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July 2013

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2013 Design Software Review

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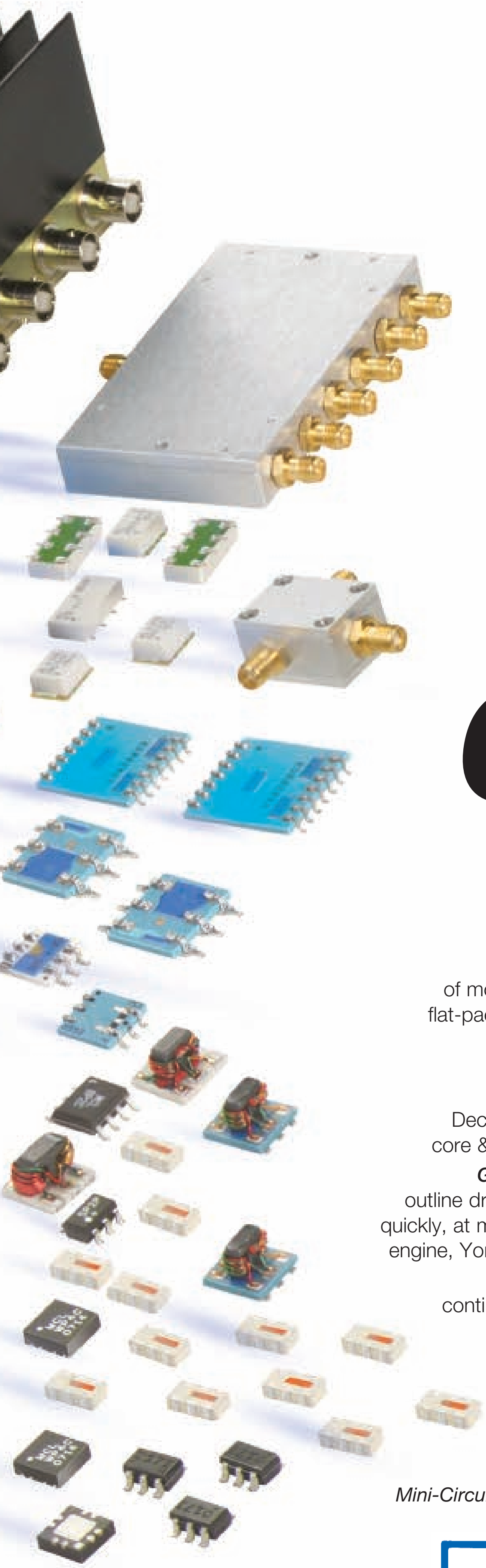


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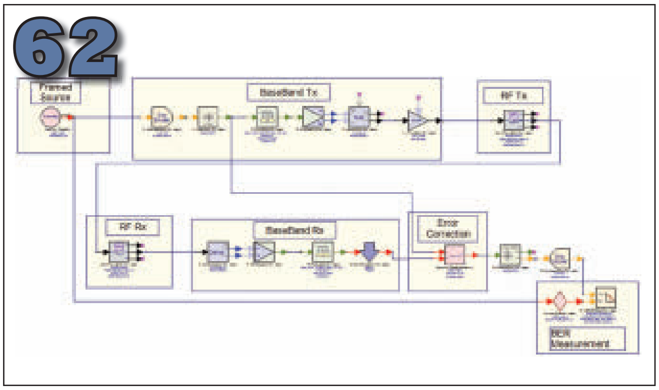

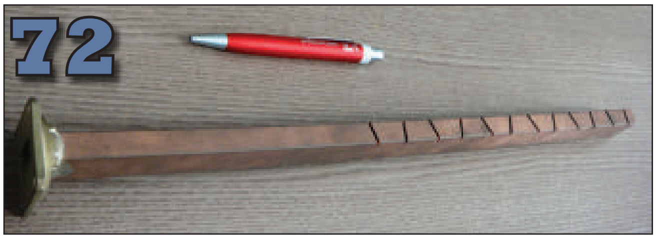

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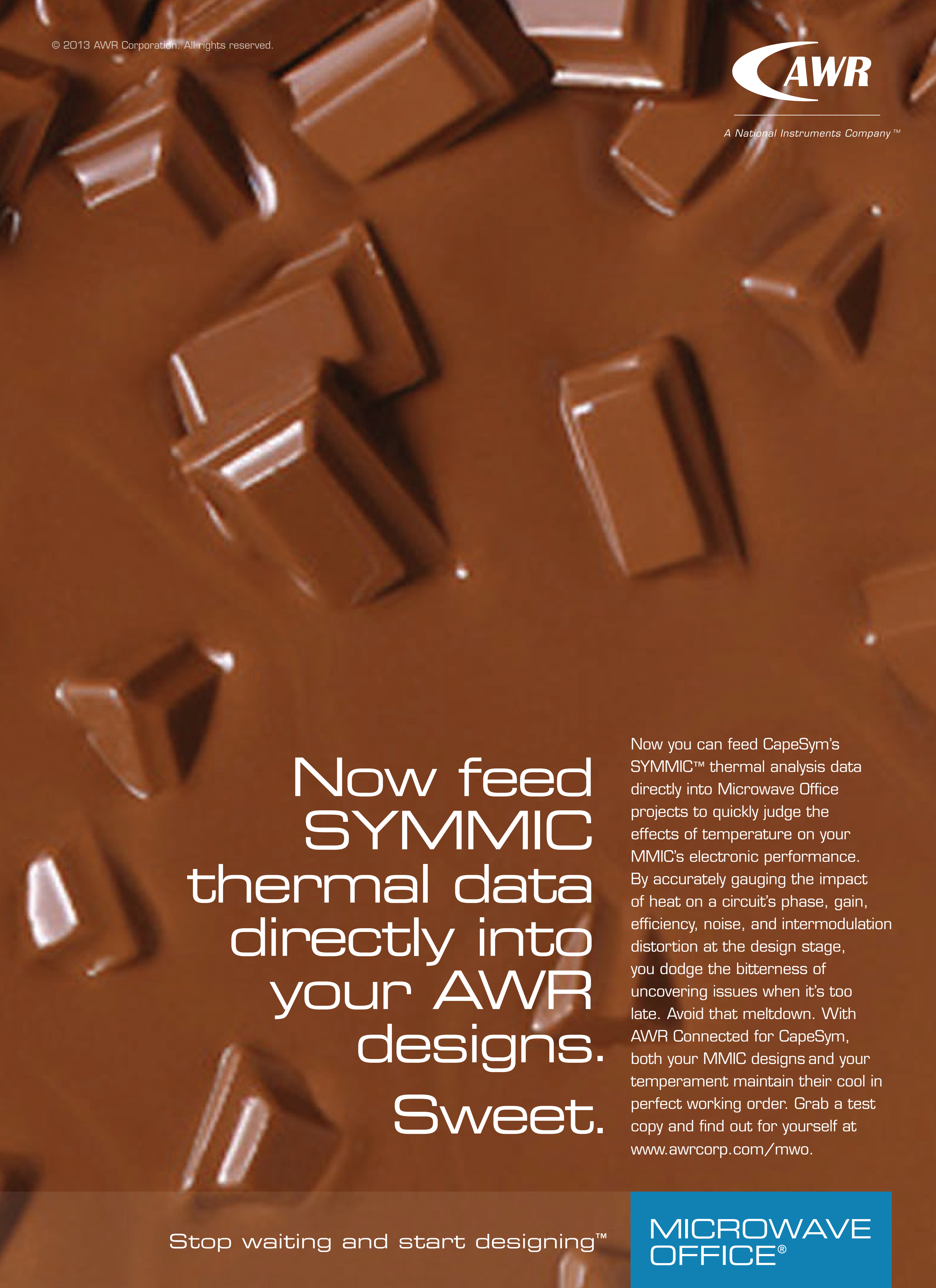
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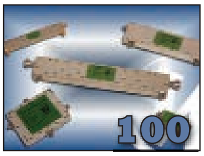

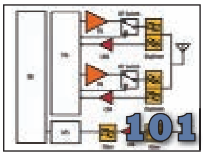

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Web Survey

Sure sign it's summer in the office....

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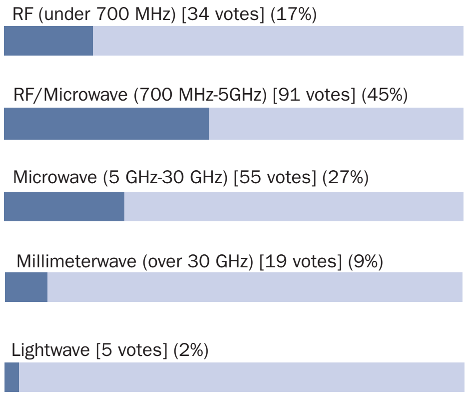
May Survey

What frequency range do you mostly design for?



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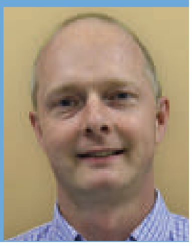

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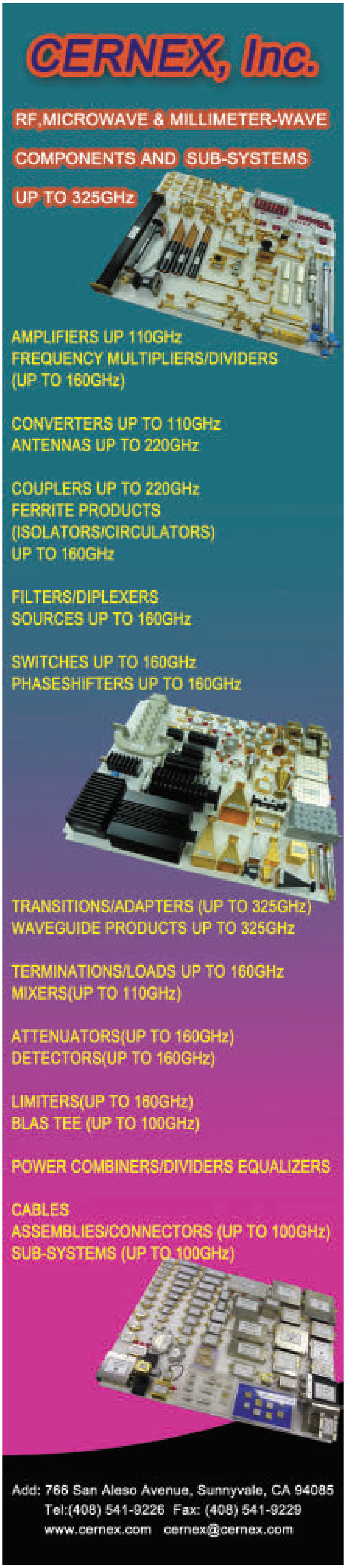

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IMS 2014
Deadline: September 10, 2013

EDI CON 2014
Deadline: September 30, 2013

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August 5–8, 2013 • Austin, TX
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EMC 2013
IEEE International Symposium on Electromagnetic Compatibility
August 5–9, 2013 • Denver, CO
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AUVSI's Unmanned Systems 2013
August 12–15, 2013 • Washington, D.C.
www.auvsishow.org

SEPTEMBER

IRMMW-THz 2013
38th International Conference on Infrared, Millimeter and Terahertz Waves
September 1–6, 2013 • Mainz, Germany
www.theconference2013.com

MMS 2013
13th Mediterranean Microwave Symposium
September 2–5, 2013 • Saida, Lebanon
www.iutsaida.ul.edu.lb/mms2013

ICUWB 2013
IEEE International Conference on Ultra-Wideband
September 15–18, 2013 • Sydney, Australia
www.icuwb2013.org

ION GNSS+ 2013
September 16–20, 2013 • Nashville, TN
www.ion.org

OCTOBER

AMTA 2013
35th Annual Symposium of the Antenna Measurement Techniques Association
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www.amta2013.org

EuMW 2013
European Microwave Week
October 6–11, 2013 • Nuremberg, Germany
www.eumweek.com

COMSOL Conference 2013
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www.comsol.com/conference2013/usa

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www.microwaveupdate.org

IEEE COMCAS 2013
International Conference on Microwaves, Communications, Antennas and Electronic Systems
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www.comcas.org

