence environment where Sonnet can run completely stand-alone. This flexibility of design flow allows Sonnet to connect different design flows together.

For integrated circuit designs incorporating RF functionality, design work often starts in Agilent's ADS. The

Sonnet EM simulator installs in ADS as a design kit and operates completely from within the ADS environment. Sonnet EM simulations can be exported from ADS to stand-alone Sonnet simulation, and already-existing Sonnet stand-alone designs can be brought into ADS. Thus designs and design flows that were originally disparate, an RF design flow in ADS, and an analog mixed-signal design flow in Cadence Virtuoso can be reconciled and con-



▲ Stack up manager. Photo courtesy of Sonnet.

nected with EM simulation analysis and layout geometry using Sonnet.

Another advantage of interconnecting designs and design flows using Sonnet is the commonality of popular functions like the stack up manager. Sonnet's new version 14 provides technology layers and a stack up manager that displays the dielectric and metal layers. Users can click on a chosen dielectric or metal layer or via to navigate through stack ups with dozens of layers. The stack up manager feature also appears with Sonnet in Cadence Virtuoso and Agilent ADS.

TECH-X

The VSim family of commercial products from Tech-X are based on the Vorpall simulation engine, a flexible electromagnetic, particle, and plasma physics software application initiated in 2001 for government applications. In the early years of its development, it was used to meet the needs of a variety of challenges for the federal government including plasma acceleration, accelerator cavity modeling and magnetic fusion studies. VSim offers a diverse range of examples, macros and the VSimComposer interface to the Vorpall simulation engine together with embedded analysis tools. The new Vorpall 6.0 features customized VSim packages for the simulations of microwave devices and plasma discharges and increased features for electromagnetic simulations. VSim for Microwave Devices (VSimMD), includes a full suite of electromagnetic and particle modeling features for magnetrons, klystrons, gyrotrons, TWTs and similar devices and is optimized for solving large problems on parallel computing hardware. ■

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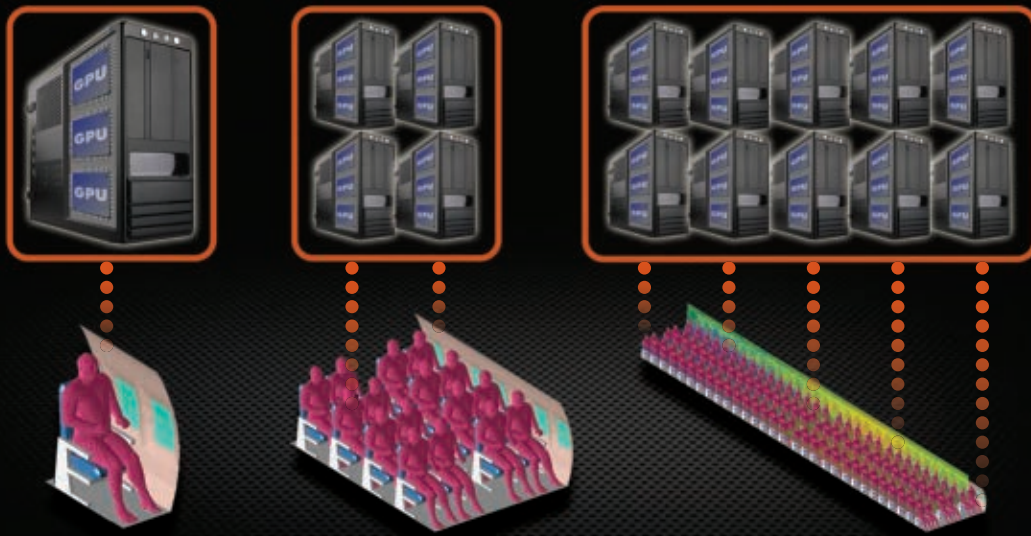
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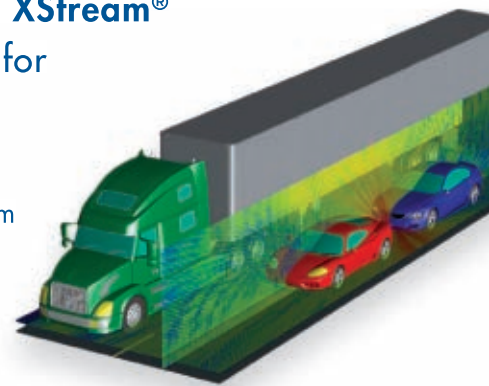
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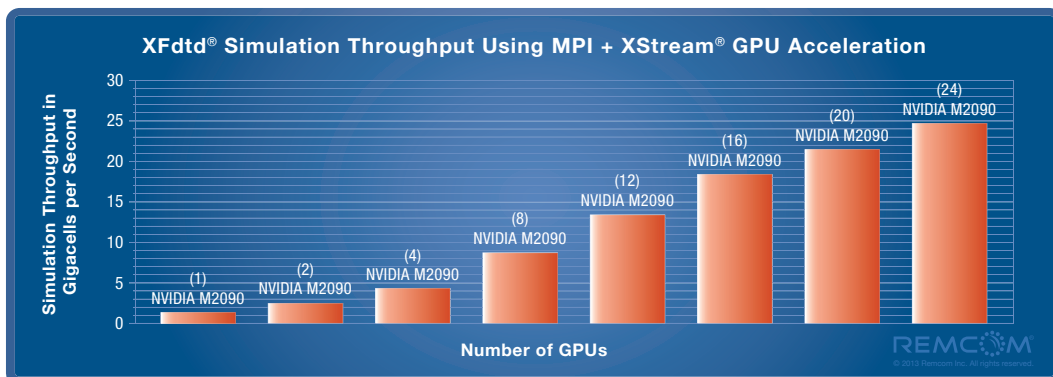
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Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA01-2110	0.5-1.0	28	1.0 MAX, 0.7 TYP	+10 MIN	+20 dBm	2.0:1
CA12-2110	1.0-2.0	30	1.0 MAX, 0.7 TYP	+10 MIN	+20 dBm	2.0:1
CA24-2111	2.0-4.0	29	1.1 MAX, 0.95 TYP	+10 MIN	+20 dBm	2.0:1
CA48-2111	4.0-8.0	29	1.3 MAX, 1.0 TYP	+10 MIN	+20 dBm	2.0:1
CA812-3111	8.0-12.0	27	1.6 MAX, 1.4 TYP	+10 MIN	+20 dBm	2.0:1
CA1218-4111	12.0-18.0	25	1.9 MAX, 1.7 TYP	+10 MIN	+20 dBm	2.0:1
CA1826-2110	18.0-26.5	32	3.0 MAX, 2.5 TYP	+10 MIN	+20 dBm	2.0:1

NARROW BAND LOW NOISE AND MEDIUM POWER AMPLIFIERS

CA01-2111	0.4-0.5	28	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA01-2113	0.8-1.0	28	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA12-3117	1.2-1.6	25	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA23-3111	2.2-2.4	30	0.6 MAX, 0.45 TYP	+10 MIN	+20 dBm	2.0:1
CA23-3116	2.7-2.9	29	0.7 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA34-2110	3.7-4.2	28	1.0 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA56-3110	5.4-5.9	40	1.0 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA78-4110	7.25-7.75	32	1.2 MAX, 1.0 TYP	+10 MIN	+20 dBm	2.0:1
CA910-3110	9.0-10.6	25	1.4 MAX, 1.2 TYP	+10 MIN	+20 dBm	2.0:1
CA1315-3110	13.75-15.4	25	1.6 MAX, 1.4 TYP	+10 MIN	+20 dBm	2.0:1
CA12-3114	1.35-1.85	30	4.0 MAX, 3.0 TYP	+33 MIN	+41 dBm	2.0:1
CA34-6116	3.1-3.5	40	4.5 MAX, 3.5 TYP	+35 MIN	+43 dBm	2.0:1
CA56-5114	5.9-6.4	30	5.0 MAX, 4.0 TYP	+30 MIN	+40 dBm	2.0:1
CA812-6115	8.0-12.0	30	4.5 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA812-6116	8.0-12.0	30	5.0 MAX, 4.0 TYP	+33 MIN	+41 dBm	2.0:1
CA1213-7110	12.2-13.25	28	6.0 MAX, 5.5 TYP	+33 MIN	+42 dBm	2.0:1
CA1415-7110	14.0-15.0	30	5.0 MAX, 4.0 TYP	+30 MIN	+40 dBm	2.0:1
CA1722-4110	17.0-22.0	25	3.5 MAX, 2.8 TYP	+21 MIN	+31 dBm	2.0:1

ULTRA-BROADBAND & MULTI-OCTAVE BAND AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA0102-3111	0.1-2.0	28	1.6 Max, 1.2 TYP	+10 MIN	+20 dBm	2.0:1
CA0106-3111	0.1-6.0	28	1.9 Max, 1.5 TYP	+10 MIN	+20 dBm	2.0:1
CA0108-3110	0.1-8.0	26	2.2 Max, 1.8 TYP	+10 MIN	+20 dBm	2.0:1
CA0108-4112	0.1-8.0	32	3.0 MAX, 1.8 TYP	+22 MIN	+32 dBm	2.0:1
CA02-3112	0.5-2.0	36	4.5 MAX, 2.5 TYP	+30 MIN	+40 dBm	2.0:1
CA26-3110	2.0-6.0	26	2.0 MAX, 1.5 TYP	+10 MIN	+20 dBm	2.0:1
CA26-4114	2.0-6.0	22	5.0 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA618-4112	6.0-18.0	25	5.0 MAX, 3.5 TYP	+23 MIN	+33 dBm	2.0:1
CA618-6114	6.0-18.0	35	5.0 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA218-4116	2.0-18.0	30	3.5 MAX, 2.8 TYP	+10 MIN	+20 dBm	2.0:1
CA218-4110	2.0-18.0	30	5.0 MAX, 3.5 TYP	+20 MIN	+30 dBm	2.0:1
CA218-4112	2.0-18.0	29	5.0 MAX, 3.5 TYP	+24 MIN	+34 dBm	2.0:1

LIMITING AMPLIFIERS

Model No.	Freq (GHz)	Input Dynamic Range	Output Power Range Psat	Power Flatness dB	VSWR
CLA24-4001	2.0-4.0	-28 to +10 dBm	+7 to +11 dBm	+/- 1.5 MAX	2.0:1
CLA26-8001	2.0-6.0	-50 to +20 dBm	+14 to +18 dBm	+/- 1.5 MAX	2.0:1
CLA712-5001	7.0-12.4	-21 to +10 dBm	+14 to +19 dBm	+/- 1.5 MAX	2.0:1
CLA618-1201	6.0-18.0	-50 to +20 dBm	+14 to +19 dBm	+/- 1.5 MAX	2.0:1

AMPLIFIERS WITH INTEGRATED GAIN ATTENUATION

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	Gain Attenuation Range	VSWR
CA001-2511A	0.025-0.150	21	5.0 MAX, 3.5 TYP	+12 MIN	30 dB MIN	2.0:1
CA05-3110A	0.5-5.5	23	2.5 MAX, 1.5 TYP	+18 MIN	20 dB MIN	2.0:1
CA56-3110A	5.85-6.425	28	2.5 MAX, 1.5 TYP	+16 MIN	22 dB MIN	1.8:1
CA612-4110A	6.0-12.0	24	2.5 MAX, 1.5 TYP	+12 MIN	15 dB MIN	1.9:1
CA1315-4110A	13.75-15.4	25	2.2 MAX, 1.6 TYP	+16 MIN	20 dB MIN	1.8:1
CA1518-4110A	15.0-18.0	30	3.0 MAX, 2.0 TYP	+18 MIN	20 dB MIN	1.85:1

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Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure dB	Power-out @ P1-dB	3rd Order ICP	VSWR
CA001-2110	0.01-0.10	18	4.0 MAX, 2.2 TYP	+10 MIN	+20 dBm	2.0:1
CA001-2211	0.04-0.15	24	3.5 MAX, 2.2 TYP	+13 MIN	+23 dBm	2.0:1
CA001-2215	0.04-0.15	23	4.0 MAX, 2.2 TYP	+23 MIN	+33 dBm	2.0:1
CA001-3113	0.01-1.0	28	4.0 MAX, 2.8 TYP	+17 MIN	+27 dBm	2.0:1
CA002-3114	0.01-2.0	27	4.0 MAX, 2.8 TYP	+20 MIN	+30 dBm	2.0:1
CA003-3116	0.01-3.0	18	4.0 MAX, 2.8 TYP	+25 MIN	+35 dBm	2.0:1
CA004-3112	0.01-4.0	32	4.0 MAX, 2.8 TYP	+15 MIN	+25 dBm	2.0:1

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Healthy Defense Industry Activity Marred by Lackluster Revenues

Ongoing activity in March and April included mergers and acquisitions, product launches and milestones, as well as seemingly healthy contract activity, but financials continue to emphasize the difficulties faced by the defense industry. Strategy Analytics Advanced Defense Systems (ADS) service reports, "Defense Electronics Industry Review: March 2013," and "Defense Electronics Industry Review: April 2013," detail significant defense industry news, including product announcements, milestones, contract activity and defense industry financial performance as the first quarter of 2013 came to a close.

Taking a snapshot of financials from companies including Boeing, Lockheed Martin, Northrop Grumman, Raytheon and United Technologies, revenues were by and large flat for most companies for the first quarter of 2013. The defense industry continues to focus on streamlining operations and ensuring profitability as revenue growth slows, stagnates or declines. While revenues stayed on par with the prior year, most company outlooks point to full-year revenue declines as purchases are offset and uncertainty around future expenditure remains.

However, revenues are not the whole story and activity around contracts, business tie-ups, product launches and milestones remained robust over March and April. March saw several key systems passing tests such as the Northrop Grumman AN/TPS-80 Ground/Air Task Oriented Radar (GATOR) and Raytheon testing a dual-band datalink with a Thales Nederland Advanced Phased Array Radar (APAR). The competition to upgrade fourth generation fast-jet platforms with fifth generation capabilities such as active electronically scanned array (AESA) radar is also starting to heat up with offerings from Raytheon and Northrop Grumman targeted at the F-16 platform. While the competition for the U.S. fleet is yet to be initiated, the first skirmish between the solutions has gone the way of Raytheon's "Raytheon Advanced Combat Radar" (RACR) AESA radar selected by the Republic of Korea to upgrade the country's KF-16C/D Block 52 Fighting Falcon fleet.

There were a number of new semiconductor products released over March and April targeted for use in defense sys-

tems and platforms. TriQuint was announcing products in conjunction with GOMACTech 2013 with the release of broadband integrated packaged solutions that combine a limiter with LNA for use in radar and electronic warfare as well as a 25 W Ku-Band GaN RF power amplifier for satellite communications. Comtech Xicom Technology also focused on GaN with the introduction of a compact and highly efficient GaN-based amplifier for X-Band MILSATCOM service in March and followed this with a GaN 6 to 18 GHz RF amplifier for electronic warfare, radar transmitters and communications applications in April. API Technologies also expanded its GaN power amplifier line targeting electronic warfare, RCIED countermeasures and national security jammer applications. GaAs-based products were also in the offing with OMMIC announcing sampling of three new production ready X-Band power amplifiers as well as GaAs-based products from Custom MMIC and MACOM.

Northrop Grumman, U.S. Navy Complete Triton Unmanned Aircraft's First Flight

The Northrop Grumman Corp.-built MQ-4C Triton high-altitude unmanned aircraft successfully completed its first flight recently from the company's manufacturing facility in Palmdale.

Triton is specially designed to fly surveillance missions up to 24 hours at altitudes of more than 10 miles – allowing coverage out to 2,000 nautical miles. The advanced suite of sensors can detect and automatically classify different types of ships.

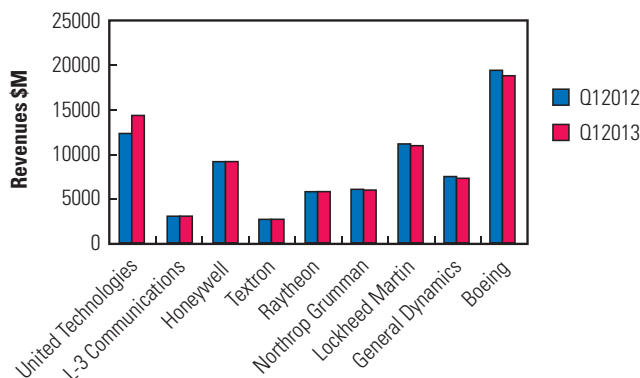
"First flight represents a critical step in maturing Triton's systems before operationally supporting the Navy's maritime surveillance mission around the world," said Capt. James Hoke, Triton program manager with Naval Air Systems Command. "Replacing our aging surveillance aircraft with a system like Triton will allow us to monitor ocean areas significantly larger with greater persistence."

A Navy and Northrop Grumman flight test team conducted about a 1.5-hour flight that started at 7:10 AM from Palmdale.

Northrop Grumman is the prime contractor to the Navy's MQ-4C Triton Broad Area Maritime Surveillance program.

"Triton is the most advanced intelligence, surveillance and reconnaissance (ISR) unmanned aircraft system ever designed for use across vast ocean areas and coastal regions," said Mike Mackey, Northrop Grumman Triton UAS deputy program director. "Through a cooperative effort with the Navy and our industry partners, we successfully demonstrated the flight control systems that allow Triton to operate autonomously. We couldn't be prouder of the entire team for this achievement."

Additional flight tests will take place from Palmdale to mature the system before being flown to the main flight test facility at Naval Air Station Patuxent River, MD, later this year.



Source: Strategy Analytics

Go to mwjournal.com for more defense news items



Advanced Aircraft Identification Systems Headed to U.S. and Allied Forces

The nation's fighting forces need secure and reliable line-of-sight identification to distinguish friend from foe during missions, and BAE Systems is answering the call. The company has been awarded a \$34 M contract to provide the U.S. Air Force with its Mode 5 Advanced Identification Friend or Foe (AIFF) system, used to identify and track military aircraft.

"The system allows the warfighter to rapidly differentiate between friendly and potentially hostile forces well beyond a pilot's visual range," said Sal Costa, product line director for Identification & Processing Solutions at BAE Systems.

The system, which was developed as an enhancement to older, less capable IFF technology, increases identification capability through the use of secure message and data transmission formats. Its improvements include increased security and enhanced algorithms as well as upgraded key management, interoperability, and supportability.

Used to reduce fratricide for U.S. and allied forces since World War II, IFF technology is an electronic questions-and-answer system composed of interrogators that ask questions and transponders that provide responses. Under

this contract, BAE Systems will provide its enhanced AN/APX-125 Mode 5 Combined Interrogator Transponders to the Air Force and the European Participating Air Force partners. BAE Systems was the first Department of Defense contractor to receive National Security Agency Mode 5 certification, which is required for use on military platforms. Work on the contract is expected to be completed by 2015.

Raytheon Books \$106 M Paveway II Contract

Raytheon Co. booked a \$106 M contract for its combat-proven Paveway™ II family of precision-guided munitions. The company was awarded the direct commercial sale from an international customer. The contract includes Paveway kits for both GBU-12 (500 lb) and GBU-58 (250 lb) guided bombs. Paveway is a Raytheon-designed kit that transforms "dumb" bombs into precision-guided munitions. The contract order was booked in Raytheon's second quarter of 2013.

"Customers worldwide continue to select Raytheon's Paveway to protect their warfighters and citizens," said Harry Schulte, vice president of Raytheon Missile Systems' Air Warfare Systems. "This contract further demonstrates Raytheon's long-standing commitment to its international partners."



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ESA Opens First Facility in UK

David Willetts, UK minister for universities and science, and Jean-Jacques Dordain, European Space Agency (ESA) director general, unveiled the Agency's first UK facility: the European Centre for Space Applications and Telecommunications (ECSAT), located at the Harwell Oxford campus.

ECSAT supports activities related to telecommunications, climate change, technology, science and 'integrated applications' – the combined use of different space and terrestrial technologies, data and infrastructures to create new everyday applications. The development of innovative public/private partnerships will be emphasised, and the centre will benefit from working closely with other space scientists and businesses at Harwell, including the Satellite Applications Catapult.

David Willetts noted: "The UK space industry is increasingly important to growth, contributing over £9 billion to

"Investing in space is investing in competitiveness and growth through knowledge, innovation and services."

the economy every year and supporting thousands of highly skilled jobs. ESA's decision to locate its high-tech facility in this country shows that we are creating the right environment for innovation and cutting-edge research."

Despite the current economic climate, the UK space industry has

been identified as a growth sector. With 70 percent of its output being exported it is a major player on the global stage. ECSAT is designed to play a key role in the UK space domain. ESA's presence in the UK is a clear sign that the Agency is supporting the increased importance given to space by the UK government.

Dordain welcomed the UK's increased interest for investing in space in particular through ESA: "Investing in space is investing in competitiveness and growth, through knowledge, innovation and services. The Harwell Oxford campus is already a unique place of competences and the building up of ESA's presence in this campus will reinforce both ESA and the campus."

Partnership Takes Flexible RF Technology to EU Universities

Universities and research establishments across the EU are set to gain access to the open source RF hardware platform, MyriadRF, and configurable transceiver technology following a deal between Lime Microsystems and Europractice, a project of the UK Science and Technology Facilities Council (STFC).

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, through low cost, easy to use boards, and advance wireless system innovation.

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

Commenting on the new agreement, Ebrahim Bush-ehri, CEO of Lime Microsystems, said, "This is a significant endorsement for both Lime's technology and the open source community of MyriadRF. More importantly, it helps bring many creative, brilliant minds to RF innovation and this can only be a good thing."

"[The agreement] helps bring many creative, brilliant minds to RF innovation..."

Sumitomo and NEC Provide Communications Infrastructure in Myanmar

Sumitomo Corp. and NEC Corp., in cooperation with NTT Communications Corp., concluded a contract with the Ministry of Communications and Information Technology of the Republic of the Union of Myanmar in support of the country's "Emergency communications network improvement plan."

This is the first infrastructure project in Myanmar that capitalizes on Official Development Assistance (ODA) from Japan since its adoption of a new economic cooperation policy towards Myanmar in April 2012. The development of this network aims to improve Myanmar's communications infrastructure to a level that rivals that of developed markets, while promoting economic revitalization and the quality of people's daily lives.