IME/China 2013
8th International Conference and Exhibition on Microwave and Antenna
October 23–25, 2013 • Shanghai, China
www.imwexpo.com

4G World 2013
October 28–30, 2013 • Dallas, TX
www.4gworld.com

NOVEMBER

APMC 2013
Asia-Pacific Microwave Conference
November 5–8, 2013 • Seoul, Korea
www.apmc2013.org

2013 Loughborough Antennas & Propagation Conference
November 11–12, 2013 • Loughborough, UK
www.lapconf.co.uk

MILCOM 2013
Military Communications Conference
November 17–20, 2013 • San Diego, CA
www.milcom.org

DECEMBER

IMaRC 2013
IEEE International Microwave and RF Conference
December 14–16, 2013 • New Delhi, India
www.imarc-ieee.org

AEMC
4th Applied Electromagnetics Conference
December 18–20, 2013 • Bhubaneswar, India
http://ieee-aemc.org

JANUARY

IEEE RWW 2014
Radio Wireless Week
January 20–23, 2014 • Newport Beach, CA
www.radiowirelessweek.org

FEBRUARY

MWC 2014
Mobile World Congress
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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

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

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, Axiem 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-

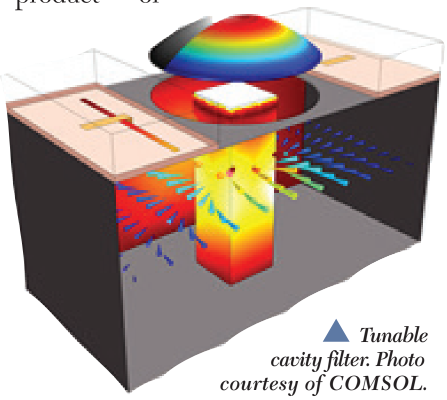
telligent combination of circuit analysis and EM analysis. Circuit-level analysis is used to connect the interconnect models. The models can be an extraction of individual pieces such as traces, vias, pads and wirebonds, or they can be S-parameter data that is collected from a test bench using test and 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.*

design can be integrated with COMSOL Multiphysics using the LiveLink™ 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

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

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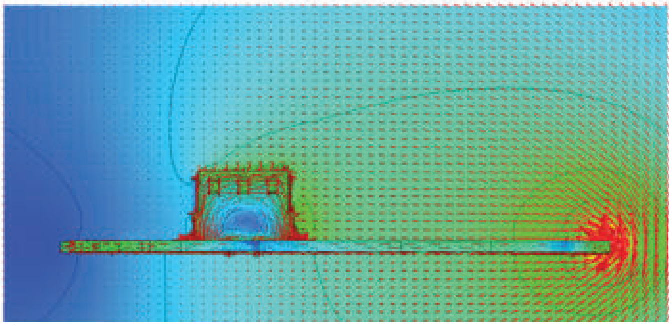


▲ *Magnetic fields coupling to a connector on a mobile device PCB. Photo courtesy of FEKO.*

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

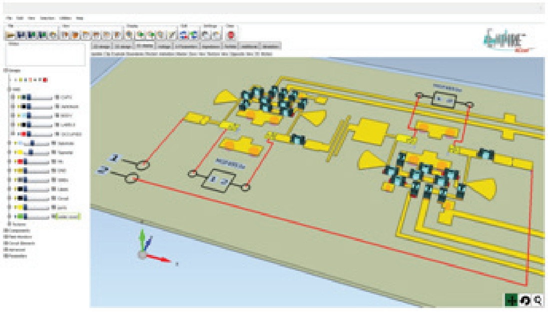
Magnetic fields coupling to a connector on a mobile device PCB and the induced currents that flow on PCB. The increased coupling can be visualized in between the battery and PCB.

IMST

IMST develops RF components in combination with its EMPIRE XCcel 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-



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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IF/RF MICROWAVE COMPONENTS

488 rev N

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 µWave Wizard™ combine different solvers for increased simulation efficiency, overcoming the limitations and shortcomings of single solvers. The modal port concept of µWave Wizard facilitates dissecting complex structures into more fundamental substructures. 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 breakpoint 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

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.

REMCOM

In its most recent release, Remcom offered users a breakthrough in FTDT-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.

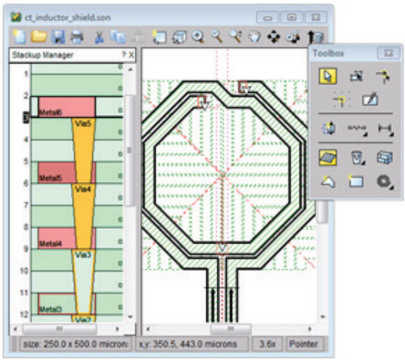
The new speed performance enables users to simulate increasingly complex scenarios in a reasonable timeframe. A growing number of designers have exhausted the amount of GPU RAM available for use in a single machine but still wish to grow the complexity of their models. Extending the GPU capabilities 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

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 connected with EM simulation analysis and layout geometry using Sonnet.



▲ *Stack up manager. Photo courtesy of 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 Vorpal 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 Vorpal simulation engine together with embedded analysis tools. The new Vorpal 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. ■

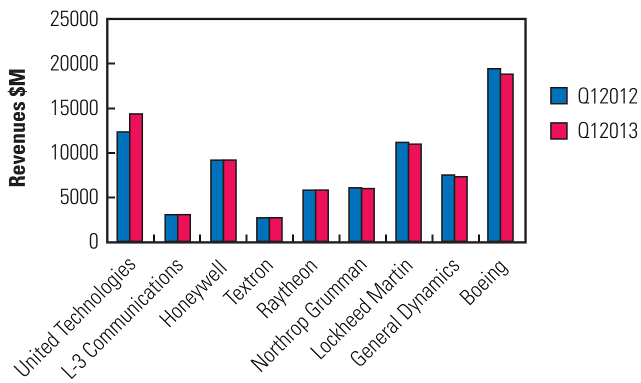
Healthy Defense Industry Activity Marred by Lackluster Revenues

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 (G/ATOR) 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 systems 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.



Source: Strategy Analytics

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.

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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 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."

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

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

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 Bushehri, 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."

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

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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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Commercial Market

Cliff Drubin, Associate Technical Editor

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.

"The emergence of standardized ultra-low power wireless technologies is one of the main enablers of the IoE…"

"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."

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

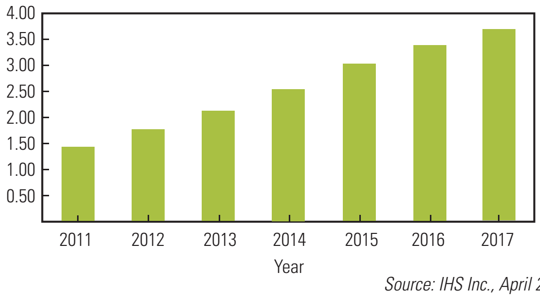
Shipments this year of Wi-Fi chipsets will reach a projected 2.14 billion units, up a robust 20 percent from 1.78 billion in 2012. This year's anticipated increase continues the impressive run of double-digit growth that started at least five years ago and will persist for three more years until 2016, 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

Around the Circuit
Laura Glazer, Staff Editor

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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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 provide 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

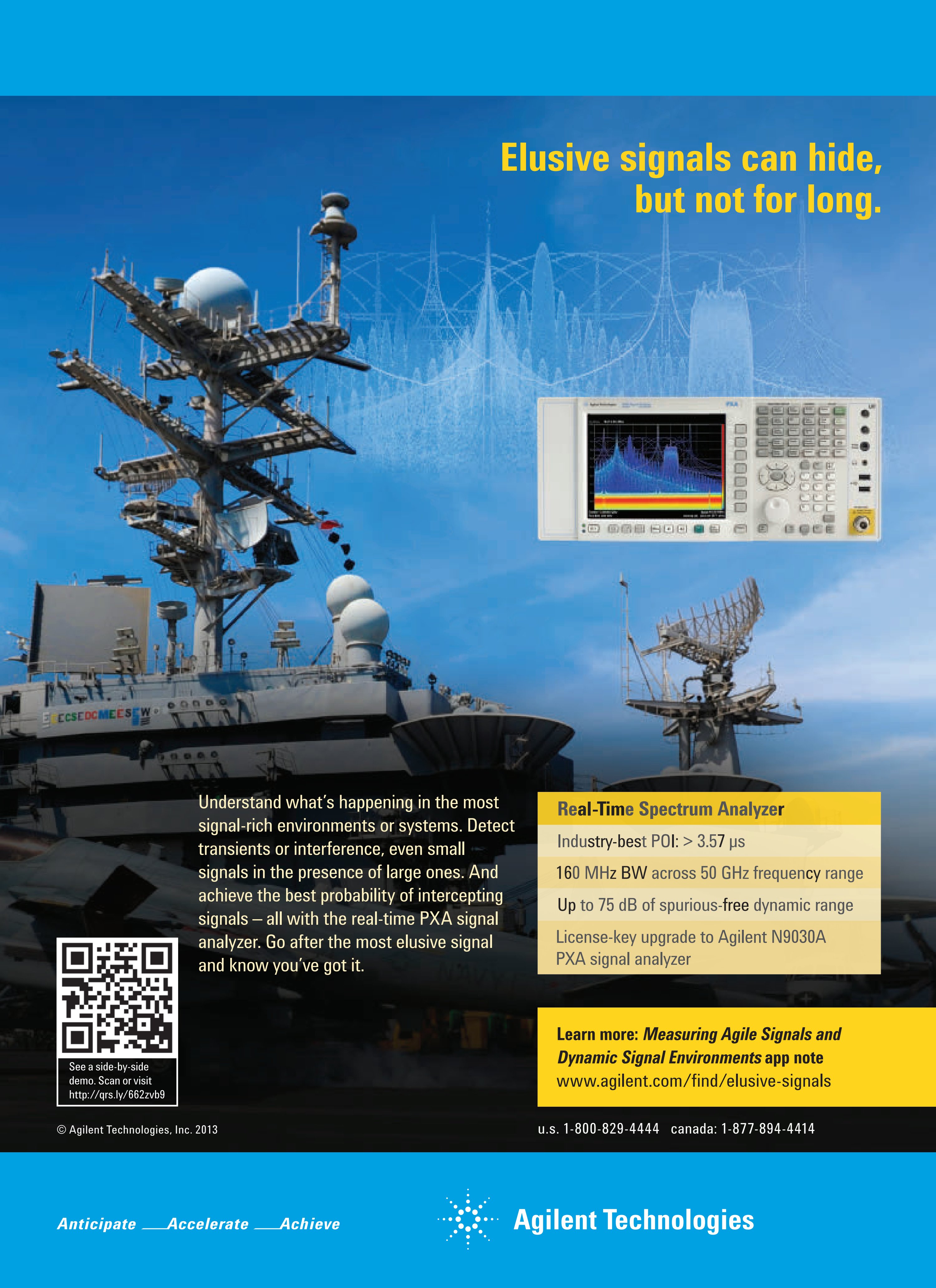
Spectra7 Microsystems Inc. announced that it has appointed **Guy Anthony** as CFO. Anthony has over 30 years of experience working with both public and private companies. He earned his MBA from the Harvard Business School and then worked at Intel Corp. for 22 years in a variety of finance and operational 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.mwjournal.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.

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-

Murthy Upmaka and Dingqing Lu
Agilent Technologies, Santa Clara, CA

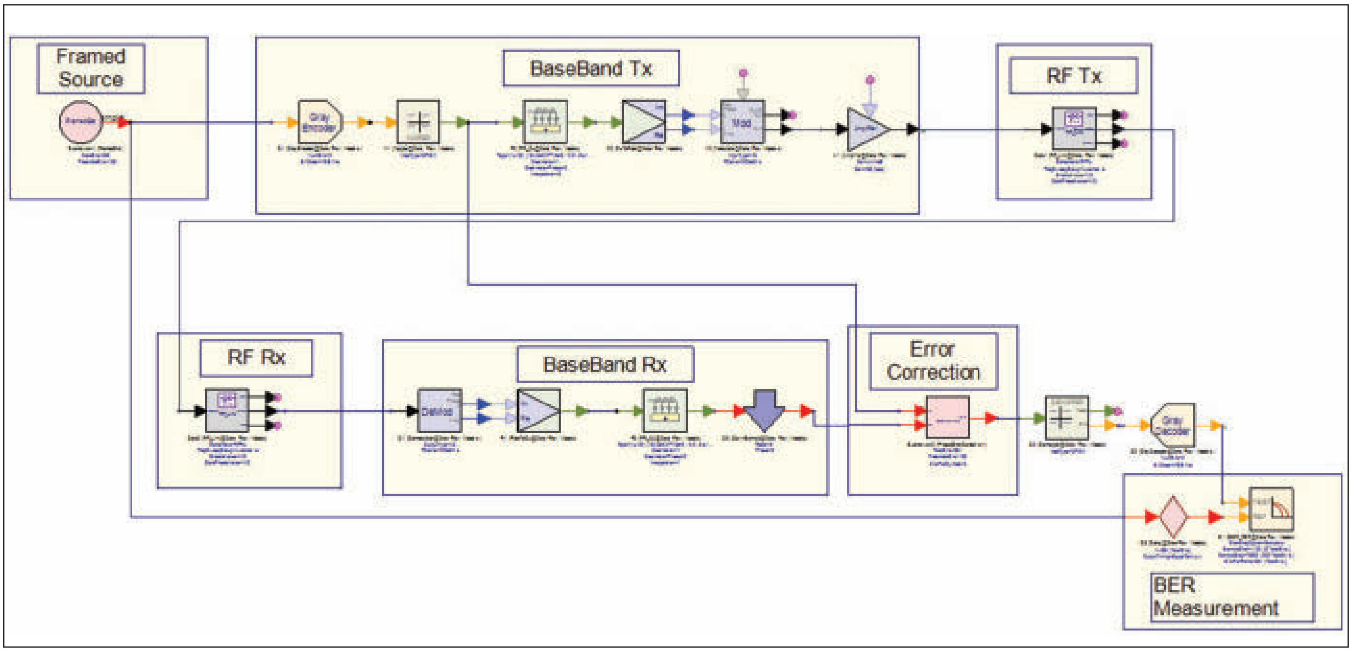


Fig. 1 *Shown here is an example of a complex communications measurement system.*

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

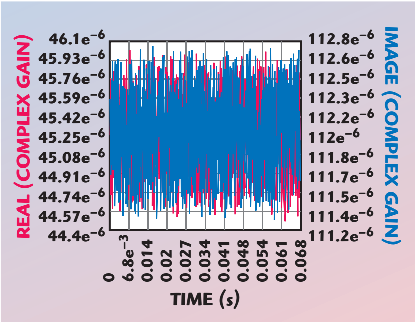


Fig. 2 *Errors in amplitude, phase and time delay in a practical measurement system can be quite complex and not something that can be calculated by hand.*

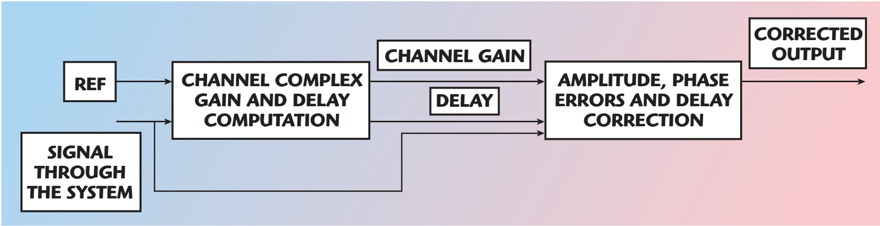


Fig. 3 This correction algorithm can be used to correct for systematic errors.

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 = 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 = abs (Corr)
   Delay_Index = 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

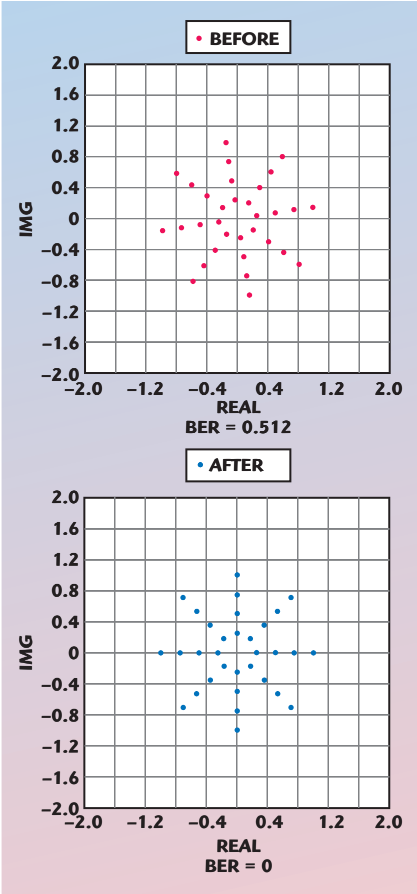
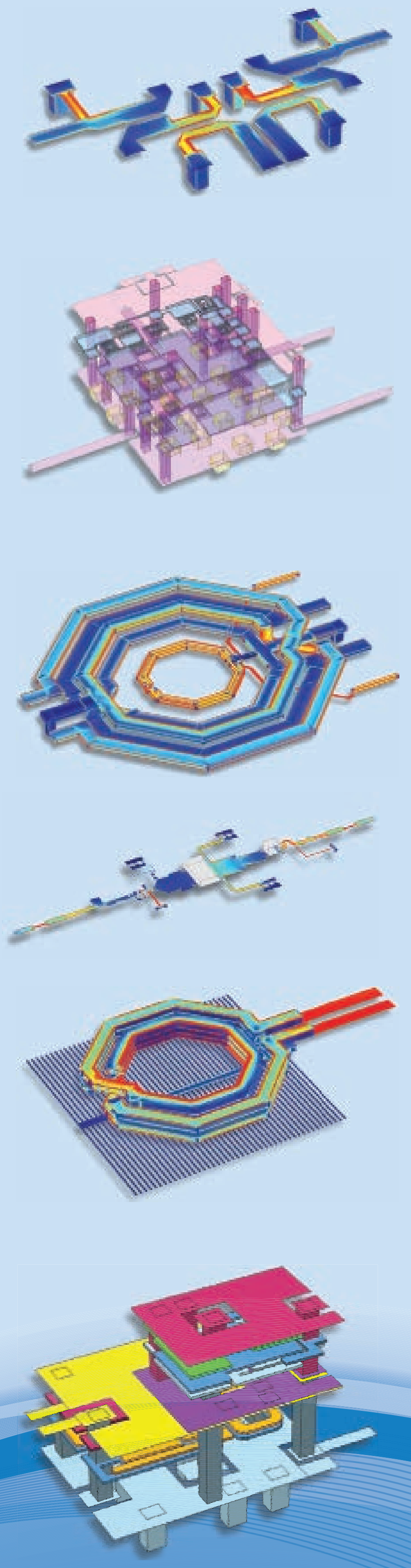


Fig. 4 Shown here are two diagrams for user-defined constellations, illustrating the before and after effects of implementing synchronization algorithms.

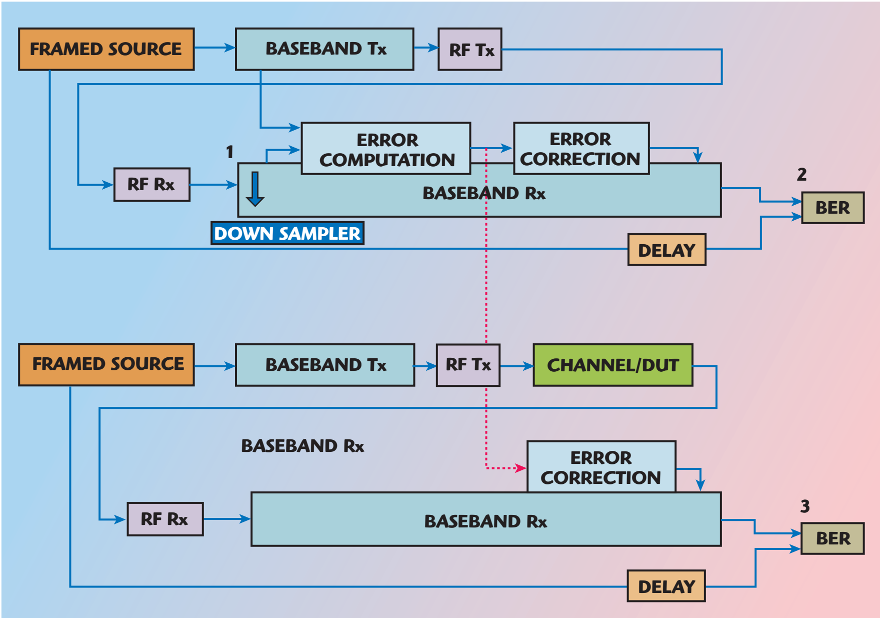
may attempt to manually rotate the constellation using a phase shifter in the signal path, but the rotational symmetry of the constellation makes this



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:Phase_states-1)
V=A(cos(B)+jsin(B))
MapperStates=[1*V 2*V 3*V 4*V]



▲ *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.*

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 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

is reduced to zero. Second, the energy per bit/noise power spectral density ratio (Eb/N0) can be varied by setting the corresponding noise density in the noisy channel/DUT to simulate BER as a function of Eb/N0.

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. ■

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 beamwidths, 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.

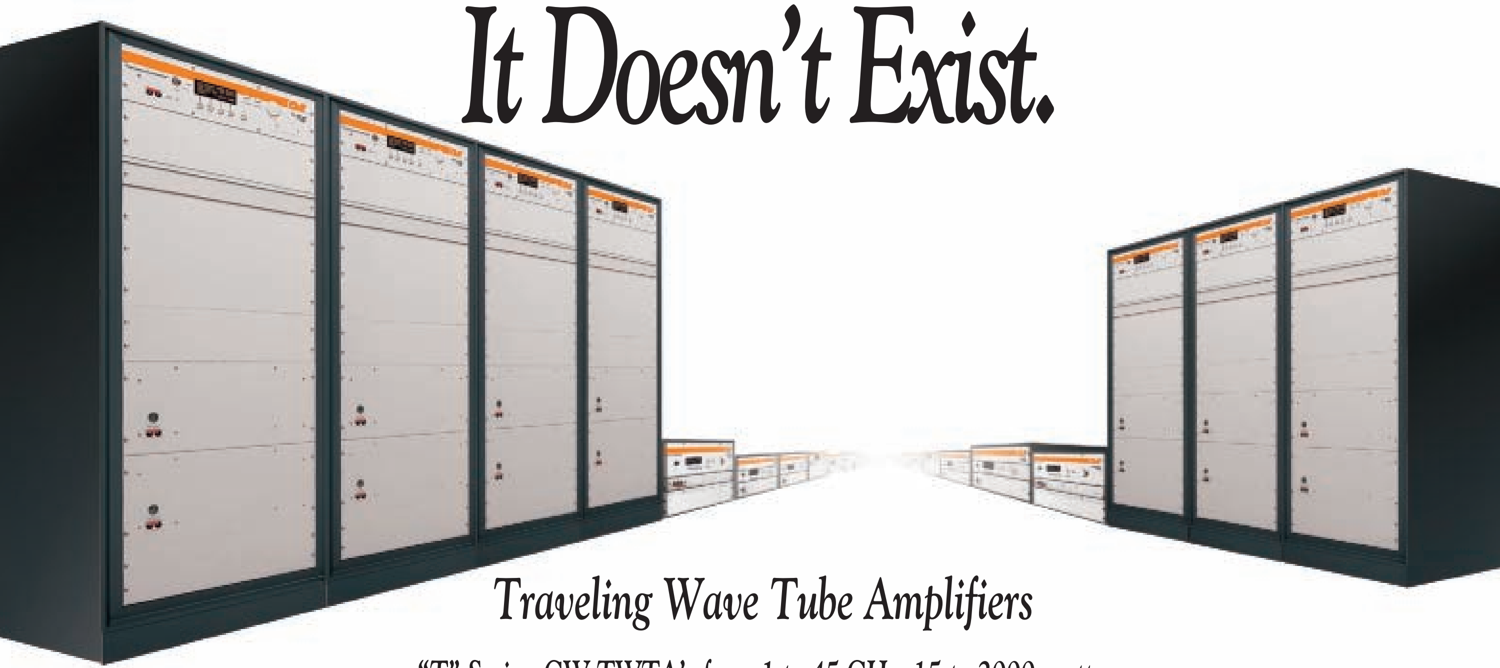
As the name suggests, slotted waveguide antennas consist of lengths of waveguide with slots milled into their conducting walls. These slots introduce discontinuities in the conductor and interrupt the flow of current along the waveguide. Instead, the current must flow around the edges of the slots, causing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

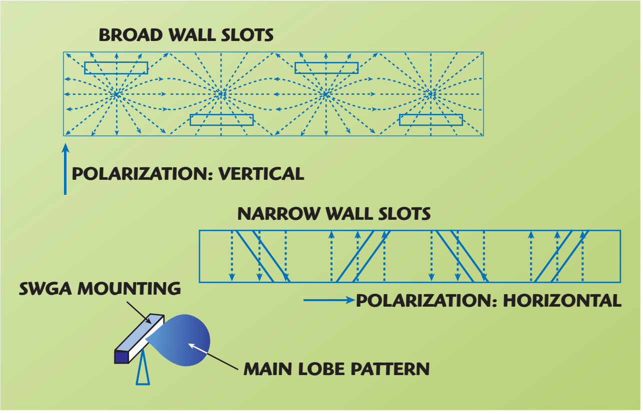
The two basic types of SWAs are standing wave and traveling wave. In a traveling wave SWA, the waveguide is built with matched loads or absorbers at the end, while in a standing wave SWA, the end of the waveguide is short-circuited. The short is usually placed at a quarter of the guided wavelength (λ_g) 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.