Myanmar's infrastructure development for daily communications, including fixed-line telephones, mobile phones, Internet access and power lines, is delayed when compared to neighbouring countries. In order to achieve the economic development that is now widely expected from Myanmar, it is essential to improve its communications networks. As one way to try to accomplish this, the government of Myanmar has made requests for assistance from the Japanese government in the urgently required



International Report

improvement of communications infrastructure, particularly in and between the cities of Yangon, Mandalay and Naypyidaw.

In response to these requests, the Japan International Cooperation Agency (JICA) concluded a grant agreement with Myanmar on December 28, 2012, promising 1.71 billion yen in ODA. The communications infrastructure built under this plan consists of a high-speed, high-capacity core optical transmission network capable of transmitting 30 Gbps between the three cities considered, as well as LTE communications, fixed-line telephones and optical transmission networks capable of 10 Gbps Internet transmissions within each city.

EC Gives €77 M Boost to High-Tech Manufacturing Sector SMEs

The European Commission is contributing €77 million from its Seventh R&D Framework Programme (FP7) to an innovation initiative for the manufacturing sector designed to help high-tech small and medium size enterprises (SME) exploit the potential of ICTs to help grow their businesses.

The ICT for Manufacturing SMEs (I4MS) initiative will help 200 SMEs across Europe, who are either attempting to reduce the risks involved in using advanced technology, which is still in its infancy, or are trying to cross the so-called

'valley of death' that separates the development of an innovative prototype from a successful product in the market.

European Commission vice president Neelie Kroes said: "Europe's research community must be at the forefront of ICT research in the manufacturing sector. And it is even more important to translate this research leadership into productivity gains and increased competitiveness of our products and industrial actors. By stimulating targeted innovation and investing in our biggest assets in that sector, namely SMEs, I4MS is bridging this gap."

I4MS officially kicks off in July 2013 and will conduct more than 150 innovation experiments over the next three years. These experiments will be implemented with the help of pan-European networks of competence centres, providing the knowledge and support for partnering beyond national borders. SMEs will be able to apply for funding through Calls for Experiments launched by these centres in 2014 and 2015.

These experiments will be implemented with the help of pan-European networks of competence centres, providing the knowledge and support for partnering beyond national borders.

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Mobile Industry Players Must Position Now to Win 5G Race

The Strategy Analytics Wireless Networks & Platforms (WNP) service report, “Is the 5G Race Beginning?,” recommends that companies start now with their strategies to influence the definition of the requirements for the new generation systems and to ensure that R&D spend translates into strong 5G patent positions.

Momentum is building as leading companies engage in the first round of 5G technology development. Samsung is the latest industry player to have announced its 5G demonstration. The traditional technical leaders in the radio transmission technology area, Ericsson and NTT DoCoMo, also revealed their progress in 5G research. Chinese industry players even formed an industrial group to promote the research and development of 5G technology.

“The official process of 5G standardization should be launched in 2015-2016 time frame, to be kicked off at ITU-R WRC-15. So all current ‘5G’ activities are only a warm-up before the official process,” noted Guang Yang, senior analyst for wireless networks & platforms. “But these warm-up activities are important for the industry to build technical consensus and to prepare the ecosystem. It is also a key period for the technology giants in the industry to predict the core components of the future system and to secure related patents.”

“The next two years will see significant movement between industry players as the building blocks of 5G are researched and defined,” added Susan Welsh de Grimaldo, director wireless networks & platforms. “Big EU companies and East Asian players (China, Japan and Korea) are already developing their 5G visions. It will be interesting to see what strategies emerge from North America. In particular, the plans of Qualcomm and Intel, the two chipset giants, should be closely watched.”

Improved data transmission rates are still a focus of the next generation 5G system, just as faster data was a focus for today’s 4G LTE. Other requirements for 5G that are beginning to emerge in industrial and academic research include support for a higher number of connected devices, longer battery life, and reduced End-to-End latency, among others.

More than 30 B Devices will Connect to the Internet of Everything in 2020

ABI Research’s latest data on the Internet of Everything (IoE) shows that there are more than 10 billion wirelessly connected devices in the market today, with over 30 billion devices expected by 2020.

“The emergence of standardized ultra-low power wireless technologies is one of the main enablers of the IoE, with semiconductor vendors and standards bodies at the forefront of the market push, helping to bring the IoE into reality,” said Peter Cooney, practice director. “The year

2013 is seen by many as the year of the Internet of Everything, but it will still be many years until it reaches its full potential. The next five years will be pivotal in its growth and establishment as a tangible concept to the consumer.”

Bluetooth, Wi-Fi, ZigBee, Cellular, RFID and many other wireless technologies are all important to drive Internet of Everything growth. The long term expansion of the market will be dependent on wireless technology becoming invisible so that the consumer will be oblivious to which technology is used and only know that it works.

“Today, Hub devices such as smartphones, tablets and laptops are pivotal in enabling the IoE ecosystem and will continue to be an essential building block,” added Cooney. “Future growth, however, is driven by node or sensor type devices and by 2020 these will account for 60 percent of the total installed base of devices.”

“The emergence of standardized ultra-low power wireless technologies is one of the main enablers of the IoE...”

Small Cells with Wi-Fi Set to Reshape Wireless Communications Market

The use of Wi-Fi functionality in small-cell base stations will be a game changer for cellphone service providers, easing heavily congested data pipes while linking together billions of devices into a single network architecture, according to the IHS iSuppli Mobile & Wireless Communications Service at information and analytics provider IHS.

Small cells—also known as metro cells—are low-power base stations each supporting approximately 100 to 200 simultaneous users. Intended to augment wireless coverage and capacity in dense urban areas, the small cells will likely be installed in public facilities such as malls, railway and subway stations, the sides of public buildings, and on street or traffic lights.

IHS expects large-scale deployment of small cells to start in 2014.

Small cells will communicate with the core network through a radio network controller to ensure that available wireless spectrum resources are properly managed and distributed between the macro or micro network and the small cells, maximizing available capacity in the process.

In general, small cells will be outdoor solutions that address capacity issues, while residential and enterprise femto base stations will be indoor solutions. Both solutions will coexist alongside each other, as well as with macro and micro base stations and also with Wi-Fi access points—all in order to provide a heterogeneous networking architecture.

“By combining the different elements of just such an architecture, wireless carriers can use small cells to deploy



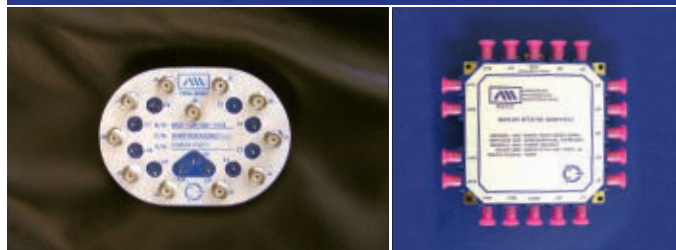


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optimized solutions tailored to the coverage and capacity requirements of networks and their different locations,” said Jagdish Rebello, PhD, director for consumer & communications at IHS. “For entrepreneurs, intellectual-property firms and wireless providers, the offloading approach also affords them an opportunity to develop a unique ‘network of networks,’ which can deliver seamless handoffs as users move from cellular to high-bandwidth personal networks like Wi-Fi.”

The rise of these new types of base stations is being propelled by the massive and growing installed base of Wi-Fi connected system worldwide.

“Wi-Fi is becoming ubiquitous and spurring new opportunities, including the capability for wireless service providers to offload chronically clogged 3G and 4G cellular networks into heterogeneous architectures,” said Steve Mather, senior principal analyst and subject matter expert for wireless at IHS. “Such architectures will involve a combination of macro and micro base stations, coupled with low-powered small cells and enterprise femto cells. This approach overall will reshape the connected world by linking billions of devices with free, high-speed links.”

Wi-Fi Everywhere

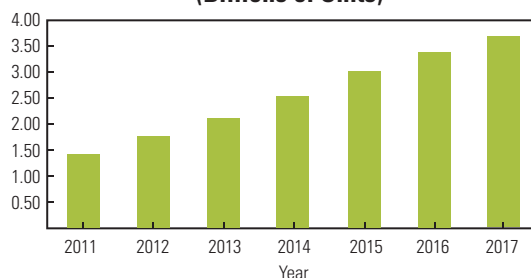
Shipments this year of Wi-Fi chipsets will reach a projected 2.14 billion units, up a robust 20 percent from 1.78 billion in 2012. This year’s anticipated increase continues the impressive run of double-digit growth that started at least five years ago and will persist for three more years until 2016, after which expansion dips to a still-strong 9 percent. By 2017, Wi-Fi chipset shipments will amount to 3.71 billion units.

Overall, approximately 18.7 billion Wi-Fi chipset units will be shipped from 2011 to 2017—nearly all of which will belong to the high-performance 802.11n version. To put that number in context, the entire planet has 7 billion people—which means that Wi-Fi chipset shipments will outnumber the earth’s population by more than two-and-a-half times.

The devices containing embedded Wi-Fi chipsets are many, but mobile handsets stand out in particular.

By 2015, nearly 1.2 billion handsets out of a total of 1.9 billion cellphones produced that year will include Wi-Fi functionality. Approximately 70 percent of handsets sold worldwide by then—and well over that figure in North America and Western Europe—will be smartphones with embedded Wi-Fi.

Worldwide Wi-Fi Chipset Shipment Forecast
(Billions of Units)



Source: IHS Inc., April 2013

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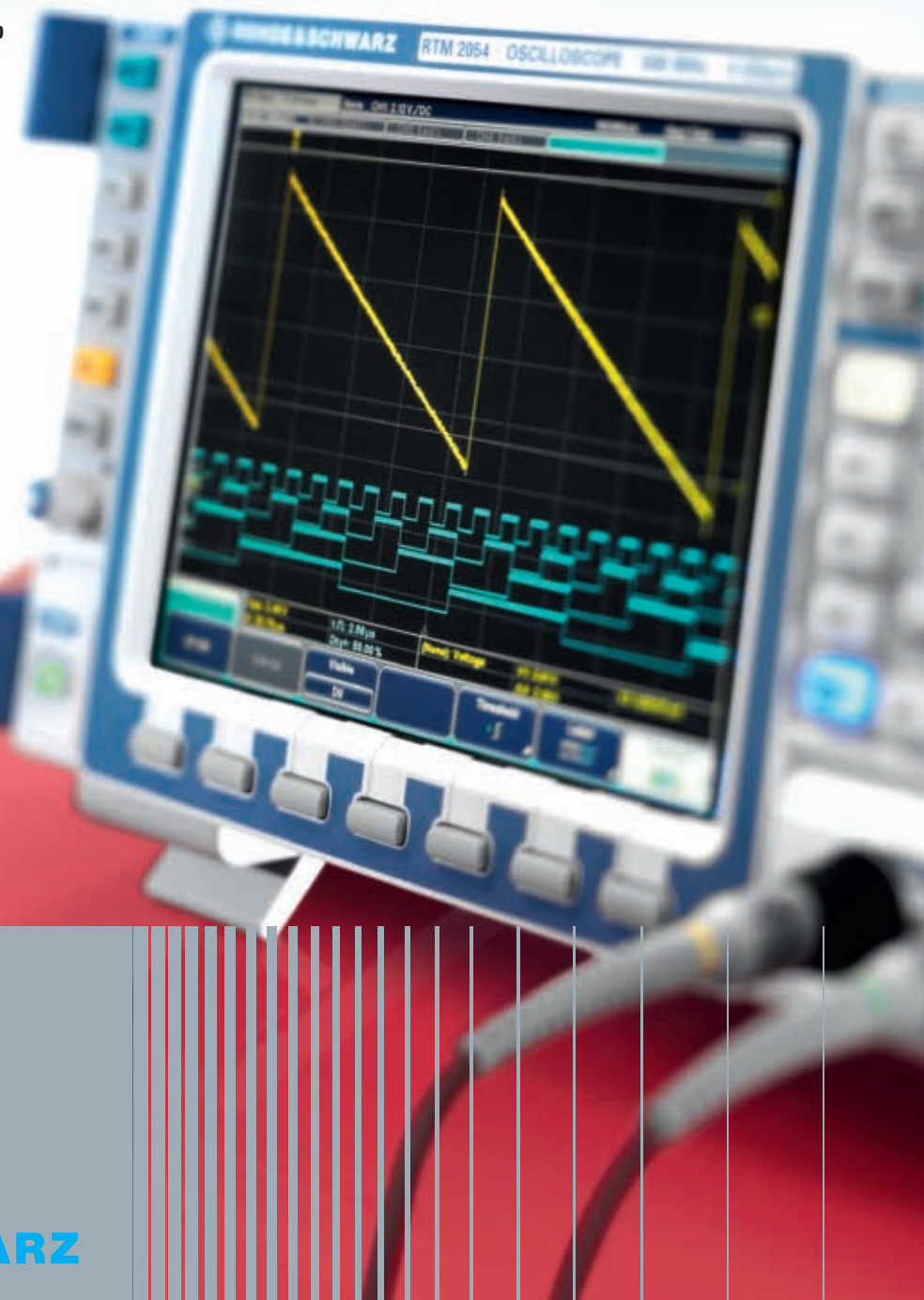
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MERGERS & ACQUISITIONS

Planar Monolithics Industries Inc. (PMI) announced that it acquired 100 percent of all the assets and property of **Hari LLC**. These assets include all the test and manufacturing equipment and machinery, designs, documentation, drawings and intellectual property. Additionally, PMI and **American Microwave Corp.** (AMC) announced that they have completed realignment and separation of AMC and PMI. This realignment allows each company to operate independently, further expand their product lines and maintain a competitive edge in the marketplace.

Element Six has acquired the assets and intellectual property of **Group4 Labs Inc.**, a semiconductor wafer materials company that manufactured GaN on-diamond semiconductor technology for RF and high-power devices. The asset acquisition will expand Element Six's semiconductor portfolio for defense and commercial applications.

Cobham plc has acquired the entire share capital of **Axell Wireless Ltd.**, a privately-owned supplier of wireless communications for commercial and public safety markets, for a total consideration of up to £85 million on a cash and debt-free basis. Cobham has paid an initial £60 million for the business, with a further conditional cash consideration of up to £25 million in total being payable during 2014 and 2015, contingent on future performance.

Silicon Labs, a leader in high-performance, analog-intensive, mixed-signal ICs, signed a definitive agreement to acquire **Energy Micro AS** based in Oslo, Norway, a late-stage privately held company that offers a power-efficient portfolio of 32-bit microcontrollers and is developing multi-protocol wireless RF solutions based on the ARM® Cortex-M architecture.

ST-Ericsson, a joint venture of **STMicroelectronics** and **Ericsson**, announced the signature of a definitive agreement to sell the assets and intellectual property rights (IPR) associated with its mobile connectivity Global Navigation Satellite System (GNSS) business to a leading semiconductor company. A team of 130 industry veterans located in Daventry, Bangalore and Singapore are anticipated to join the buyer at closing of the transaction. The closing of the transaction is expected to be completed in August. ST-Ericsson estimates the proceeds from the sale, combined with the avoidance of employee restructuring charges and other related costs, will reduce the joint venture's cash needs by approximately \$90 million.

COLLABORATIONS

Azimuth Systems Inc. and **JDSU**, two leaders in communications test and measurement products for the telecommunications industry, announced a collaboration to answer the mobile industry's call for more efficient, effective and

end-to-end test solutions. Azimuth's Field-to-Lab™ system replays live-network radio environments by parsing captures and logs from the JDSU E6474A RANAdvisor wireless network optimization software and W1314A/B multi-band wireless measurement receiver. The Field-to-Lab (FTL) strategy from Azimuth and JDSU allows service providers and equipment manufacturers to replay real-world channel conditions collected from drive testing in Azimuth's ACE™ channel emulators.

Skyworks Solutions Inc. announced that it is partnering with **SMC Networks**, a leading customer premise equipment manufacturer for multi-service operators (MSO), to develop wireless connectivity solutions 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.

Peregrine Semiconductor Corp. announced the signing of a collaborative agreement with **Murata Manufacturing Co.** on a multi-sourcing arrangement for RF switches based on Peregrine's proprietary UltraCMOS® technology. Under the collaboration agreement, Murata agrees to source a majority of its RF switching requirements from Peregrine in exchange for being granted a license to purchase or manufacture RF CMOS switches utilizing Peregrine's technology and intellectual property (IP). The parties expect this agreement to result in an expanded source of supply for these RF components and to assure global OEMs broad access to RF CMOS products.

Auriga Microwave and **Focus Microwaves** integrated their showcase systems, Auriga's AU4850 Pulsed IV/RF Characterization System and Focus' Harmonic Load-pull System to provide users unmatched measurement capabilities. Responding to market demands, Auriga and Focus have developed a software bridge to provide users harmonic pulsed load-pull measurement capability. The software will be offered by both companies through their respective sales channels.

NEW STARTS

Advantech Wireless Inc., a global wireless solutions provider for Satellite, RF Equipment, Microwave Troposcatter and Point-to-Point Systems, announced the opening of its new headquarters office in the U.S. The new office is located in Manassas, VA and will allow the company to meet the growing demand for its newest line of GaN solid state power amplifiers and next generation discovery VSAT hubs.

Dover announced that its board of directors has unanimously approved a plan to spin off certain areas of its



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Around the Circuit

communication technologies businesses into a standalone, publicly traded company. Upon completion of the spin off, the new company, **Knowles Corp.**, will be in the communication technologies space. Dover also announced that **Jeffrey Niew** will serve as president and CEO of Knowles upon completion of the transaction. Niew currently serves as president and CEO of Dover's communication technologies segment.

M/A-COM Technology Solutions announced that it will be referred to simply as **MACOM** going forward. The company started out in 1950 as Microwave Associates and changed to M/A-COM in 1978 after many changes and acquisitions. In 2008, Cobham purchased the RF components and microwave subsystems business from Tyco Electronics and re-named it M/A-COM Technology Solutions.

ACHIEVEMENTS

Astronomers using the new Atacama Large Millimeter/submillimeter Array (ALMA) have imaged a region around a young star where dust particles can grow by clumping together. This is the first time that such a dust trap has been clearly observed and modelled. It solves a long-standing mystery about how dust particles in discs grow to larger sizes so that they can eventually form comets, planets and other rocky bodies. The results were published in the journal *Science* on 7 June 2013.

Selex ES, a Finmeccanica company, has completed deliveries of the Praetorian electronic warfare self protection system for Tranche 2 Eurofighter Typhoons. All 236 Tranche 2 Typhoons operated by the UK, Germany, Italy and Spain will be equipped with electronic support measures, electronic countermeasures and missile approach warning elements. Together, these combine to inform the pilot of potential hazards and automatically take measures to protect the fighter.

Rockwell Collins recently conducted two live over-the-air tests of its Wideband High Frequency (WBHF) radio between Ottawa and Cedar Rapids, Iowa. During the tests, the team was able to demonstrate streaming full-color video and ad hoc Internet Protocol networking over an HF link. Additional demonstrations are planned for this summer.

OEwaves' chip-scale Micro-Opto-Electronic Oscillator (Micro-OEO) supported the **Lockheed Martin** Extended Area Protection and Survivability (EAPS) program's successful Guided Test Flight of the Miniature Hit-to-Kill (MHTK) interceptor. The very small and agile interceptor incorporates OEwaves' Micro-OEO, a chip-scale oscillator that generates fixed microwave and millimeter wave reference signals with breakthrough phase noise performance.

CONTRACTS

Harris Corp. received a \$40 million order for Falcon® tactical radios from the **Royal Brunei Armed Forces**. The radios will be part of a broader tactical communications system. Harris will supply Brunei's military with several models from its Falcon III® family. Harris also will pro-

vide logistical and customer field support. The order was received in the third quarter of Harris' 2013 fiscal year.

ITT Exelis received a \$9.4 million contract from **Lockheed Martin Aeronautics Co.** to supply the Continuous Wave Illuminator (CWI) subsystem for the F-16 Fighting Falcon. The Exelis CWI subsystem is a special purpose transmitter that works with the aircraft fire control radar and mission computer to guide semi-active missiles when launched. Using RF energy, the system illuminates airborne targets to ensure the missile finds its target. Exelis Electronic Systems in Clifton, NJ, will perform the manufacturing work under this contract.

Terma has been contracted by **HITT Traffic** to deliver and install three SCANTER 5502 surface movement radar systems to the Brazilian Airports in Rio de Janeiro and Curitiba. The delivery is a part of the Brazilian Airport Administration company **INFRARERO's** investment in airports before the Soccer World Cup in 2014 and the Olympics in 2016. The purpose of the surface movement radar is to maximize safety in airports by allowing air traffic controllers to monitor, advise, and instruct aircraft, vehicles, and personnel moving around on the ground in an airport.

PEOPLE

Spectra7 Microsystems Inc. announced that it has appointed **Guy Anthony** as CFO. Anthony has over 30 years of experience working with both public and private companies. He earned his MBA from the Harvard Business School and then worked at Intel Corp. for 22 years in a variety of finance and operational related positions. Since leaving Intel he has been the CFO for a number of successful Silicon Valley-based technology companies including Quellan (acquired by Intersil), Solaicx (acquired by MEMC Electronic Materials), Stentor (acquired by Philips) and most recently Medicalis.



▲ Brian Rowe

Johanson Manufacturing announced the appointment of **Brian Rowe** as vice president of sales. Rowe has been in the RF and microwave industry for more than 25 years. He recently served as business development manager at the Ceramic and Microwave Product Group of Dover Corp. He returns to Johanson Manufacturing after having spent eight years with the company from 1984 to 1992.

Mercury Systems Inc. announced the appointment of **Anthony Sweeney** as general manager of the RF and microwave components group, part of Mercury's Commercial Electronics business unit. Sweeney will provide overall business direction as well as lead day-to-day operations of the group, which is located in NH, NJ and CA. Prior to joining Mercury, Sweeney served as president of A C Executive Solutions, and held the positions of VP of operations, director of marketing and product management and director of engineering during his nine years with Endwave Corp. To view an interview Microwave Journal held with Sweeney at IMS 2013, go to www.mwjjournal.com/MercuryInterview.