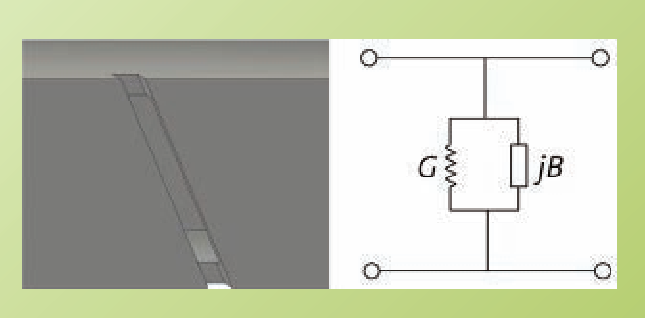
Rodrigo Kenji Enjiu
CST AG, Darmstadt, Germany
Marcelo Bender Perotoni
UFABC, Santo André, Brazil

If You Can't Find The Power You Need Here, It Doesn't Exist.





▲ *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 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).

TABLE I

ANTENNA SPECIFICATION

Parameter	*Specification*
Gain	> 15 dB
Polarization	Horizontal
Frequency	9.375 GHz
Side lobe level (SLL)	30 dB

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 distribution[4] 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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Typical Conversion Loss
0
-5
-10
-15
-20
0
5
10
15
20
25
.320"
.152"
.090"
.600"
Actual Size
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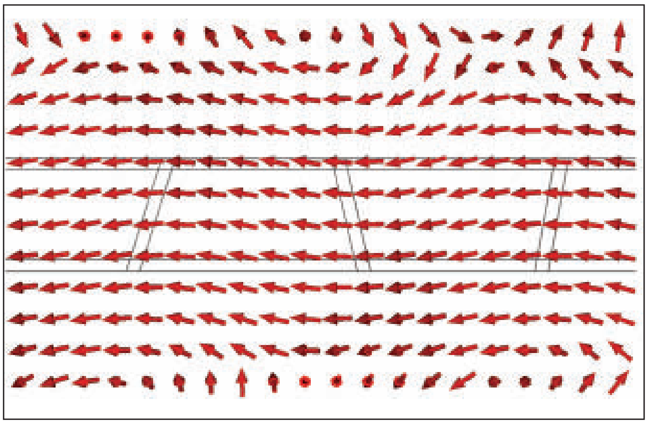
waveguide input as if they were at the same position.

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.

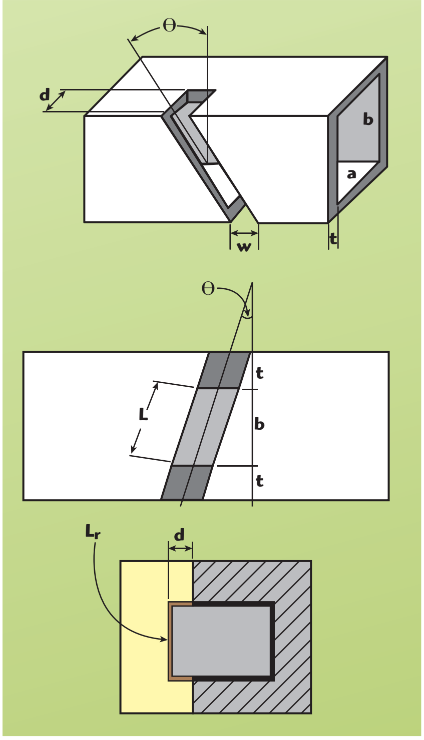
The procedure assigns a theoretical excitation distribution to the array, where each element coefficient corresponds to a slot conductance (at the central frequency where the susceptance is zero) ensuring the length of each slot corresponds to a resonance at the operational frequency.



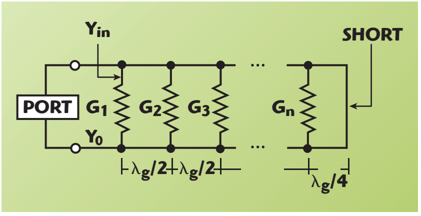
▲ *Fig. 3 Vertical E-field component spatially cancelled, resulting in a horizontally polarized wave over the azimuthal plane.*

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 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]



▲ *Fig. 4 Geometric parameters for the edge slots.*



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

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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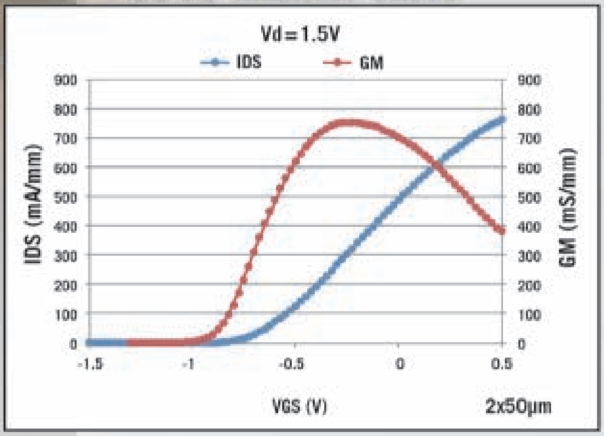
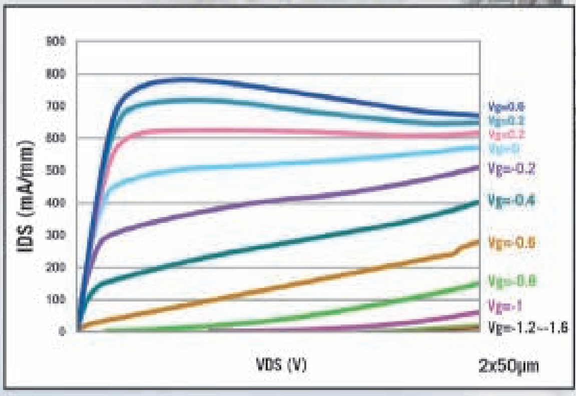
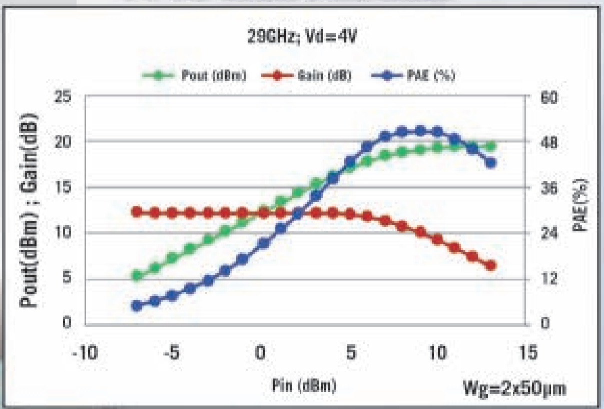


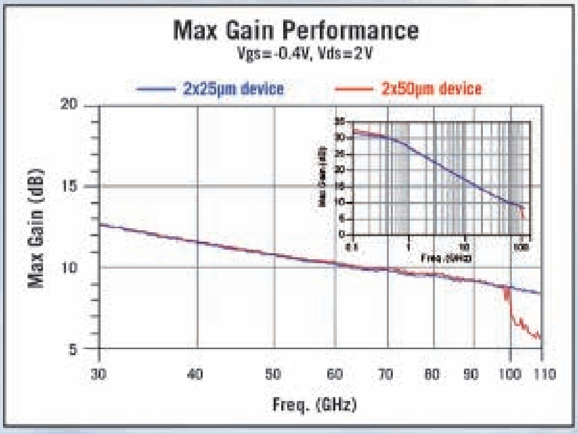
PP10 I-V Curves



PP10 Load Pull Data



PP10 Max Gain



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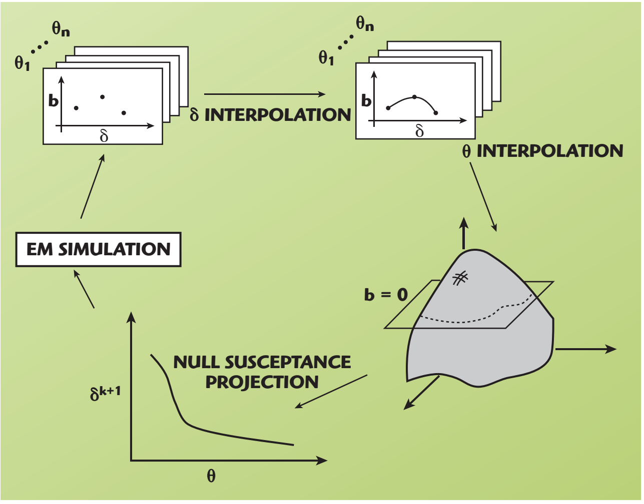
the Smith chart, so that the resultant admittance measured at the first slot, Y_{in}, is equivalent to the sum of all the admittances.

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.

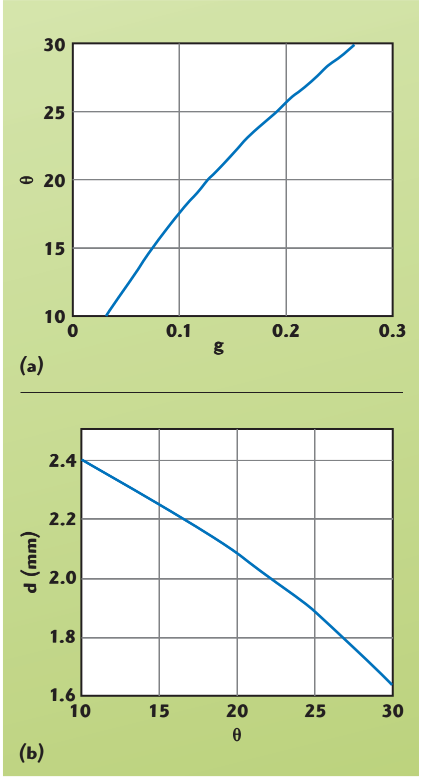
At the end of this process two curves are derived: slot inclination versus required slot conductance, and slot resonant length versus slot inclination. These curves are the design curves used in the synthesis of each slot in an N edge-slotted waveguide antenna.