Cliff Drubin has been named associate technical editor at **Microwave Journal**. Drubin recently retired from a distinguished career at Raytheon where he was a principal

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Around the Circuit



▲ Cliff Drubin

engineering fellow. He led engineering development of complex radar subsystems for many years in Raytheon's operating divisions and most recently supplied enterprise technology initiatives and was managing editor of Raytheon's corporate publication, *Technology Today*. Previous to Raytheon, he served in the USAF as a navigator and electronics warfare officer and later in the Massachusetts Air National Guard as an engineering officer.

Microwave Journal is pleased to announce that **Raymond Pengelly** has joined the Editorial Review Board as a consulting editor. Pengelly is currently strategic business development manager at Cree. He has written over 100 technical papers, four technical books, holds 14 patents and is a fellow of the IET and fellow of the IEEE.

REP APPOINTMENTS

Abracon Corp. announced that **Avnet Abacus**, one of Europe's leading interconnect, passive, electromechanical and power distributors, has entered into a pan-European distribution agreement with Abracon, a leading global vendor of frequency control and magnetic components.

EnSilica has partnered with **Cross Border Technologies** to accelerate the sales of both its IC design services and system IP solutions in key European and Asian markets, particularly Germany, France, Japan and Korea. The move is intended to build on the initial design win successes that EnSilica has recently achieved in these markets, particularly for mixed signal applications.

Precision Devices Inc. (PDI), a member of the Avrio Technology Group, has appointed **Dimac** as a pan-European distributor of its Hi-Rel frequency control products. PDI is one of only five manufacturers that are on the Defense Electronics Supply Center's Quality Parts List, and is the first to receive approval for space usage (MIL-PRF-38534) and is ITAR compliant.

Pasternack Enterprises Inc., an ISO 9001:2008 certified manufacturer and global supplier of RF and microwave components and assemblies, announces that it has appointed **ZEAP Meratronik S.A.** as Pasternack's exclusive distributor for Poland.

Tegam Inc. announced the addition of **Aerotecs** as its distributor for aerospace testing products in the European Union. Tegam's line of bond meters is complemented by Aerotecs' focused line of products and services solely for the aerospace market.

Pole/Zero Corp. and **Zeger-Abrams Inc.** have recently completed an exclusive technology transfer and technology licensing agreement covering the entirety of Zeger-Abrams technology and products including cosite interference cancellers, anti-jam adaptive arrays, power amplifier linearizers and cosite notch filters.

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IF/RF MICROWAVE COMPONENTS

Streamlining BER Simulation and Measurement

Bit Error Rate (BER) remains the ultimate quality metric for all communication systems. Emerging 4G systems like LTE specify throughput rate as a metric for system performance. These 4G systems add intelligence by using adaptive modulation based on channel quality, but under the hood, BER is measured while the modulation is adjusted.

BER is measured by comparing the transmitted bit sequence to the received and recovered bit sequence. For a good comparison, the two sequences must be synchronized and aligned. Any slight misalignment—whether from the Device-Under-Test (DUT) or other parts of the simulation/measurement system—may lead to an erroneous BER. In a typical BER simulation/measurement system, comprising a signal generator, DUT and signal analyzer, the signal generator and analyzer may introduce amplitude, phase and time delay errors.

With careful consideration and mathematical processing, these systematic errors can be removed. What's required is a simple, systematic and automated method for calibrating the simulation/measurement system. We propose one approach. For the purposes of this article, it is implemented on the SystemVue simulation platform, although it is generic and can be employed using any simulation tool. This

calibration method enables engineers to accurately simulate or make actual measurements on a DUT.

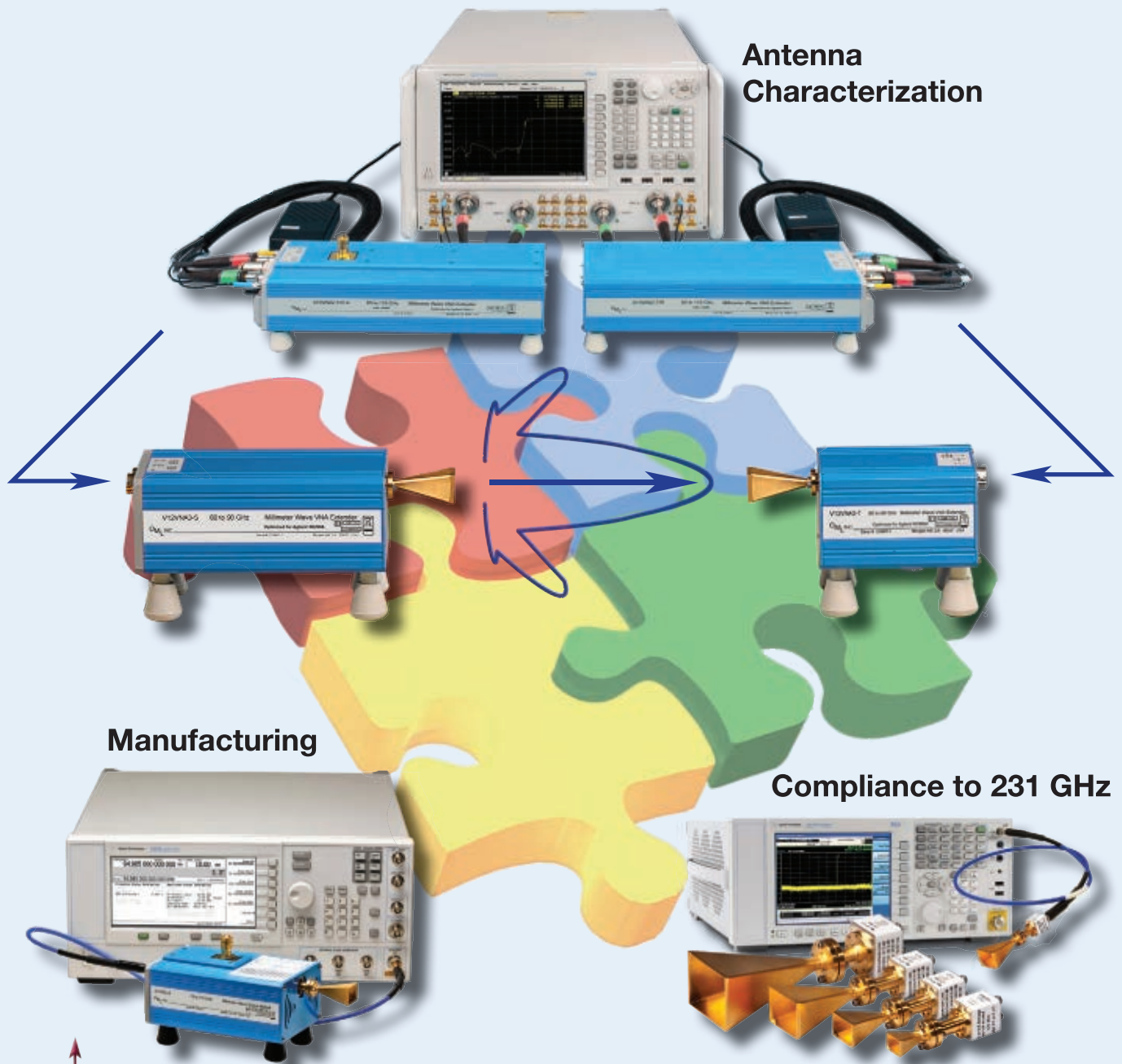
BER SIMULATION

For simple measurement systems, amplitude errors, phase and time delay errors can be calculated by hand. For more practical systems, these errors are more complicated and can only be corrected algorithmically. Consider the complex system shown in **Figure 1**, which includes RF sections in the transmitter and receiver. A DUT (e.g., a communication channel) might also be included between the RF transmitter and receiver to determine its BER. Before doing that, however, it is necessary to ensure that the measurement system itself has a zero BER.

If a simulation is performed on the measurement system, alone, it may not have a zero BER because the baseband and RF filters introduce finite time delays. Additionally, nonlinear RF components exhibit AM-PM conversion in saturation giving rise to phase rotation. Moreover, RF components may have non-ideal amplitude and phase responses within the in-

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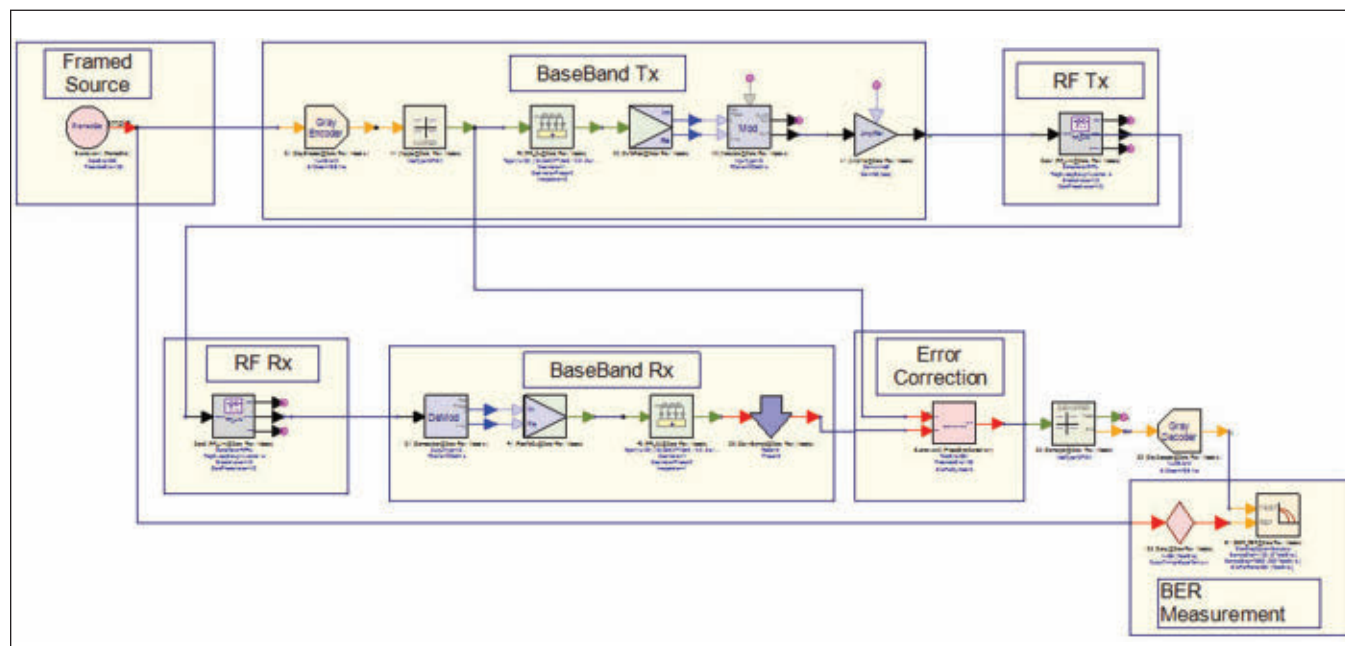


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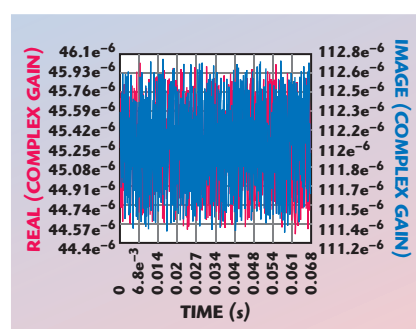
▲ Fig. 1 Shown here is an example of a complex communications measurement system.

formation bandwidth. These three error contributors—amplitude, phase and delay—must be corrected in the output bits before they are compared to the input bits in the BER sink. For example, the complex gain that must be applied to the symbols through the system shown in Figure 1 is displayed in **Figure 2**.

With a tool like SystemVue, engineers can write correction algorithms and turn them into custom models to aid in model-based engineering. To estimate these errors, the input bit sequence must be known. The input bit

sequence may not be known, however, it may be randomly generated and encrypted. In order to perform the amplitude, phase and delay corrections, a known bit sequence is employed. This is generally referred to as framing the data by adding a preamble. The system in Figure 1 includes this framing concept and algorithmic components.

After the bits go through the baseband transmitter, RF transmitter, RF receiver and baseband receiver, they may have undergone amplitude, phase and delay changes. This must be corrected before comparing them



▲ Fig. 2 Errors in amplitude, phase and time delay in a practical measurement system can be quite complex and not something that can be calculated by hand.

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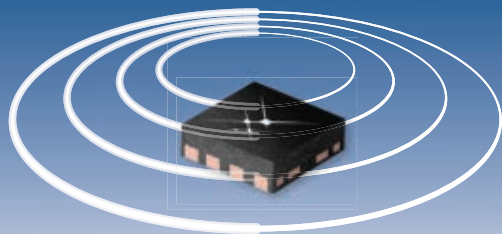
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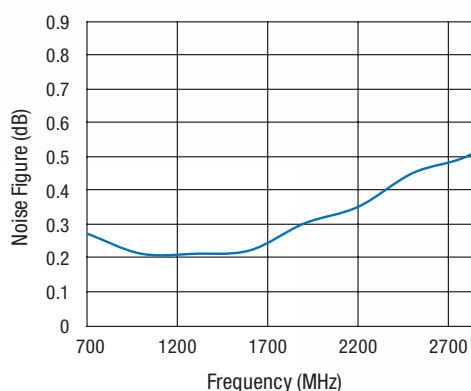
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SKY67151-396LF Noise Figure Performance

Frequency (MHz)	Noise Figure (dB)	Gain (dB)	OIP3 (dBm)	OP _{1dB} (dBm)	Supply Voltage (V)	Supply Current (mA)
700–1500	0.25	26.0	34	21	5	80
1600–2200	0.35	20.5	36	20	5	70
2300–2900	0.45	19.0	36	20	5	70
3000–4000	0.70	16.5	36	18	5	80

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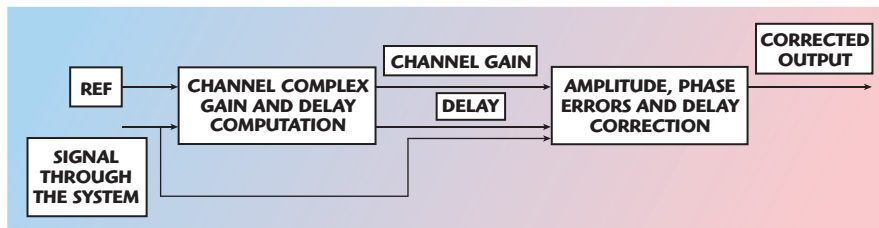
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▲ Fig. 3 This correction algorithm can be used to correct for systematic errors.

in the BER sink, a process that can be accomplished using the correction algorithm illustrated in **Figure 3**.

In a two-step process, this model (1) computes the amplitude, phase and delay errors and then (2) applies corrections on the framed input symbols, resulting in completely corrected and synchronized output symbols. The key is that known preamble bits are used in the computation of amplitude, phase and delay errors.

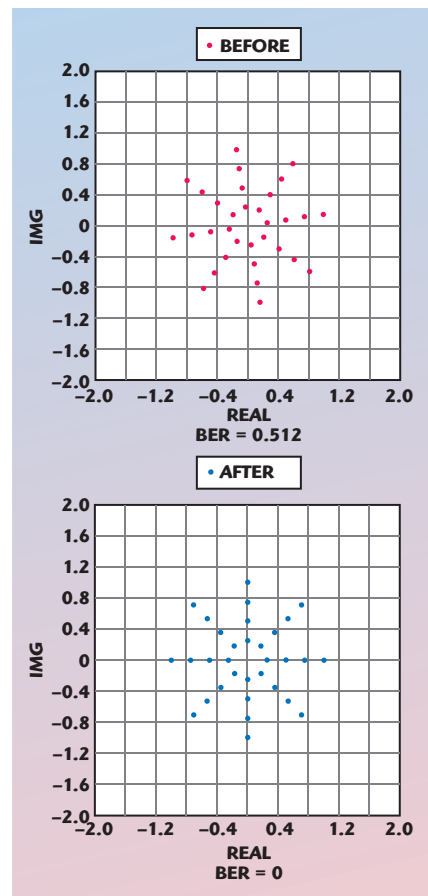
The pseudo-code for the algorithm's amplitude and phase error correction is as follows:

1. Define Input ports as Input and Ref
Define Output port as Output
Assuming Sizes of Input signal, Reference signal and Output signal are the same.
2. Get size of Reference signal
 $Ref_Size = \text{Number of Ref signal points}$
3. Define and Initialize internal variables of Corre and Corre_1 for correlation results
Set Corre = Correlation (input, Ref)
Set Corre_1 = Correlation (Input, 1./Ref)

4. Find Delay between Input and Ref
 $Abs_Corr = \text{abs} (Corr)$
 $Delay_Index = \text{find} (Abscorr == \max(abscorr))$
5. Find Channel Imbalance
 $Channel_Imbalance = Corr_1(Delay_Index)/Ref_Size$
6. Output = Output/ Channel Imbalance

Assuming that the amplitude, phase and delay errors in the system are constant (i.e., systematic), then the above correction should result in a zero BER.

To illustrate the effectiveness of the synchronization algorithms, consider the simulation results in **Figure 4**. Here, the constellation diagrams before and after application of the synchronization algorithmic blocks are shown, along with the BER. The case represented in the diagrams is for a user-defined constellation, demonstrating the algorithm's generality for any type of modulation format. Note that a delay correction alone will not synchronize the input and output bits – in this case, phase rotation is the cause for the high BER. The engineer



▲ Fig. 4 Shown here are two diagrams for user-defined constellations, illustrating the before and after effects of implementing synchronization algorithms.

may attempt to manually rotate the constellation using a phase shifter in the signal path, but the rotational symmetry of the constellation makes this

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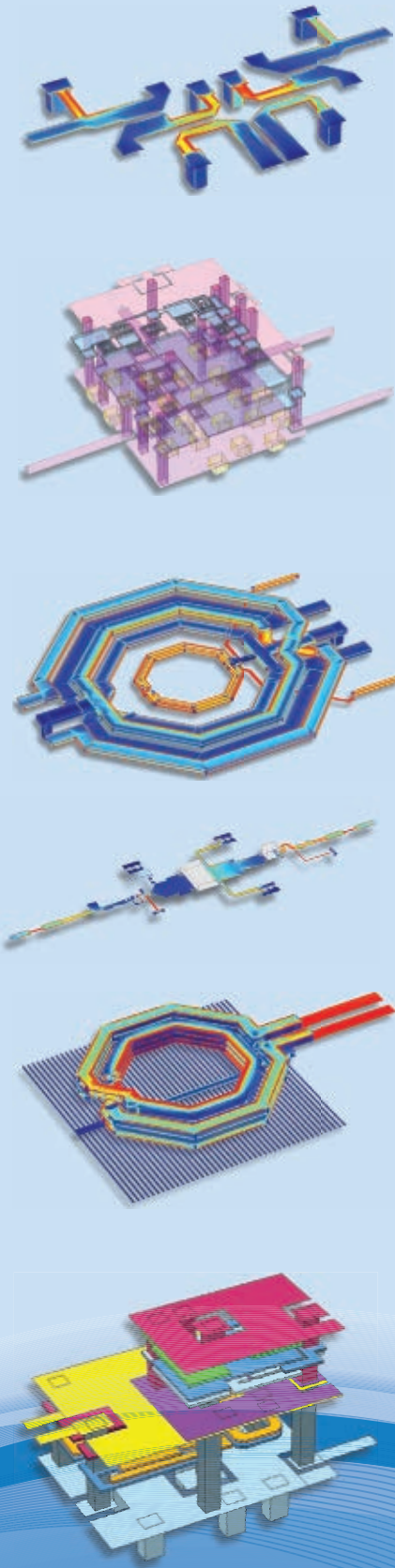
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tricky and tedious. The engineer may not know, for example, how many rotations the signal has undergone, making a stronger case for the algorithmic approach.

As can be seen from the constellation, there are a total of 32 points distributed as 4 amplitude states and 8 phase states. If these points are generated as complex numbers, they can then be specified as the mapping states in the Mapper and DeMapper components. Also, each symbol can be generated from five bits since $\log_2 32 = 5$. Hence, BitsPerSymbol = 5. The equations governing the generation of mapping states for a user-defined constellation are given by:

Amplitude_states=4

Phase_states=8

A=0.25

$B = (\pi/4)(0:\text{Phase_states}-1)$

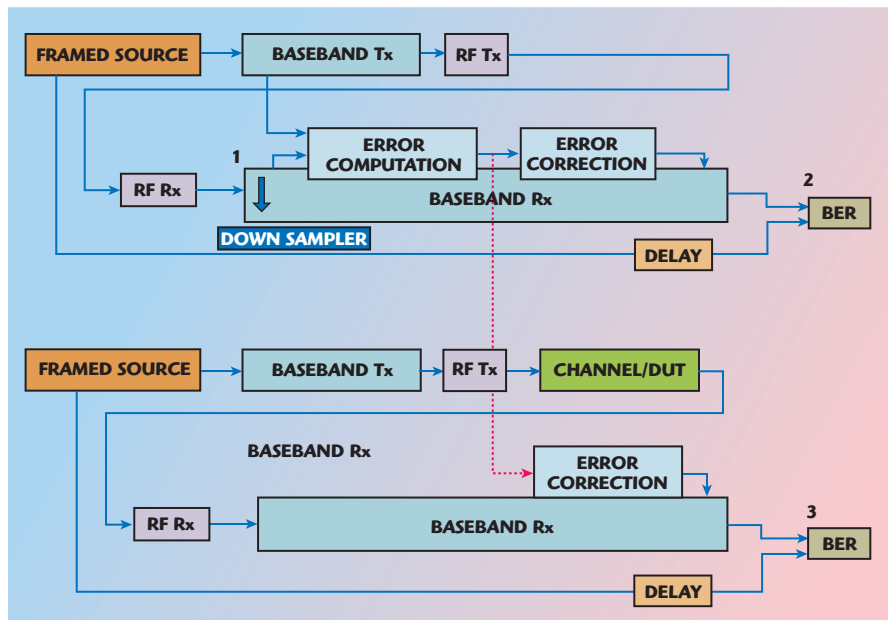
$V = A(\cos(B) + j\sin(B))$

MapperStates=[1*V 2*V 3*V 4*V]

SIMULATING BER OF A NOISY COMMUNICATIONS CHANNEL/DUT

Once the system is calibrated, the BER of the DUT (in this case, a noisy communications channel) can be simulated. While doing this, the engineer should apply the amplitude, phase and delay corrections that are caused by the system only, and not by the channel. The implementation is shown in **Figure 5**.

The output after the modulator in the baseband transmitter is split into



▲ Fig. 5 In this block diagram, measurement of a noisy communications channel is simulated. Only the amplitude, phase and delay corrections for errors caused by the measurement system are applied.

two paths. One of the paths (the top one in the figure) goes through the baseband transmitter, RF transmitter, RF receiver, baseband receiver, and the algorithmic blocks to compute the measurement channel gain (which causes amplitude and phase errors) and sync index (which causes time delay). These errors are corrected.

The lower path, after the modulator in the baseband transmitter, goes through the noisy channel/DUT and then through the baseband receiver where it is corrected for channel gain

and sync index errors computed in the other path. This corrects the systematic errors in the measurement system but does not affect errors introduced by the noisy channel/DUT. Finally, the BER computed at Location 3 in the figure reflects errors caused by the noisy channel/DUT only.

A few details must be noted while running the simulation represented in Figure 5. First, the engineer must adjust the phase of the down sampler at Location 1 in the top portion of the figure, so that the BER at Location 2

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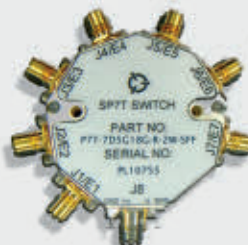
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is reduced to zero. Second, the energy per bit/noise power spectral density ratio (E_b/N_0) can be varied by setting the corresponding noise density in the noisy channel/DUT to simulate BER as a function of E_b/N_0 .

BER MEASUREMENT

Performing a BER measurement on an actual DUT is very similar to the simulation, although it is now a three step process.

(1) Download the Waveform to a Signal Source

A framed signal is created by adding a known preamble to the user data. Next, the signal is mapped and modulated with the required modulation format and then downloaded to a vector signal source. The downloaded waveform resides in the Random Access Memory (RAM) of the signal source. A digital vector signal source

provides the functionality of digital up conversion and modulation onto an RF carrier.

(2) Calibrate the Measurement System

The signal generator's output is connected to a signal analyzer through a low loss cable. The signal is received by the analyzer and may be captured in the form of I and Q files, which can then be run through the baseband receiver in the software. Typically, after the receive filter (a matched filter), the symbols are corrected for the amplitude and phase errors and also the time delay. The receive filter is usually a decimation filter. The phase of the decimation must be properly chosen to obtain good synchronization after error correction. The error computation and error correction follows the same method shown in Figure 3.

(3) Measure the BER of the DUT

In this step, the DUT is connected between the signal generator and the signal analyzer, making sure that the cable used in Step 2 is the only additional hardware besides the device. Any adapters used must be electrically small and should be low loss. Again, the signal is captured from the signal analyzer in the form of I and Q files for software processing. Baseband processing in software now needs to apply only the corrections determined in Step 2. The input symbols at the input and the output after error correction will not be perfectly synchronized if the DUT contributes a finite BER. The BER measurement then reveals only the BER of the DUT.

CONCLUSION

BER simulation and measurement of signals with common or proprietary modulation, coding and encryption can be difficult. One way to simplify this process is by following a systematic method that takes advantage of an algorithm to correct for measurement system amplitude and phase errors, as well as time delay. The measurement system calibration described here can be done automatically and adapts to any type of modulation format. For more information on this topic, go to <http://cp.literature.agilent.com/litweb/pdf/5990-7757EN.pdf> and <http://edocs.soco.agilent.com/display/sv201301/SystemVue+E-Books+Gallery>. ■

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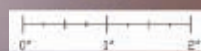
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Slotted Waveguide Antenna Design Using 3D EM Simulation

Slotted waveguide antennas (SWA) are often employed in radar applications where design specifications commonly require high gains and mechanical robustness. Since the peak power transmitted by radar antennas is usually very high, waveguide antennas present a practical alternative to planar arrays. While numerous design references and guidelines exist for planar arrays, there are far fewer for slotted waveguide antennas. This article presents a comprehensive workflow for the analysis and design of a slotted waveguide antenna with slots placed on the narrow wall of the waveguide. The virtual design is modeled and simulated using two different numerical methods and different mesh types. This simulation is compared to the analytical solution for array antennas and to the performance of a physical prototype.

Radar is an essential, safety-critical component of modern navigation and radar antennas need to be designed to exacting specifications. Not only do the antennas used on mobile platforms such as ships need to be high gain with tightly-controlled beam-widths, they also need to be strong, compact, lightweight and resistant to the effects of roll and motion. Slotted waveguide antennas can fulfill all of these criteria.

As the name suggests, slotted waveguide antennas consist of lengths of waveguide with slots milled into their conducting walls. These slots introduce discontinuities in the conductor and interrupt the flow of current along the waveguide. Instead, the current must flow around the edges of the slots, causing them to act as dipole antennas.^{1,2}

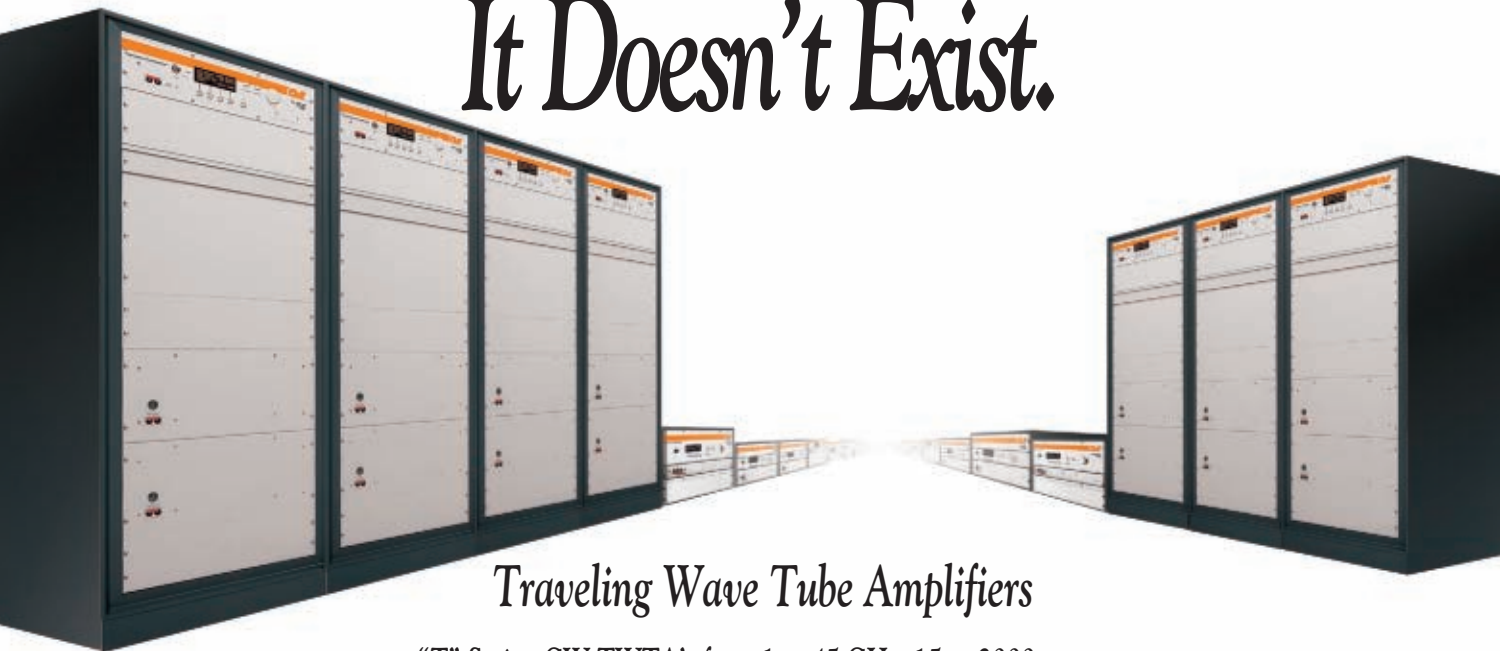
The two basic types of SWAs are standing wave and traveling wave. In a traveling wave SWA, the waveguide is built with matched loads or absorbers at the end, while in a standing wave SWA, the end of the waveguide is

short-circuited. The short is usually placed at a quarter of the guided wavelength (λ_g) after the last slot so that it behaves as an open circuit to the last slot. Standing wave slotted waveguide antennas are resonant structures and, therefore, have narrower bandwidths, but in general they are easier to fabricate than traveling wave antennas.

Depending upon the desired field polarization, the slots can be placed on either the narrow or broad wall of the waveguide, as shown in **Figure 1**. At the fundamental TE₁₀ mode, longitudinal slots on the broad wall will produce a field with vertical polarization, while transverse slots on the narrow wall result in a horizontal field polarization. For each design, the polarization depends on the specific antenna use.

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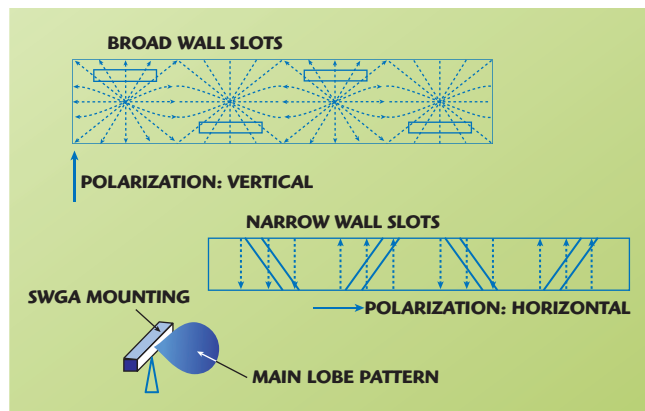
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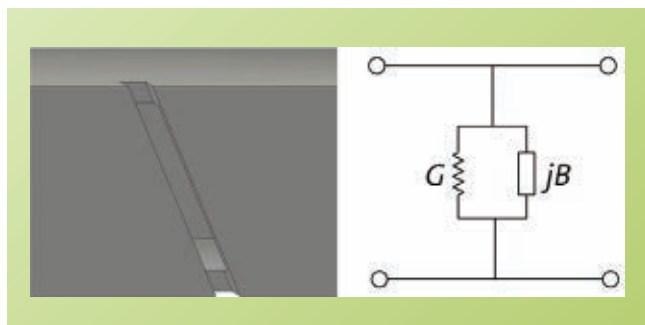
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▲ Fig. 1 The choice of slot position affects the polarization of the fields. The dashed lines depict the peak currents that flow on the walls for the standing wave TE₁₀ condition.



▲ Fig. 2 Edge-slot transmission line circuit model.

To demonstrate the applicability of 3D simulation to SWAs, this article describes the design of a naval radar antenna. The specification requires that the antenna operate in X-Band (8 to 12 GHz).³ The scanning beam must have a narrow beamwidth in the azimuth plane and a wider beamwidth in the elevation plane to compensate for the roll of the ship. Other parameters are specified in **Table 1**.

These requirements can be fulfilled by the arrays in Figure 1, with the horizontal polarization requirement determining

TABLE I	
ANTENNA SPECIFICATION	
Parameter	Specification
Gain	> 15 dB
Polarization	Horizontal
Frequency	9.375 GHz
Side lobe level (SLL)	30 dB

the use of the narrow wall slots. In order to achieve a resonant length, narrow wall slots must penetrate into the upper and bottom broad walls. These slots are known as edge-slots. Figure 1 shows these slots running diagonally between the broad walls. If they were perfectly perpendicular, they would not radiate, since the slots would run parallel to the current lines and therefore would not interrupt the current flow. By tilting the slots, a fraction of the current lines are interrupted, causing the slots to radiate. **Figure 2** shows the edge-slot construction and its circuit representation. The slot has a characteristic admittance which can be broken down into contributions from the conductance (G) and the susceptance (B).

For the design shown in Figure 1, adjacent slots have opposite inclinations so that the vertical components from these slots are cancelled out in space, as shown in **Figure 3**. This improves the spectral purity of the transmitted waves.

ARRAY DESIGN

The slots are distributed along the waveguide so that they form an array; the choice of array type and its setup allow the engineer to specify the gain, side lobe level (SLL) and beam steering. The discrete Taylor distribution⁴ was chosen for the array, since it produces a good theoretical match to the SLL requirement as well as providing a smooth variation between the excitations of adjacent elements – a useful characteristic when mutual coupling is a concern.

Because this is an SWA, the waveguide hosts a standing wave, in which slots are placed at the antinodes – locations where the electric field reaches its maximum. They are therefore separated by half of the guided wavelength ($\lambda_g/2$). Since a half wavelength on the Smith chart corresponds to a complete rotation, the individual slot admittances are summed at the

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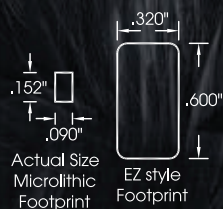
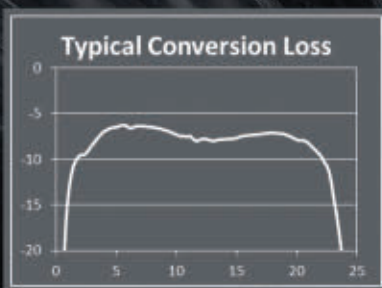
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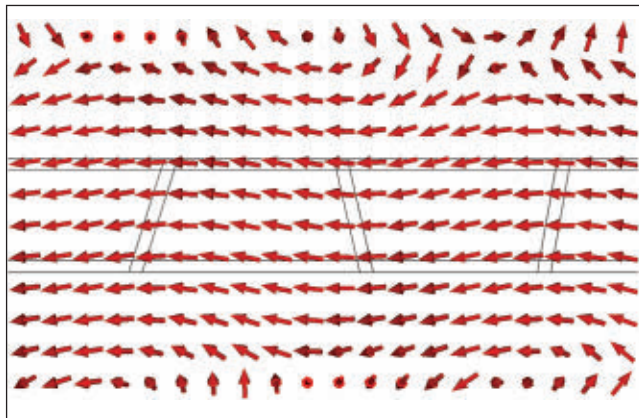


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waveguide input as if they were at the same position.

SWA designs do not usually take into account mutual coupling between slots.⁵ Since mutual coupling and waveguide thickness have a significant influence on the admittances of the edge-slots, an accurate analysis of the antenna should take their effects into account. Electromagnetic (EM) simulation can model both these effects, as well as the effects due to coaxial transitions and flanges. With EM simulation, the traditional empirical trial-and-error method is replaced by a computational evaluation.

The procedure assigns a theoretical excitation distribution to the array, where each element coefficient corresponds to a slot conductance (at the central frequency where the suscep-

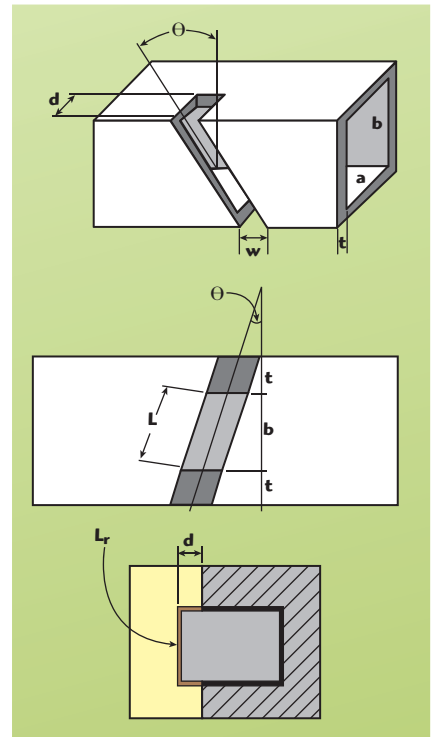


▲ Fig. 3 Vertical E-field component spatially cancelled, resulting in a horizontally polarized wave over the azimuthal plane.

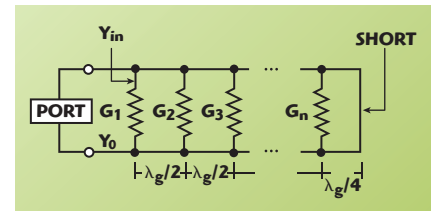
tance is zero) ensuring the length of each slot corresponds to a resonance at the operational frequency.

The first step characterizes the individual slots. **Figure 4** shows the important parameters.

The choice of waveguide (WR-90) and milling equipment determines the parameters $a = 22.86$ mm, $b = 10.16$ mm, $w = 1.59$ mm and $t = 1.27$ mm. This leaves only two independent parameters to optimize: θ (slot



▲ Fig. 4 Geometric parameters for the edge slots.



▲ Fig. 5 Equivalent circuit model for the resonant SWA.

inclination angle) and d (depth of the slot). The complete slot length is assumed to be the one measured on the internal face of the waveguide, parameter L_r , with a resonant length $L_r = 0.4625 \lambda_g$.⁶

EVALUATION OF THE RESONANT PARAMETERS θ AND L_r

For each slot, the first value to be found is the slot resonant length ($L_{r,i}$) for a given slot inclination (θ_i). Since mutual coupling must be taken into account, small variations from the initial L_r value are expected. If the final antenna has N slots, an array of N identical slots is simulated for each angle. This is more realistic than a single slot simulation, since it considers the effect of mutual coupling. **Figure 5** shows the equivalent circuit model of a generic SWA. Note that a displacement of $\lambda_g/2$ in a lossless transmission line corresponds to the same point on

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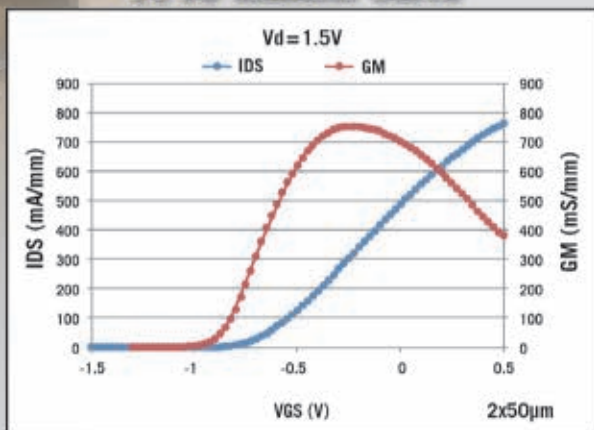
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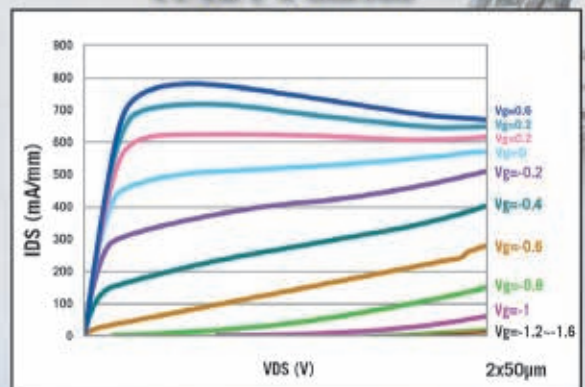
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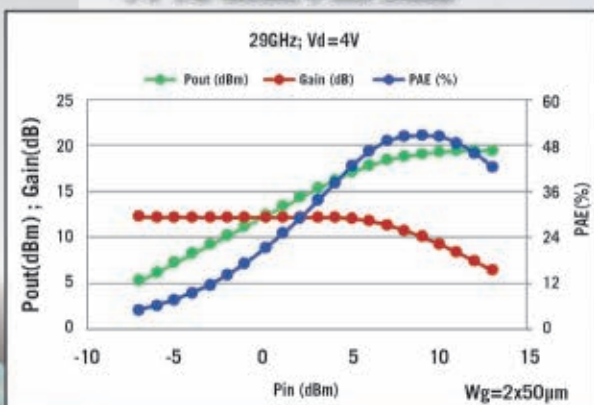
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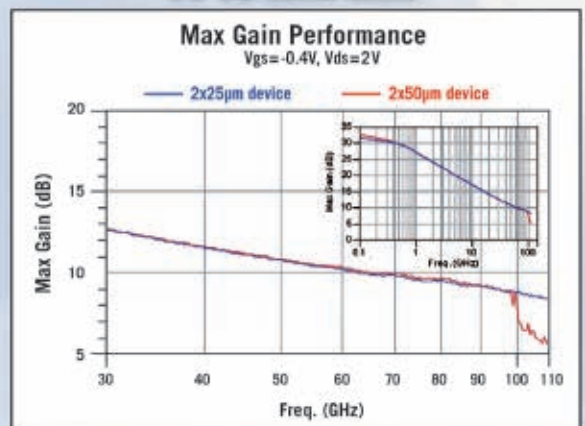
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the Smith chart, so that the resultant admittance measured at the first slot, Y_{in} , is equivalent to the sum of all the admittances.

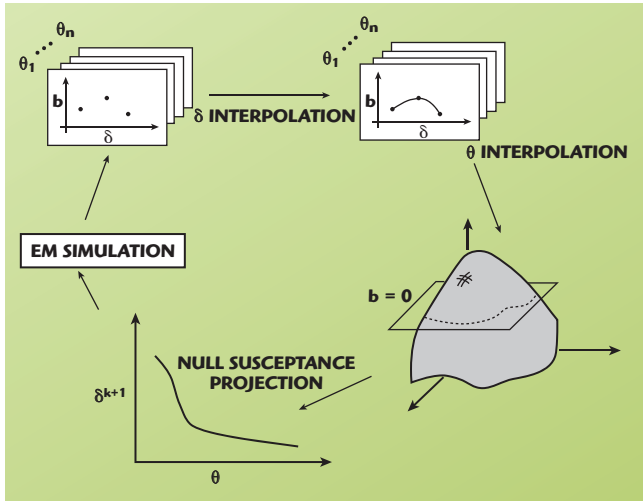
A parameter sweep using the frequency domain solver (F-solver) of CST MICROWAVE STUDIO®7 is carried out for each angle (θ), adjusting the slot depth (d) to find the slot's resonant length (L_r). The resonance is found for the single slot when the normalized susceptance (b) of the de-embedded waveguide port to the center of the first slot is null. We can assume that the computed admittance at the waveguide port is the product of the number of slots and the normalized slot admittance.