EVALUATION OF THE NULL SUSCEPTANCE CURVES

The parameter sweep returns a set of admittance points that must be evaluated 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 contourc. The curve described by this contour contains the values of L_r (θ) required for resonance. These are then inserted back into the 3D model, and the antenna is re-simulated. This process is



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

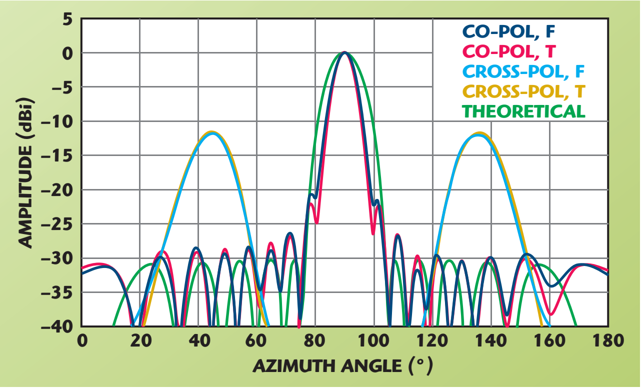


▲ *Fig. 7 Design curves for an edge-slotted waveguide antenna with 12 elements.*

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

TABLE III RESULTANT PARAMETERS OF THE ANTENNA				
n	a_n	g_n	θ(°)	*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 design 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 elements and the number of side lobes 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.

$$g_n = \frac{a_n^2}{\sum_{i=1}^{N} a_i^2} \quad n = 1, 2, \ldots, N \tag{1}$$

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

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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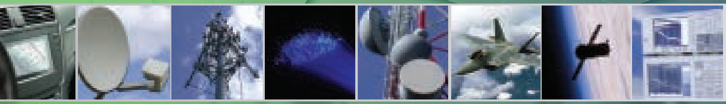

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	HMCAD1511	8-Bit	250 / 500 / 1000 MSPS	4 / 2 / 1	710 mW	49.8	70 / 63 / 64 [1]	EKIT01-HMCAD1511
	HMCAD1510	8-Bit	125 / 250 / 500 MSPS	4 / 2 / 1	295 mW	49.7 / 49.8	69 / 65 [1]	EKIT01-HMCAD1510
	HMCAD1104	10-Bit	20 / 40 / 50 / 65 MSPS	8	12 / 20 / 25 / 30 mW / Channel	61.6	81	EKIT01-HMCAD1104
	HMCAD1102	13 / 12-Bit	80 MSPS	8	59 mW / Channel	70.1	77	EKIT01-HMCAD1102
	HMCAD1101	13 / 12-Bit	65 MSPS	8	51 mW / Channel	72.2	82	EKIT01-HMCAD1101
	HMCAD1100	13 / 12-Bit	20 / 40 / 50 MSPS	8	23 / 35 / 41 mW / Channel	72.2	82	EKIT01-HMCAD1100
	HMCAD1050-80	13 / 12-Bit	65 / 80 MSPS	2	85 / 102 mW	72.6 / 72	81 / 77	EKIT01-HMCAD1050
	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
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[1] Excluding interlacing spurs. *[2] For BW <40 MHz. See HMCAC1052/1054/1056 datasheets.*

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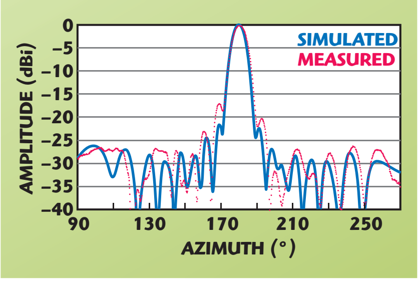
TABLE IV
FINAL ANTENNA CHARACTERISTICS

Parameter	Result
Realized gain in co-pol	16 dB
SLL	-21.9 dB
Cross-polarization lobes	±45°
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 al[8] 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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TABLE V
SUMMARY OF ANTENNA PERFORMANCE

	Simulated, dB	*Measured, dB*
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 numerically, without any changes needed to further improve the final design. The measurement of a prototype validates the accuracy of the simulation. ■

ACKNOWLEDGMENT

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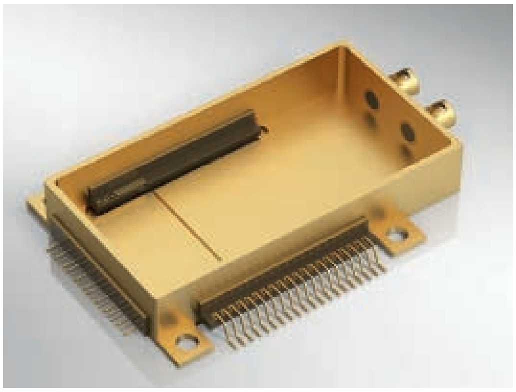


Resolving the Complexity of Hermetic RF Hybrid Housings

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.

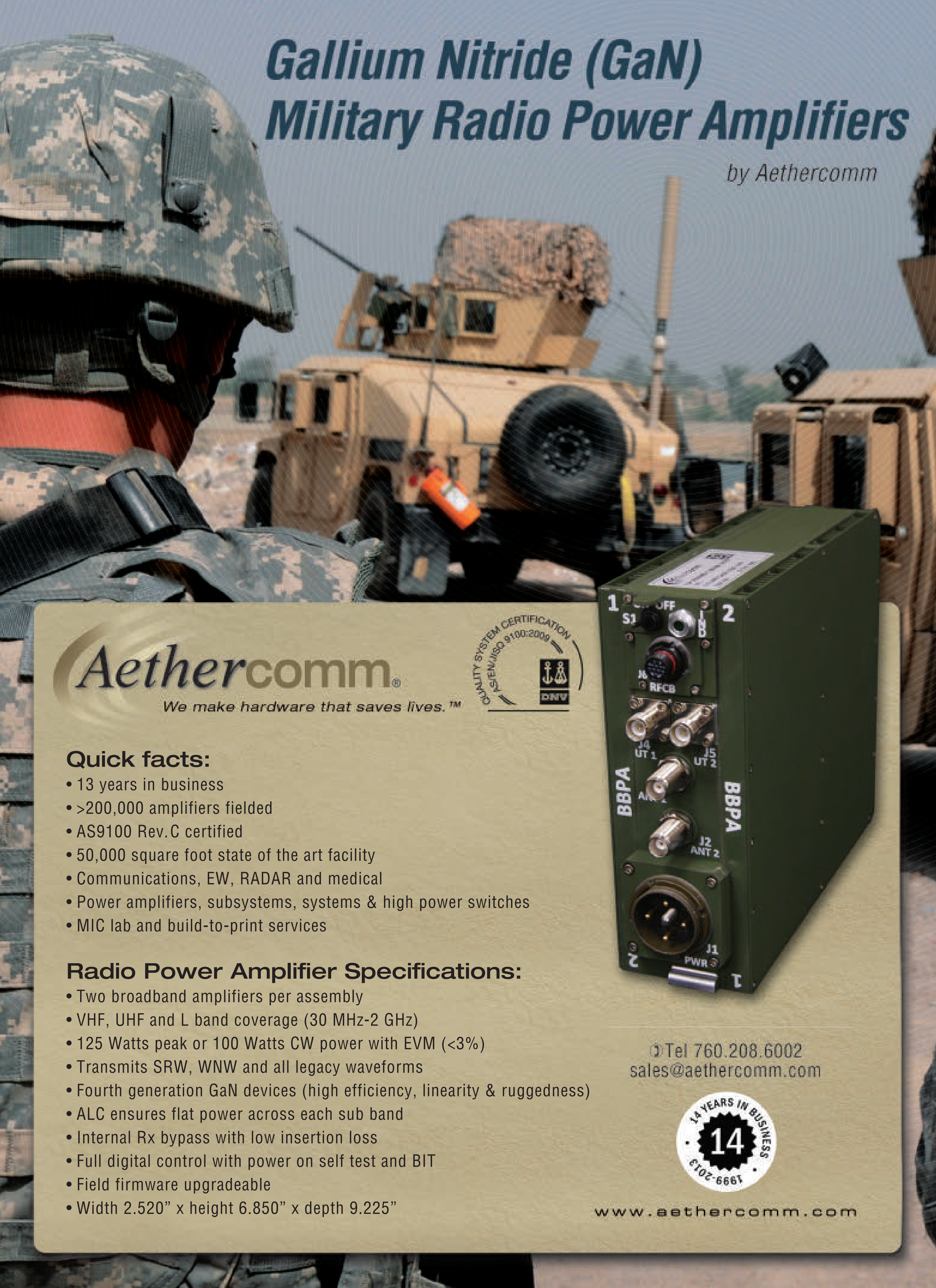
A reliable, long-term protection of highly sensitive electronics is achieved by using hermetic housings. With world-leading competences in glass-to-metal sealing, ceramic-to-metal-sealing as well as full ceramic packages, Schott's electronic packaging business unit offers all hermetic housing technologies 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.

SCHOTT ELECTRONIC PACKAGING
Landshut, Germany
IX-CAD GMBH
Eichenau/Munich, Germany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• MIC lab and build-to-print services
Radio Power Amplifier Specifications:
• Two broadband amplifiers per assembly
• VHF, UHF and L band coverage (30 MHz-2 GHz)
• 125 Watts peak or 100 Watts CW power with EVM (<3%)
• Transmits SRW, WNW and all legacy waveforms
• Fourth generation GaN devices (high efficiency, linearity & ruggedness)
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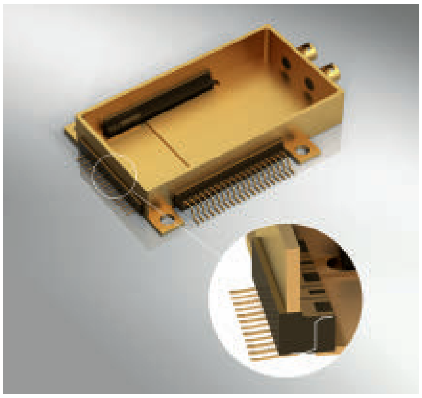
MULTILAYER CERAMICS

The strength of multilayer ceramics lies in the high number of electrical feedthroughs that can be connected in a complex manner to achieve a dense routing inside a very small hermetic unit. High Temperature Cofired Multilayer Ceramics (HTCC) are mainly used for their high mechanical and temperature stability. They can easily be integrated into metal housings via high temperature brazing due to their matched thermal coefficients of expansion.

For special miniaturization and performance needs, Low Temperature Cofired Multilayer Ceramics (LTCC) offer a low dielectric constant and allow for the use of high conductivity metal as well as for embedding passive components such as resistors, inductors or capacitors. In general, multilayer ceramics are indispensable when it comes to miniaturizing opto-electronic components for use in the high-frequency range.



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

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

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 measurement 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 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.

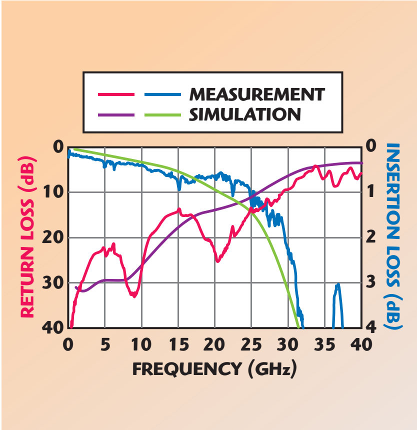


Fig. 2 Simulated and measured return loss (S_{11}) and insertion loss (S_{11}) of the package feedthrough.

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CTS filtered terminal blocks allow the engineer to eliminate EMI using an existing mechanical design element combined with the excellent performance of a Pi filter.

SPECIFICATIONS

- 2-8 terminals available
- Operating temperature: -55°C to 105°C
- Working voltage: Up to 250 V_{AC}
- Capacitance: Up to 15 nF
- Insertion loss: 65dB up to 10GHz
- DC resistance: 0.01 Ohms max.
- Wire sizes to #12 AWG
- Screw size #6-32 or #8-32 head screw

Feed-Thru EMI/RFI Filters

CTS has a wide range of high frequency, low pass filters that are small sized and offers excellent performance. These filters save bulkhead space and eliminate EMI while reducing cost.

Application includes Telecommunications, CATV, Telemetry, Radar, Amplifiers, and RF Switches.

SPECIFICATIONS

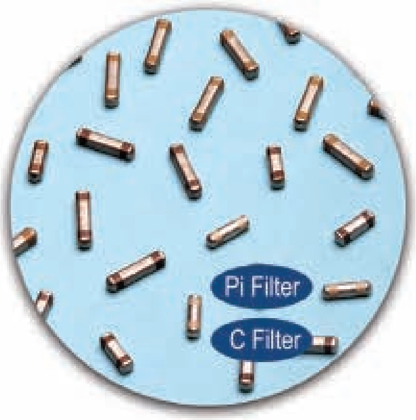
- Frequency range from 1MHz to 10GHz
- Operating temperature: -55°C to +125°C
- Capacitance values up to 100,000 pF
- Capacitance tolerance (+100%, 0%) (+80%, -20%), or customer specific
- Working voltage: 50-2,000 V_{DC}
- Current: 5-25 AMPS
- Hex nut 0.125 in - 0.5 in across the flats

Surface Mount EMI/RFI Filters

CTS 4700 series are used where cost and space savings are a priority and improved insertion loss is required. The filter's unique design makes it suitable for common production soldering processes. The available square body allows easy handling and positioning onto the PCB.