At the end of this process two curves are derived: slot inclination versus

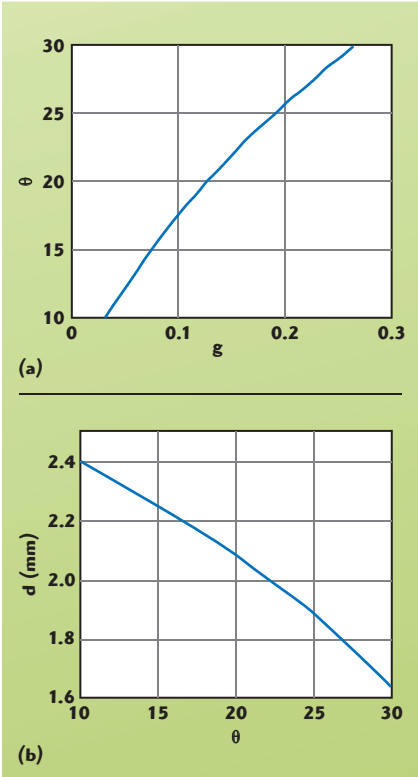
required slot conductance, and slot resonant length versus slot inclination. These curves are the design curves used in the synthesis of each slot in an N edge-slotted waveguide antenna.

EVALUATION OF THE NULL SUSCEPTANCE CURVES

The parameter sweep returns a set of admittance points that must be evalu-



▲ Fig. 6 Interpolation routine implemented as a search routine for the best parameters that generate a null susceptance slot.



▲ Fig. 7 Design curves for an edge-slotted waveguide antenna with 12 elements.

TABLE II	
DESIGN PARAMETERS FOR ARRAY EXCITATION COEFFICIENTS FOLLOWING THE VILLENEUVE METHOD	
Parameter	Value
Number of elements	12
Number of equal amplitude side lobe levels, n	4
SLL (dB)	30

ated in order to determine the optimum geometrical parameters to achieve null susceptance. For that we use an interpolation routine implemented in MATLAB, as illustrated in Figure 6. At first, the points of susceptance as a function of the slot length (here δ is used as a tweaking coefficient for L_r) are interpolated using the interp1 function with pchip method for each angle, and then the curves are interpolated in θ using the interp2 function with the cubic method. This builds up a susceptance surface. The slice of null susceptance ($b=0$) is derived by using the function contour. The curve described by this contour contains the values of $L_r(\theta)$ required for resonance. These are then inserted back into the 3D model, and the antenna is re-simulated. This process is

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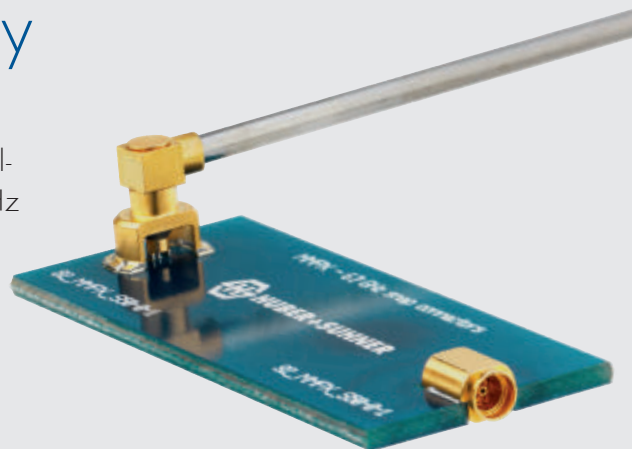
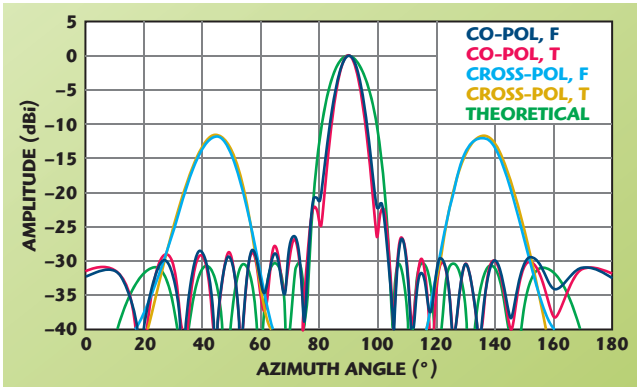


TABLE III

RESULTANT PARAMETERS OF THE ANTENNA

n	a_n	g_n	$\theta(^{\circ})$	d (mm)
1	0.2543	0.0110	—	—
2	0.3991	0.0241	—	—
3	0.5677	0.0547	12.8450	2.3195
4	0.7614	0.0984	17.4422	2.1716
5	0.9146	0.1420	21.3262	2.0350
6	1.0000	0.1698	23.4788	1.9541



▲ Fig. 8 Comparison of the different solver results and the theoretical array factor.

repeated until the desired accuracies are achieved. **Figure 7** shows the de-

ments and the number of side lobes

sign curves for a 12-slot antenna. These curves allow the engineer to carry out antenna array synthesis.

ANTENNA SYNTHESIS

The antenna synthesis procedure starts with the Taylor polynomial that represents the array function: parameters such as the SLL, the number of ele-

are the inputs, and the outputs are the slots' individual excitations (a_n). The curves generated in MATLAB are then examined in order to determine which θ and L_r will eventually generate the required conductance. **Table 2** summarizes the input parameters for the synthesis polynomial.

The next step is the evaluation of the required admittances for the final antenna, considering each element's excitation. The required normalized conductances (g_n) are derived using these equations.

$$g_n = \frac{a_n^2}{\sum_{i=1}^N a_i^2} \quad n = 1, 2, \dots, N \quad (1)$$

$$\sum_{n=1}^N g_n = 1 \text{ (End-feed condition)} \quad (2)$$

With the design curves in Figure 7, the inclination and resonant length of each slot are determined. **Table 3** summarizes the final antenna parameters.

By symmetry, the parameters of the rest of the slots are the same as those of the first half, but in reverse order. Note that the first two elements, and therefore the last two elements, require conductances that are out of the design curve range. In those cases, the lowest inclination is adopted: slots with 10° tilt that are 2.4044 mm deep.

COMPLETE EM SIMULATION

The antenna design is then evaluated within CST STUDIO SUITE[®],⁷ with the slots filled by a dummy object (made of vacuum). This allows local refinement to be carried out directly on the slot volume, so that convergence is achieved much quicker.

The antenna was simulated with the F-solver, and the simulation was validated using the time domain solver (T-solver). The simulations used adaptive meshing and local mesh refinement over the slots. As shown in **Figure 8**, the far field results from the F-solver and T-solver agreed closely for both the co-polarization and the cross-polarization. Carrying out two simulations using different numerical methods and meshes helps us confirm the accuracy of the simulation. **Table 4** summarizes the antenna characteristics.

The antenna's maximum gain is 16 dB, and the SLL is -21.9 dB. It is known that the final array radiation pattern is a combination of the pattern of a single radiating element (in this case, a slot), and the array factor (AF).

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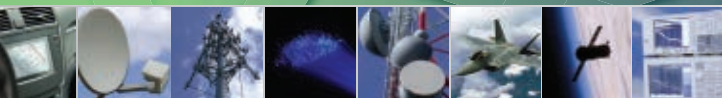
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	HMCAD1050-40	13 / 12-Bit	20 / 40 MSPS	2	30 / 55 mW	72.2 / 72.7	85 / 81	EKIT01-HMCAD1050
	HMCAD1051-80	13 / 12-Bit	65 / 80 MSPS	1	50 / 60 mW	72.6 / 72	81 / 77	EKIT01-HMCAD1051
	HMCAD1051-40	13 / 12-Bit	20 / 40 MSPS	1	19 / 33 mW	72.2 / 72.7	85 / 81	EKIT01-HMCAD1051
	HMCAD1040-80	10-Bit	65 / 80 MSPS	2	65 / 78 mW	61.6	77 / 75	EKIT01-HMCAD1040
	HMCAD1040-40	10-Bit	20 / 40 MSPS	2	24 / 43 mW	61.6	81	EKIT01-HMCAD1040
	HMCAD1041-80	10-Bit	65 / 80 MSPS	1	38 / 46 mW	61.6	77 / 75	EKIT01-HMCAD1041
	HMCAD1041-40	10-Bit	20 / 40 MSPS	1	15 / 25 mW	61.6	81	EKIT01-HMCAD1041
NEW!	HMCAD1052	12-Bit	160 MSPS	4	490 mW	69	78 ^[2]	EKIT01-HMCAD1052
NEW!	HMCAD1054	12-Bit	320 MSPS	2	490 mW	69	78 ^[2]	EKIT01-HMCAD1054
NEW!	HMCAD1056	12-Bit	640 MSPS	1	490 mW	69	78 ^[2]	EKIT01-HMCAD1056
NEW!	HMCAD1062	14-Bit	80 / 105 / 125 MSPS	4	490 / 605 / 765 mW / Channel	74	85	EKIT01-HMCAD1062
NEW!	HMCAD1068	14-Bit	80 / 105 / 125 MSPS	2	300 / 380 / 460 mW	74	85	EKIT01-HMCAD1068
NEW!	HMCAD1063	14-Bit	400 MSPS	2	750 mW / Channel	72	85	EKIT01-HMCAD1063
NEW!	HMCAD1073	16-Bit	400 MSPS	2	1100 mW / Channel	76	90	EKIT01-HMCAD1073

[1] Excluding interlacing spurs.

[2] For BW < 40 MHz. See HMCAC1052/1054/1056 datasheets.



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TABLE IV

FINAL ANTENNA CHARACTERISTICS

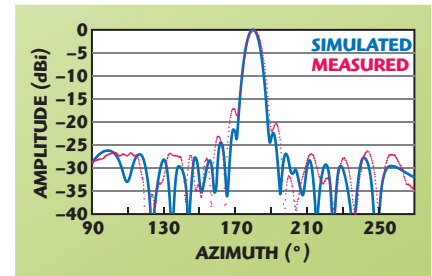
Parameter	Result
Realized gain in co-pol	16 dB
SLL	-21.9 dB
Cross-polarization lobes	$\pm 45^\circ$
S_{11}	~ -30 dB
Azimuth beamwidth (-3 dB)	7.5°
Elevation beamwidth (-3 dB)	90°

In Figure 8 the theoretical radiation pattern, based on the desired AF, is compared with the simulated complete antennas. Note that the highest simulated side lobe is within the theoretical main lobe, thereby suggesting that it is a modulation of the AF main lobe and not a true secondary lobe. It cannot be mitigated unless the slot geometry is modified.

The array's actual first SLL is -26 dB. Elsallal et al⁸ have suggested that



▲ Fig. 9 Slotted antenna made from a copper WR90 waveguide, top-milled by a CNC machine.



▲ Fig. 10 Co-polarization far field pattern results in the azimuth plane (measurement and simulation).

due to errors in the phase of the slot excitations, a -30 dB SLL result is not possible in practice. The authors also suggest an optimization technique that modulates the conductance of the slots in order to achieve a simulated -27.3 dB SLL. Since no modulation technique was used, the -26 dB SLL is accepted as an optimum result by the numerical verification of the far field pattern.

PROTOTYPE MEASUREMENT

The final antenna, shown in **Figure 9**, was prototyped and tested in an anechoic chamber. The co-polarization pattern (see **Figure 10**) shows that this antenna is very directional in the azimuth plane and demonstrates a close agreement between measurement and simulation. Some of the variation between the far field measurements and the simulation may be attributed to the measurement setup. The antenna was attached to a metallic mast, and it is possible that this mast interacted with the fields. The results are summarized in **Table 5**.

CONCLUSION

Edge-slotted waveguide antennas are widely used in radar applications where they outperform other types of antennas such as printed arrays. Despite the ubiquity of SWAs, we were unable to find any previous literature describing comprehensive analytical formulations or computer-aided design programs for SWA synthesis. In the absence of design curves or suitable measurement data, the designer usu-

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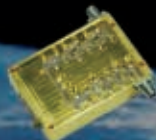
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TABLE V

SUMMARY OF ANTENNA PERFORMANCE

	<i>Simulated, dB</i>	<i>Measured, dB</i>
Gain	16,10	18,31
SLL	25,32	22,85
S ₁₁	-28,23	-20,12

ally resorts to empirical methods to optimize the design. The use of modern computer simulation software offers an alternative approach to SWA design.

The workflow proposed in this paper covers the entire antenna project, from slot characterization to physical prototyping of the antenna, and shows how simulation can be used at every step to improve antenna performance. The antenna described in this article has 12 slots. It achieved optimum performance, verified numeri-

cally, without any changes needed to further improve the final design. The measurement of a prototype validates the accuracy of the simulation. ■

ACKNOWLEDGMENT

The authors would like to acknowledge ATMOS Sistemas Ltda. for financing the antenna manufacturing.

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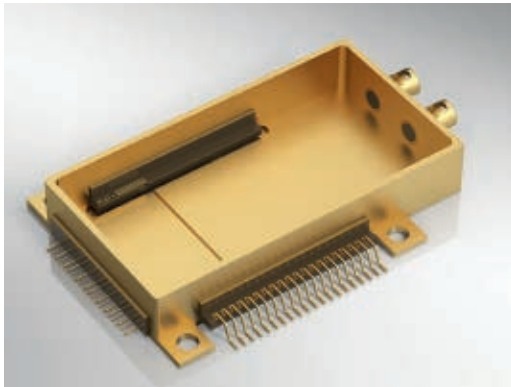
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Resolving the Complexity of Hermetic RF Hybrid Housings

Opto-electronic components used in the high-speed data and telecommunications industries are susceptible to the effects of humidity, temperature variations and other physically and chemically demanding environmental conditions. With the growing trend for replacing electrical signals with optical ones, the importance of protecting these opto-electronic components is also growing.

A reliable, long-term protection of highly sensitive electronics is achieved by using hermetic housings. With world-leading competences in glass-to-metal sealing, ceramic-to-metal-sealing as well as full ceramic packages, Schott's electronic packaging business unit offers all hermetic housing technologies from one source. This enables the optimization of the packaging in consideration of the many different performance criteria.

DESIGNING COMPACTNESS

Many RF packages, for instance, are Butterfly packages. The lead frame of these packages has the same height as the RF signal inside the

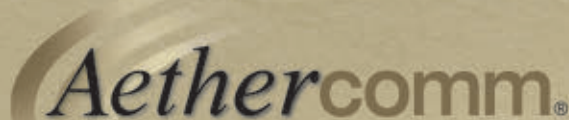
package to achieve an RF path with low reflection. However, for connecting with the lines on the host board, such a package requires a cut out in the host board or bent leads. These options are far from ideal for technical, design and assembly reasons.

For cost-efficient assembly, many customers prefer surface mount packages. Schott has recently developed a space-saving, standard-looking SMD package (see **Figure 1**) with a bandwidth greater than 30 GHz that allows for a highly customizable design of the package interior, while the outside package I/Os look pretty much standard. The height difference between the RF signal inside the package and the host board is bridged with a sophisticated hermetic multilayer ceramic package feedthrough.

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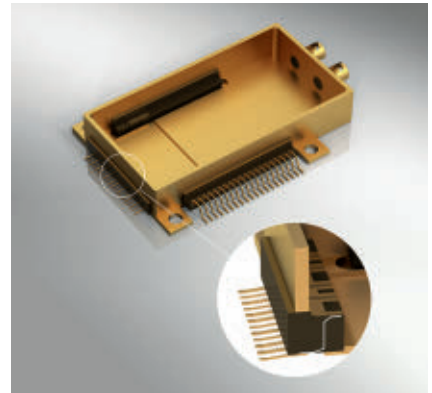
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▲ Fig. 1 Surface-mount RF package with four differential line pairs, allowing for a data rate of up to 28 Gbit/s per pair.

when it comes to miniaturizing optoelectronic components for use in the high-frequency range.

DESIGN CHALLENGES

The design and simulation of high performance fiber optical and telecommunication products is very important and Schott works closely with ix-cad GmbH, which provides computer aided design and simulation. For an opto-electronic package, several design challenges need to be solved: The height difference of the planar waveguide for the signal path inside the housing and the host board needs to be bridged. The signal propagation direction has to be turned from the horizontal direction into the vertical direction and once again into the horizontal direction to finally go through the ground plane in an inner layer (see Figure 1, cross-section).

To keep the impedance of the waveguide at this transition at the desired value, e.g., 50 Ω , the dielectric and metallic structures are designed in various geometries. Then, the electromagnetic (EM) field is simulated and the feedthrough is tested at ix-cad GmbH. The virtual prototyping process allows for quick modifications to achieve the optimal design. It significantly reduces development costs and shortens the time-to-market.

An additional benefit of this approach is that one can analyze the EM field inside the model and get insights into its behavior to improve the signal path quality. The simulation results show the insertion loss and the return loss and enable an optimization of the

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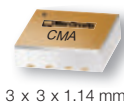
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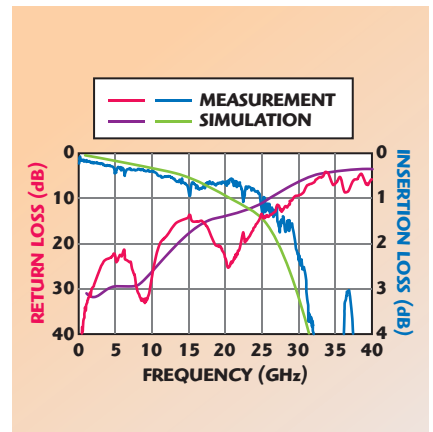
performance. The goal of this method is to achieve first-pass success with the prototype.

COMPLETE SIMULATION

All transitions of the feedthrough are modeled and optimized separately. Finally, the complete feedthrough is designed, including the transition to the host board. The next step is to produce the prototype and verify the performance. **Figure 2** shows the mea-

surement and simulation results of a high frequency package feedthrough including the connection to the host board in a frequency range from 1 to 40 GHz.

The height difference between the RF level inside the package and the host board may be several millimeters. In the example shown in **Figure 2**, the measured insertion loss (S_{21}) displays a 3 dB bandwidth of 31 GHz. The measured return loss (S_{11}) is < 10 dB up to



▲ Fig. 2 Simulated and measured return loss (S_{11}) and insertion loss (S_{21}) of the package feedthrough.

30 GHz. Simulation and measurement results fit well and demonstrate that this development process is based on the right model and enables enhanced and innovative designs of hermetic hybrid packages.

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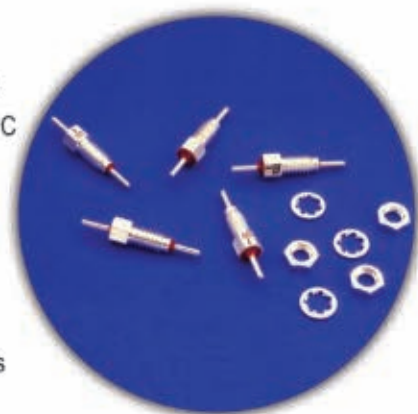
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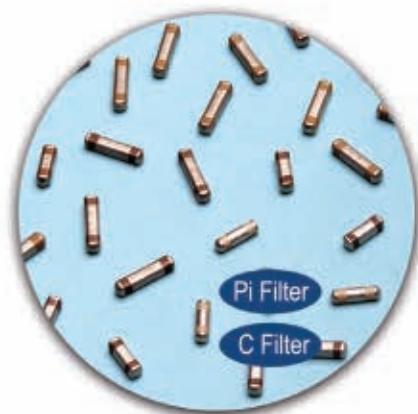


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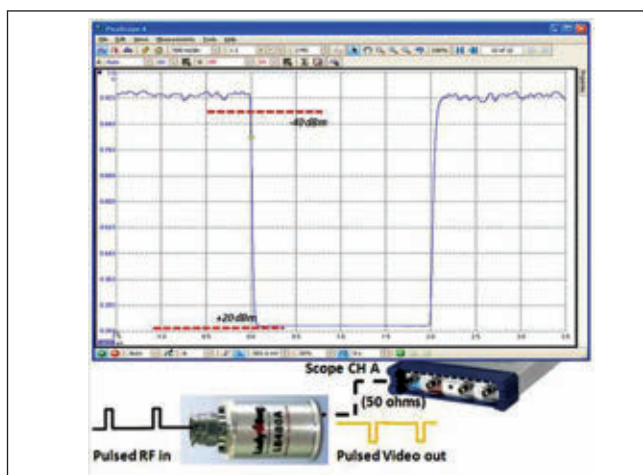
- 100 V_{DC} up to 125°C
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Pulse Profiling USB Power Sensors

An efficient, accurate and cost-effective method for making RF signal timing and latency measurements is to use wideband



▲ Fig. 1 Option OW2 provides a wideband, calibrated analog, negative detector video output signal, 0 to -1 V.

video detectors at the two points within the circuit from which the timing comparison is desired. Pulse Profiling USB power sensors from LadyBug Technologies enable easy measurement of one-shot pulse events and other real-time modulated signals with a real-time, wide bandwidth, calibrated analog detector output signal together with a high speed oscilloscope (see **Figure 1**). This feature (option OW2) is available on LadyBug models LB480A and LB680A.