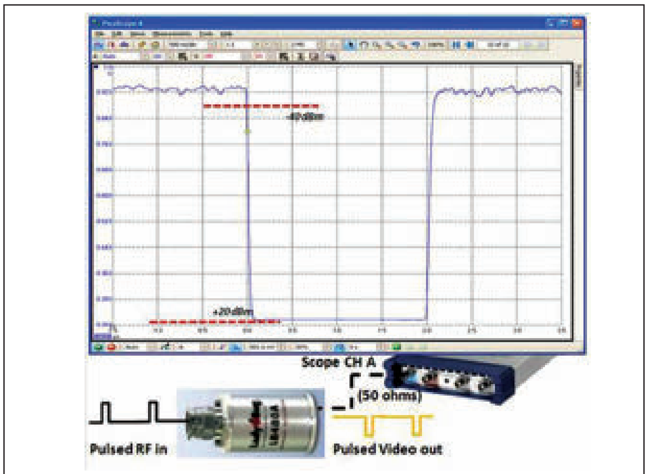
SPECIFICATIONS

- 100 V_{DC} up to 125°C
- Dielectric withstanding: 300 V_{DC}
- 4700/4701 DC rating: 10 AMPS; 4702 DC rating: 20 AMPS
- Insertion loss: Up to 70dB at 1GHz
- Capacitance: 100 pF to 5,000 pF



Pulse Profiling USB Power Sensors

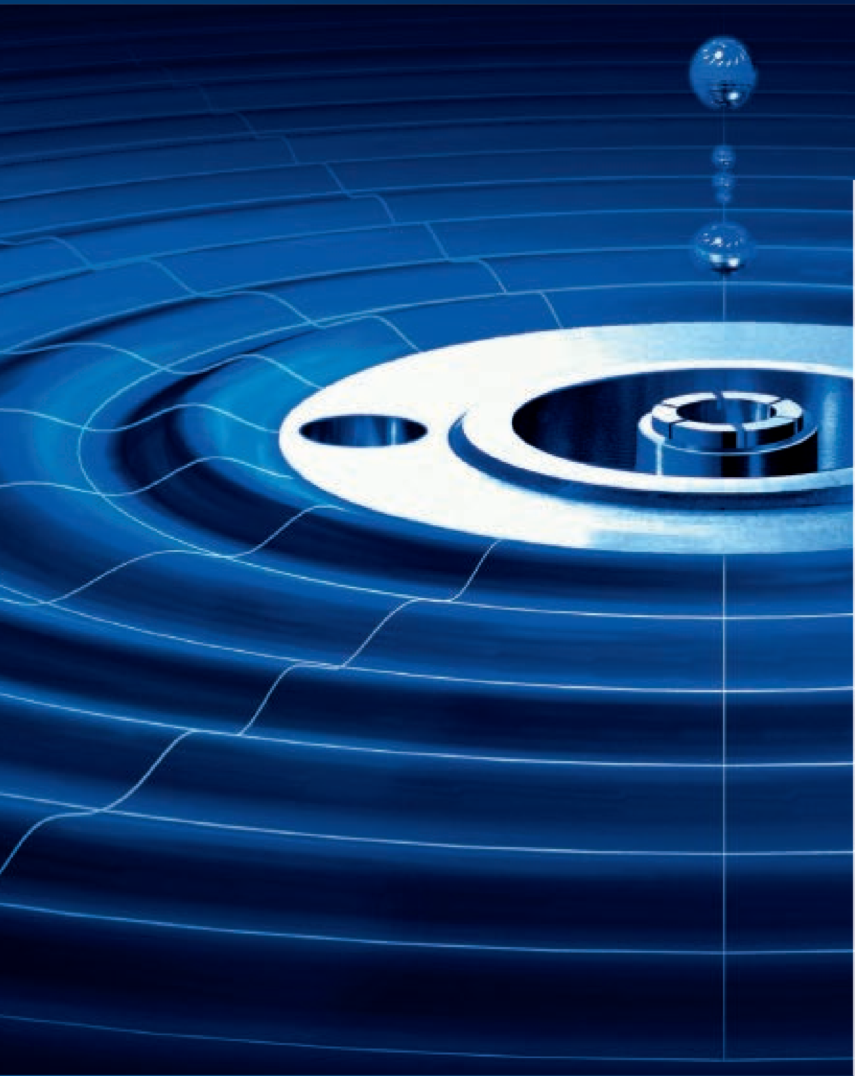
An efficient, accurate and cost-effective method for making RF signal timing and latency measurements is to use wideband video detectors at the two points within the circuit from which the timing comparison is desired. Pulse Profiling USB power sensors from LadyBug Technologies enable easy measurement 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.

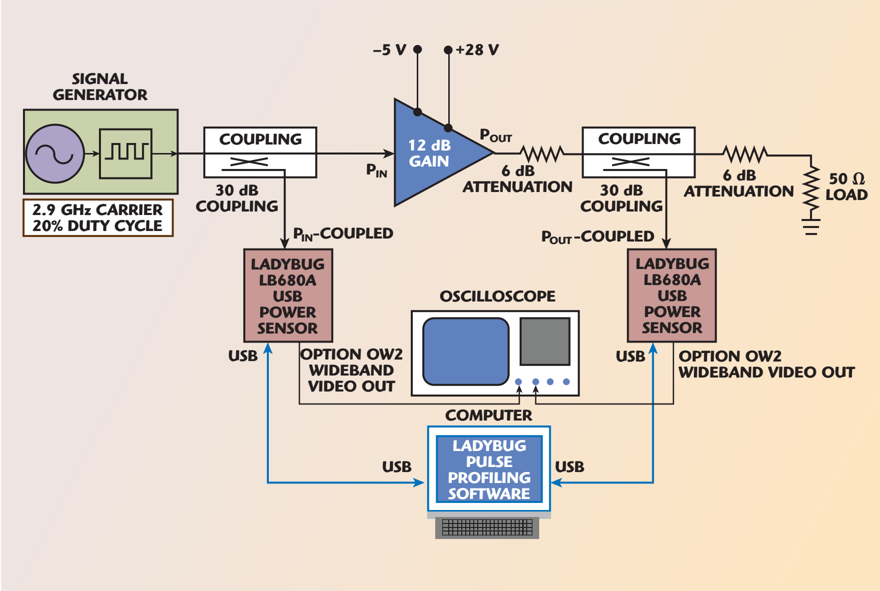


▲ *Fig. 1 Option OW2 provides a wideband, calibrated analog, negative detector video output signal, 0 to –1 V.*

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

LadyBug Technologies
Santa Rosa, CA

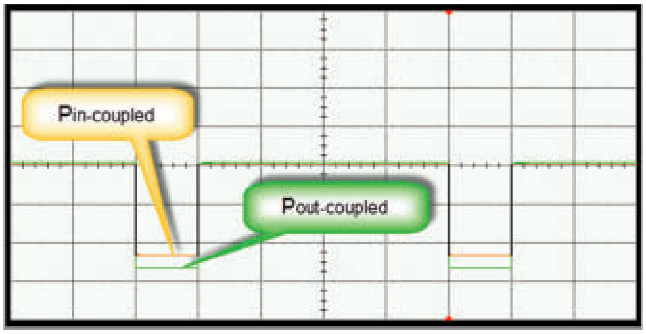




▲ *Fig. 2 Pulse latency measurement setup.*

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.

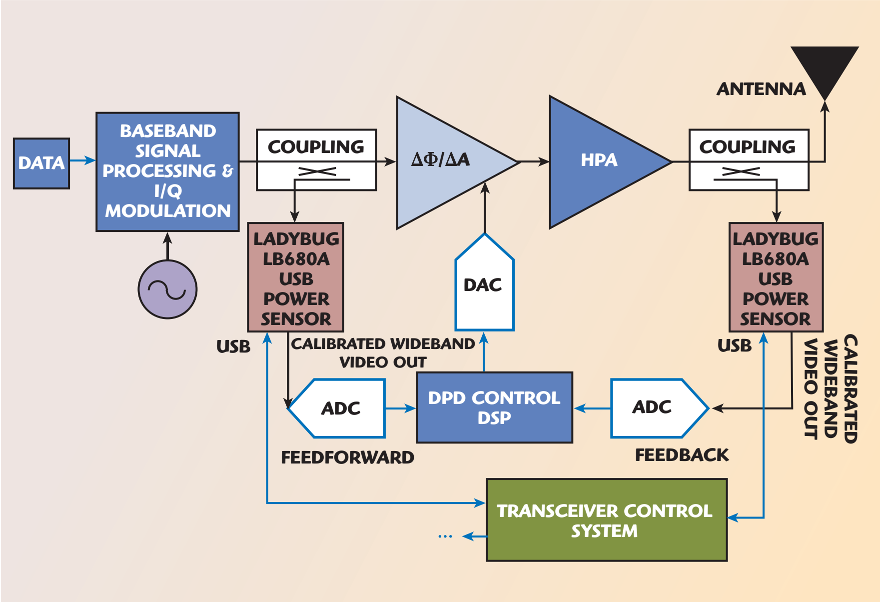


▲ *Fig. 3 Wideband analog video outputs of the two sensors on an oscilloscope.*

▲ *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).*

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 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



▲ *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 with an oscilloscope 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-

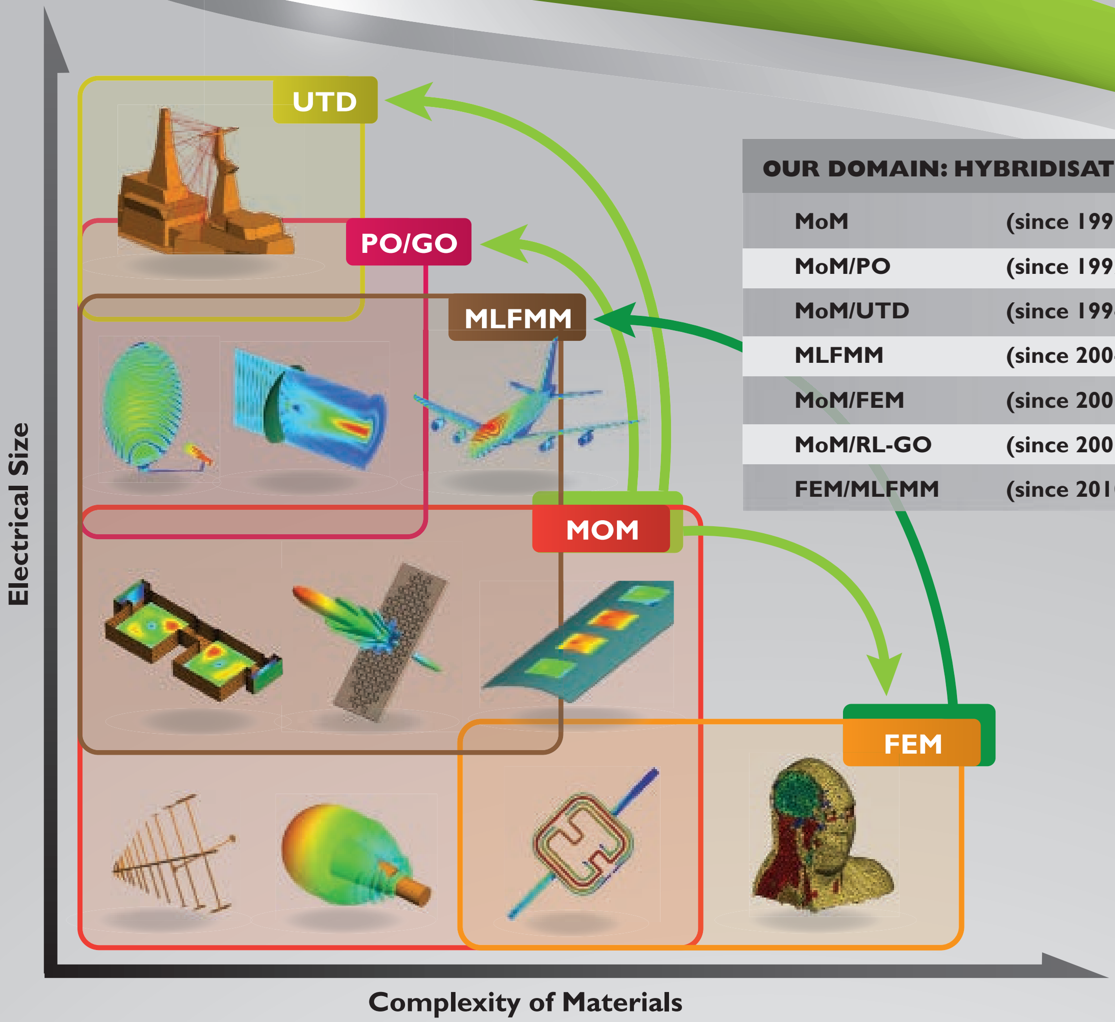


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TABLE I

VIDEO DETECTOR SPECIFICATIONS

Wideband Video Detector Out	*Option OW2 (Requires opt 004, not available with opt 001)*
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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Amazingly Low Phase Noise SAW VCO's

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Model	Frequency (MHz)	Tuning Voltage (VDC)	DC Bias VDC @ I [Max.]	Phase Noise @ 10 kHz (dBc/Hz) [Typ.]
HFSO640-5	640	0.5 - 12	+5 @ 35 mA	-151
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
HFSO1000-12	1000	0.5 - 12	+12 @ 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 × 2.25 × 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 blocking and DC passing. Their digitally controlled and voltage variable attenuators provide accurate control and resolution with flat performance over very broad frequency ranges up to 7 GHz.

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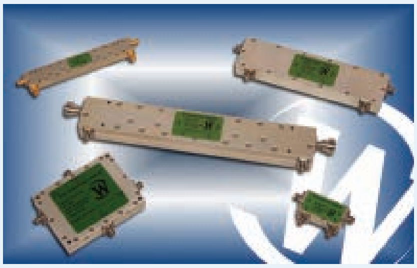

Test and Measurement Directional Couplers

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.

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Patterson, NY,
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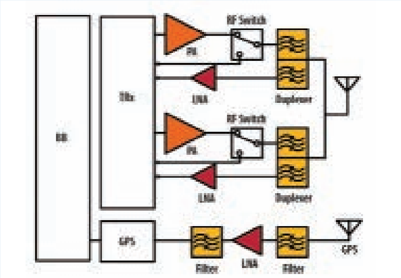
RF Front End Solutions for Small Cells



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.

LINEAR PA

(MGA-43xxx)

Frequency band coverage: B1-5, B7-8, B13, B17, B25, B40

Linear P_{out} of 27 dBm @ 48 to 50 dBc ACLR

High gain (up to 42 dB)

High PAE ranging from 13 to 15 percent

Small and common footprint: 5 × 5 mm

LNA

(MGA-62xxx, MGA-68xxx)

Low NF (as low as 0.6 dB)

High gain (up to 22 dB)

IIP3 (up to 17.5 dBm)

FBAR FILTER

(ACFF-1024, ACPF-8040/-7041)

WiFi filter enabling coexistence with B7, B38 and B40

B40 and B41 LTE filters enabling coexistence with WiFi and Bluetooth

FBAR DUPLEXER

(ACMD-6xxx, ACMD-7xxx)

Frequency band coverage: B1-4, B7-8, B25

Low insertion loss (as low as 1.3 dB)

Superior out-of-band rejection

Small and common footprint: 2 × 2.5 mm

GPS/GNSS LNA FILTER MODULE

(AGPS-x001, ALM-xx12)

Superior out-of-band rejection

Low NF (as low as 0.82 dB)

High gain (up to 17 dB)

IIP3 (up to 7 dBm)

Avago Technologies,
San Jose, CA,
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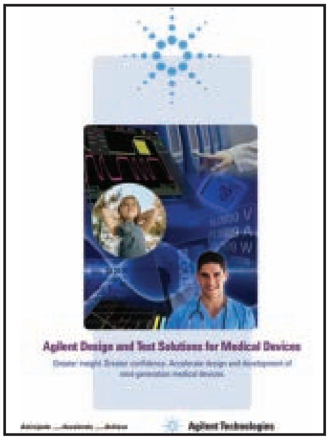
Catalog Update

Test Solutions for Medical Devices Brochure



A new brochure, "Agilent Design and Test Solutions for Medical Devices," shows how Agilent's medical device design and test products can help you gain greater insight into your medical devices. This new brochure spans the RF, microwave, wireless and digital technologies that are the building blocks of today's medical technology and more. Download the new brochure today from Agilent's website.

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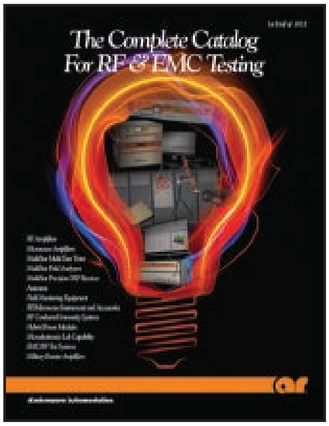
Agilent Technologies Inc., www.home.agilent.com.

RF & EMC Testing Catalog



AR's new product catalog is now available from your local AR sales associate. The catalog is easy to use, with "find-it-fast" charts and color coding to help get right to whatever you need for RF & EMC testing. It is available for free download, either in full or by section at www.arworld.us.

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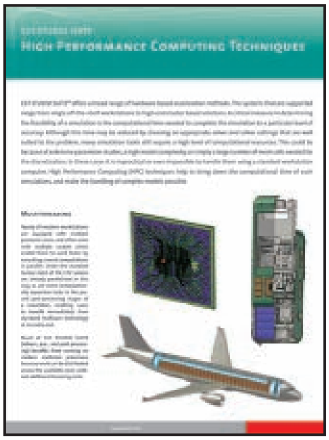
High Performance Computing Brochure



High performance computing (HPC) techniques lower the computational time for electromagnetic (EM) simulations. CST STUDIO SUITE® offers a range of hardware based acceleration methods and this brochure explores which techniques are available to handle complex simulation models, including multithreading, GPU, MPI and distributed computing. Each technique is presented in the brochure, detailing how they work and highlighting the types of simulation where they are of most use. The brochure is free to download and is available at www.cst.com/Content/Documents/Products/CST-HPC-Flyer.pdf.

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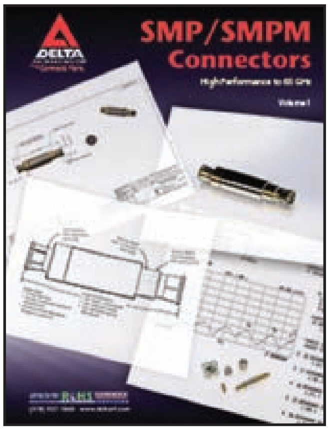
SMP/SMPM Catalog



Delta Electronics Manufacturing Corp.'s new 24 page SMP/SMPM series catalog details 167 part numbers that span 37 different connector configurations in these two series that operate from: SMP: DC to 40 GHz/SMPM: DC to 65 GHz. These connector interfaces are developed for applications in phased array radar systems, airborne radar, ground radar, shipboard radar and active antennas. Products include: Cable mount males and females, shrouds, panel mounts and accessory pins. In addition, the catalog features information on applications, materials, finishes, typical electrical performance and assembly procedures.

Delta Electronics Manufacturing Corp., www.deltarf.com.

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.

HUBER+SUHNER AG, www.hubersuhner.com.

Components and Test Equipment

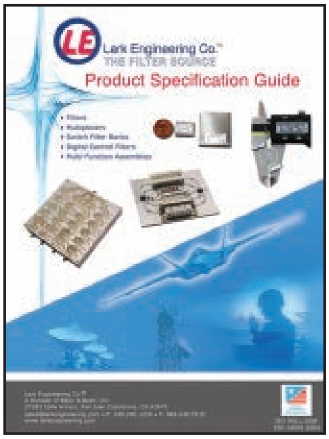
The new KRYTAR 12-page short-form catalog displays microwave components and test equipment specializing in ultra-broadband frequencies ranging from DC to 67 GHz. The wide product line includes directional couplers, directional detectors, 3 dB 90 and 180 degree hybrid couplers, MLDD power dividers/combiners, detectors, limiters, coaxial terminations and adapters, a power meter and power sensors. KRYTAR's microwave components are manufactured in full compliance with the EU RoHS-6 Environmental Requirements.

KRYTAR Inc., www.krytar.com.


Big and Small,
we have 'em all
Almost any Waveguide to almost any Coax Connector
WG Materials : Aluminum, Copper, Brass
Connectors : 1.92mm ...SMA....
TNC....N...7/16
Spectrum
Elektrotechnik GmbH
when Quality is needed
80905 Munich, Germany
P.O. Box 450533
Telephone: +49-89-3548-040
Facsimile: +49-89-3548-0490
WWW.SPECTRUM-ET.COM
Email: Sales@Spectrum-et.com
WG-Big&SmallE5

Catalog Update

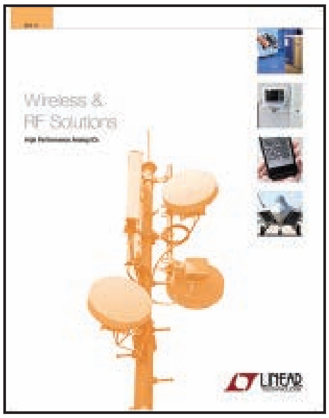
Product Specification Guide



Lark Engineering announces a new product specification guide highlighting its wide range of filter products including the new digital control filters, switch filter banks and multiplexers. The 12-page short form catalog features a user friendly, quick reference to filter specifications and capabilities that guides users to the filter ideally suited for their application. Specifications and performance simulations are instantly available using the company's filter design tool located on its website.

Lark Engineering,
www.larkengineering.com.

Wireless & RF Solutions



Linear offers high performance RF and signal chain solutions for wireless and cellular infrastructure, supporting LTE, LTE-Advanced, GSM, W-CDMA, TD-SCDMA, CDMA, CDMA2000 and WiMAX. Applications include broadband microwave data links, secure communications, satellite receivers, broadband wireless access, wireless broadcast systems, cable infrastructure and wireless sensor networks. Linear's products include high linearity active mixers, direct conversion I/Q demodulators, low distortion IF amplifiers/ ADC drivers, variable gain amplifiers, integrated RF-to-digital receivers, high speed ADCs, RF detectors, active filters and wireless sensor network products.

VENDORVIEW

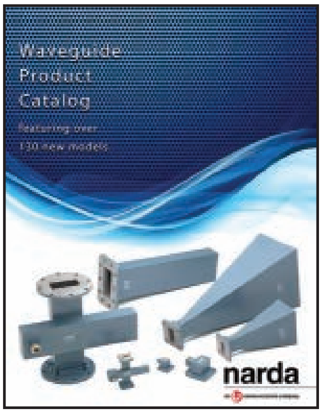
Linear Technology,
www.linear.com.

Cable Assemblies and Components Catalog

Mesa Microwave manufactures connectors, cable assemblies and components for the RF and microwave industry in frequency ranges up to 110 GHz. The company's 2013 catalog shows a variety of its series of connectors, adapters and cable assemblies. It has over twenty different series of connectors in plugs, jacks, bulkheads, reverse polarity, PCB, panel mounts and more. The company also specializes in customized solutions for standard and unique applications, and is focusing on adding more precision adapters (2.4. K, 3.5,…).

Mesa Microwave,
www.mesamicrowave.com.

Waveguide Product Catalog

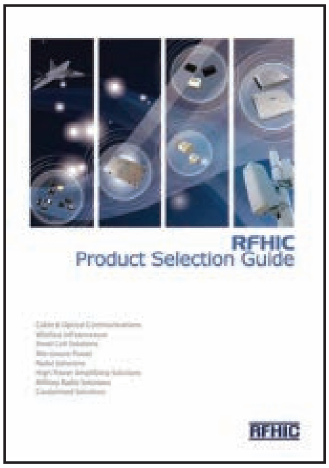


Narda Microwave-East announces the availability of its new Waveguide Product Catalog. The catalog includes specifications for its expanded waveguide product line and features 130 new models in four distinct catagories: waveguide-to-coaxial adapters (right angle and end launch); gain horns; low and medium 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.