As an example, the latency of a pulsed signal passing through a CREE™ GaN high electron mobility transistor (HEMT) power amplifier for S-Band radar application was measured. The test setup is shown in **Figure 2**. A pulse signal with a 20 percent duty cycle and a 2.9 GHz carrier frequency was applied to the input through a coupler that was used to provide

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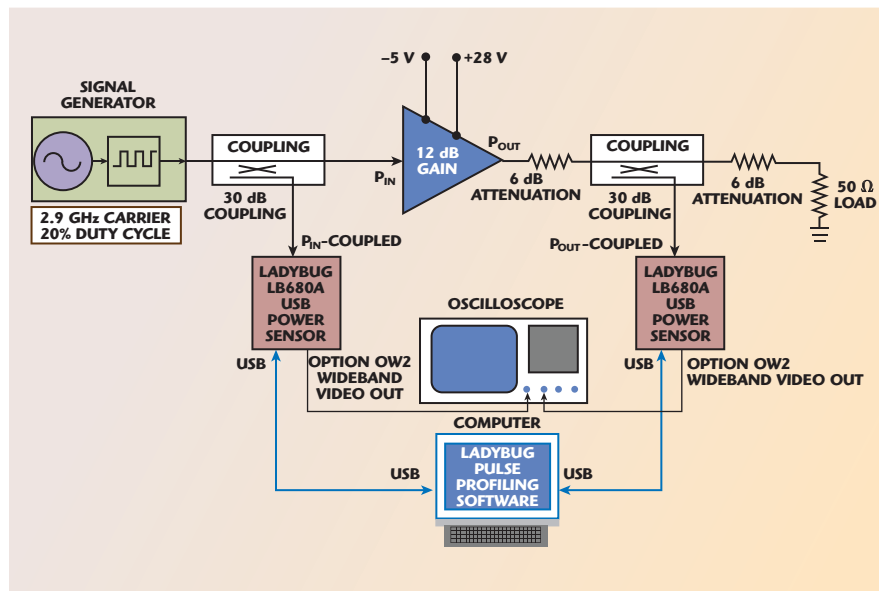
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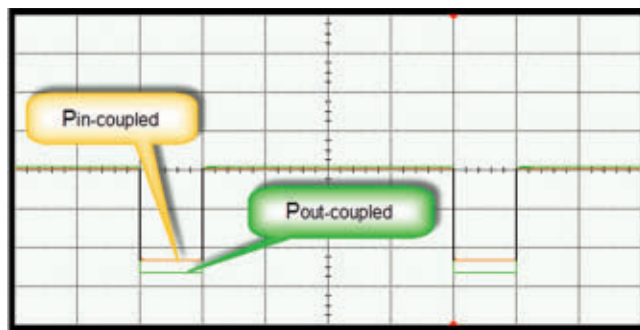


▲ Fig. 2 Pulse latency measurement setup.

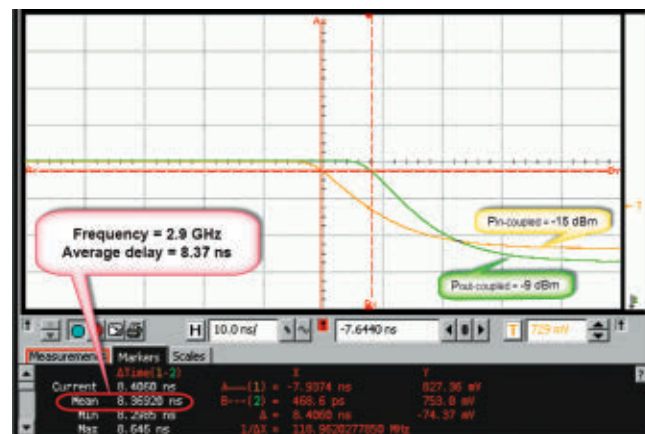
access to the input signal. The amplifier operates in saturated mode to maximize efficiency and provide fast switching speed for pulsed waveforms. The amplifier supplies 12 dB of gain in its saturated state.

Connecting a LadyBug LB680A power sensor equipped with the wideband video output to both the input and output of the amplifier and the video out of the sensors to two inputs of an oscilloscope enables the time delay measurement (see Figure 3). LadyBug Pulse Profiling software allows temporal measurements of the pulses such as rise and fall times, overshoot, droop and others at both points in the circuit showing the effects of the amplifier on these parameters.

The latency measurement of the two video outputs on an oscilloscope is shown in Figure 4. With a 2.9 GHz carrier frequency, the average delay



▲ Fig. 3 Wideband analog video outputs of the two sensors on an oscilloscope.



▲ Fig. 4 Latency measurement results using an oscilloscope with LadyBug LB680A USB power sensors and option OW2 (multiple measurements of time delay were made at different carrier frequencies).

measured was 8.37 ns. This was measured at the rising edge of the RF pulse just as the signals began rising. Averaging was used to reduce the effect of random noise.

Additionally, multiple measurements of time delay were made at

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NEW USB-8SPDT-A18	8	0.25	1.2	80	10	2495.00

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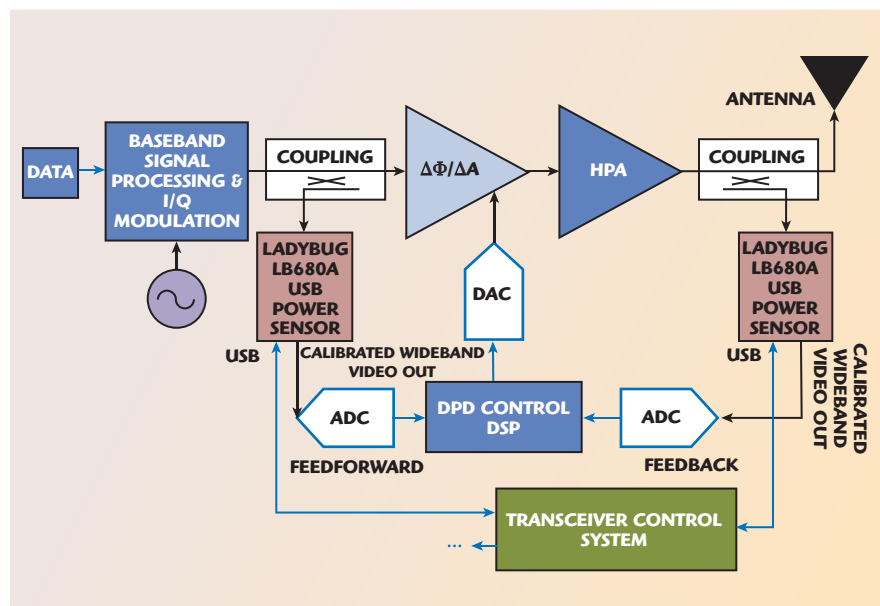
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Product Feature



▲ Fig. 5 RF Digital predistortion block diagram using signal feed-back and feed-forward.

different carrier frequencies. For this amplifier, the timing latency drops as the carrier frequency increases. At 2.7 GHz, latency is measured as 8.66 ns, falling to 8.14 ns when the frequency is increased to 3.1 GHz.

TIME INTERVAL ANALYSIS OF PULSES AND PULSE TRAINS

Precise, fast and efficient frequency and time interval analysis (TIA) measurements for a radar system are essential. Pulsed RF signal time and frequency parameters are easily characterized by time stamping the rising and falling RF pulse envelope edges.

For an unmodulated CW pulse, measuring pulse parameters such as pulse repetition interval (PRI) and pulse width (PW) are relatively easy to derive from the spectrum display on a spectrum analyzer. Pulse repetition frequency (PRF = 1/PRI) lines can be obtained by narrowing the resolution bandwidth (RBW) of the spectrum analyzer. Pulse width can be determined by measuring the peak of the spectrum trace to one of the first nulls.

These measurements can be challenging for more complex radar signals. Using the wideband video detector on a LadyBug power sensor provides a viable solution. To gather needed information about a long train of pulses with a low duty cycle the oscilloscope or digitizer used will require a substantial amount of memory to acquire a large set of

real-time data. Questions include: When does the pulse turn on and off? When does the next pulse turn on and off relative to the previous pulse?

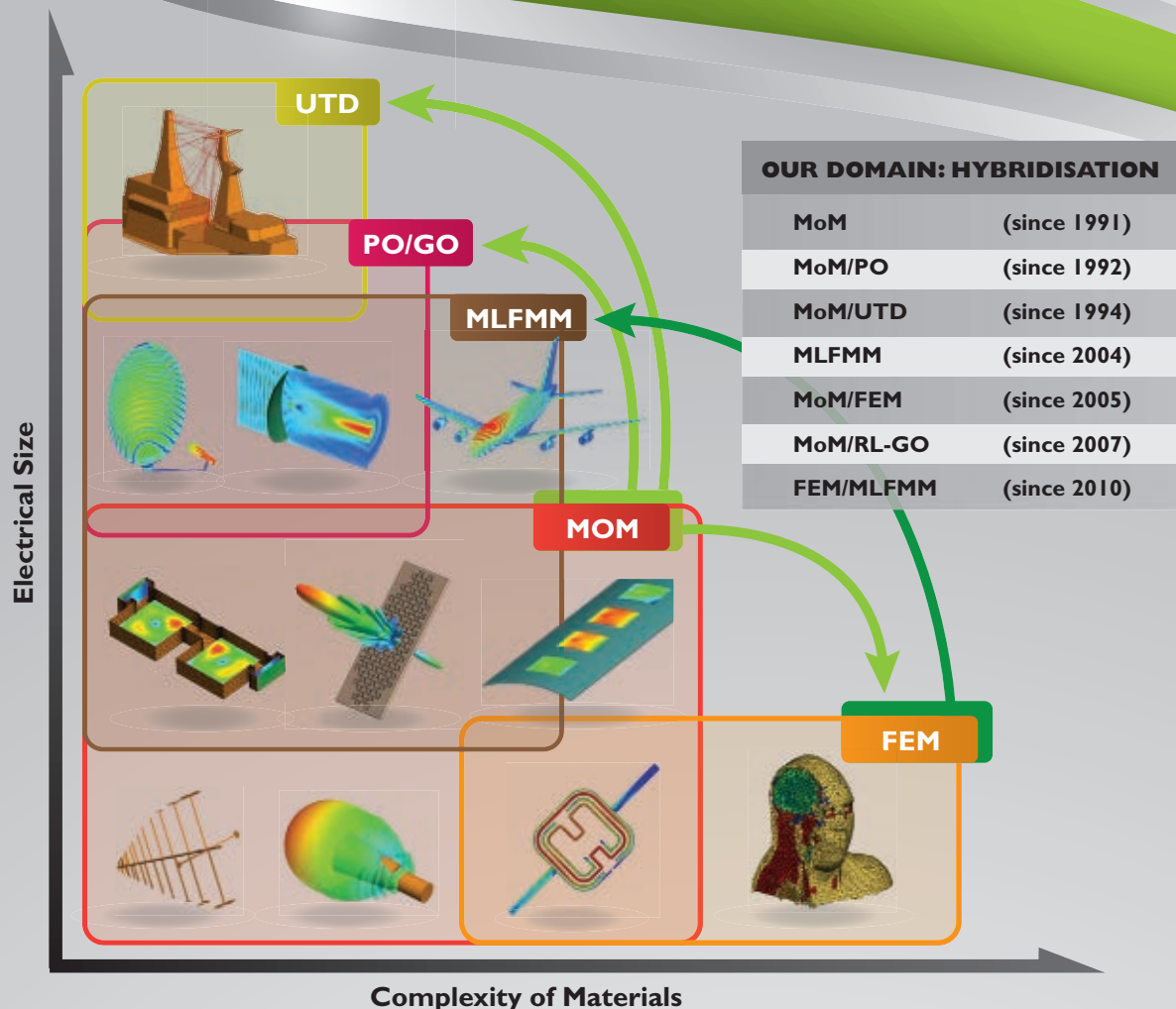
In most radar applications, systems tend to change modes and vary their PW and PRI over time. Without a fast, real-time TIA capability, these mode and timing changes would not be seen.

One answer: measure the timing of the pulse envelope edges provided by the analog envelope signal from the LadyBug power sensor using an oscilloscope or digitizer. Only the timing of the pulse edges needs to be recorded.

For time interval analysis of radar signals, use a wideband video detector and oscilloscope to make measurements and facilitate analysis such as: raw time interval data and frequency vs. time data; RF PW vs. time; RF PRI vs. time; develop PW and PRI histograms and statistics (min/max, mean, standard deviation).

SIMPLIFYING PREDISTORTION CIRCUITRY

System elements affecting the performance of the RF predistortion design are the analog envelope detectors required for generating control signals for the analog or digital control circuitry. One method of simplifying the predistortion circuitry: employ the video detector of a LadyBug peak and average power sensor. This would not be feasible for portable user devices and may not be cost effective for some lower power and lower frequency pre-



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Product Feature

TABLE I

VIDEO DETECTOR SPECIFICATIONS

<i>Wideband Video Detector Out</i>	<i>Option OW2 (Requires opt 004, not available with opt 001)</i>
Range	
Voltage Output	1 to 0 V typical (Negative Power Detecting)
Real-Time Detected RF Power	-45 to +20 dBm typical
Output Impedance/Bandwidth	50 ohm typical/10 MHz typical
Sensitivity	0.15 dB/V typical
Connector Type	SMB male (replaces Trigger Output)

distortion applications (L- and S-Band). For higher power fixed applications with the carrier frequencies to 20 GHz, the calibrated video output on the LadyBug power sensor provides a simplifying alternative.

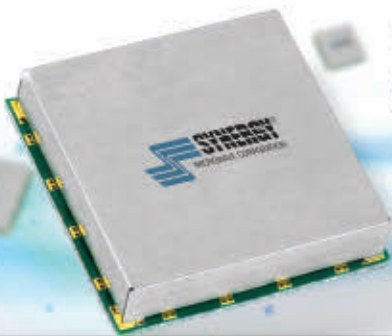
The level of the video output is fully calibrated so the absolute amplitude of the PA output is accurately tracked by the video signal. It can then be sampled and fed to the DSP based digital predistortion circuit without the need to pass through a calibration look-up-table (LUT) reducing the feedback latency.

Figure 5 shows one predistortion configuration out of a multitude of techniques and designs. Here we have implemented digital predistortion using feedback and feed-forward of the analog envelope signals of the RF input and output. Out of all the different possible configurations for PA predistortion, most require at a minimum an accurate real-time sampling of the output power level. The video detector option OW2 is available on LadyBug models LB480A and LB680A pulse profile, peak and average sensors.

Option OW2 provides real-time, calibrated detector output capability (see **Table 1**). This allows viewing of one-shot pulses and other real-time modulated signals by using a high speed oscilloscope to display the detector's analog output. The option OW2 signal is made available on the trigger out (TO) SMB connector (so the TO signal will not be available). Option OW2 requires option 004 and is not available if option 001 is ordered.

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HFSO745R84-5	745.84	0.5 - 12	+5 @ 35 mA	-147
HFSO776R82-5	776.82	0.5 - 12	+5 @ 35 mA	-146
HFSO800-5	800	0.5 - 12	+5 @ 30 mA	-146
HFSO914R8-5	914.8	0.5 - 12	+5 @ 35 mA	-139
HFSO1000-5	1000	0.5 - 12	+5 @ 35 mA	-141
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LTCC High Power Attenuators

RCAT attenuators have high power handling of 2 W and wideband width from DC to 20 GHz. The devices are fixed value absorptive attenuators. The thermally optimized design can operate reliably at much higher input power as compared to similar devices. The high precision and repeatable monolithic attenuator chip is processed using the most advanced semiconductor processing techniques. The Cu filled through-die vias and Cu metallization on the backside provide a very low thermal resistance path to dissipate the attenuated power.

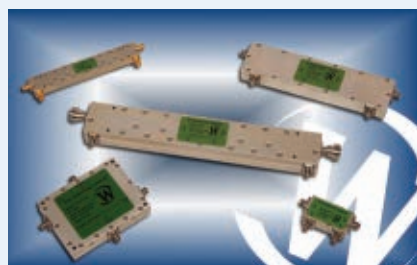
The attenuator chip is packaged in an LTCC hermetic package utilizing fully automated and highly reliable manufacturing processes. They are assembled in a miniature $2.25 \times 2.25 \times 1.1$ mm ceramic package. The highly reliable hermetic package provides predictable and repeatable performance in military applications including ground, air and ship requirements.

Mini-Circuits offers a wide variety of cost effective fixed attenuators including surface mount based designs and MMIC and connectorized units up to 26 GHz with power handling up to 100 W that include both DC

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VENDORVIEW

**Mini-Circuits,
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www.minicircuits.com.**



Test and Measurement Directional Couplers

Werlatone® Inc. supplies high power, ultra-wideband directional couplers throughout the world. Over the past 45 years it has grown its test and measurement coupler line in support of specific programs, but also based upon its market vision, whether in the military or commercial segments.

Multi-octave directional couplers are available throughout the marketplace, as are high power designs. However, Werlatone provides a combination of bandwidth, power and low loss. Loss on such designs is very critical as it will quickly translate to heat and ultimately unit failure. Model C8060 (20 dB bi-directional coupler,

200 to 6000 MHz, 200 W CW) is an example of bandwidth, power and low loss in a compact size. As a test coupler, the C8060 allows for accurate readings at lower power due to its coupling factor. With an attenuator, the user can loosen the coupling to test at higher power levels as well. Regardless, the loss and thus the heating remain minimal.

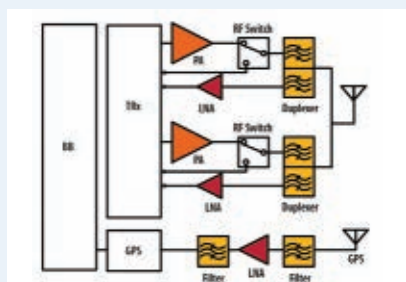
At 30 dB coupling, the C9191 (20 to 1000 MHz, 100 W CW) and the C8000 (600 to 6000 MHz, 100 W CW) provide excellent bandwidth covering multiple frequency bands in a test environment. As the coupling factor loosens, the power ratings go up. At 40 dB coupling, Model C6021

covers a full 10 kHz to 1000 MHz at 500 W CW, incurring an insertion loss of less than 0.6 dB.

Additional showcase designs include the C7734 (30 to 2500 MHz, 100 W CW) and the C8998 (100 to 3000 MHz, 250 W CW). Peak power levels are typically 10× the CW power, but please seek confirmation first on specific models. The combination of high power, wide bandwidth and low loss is a challenging requirement that Werlatone couplers meet.

VENDORVIEW

**Werlatone Inc.,
Patterson, NY,
www.werlatone.com.**



Designers of Small Cell BTS systems face many technical challenges when specifying and designing the RF front end. In many ways, those challenges are similar to the ones faced by designers of mobile handsets. There are issues with size, power consumption, power added efficiency (PAE), receiver sensitivity, frequency band coverage, coexistence with other radios, and hardware design and layout flexibility.

Avago Technologies has addressed these concerns with a broad portfolio of RF product solutions including power amplifiers (PA), low noise amplifiers (LNA), FBAR filters and duplexers, and integrated GPS/GNSS LNA filter modules for small cell BTS applications.

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IIP3 (up to 7 dBm)

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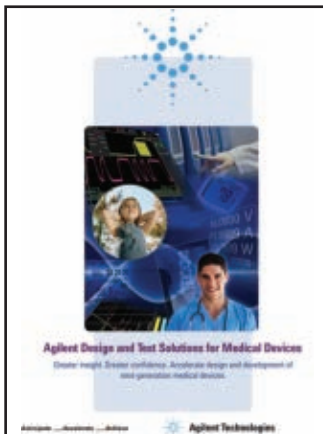
Catalog Update

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RF Portfolio

This 36-page brochure by HUBER+SUHNER offers a clear-cut overview of the company's versatile range of RF cable and connector families. The brochure supplements its comprehensive catalogues, *RF Cables* and *RF Connectors*, which are continuously updated as online versions. The brochures *RF Portfolio*, *RF Connectors* and *RF Cables*, along with another hundred brochures, can be downloaded as e-papers or PDFs from the download section of the website.

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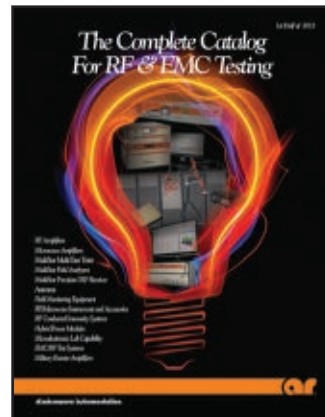


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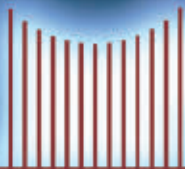
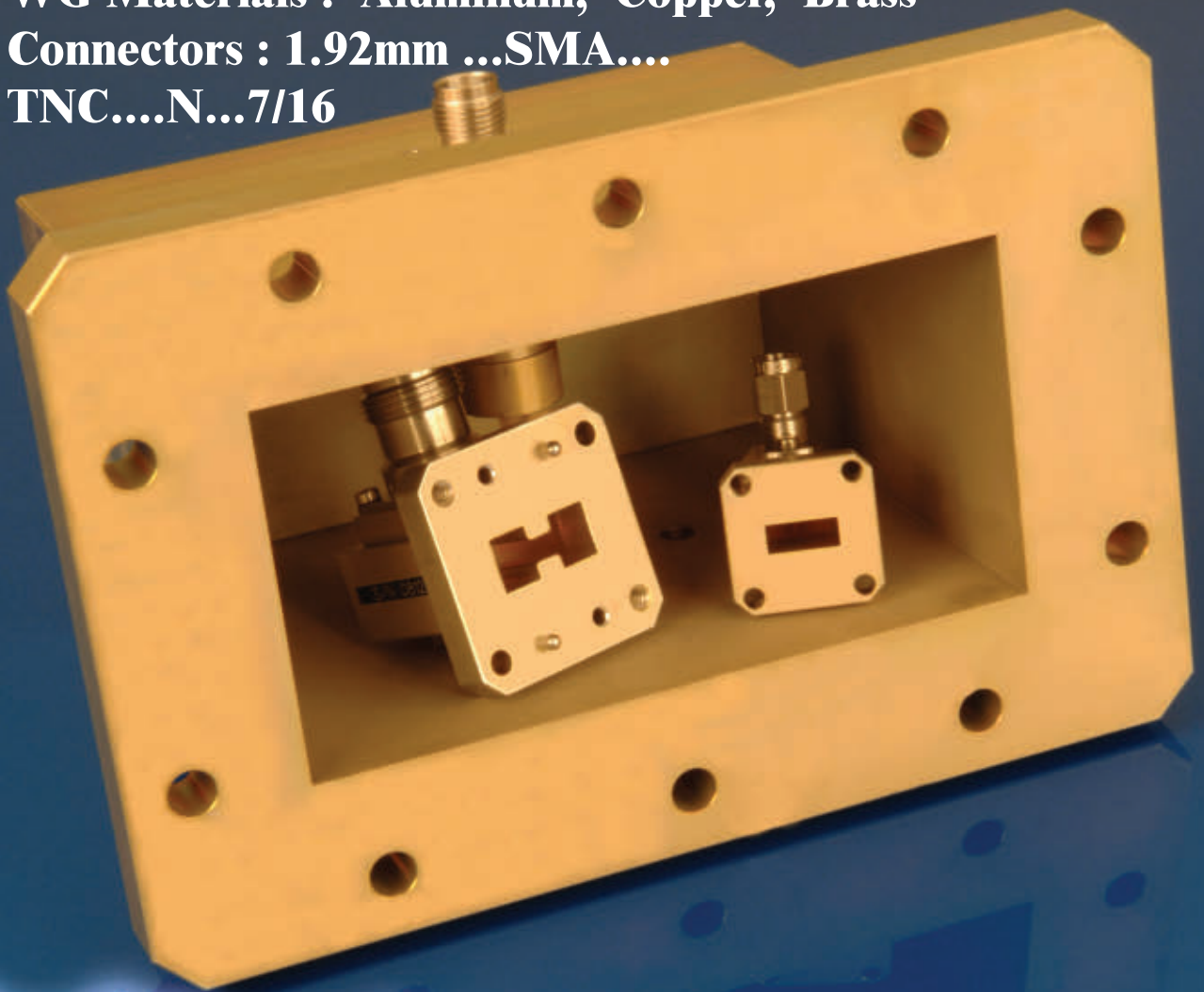
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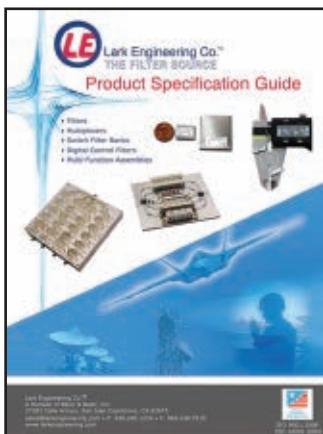
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Linear Technology,
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Waveguide Product Catalog

Narda Microwave-East announces the availability of its new Waveguide Product Catalog. The catalog includes specifications for its expanded waveguide product line and features 130 new models in four distinct categories: waveguide-to-coaxial adapters (right angle and end launch); gain horns; low and medium power terminations; and crossguide directional couplers. Models are available from stock and cover frequencies from 1.7 to 40 GHz. Please visit the company's website to download a copy of the catalog.



Narda Microwave-East,
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Product Selection Guide

RFHIC's new season 2013/2014 product selection guide provides specifications of GaN, LDMOS and GaAs technologies based RF products for the RF industry. RFHIC's product selection guide lists products servicing broadcasting, telecommunication and defense market. Download the product selection guide by visiting www.rfhic.com/data/download/rfhic_2013.pdf or contact a sales representative in your area to receive a copy.

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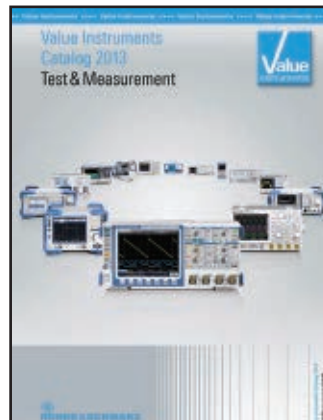


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Frequency Matters.

Tuesday, 8th and Wednesday, 9th October 2013 • Room St. Petersburg, NCC Nuremberg, Germany

A one and a half-day Forum focusing on defence and automotive radar.

Programme:

Tuesday, 8th October 2013

13:50 - 15:30 Development and Production Requirements for Automotive and Military Radar

Experts on radar manufacturing from the different markets will present their view on the various volume production aspects and trends for the next generation of radar manufacturing.

16:00 - 17:40 EuMIC Closing Session

Wednesday, 9th October 2013

08:30 - 10:10 Microwave Journal Industry Panel Session

The session offers an industrial perspective on the key issues facing the defence and security sector and, in accordance with the theme for 2013, the Panel will address: *Defence and Automotive Radar – Differences and Commonalities*.

10:40 - 12:20 EuRAD Opening Session

12:30 - 13:30 Strategy Analytics Lunch & Learn Session

This session will add a further dimension to the Defence and Automotive Radar theme by offering a market analysis perspective, illustrating the status, development and potential of the market.

13:50 - 15:30 Experience and Future Expectations regarding Automotive and Military Radars

This session reports on the experiences obtained with radar sensors in many different applications, with the purpose of identifying the remaining challenges for radar development and production.

16:00 - 17:40 EuMW Defence & Security Executive Forum

The Forum will feature executives from defence and security agencies and leading companies as well as experts and executives from companies involved in automotive radars. They will discuss the challenges and trends of the future and offer views regarding cross-fertilisation, in development and production, between different markets.

17:40 - 19:00 Cocktail Reception

The opportunity to network and discuss the issues raised throughout the Forum in an informal setting.



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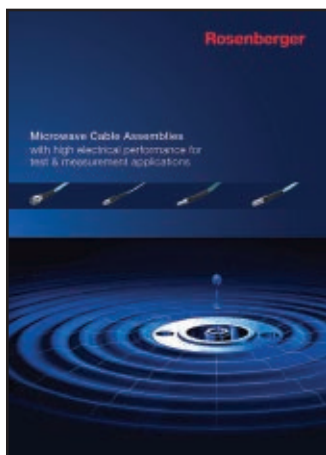
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Catalog Update

Microwave Cable Assemblies

This new brochure presents Rosenberger's standard portfolio of flexible microwave cable assemblies. They are available in defined lengths for applications in various frequencies up to 70 GHz, outstanding features are excellent phase stability and very high number of mating cycles. The range of cables includes ultra low loss cables for antennas or high power applications, miniature cables for test systems or applications with high flexibility, indoor cables, outdoor cables, special shielded cables and extremely phase stable cables for test & measurement applications.

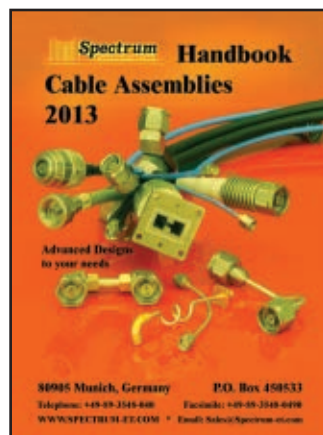
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www.rosenberger.com.



Cable Assembly Handbook

Spectrum Elektrotechnik GmbH is issuing a new comprehensive handbook, covering the following products: high performance cable assemblies, operating to 71 GHz; phase matched cable assemblies, showing also phase adjustable connectors to 40 GHz; multipin/multiport cable assemblies; phase king assemblies with limited phase shift over temperature; phase stable assemblies to 26 GHz; push on and quick connection assemblies; assemblies with interchangeable connectors; SpectrumFlex assemblies; commercial cable assemblies; semi rigid cable assemblies; handy form cable assemblies; delay lines; and details on connector outlines.

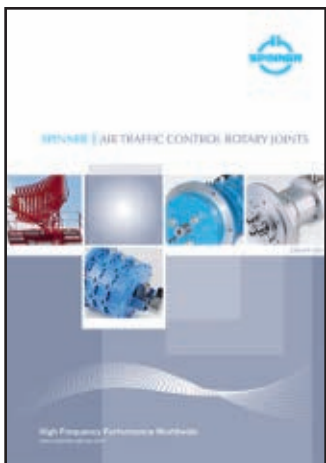
Spectrum Elektrotechnik GmbH,
www.spectrum-et.com.



ATC Catalog

SPINNER is a reliable supplier of advanced components for radar systems – especially rotary joints. These include the broad field of air traffic control (ATC) radar systems like surface movement radar (SMR), precision approach radar (PAR), air surveillance radar (ASR), en-route radar or Doppler weather radars (DWR). When it comes to application in ATC, all major customers in Europe already trust in SPINNER rotary joints. With this new catalog, the company wants to put a special focus on this market.

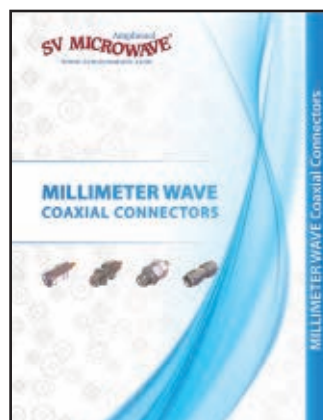
SPINNER GmbH,
www.spinner-group.com.



Millimeter Wave Connector Catalog

SV Microwave has released a new catalog for its millimeter wave connector series. This expanding product line is designed and manufactured in the U.S. to deliver the precision needed for the millimeter wave spectrum through 67 GHz. The company's standard product portfolio includes 3.5 mm, 2.92 mm, 2.4 mm and 1.85 mm connectors, adapters, terminations, attenuators, cable assemblies and customized solutions. To access the new catalog, please visit www.svmicrowave.com/ProductLiterature.

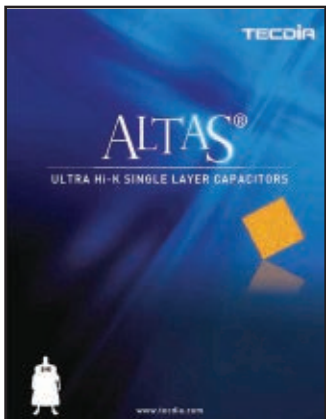
SV Microwave,
www.svmicrowave.com.



Hi-K Single Layer Capacitors

Tecdia's product catalog for Altas Hi-K single layer capacitors is now available from your local representative. Available from 50 to 10,000 pF, Tecdia's K=16,000 and K=30,000 dielectrics are best suited for MMIC bypass, DC blocking and filtering for both microwave and optical devices. Additional information can be found at www.tecdia.com/us/products/hf/altas.php.

VENDORVIEW
Tecdia Inc.,
www.tecdia.com.



Wireless Products Catalog

Times Microwave Systems announces the availability of the 17th edition of the LMR® wireless products catalog. The expanded 250-page catalog includes the entire range of LMR cables, the Times-Protect® line of innovative lightning surge protector products for RF equipment including the unique IP-67 weatherized LP-BTRW series and the LP-18-400 series of connector-protectors all-in-one and the latest Silver-Line® test cable innovations. Also included are the LMR®-SW low loss, low PIM cables and the latest -X no-braid-trim LMR® connectors.

Times Microwave Systems,
www.timesmicrowave.com.



SIX DAYS

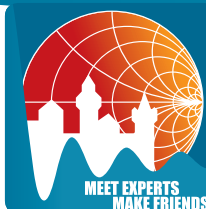


THREE CONFERENCES



ONE EXHIBITION

NÜRNBERG
CONVENTION CENTER,
NUREMBERG, GERMANY
OCTOBER 6-11, 2013



**EUROPEAN
MICROWAVE WEEK**
NCC NUREMBERG, GERMANY
6-11 OCTOBER 2013
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EUROPEAN MICROWAVE WEEK 2013

REGISTRATION INFORMATION



**EUROPE'S PREMIER
MICROWAVE, RF,
WIRELESS AND
RADAR EVENT**

EuMA
European Microwave Association

Official Publication:

**Microwave
Journal**

Organised by:

h horizon
house

Supported by:

IBT The Institution of
Engineering and Technology

Co-sponsored by:

MTT-S

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2013

The 10th European Radar Conference

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The 43rd European Microwave Conference

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The 8th European Microwave
Integrated Circuits Conference

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Register online at:
www.eumweek.com



EUROPEAN MICROWAVE WEEK 2013

THE ONLY EUROPEAN EVENT DEDICATED TO THE MICROWAVE AND RF INDUSTRY

European Microwave Week continues its series of successful events, with its 16th at the Nürnberg Convention Center, Nuremberg, Germany. The EuMW 2013 team are excited to host this year's event for the first time in the unique and hospitable city of Nuremberg. Bringing industry, academia and commerce together, European Microwave Week 2013 will see in excess of 1,700 conference delegates, over 5,000 visitors and 250 plus exhibitors.

THE EXHIBITION

Concentrating on the needs of engineers, the event showcases the latest trends and developments that are widening the field of the application of microwaves. Pivotal to the week is the European Microwave Exhibition, which offers YOU the opportunity to see, first hand, the latest technological developments from global leaders in microwave technology, complemented by demonstrations and industrial workshops.

Registration to the Exhibition is FREE!

- **International Companies** - meet the industry's biggest names and network on a global scale
- **Cutting-edge Technology** - exhibitors showcase the latest product innovations, offer hands-on demonstrations and provide the opportunity to talk technical with the experts
- **Technical Workshops** - get first hand technical advice and guidance from some of the industry's leading innovators

BE THERE

Exhibition Dates	Opening Times
Tuesday 8th October	09:30 - 17:30
Wednesday 9th October	09:30 - 17:30
Thursday 10th October	09.30 - 16:30

Fast Track Badge Retrieval

Entrance to the Exhibition is FREE and attending couldn't be easier.

VISITORS

Registering for the Exhibition

- Register as an Exhibition Visitor online at www.eumweek.com
- Receive a confirmation email with barcode
- Bring your barcode with you to the Exhibition
- Go to the Fast Track Check In Desk and print out your visitor badge
- Alternatively, you can register onsite at the self service terminals during the Exhibition.

Please note NO visitor badges will be mailed out prior to the Exhibition.

www.eumweek.com



EUROPEAN MICROWAVE WEEK 2013

THE CONFERENCES

Don't miss Europe's premier microwave conference event. The 2013 week consists of three conferences and associated workshops:

- European Microwave Integrated Circuits Conference (EuMIC): 7th - 8th October 2013
- European Microwave Conference (EuMC): 8th - 10th October 2013
- European Radar Conference (EuRAD): 9th - 11th October 2013
- Workshops and Short Courses from 6th October 2013

The three conferences specifically target ground breaking innovation in microwave research through a call for papers explicitly inviting the submission of presentations on the latest trends in the field, driven by industry roadmaps. The result is three superb conferences created from the very best papers, carefully selected from over 1,500 submissions from all over the world.

Special rates are available for EuMW delegates. For a detailed description of the conferences, workshops and short courses please visit www.eumweek.com. The full conference programme can be downloaded from there.

Fast Track Badge Retrieval

Register online and print out your badge in seconds onsite at the Fast Track Check In Desk

Conference Prices

There are TWO different rates available for the EuMW conferences:

- **ADVANCE DISCOUNTED RATE** – for all registrations made online until 6th September
- **STANDARD RATE** – for all registrations made online from 7th September and onsite

Please see the Conference Registration Rates table on the back page for complete pricing information.

All payments must be in Euros – cards will be debited in Euros.

Online registration is open now, up to and during the event until 11th October 2013

DELEGATES

Registering for the Conference

- Register online at www.eumweek.com
- Receive a confirmation email receipt with barcode
- Bring your email, barcode and photo ID with you to the event
- Go to the Fast Track Check In Desk and print out your delegate badge
- Alternatively, you can register onsite at the self service terminals during the registration opening times below:

- Saturday 5th October (16.00 – 19.00)
- Sunday 6th October (07.30 – 17.00)
- Monday 7th October (07.30 – 17.00)
- Tuesday 8th October (07.30 – 17.00)

- Wednesday 9th October (07.30 – 17.00)
- Thursday 10th November (07.30 – 17.00)
- Friday 11th November (07.30 - 10.00)

Once you have collected your badge, you can collect the conference proceedings on USB stick and delegate bag for the conferences from the specified delegate bag area by scanning your badge.

CONFERENCE REGISTRATION INFORMATION

EUROPEAN MICROWAVE WEEK 2013, 6th - 11th October, Nuremberg, Germany

Register Online at www.eumweek.com

ONLINE registration is open from 1st June 2013 up to and during the event until 11th October 2013.

ONSITE registration is open from 16:00h on 5th October 2013.

ADVANCE DISCOUNTED RATE (until 6th September) STANDARD RATE (from 7th September & Onsite)

Reduced rates are offered if you have society membership to any of the following: EuMA, GAAS, VDE, IET or IEEE.

EuMA membership costs: Professional € 25/year, Student € 15/year.

Reduced Rates for the conferences are also offered if you are a Student/Senior (Full-time students less than 30 years of age and Seniors 65 or older as of 11th October 2013).

ADVANCE REGISTRATION CONFERENCE FEES (UNTIL 6 SEPT)

CONFERENCE FEES	ADVANCE DISCOUNTED RATE			
	Society Member (*any of above)		Non Member	
	Standard	Student/Sr.	Standard	Student/Sr.
<i>1 Conference</i>				
EuMC	€ 420	€ 100	€ 550	€ 130
EuMIC	€ 325	€ 90	€ 430	€ 120
EuRAD	€ 280	€ 80	€ 370	€ 110
<i>2 Conferences</i>				
EuMC + EuMIC	€ 600	€ 190	€ 790	€ 250
EuMC + EuRAD	€ 570	€ 180	€ 740	€ 240
EuMIC + EuRAD	€ 490	€ 170	€ 650	€ 230
<i>3 Conferences</i>				
EuMC + EuMIC + EuRAD	€ 730	€ 270	€ 960	€ 360

STANDARD REGISTRATION CONFERENCE FEES (FROM 7 SEPT AND ONSITE)

CONFERENCE FEES	STANDARD RATE			
	Society Member (*any of above)		Non Member	
	Standard	Student/Sr.	Standard	Student/Sr.
<i>1 Conference</i>				
EuMC	€ 550	€ 130	€ 720	€ 170
EuMIC	€ 430	€ 120	€ 560	€ 160
EuRAD	€ 370	€ 110	€ 490	€ 150
<i>2 Conferences</i>				
EuMC + EuMIC	€ 790	€ 250	€ 1030	€ 330
EuMC + EuRAD	€ 740	€ 240	€ 980	€ 320
EuMIC + EuRAD	€ 650	€ 230	€ 850	€ 310
<i>3 Conferences</i>				
EuMC + EuMIC + EuRAD	€ 960	€ 360	€ 1260	€ 480

WORKSHOP AND SHORT COURSE FEES (ONE STANDARD RATE THROUGHOUT)

FEES	STANDARD RATE			
	Society Member (*any of above)		Non Member	
	Standard	Student/Sr.	Standard	Student/Sr.
1/2 day WITH Conference registration	€ 80	€ 60	€ 110	€ 80
1/2 day WITHOUT Conference registration	€ 110	€ 80	€ 150	€ 110
Full day WITH Conference registration	€ 120	€ 90	€ 160	€ 110
Full day WITHOUT Conference registration	€ 160	€ 120	€ 210	€ 150

Proceedings on USB Stick

All papers published for presentation at each conference will be on a USB stick, given out FREE with the delegate bags to those attending conferences. For additional USB sticks the cost is € 50.

DVD Archive EuMC

DVD Archive EuMC 1969-2003	FREE
DVD Archive EuMC 2004-2008	€ 10

Partner Programme and Social Events

Full Details and contacts for the Partner Programme and other Social Events can be obtained via the EuMW website www.eumweek.com.

SPECIAL FORUMS & SESSIONS

Date	Time	Title	Location	No. of Days	Cost
Tues 8th & Weds 9th October	Tues: 13:50h - 17:40h Weds: 08:30h - 17:40h	The Defence & Security Forum	Room St. Petersburg	2	FREE
Mon 7th & Tues 8th October	08:30h - 17:40h	European Microwave Student School	Room Oslo	2	€ 40
Thurs 10th & Fri 11th October	08:30h - 17:40h	European Microwave Doctoral School	Room Oslo	2	€ 80

SIX DAYS

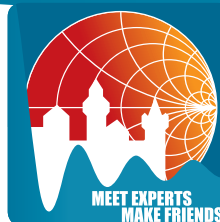


THREE CONFERENCES



ONE EXHIBITION

EUROPEAN MICROWAVE WEEK 2013
NÜRNBERG NCC, GERMANY,
OCTOBER 6 - 11, 2013



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MICROWAVE WEEK**
NCC NUREMBERG, GERMANY
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EUROPE'S PREMIER MICROWAVE, RF, WIRELESS AND RADAR EVENT

EuMW 2013 will be held for the first time at the Nürnberg Convention Center (NCC) in the beautiful city of Nuremberg. Bringing industry, academia and commerce together, European Microwave Week 2013 is a SIX day event, including THREE cutting edge conferences and ONE exciting trade and technology exhibition featuring leading players from across the globe.



The Exhibition (8th - 10th October 2013)

- 7,500 sqm of gross exhibition space
- 5,000 key visitors from around the globe
- 1,700 - 2,000 conference delegates
- In excess of 250 exhibitors

The Conferences:

- European Microwave Integrated Circuits Conference (EuMIC) 7th - 8th October 2013
- European Microwave Conference (EuMC) 8th - 10th October 2013
- European Radar Conference (EuRAD) 9th - 11th October 2013
- Plus, Workshops and Short Courses (From 6th October 2013)

Plus a one day Defence and Security Conference

EuMA
European Microwave Association

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eLEARNING center

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Agilent in Aerospace/Defense

Vector Modulation and Frequency Conversion Fundamentals

Live webcast: 7/18/13, 1:00 PM ET

FieldFox Handheld Analyzers

Presented by: Agilent Technologies

Correlating Microwave Measurements Between Handheld and Benchtop Analyzers

Live webcast: 7/24/13, 1:00 PM ET

Agilent in Wireless Communications

Validating Performance of Satellite Navigation Systems and Receivers

Live webcast: 7/25/13, 1:00 PM ET

Innovations in EDA

Presented by: Agilent Technologies

Designing Custom RF and Analog Filters Through Direct Synthesis

Live webcast: 8/1/13, 1:00 PM ET

Past Webinars On Demand

RF/Microwave Training Series

Presented by: Besser Associates

- Mixers and Frequency Conversion

Market Research Webinar Series

- Technology Trends for Radar Systems

Technical Education Training Series

- Fundamental Tradeoffs for Space, Air and UAV SAR
- Maximize the Performance of Your RF Signal Analyzer
- LTE Performance Testing - Using a MIMO Over-the-Air Solution for Efficient Device Verification
- Increasing Output Power and Efficiency of Microwave P2P Systems
- Future Directions in GPS Location Assurance

CST Webinar Series

- CST STUDIO SUITE 2013 - MW&RF Simulation
- Improvements to EDA and EMC Workflows in CST STUDIO SUITE 2013

Innovations in EDA/Signal Generation & Analysis Series

Presented by: Agilent EEsof EDA/Agilent Technologies

- Beyond CMOS vs. GaAs – Finding the Best Technology Mix for a Handset PA
- Accurate Modeling of GaAs and GaN HEMTs for Nonlinear Applications
- Accelerating Radar/EW System Design Using Wideband Virtual Scenarios
- GaN on SiC: RFMD High Power Design, Modeling and Measurement
- World's Fastest Antenna Performance Measurement Technique

Presented by: Agilent Technologies

- Test Wireless Designs with a Low-Cost RF Vector Signal Generator

Agilent in Aerospace/Defense Series

- LTE Design and Test Challenges for Public Safety Radio and SDR Applications
- Multi-Antenna Array Measurements Using Digitizers
- Radar: Trends, Test Challenges and Solutions
- Understanding Probability of Intercept for Intermittent Signals
- Electronic Warfare Testing: Capture, Measurement and Emulation
- RF/uW Measurement Uncertainty: Calculate, Characterize, Minimize

Agilent in LTE/Wireless Communications Series

- MIMO Over the Air (OTA) Handset Performance and Testing
- Your LTE Devices Need to Pass Conformance Tests – Now What?
- 8x8 MIMO and Carrier Aggregation Test Challenges for LTE
- LTE and the Evolution to LTE-Advanced Fundamentals: Part 1 and Part 2
- NFC Test Challenges for Mobile Device Developers

RF and Microwave Education Series

Presented by: Agilent Technologies

- Analyze Agile or Elusive Signals Using Real-Time Measurement and Triggering
- Signal Analyzer Fundamentals and New Applications
- Signal Generator Fundamentals and New Applications

FieldFox Handheld Analyzers Series

Presented by: Agilent Technologies

- Techniques for Precise Power Measurements in the Field
- Techniques for Precise Time Domain Measurements in the Field

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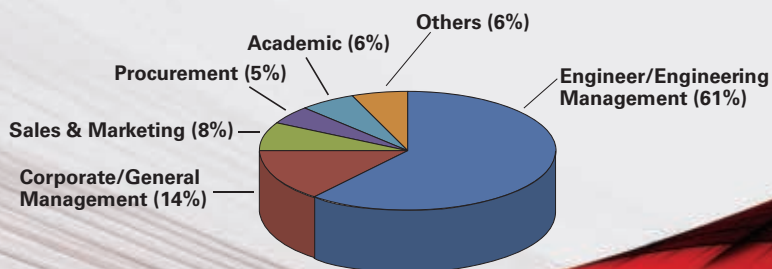


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Guy Séné, President, Electronic Measurement Group, Agilent Technologies

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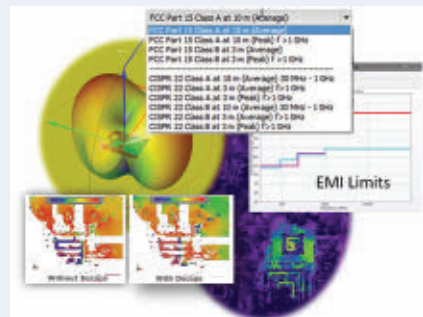
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3D EM Simulation Software

VENDORVIEW



Agilent announced the latest release of Electromagnetic Professional (EMPro), its 3D electromagnetic simulation software. EMPro 2013 helps design engineers identify and resolve difficult electromagnetic interference (EMI) problems. It also offers a number of new capabilities to reduce simulation time and increase design efficiency. The software allows engineers to simulate the radiated emissions of electronic circuits and components and then determine whether these emissions are within levels specified by common electromagnetic compatibility (EMC) standards, such as FCC Part 15, CISPR 22 and MIL-STD-461F.

Agilent Technologies Inc.,
www.agilent.com.

CA Software

VENDORVIEW



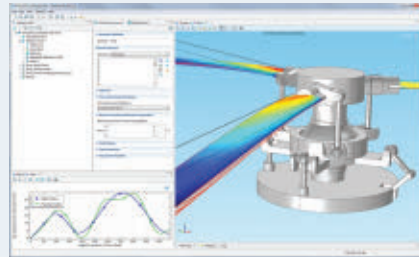
Anritsu announced the availability of LTE Advanced carrier aggregation (CA) measurement software for its

MT8820C RF tester, enabling analysis of leading-edge mobile devices incorporating the new ultra-fast technology evolution. The new option leverages the ParallelPhone Mode dual-RF capability of the MT8820C to simulate inter-band and intra-band downlink Frequency Domain Duplex CA with call processing. With the software installed, the MT8820C becomes the first single-box tester with the capability to conduct

three critical CA receiver measurements, providing LTE device designers and manufacturers with a cost- and space-efficient solution.

Anritsu Co.,
www.anritsu.com.

Simulation Platform Additions



COMSOL announced the release of major new additions to the COMSOL simulation platform. The latest version of COMSOL Multiphysics, version 4.3b, introduces five new application-specific modules and expanded modeling and analysis tools. With the introduction of the new modules (Multibody Dynamics, Wave Optics, Molecular Flow Semiconductor, and Electrochemistry), users in key application areas from major industries now have access to the new modeling and simulation tools offered by COMSOL. Release highlights are available at www.comsol.com/4.3b.

COMSOL Inc.,
www.comsol.com.

Web-Based Interface



Comtech Xicom Technology Inc. announced a new Web-based interface for the company's

LCD touch screen amplifiers. The new graphical user interface (GUI) displays the identical images on a computer screen as that shown on the amplifier's LDC control panel offering an easy-to-use off-site interface for monitoring and controlling multiple amplifiers and switches. New features such as built-in uplink power control and new system configurations have been added and like the new Web browser support, are available with a firmware upgrade.

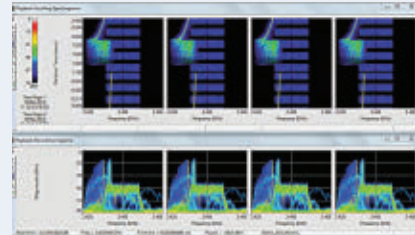
Comtech Xicom Technology Inc.,
www.xicomtech.com.

MIMO Testing Release

EMSCAN introduced RFX2 and RFXpert software release 4.0 to address MIMO testing. This improved RFX2 has the capability of calculating pattern correlation and envelope correlation in multi-antenna systems; these coefficients can be used in calculation of MIMO diversity gain and channel capacity for specific wireless channels. The 4.0 release is a major improvement for RFXpert as it includes a large number of new features including MIMO data, user requested enhancements and substantial accuracy improvements.

EMSCAN,
www.emscan.com.

RF and Microwave Signal Analysis



X-COM Systems introduced version 4.0 of its Spectro-X RF and microwave signal analysis software, the industry's most comprehensive toolkit designed to search for and analyze signals of interest within long-duration recordings of signal activity. New features include the ability to simultaneously analyze up to four recorded RF and microwave spectrum files with precision file alignment to plus or minus one sample, multi-domain correlated markers and features that make the software more versatile and easier to use.

X-COM Systems LLC,
www.xcomsystems.com.

Components

Outdoor Cavity Bandpass Filter

VENDORVIEW



The AB913B488 water-resistant cavity bandpass filter has a center frequency of 913 MHz, bandwidth of 20 MHz, insertion loss of 1.6 dB, rejection of at least 40 dB at 895 MHz and 931 MHz, and handles 30 W. Return loss is greater than 15 dB, ripple is less than 0.2 dB, operating temperature range is -40° to +70°C, and connectors are Type-N female. The filter measures 140 × 80 × 56 mm.

Anatech Electronics Inc.,
www.anatechelectronics.com.

Lab-Flex AF Cables

VENDORVIEW



Lab-Flex® AF, a modified version of the popular Lab-Flex series, is now available from Florida RF Labs. This new family of cables has been enhanced to perform in typical harsh environments associated with airborne, shipboard and ground-based applications. Florida RF Labs proprietary cable assembly design utilizes a redundant sealing system to prevent water ingress in both cable and connector interfaces and it employs a very durable dielectric design which is able to withstand crushing or kinking.

Florida RF Labs,
www.emc-rflabs.com.

Diode Phase Shifter



Model P2P-68T-5 is a broadband digitally controlled pin 360° diode phase shifter operating from 6 to 18 GHz. This device offers up to 0.088° resolution with 12 bits of TTL compatible binary logic and switches in less than 500 nSec. Across the entire band, phase accuracy is ±10°, amplitude balance ±1.0 dB, and VSWR 1.9:1 in 50 Ω. Input power is up to +15 dBm CW or 1 W max. The operating temperature range is extended from -55° to +85°C.

G.T. Microwave Inc.,
www.gtmicrowave.com.



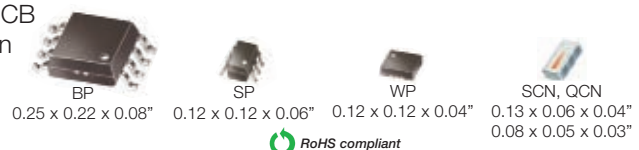
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IF/RF MICROWAVE COMPONENTS

New Products

Limiters



Herotek has recently developed many different types of microwave limiters. The high frequency bands for 1 to 40 GHz have power handling of 1 W CW and fast response and recovery time. The 10 W LS Series offer super broadband for low-frequency 0.01 to 6 GHz range application with extremely low insertion loss and VSWR. The 25 and 40 W CW LS Series offer high-power limit-

ing performance over 1 to 12 GHz. Custom designed high power limiters may have power up to 200 W CW.

Herotek,
www.herotek.com.

Low PIM Terminations



MECA Electronics announced its latest low PIM terminations/loads with industry leading -170 dBc (typical) passive intermodulation. All of the terminations cover 698 to 2700 MHz frequency bands. Ideal for IDAS/ODAS, in-building, base station, wireless infrastructure, 4G and AWS applications. VSWR = 1.10:1 (typical). Made in USA and 36-month warranty.

Microwave Electronics Corp. of America,
www.e-meca.com.

Integrated Microwave Assemblies

Mercury Systems' switching capability forms the core of its integrated microwave assemblies (IMA). These products are custom-based designs for mission-specific applications. The assemblies typically consist of the integration of switches and switch matrices, amplifiers, digital/variable attenuators, filters, gain equalizers, BIT circuitry, oscillators and other RF and microwave functions. Benefits include FPGA and CPLD logic

devices simplify the control interface for complex logic requirements; programmable temperature compensation; attractive choice for airborne applications; and custom-based designs for mission-specific applications.

Mercury Systems,
www.mrcy.com.

Bandpass Filter



NBP-1560+ is a bandpass filter built in a rugged connectorized package. Covering a passband of 1500 to 1620 MHz, these units offer good matching within the passband and high rejection. This will find its application in transmitters/receivers

and harmonic rejection. It has repeatable performance across production lots and consistent performance across temperature.

Mini-Circuits,
www.minicircuits.com.

Phase Shifter



The PS-360-DC-IR-9G10G is a 10-Bit digitally controlled 360° phase shifter that operates from 9 to 10 GHz. This model offers low insertion loss of 7.5 dB and a phase shift accuracy of $\pm 0.6^\circ$ typically. The typical switching speed is 300 nsec and operates with input power levels up to +20 dBm. This model requires a single voltage supply of +12 to +15 V DC with a current draw of 40 mA. The housing mea-

sures 4.95" \times 3.38" \times 1.02". Other frequency ranges are available.

Planar Monolithics Industries,
www.pmi-rf.com.

Waveguide Isolator



Renaissance Electronics has developed a new low loss, high isolation waveguide isolator for Satcom applications that covers 43 to 46 GHz with industry standard interface of WR 22. With loss of 0.5 dB and 18 dB isolation, it is ideal for low noise figure Satcom receivers.

Renaissance Electronics,
www.rec-usa.com.

Low Conversion Loss Wideband Mixer



The SGS-5-17 mixer is a wideband, surface mount mixer designed to cover the frequency ranges from 3 to 19 GHz. This makes it ideal for radar and fixed microwave radio and instrumentation applications. This mixer comes in a very small, surface mount package. The overall dimensions of the mixer are 0.275" \times 0.20" \times 0.06". Further full band characteristics

are typical conversion loss of 7.5 dB with local oscillator power of +17 dBm, typical LO to RF isolation of 25 dB.

Synergy Microwave Corp.,
www.synergymicrowave.com.

Digital Attenuators



Vaunix announced additions to its LDA digital attenuators line. Five of its LDA digital attenuators are now available with N-Type connectors. The LDA series of Lab Brick® digital attenuators includes 50 Ω RF step attenuators with calibrated operation up to 6 GHz. These units connect to a USB port for control and power and require no additional DC supply voltage. They are easily programmable for fixed attenuation or swept attenuation ramps directly from the included GUI.

Vaunix Technology Corp.,
www.vaunix.com.

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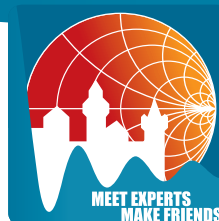


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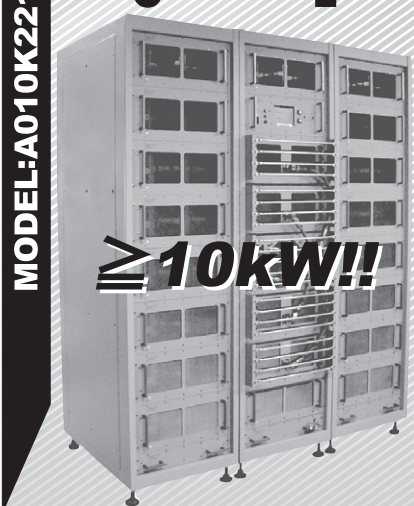


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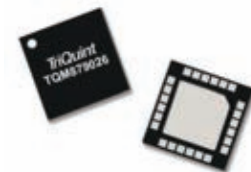
Model SBP-1031133040-SFSF-C1 is an X-Band power amplifier that delivers 30 dB small signal gain and 10 W linear power to cover the 9.5 to 10.5 GHz frequency range. The amplifier integrates input and output isolators to offer better than 1.2:1 VSWR and safe operation when input or output show extreme load conditions. It operates at +12 V DC and typically consumes 80 W power. The RF connector type for the model is SMA (F). The amplifier measures 4.1" × 5.5" × 3.0" approximately.



SAGE Millimeter Inc.,
www.sagemillimeter.com.

DVGA

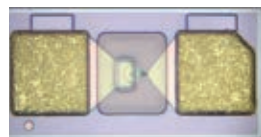
The TQM879026 is a digital variable gain amplifier (DVGA) featuring high linearity performance in a fully integrated module. The amplifier module features the integration of a high performance gain block, a digital step attenuator (DSA), along with a high linearity 1/4 W amplifier in a compact package. The internal



DSA offers 0.5 dB step, 6-bit, and 31.5 dB range and has a serial controlled interface. The individual stages are accessible to external ports.
TriQuint Semiconductor Inc.,
www.triquint.com.

Semiconductors

Flip Chip PIN Diode



MADP-000907-14020 is designed for customers who need a versatile, low cost, ultra-small PIN diode solution for police radar, point to point, electronic warfare and aerospace and defense applications. The device is a package-less PIN diode with contacts that allow for standard solder reflow manufacturing processes. Unlike its nearest alternatives, the MADP-000907-14020 is fabricated using an AlGaAs process which provides customers full passivation for increased performance and reliability.
M/A-COM Technology Solutions Inc.
(MACOM), www.macomtech.com.

Surface Mount Limiter Diode



Skyworks Solutions introduced a surface mount limiter diode for receiver protection



applications. The CLA4608-085LF is a low capacitance silicon PIN limiter diode designed for high power applications ranging from 10 MHz to over 6 GHz. Maximum resistance at 10 mA is 1.2 Ω and maximum capacitance at 38 V is 0.65 pF. Given its low thermal resistance (50°C/W) and capacitance, the new shunt connected diode is best suited for infrastructure, land mobile radios, jammers and radar in the military and consumer markets.

Skyworks Solutions Inc.,
www.skyworksinc.com.

Sources

VCO

Crystek's CVCO33BE-6000-6000 voltage controlled oscillator (VCO) operates at 6000 MHz with a control voltage range of 0.5 to 4.5 V. This



VCO features a typical phase noise of -85 dBc/Hz @ 10 KHz offset and has excellent linearity. Output power is typically +5 dBm. Engineered and manufactured in the USA, the model CVCO33BE-6000-6000 is packaged in the industry-standard 0.5" × 0.5" SMD package. Input voltage is 5 V, with a maximum current consumption of 40 mA.

Crystek Corp.,
www.crystek.com.

OCXO



Model 144 is an ultra-low power miniature low profile OCXO. The oscillator uses a unique heating technology allowing optimal performance at an extremely low 0.15 W. The device's SC cut crystal is housed inside a TO-8 vacuum package and is DIL-14 compatible, thus radically reducing its weight, power consumption and warm-up time (30 seconds). In addition, the part is highly stable (±5 ppb over -30° to +70°C) and it has exceptional performance with phase noise as low as -170 dBc/Hz floor at 100 MHz.

CTS Electronic Components Inc.,
www.ctscorp.com.

GPSDO



Jackson Labs Technologies' latest product combines the Cesium Vapor Cell reference with an ultra-high-precision ovenized SC-cut crystal oscillator for ultra-fast warmup, excellent holdover, low power, exceptional phase noise, and Allan Deviation (ADEV) performance in the xE-012 range. The combination of the relative strengths of both oscillators results in an overall package that is capable of competing with the highest performance

New Products

commercially available Cesium Reference clocks, with a price point an order of magnitude lower than legacy products.

Jackson Labs Technologies Inc.,
www.jackson-labs.com.

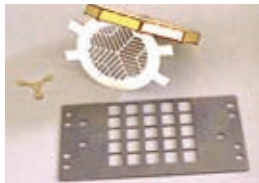
RoHS Compliant VCO



Z-Communications announced a new RoHS compliant voltage controlled oscillator (VCO) model SMV2950A-LF in the S-Band. The SMV2950A-LF operates at 2850 to 3050 MHz with a tuning voltage range of 0 to 2.5 V DC. This compact VCO features phase noise of -85 dBc/Hz @ 10 kHz offset while operating off a 3.0 V DC supply and typically drawing 15 mA of current. The SMV2950A-LF provides the end user typical output power of 3 ± 3 dBm into a 50Ω load.

Z-Communications Inc.,
www.zcomm.com.

Processing Equipment



Rache Corp. has developed a proprietary laser cutting process that can cut virtually all thin, ferrous metal and non-ferrous metal foils that range between 0.0005" to 0.060" thickness (0.005 to 0.040 inches for Aluminum, Brass, and Copper). Microwave stripline and EMI shielding are excellent candidates for Rache's rapid prototyping service. Production quantities of final designs can be delivered only days after prototype approval. Cost for up to five laser-cut prototypes is only \$295, 48-hour turnaround on prototype's is guaranteed or they are free.

Rache Corp.,
www.rache.com.

Test Equipment

GNSS Constellation Simulator



Spectracom announced its GSG series GNSS simulators, designed to offer as much capability as needed by developers, integrators, and manufacturers of applications for global satellite navigation. The company offers two fully configurable and upgradeable platforms. For common single frequency applications, the GSG-5 series simulates up to 16 GPS satellites in the L1 band. For more advanced applications, the GSG-6 series offers up to 64 channels in 4 different frequency bands simultaneously.

Spectracom,
www.spectracomcorp.com.

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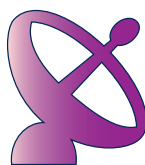
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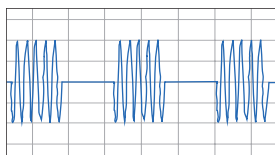
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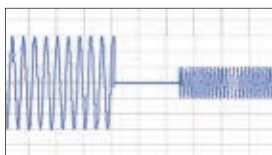
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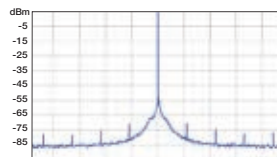
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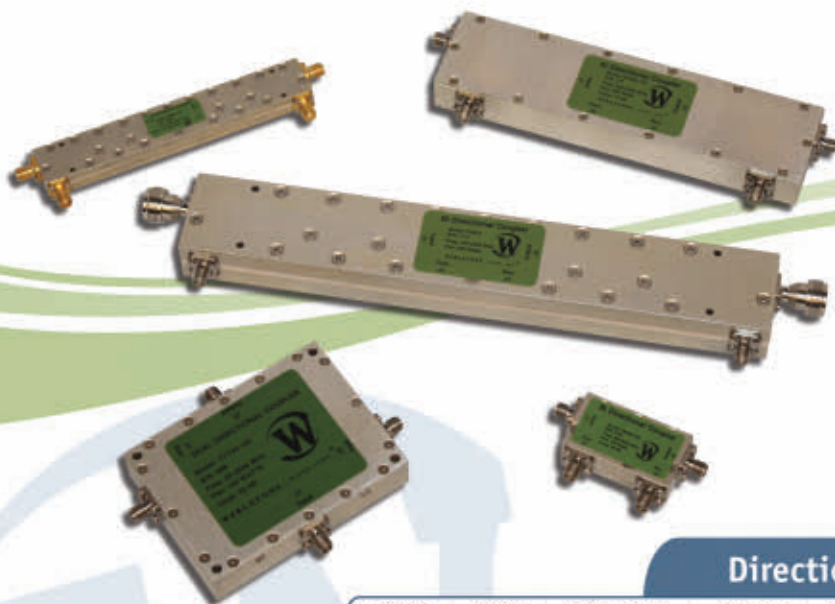


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C7734	Dual	30-2500	100	43	0.35	1.25:1	3.5 x 2.6 x 0.7
C8188	Uni	30-3000	20	20	2.4	1.35:1	6 x 1.5 x 1.1
C3910	Dual	80-1000	200	40	0.2	1.20:1	3 x 3 x 1.09
C8373	Bi	100-2500	200	20	0.8	1.25:1	9.58 x 1.48 x 0.88
C7711	Dual	100-3000	100	40	0.35	1.25:1	3 x 2.2 x 0.7
C7058	Bi	200-2000	200	10	0.3	1.25:1	6.4 x 1.6 x 0.72
C8060	Bi	200-6000	200	20	1.1	1.40:1	4.8 x 0.88 x 0.5
C7248	Bi	300-3000	100	6	0.35	1.25:1	6 x 2 x 0.85
C8000	Bi	600-6000	100	30	0.4	1.25:1	1.8 x 1 x 0.57
C8214	Bi	700-2500	100	6	0.35	1.25:1	6 x 2 x 0.85
C8644	Bi	1800-6100	60	20	0.4	1.25:1	1.1 x 0.75 x 0.48

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