VENDORVIEW

Narda Microwave-East,
www.nardamicrowave.com/east.

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/down/rfhic_2013.pdf or contact a sales representative in your area to receive a copy.

RFHIC,
www.rfhic.com.

Value Instruments Catalog

Whatever your job is, you are not always performing complex measurements and do not always need the ultimate high-end T&M equipment. What you need are precise, reliable, universal measuring instruments. That is exactly what you get with value instruments from Rohde & Schwarz: they combine practical features with excellent measurement characteristics; they are easy to use and easy on the budget. Find out more in the Value Instruments Catalog 2013 from Rohde & Schwarz.

VENDORVIEW

Rohde & Schwarz GmbH & Co. KG,
www.rohde-schwarz.com.

The 2013 Defence and Security Forum

At European Microwave Week

EuMA European Microwave Association

Microwave Journal 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.

FREE ATTENDANCE ■ REGISTER AT EUMWEEK.COM

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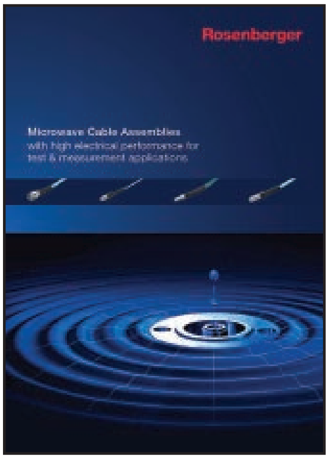
Photos courtesy of Shmuel Auster.

Catalog Update

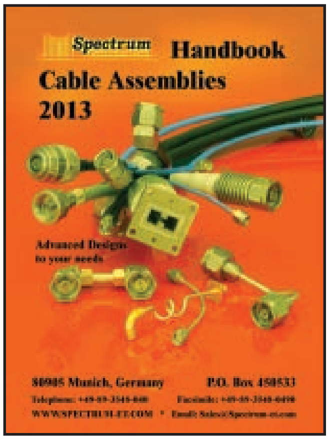
Microwave Cable Assemblies



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.

Rosenberger Hochfrequenztechnik GmbH & Co. KG,
www.rosenberger.com.

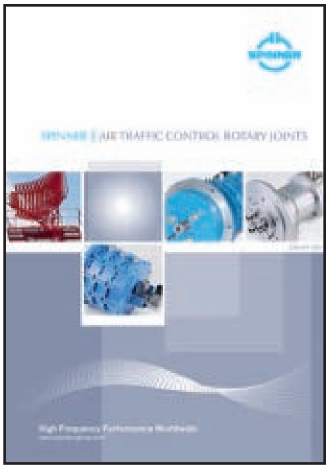
Cable Assembly Handbook



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.

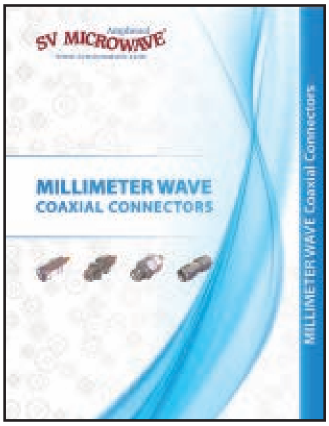
ATC Catalog



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.

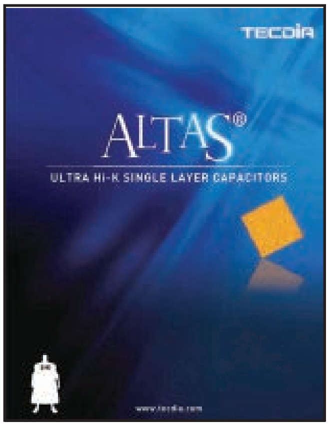
Millimeter Wave Connector Catalog



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 SilverLine® 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.

EUROPEAN MICROWAVE WEEK
NCC NUREMBERG, GERMANY
6-11 OCTOBER 2013
www.eumweek.com
MEET EXPERTS MAKE FRIENDS

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: Eu*M*A, GAAS, VDE, IET or IEEE.

Eu*M*A 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	
1 Conference	Standard	Student/Sr.	Standard	Student/Sr.
EuMC	€ 420	€ 100	€ 550	€ 130
EuMIC	€ 325	€ 90	€ 430	€ 120
EuRAD	€ 280	€ 80	€ 370	€ 110
2 Conferences				
EuMC + EuMIC	€ 600	€ 190	€ 790	€ 250
EuMC + EuRAD	€ 570	€ 180	€ 740	€ 240
EuMIC + EuRAD	€ 490	€ 170	€ 650	€ 230
3 Conferences				
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	
1 Conference	Standard	Student/Sr.	Standard	Student/Sr.
EuMC	€ 550	€ 130	€ 720	€ 170
EuMIC	€ 430	€ 120	€ 560	€ 160
EuRAD	€ 370	€ 110	€ 490	€ 150
2 Conferences				
EuMC + EuMIC	€ 790	€ 250	€ 1030	€ 330
EuMC + EuRAD	€ 740	€ 240	€ 980	€ 320
EuMIC + EuRAD	€ 650	€ 230	€ 850	€ 310
3 Conferences				
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

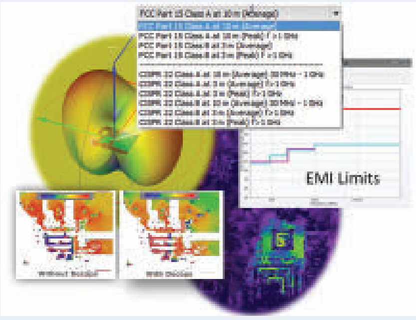
Partner Programme and Social Events

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

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.

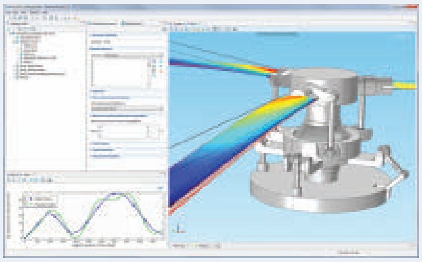
CA Software

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.

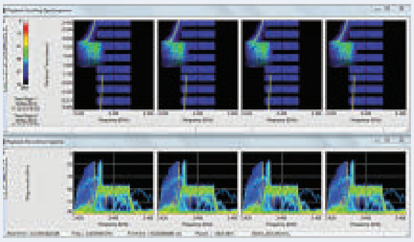
Comtech Xicom Technology Inc.,
www.xicomtech.com.

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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Choose from over a hundred models. Mini-Circuits rugged LTCC and semiconductor power splitters are available with narrowband and broadband coverage through 7200 MHz. Small in size and cost, but big on performance, they can handle as much as 20 W input power, with high isolation and low insertion loss. Yet they won't take up valuable circuit board space. Sizes as small as 0805 also contribute to minimal amplitude and phase unbalance, while retaining outstanding unit-to-unit repeatability.

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BP
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SP
0.12 x 0.12 x 0.06"


WP
0.12 x 0.12 x 0.04"


SCN, QCN
0.13 x 0.06 x 0.04"
0.08 x 0.05 x 0.03"

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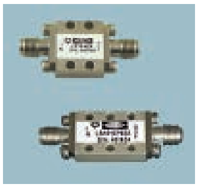
U.S. Patents
7739260, 7761442

IF/RF MICROWAVE COMPONENTS

459 rev J

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 limiting 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 ±0.6° 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 measures 4.95" × 3.38" × 1.02". Other frequency ranges are available.

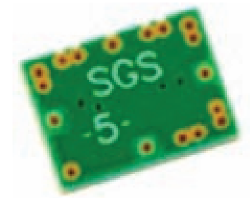
Planar Monolithics Industries,
www.pmi-rf.com.

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" × 0.20" × 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.synergymwave.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.

New Products

Amplifiers

Linear PA

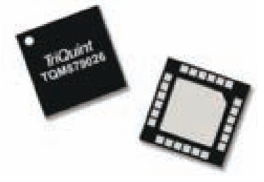
VENDORVIEW

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

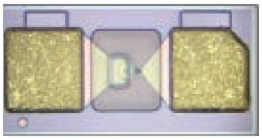
The TQM879026 is a digital variable gain amplifier (DVGA) featuring high linearity performance in a fully integrated module. The amplifier module features the integration of a high performance gain block, a digital step attenuator (DSA), along with a high linearity ¼ W amplifier in a compact package. 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

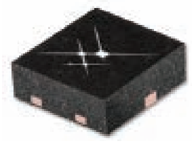


MACOM announced a new broadband general purpose amplifier for Multi-market applications. The MADP-000907-14020 is designed for customers who need a versatile, low cost, ultra-small PIN diode solution for police radar, point to point, electronic warfare and aerospace and defense applications. The device 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

VENDORVIEW

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

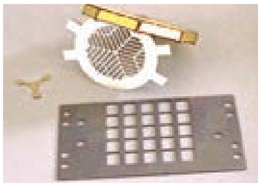
Jackson Labs Technologies' latest product combines the Cesium Vapor Cell reference with an ultra-high-precision ovenized SC-cut crystal oscillator for ultra-fast warmup, excellent holdover, low power, exceptional phase noise, and Allan Deviation (ADEV) performance in the xE-012 range. The combination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

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 SMV12950A-LF provides the end user typical output power of 3±3 dBm into a 50 Ω 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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On both a professional and personal level, we have something for everyone and we look forward to welcoming you in Tel Aviv!

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Advances in FDTD Computational Electrodynamics: Photonics and Nanotechnology

Edited by Allen Taflove, Steven G. Johnson and Ardavan Oskooi

The most efficient computational modeling of optical interactions with nanoscale 3D material structures is based on the numerical solution of the fundamental Maxwell's equations of classical electrodynamics, supplemented as needed by spatially localized hybrids with quantum electrodynamics. This book presents the current state-of-the-art in formulating and implementing computational models of these interactions. Maxwell's equations are solved using the finite-difference time-domain (FDTD) technique, pioneered by the senior editor, whose prior Artech House books in this area are among the top ten most-cited in the history of engineering.

This resource helps the reader understand the latest developments in computational modeling of nanoscale optical microscopy and microchip lithography. It also explores cutting-edge details in modeling nanoscale plasmonics, including nonlocal dielectric functions, molecular interactions, and multi-level semiconductor gain. Other critical topics include nanoscale biophotonics, especially for detecting early-stage cancers, and quantum vacuum, including the Casimir effect and blackbody radiation. A couple of chapters are dedicated to metamaterial structures and cloaks which are of interest to many microwave engineers.

This book is aimed at academic and industrial researchers working in all areas of photonics and nanotechnology. It provides an update of the FDTD techniques covered in the 2005 Taflove-Hagness Artech book, *Computational Electrodynamics: The Finite-Difference Time-Domain Method, 3rd edition*. It also provides a wide-ranging review of recent FDTD techniques aimed at solving specific current problems of high interest in photonics and nanotechnology. The book assumes familiarity with the fundamentals of FDTD solutions of Maxwell's equations so it is not for the novice. It is good resource for those interested in this specific topic.

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About the Tampa Bay area of Florida

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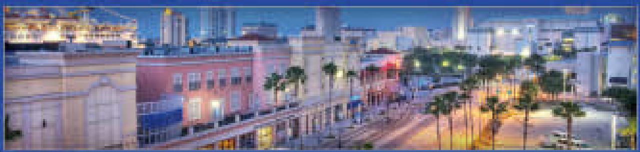
A dynamic and diverse region, Tampa Bay enjoys an excellent quality of life. From the waterfront location to the Southern hospitality of its residents, the area takes pride in its vibrancy and welcoming spirit. The only city to be invaded by a band of pirates during the annual Gasparilla celebration, special events and festivals are part of the area's cultural fabric. From balloon rides, strawberry farms and lush nature to walkable neighborhoods, the region's character is hard to match. It easily blends its rich, cultural heritage with big-city style. With much to experience, one quickly discovers an exciting, authentic metropolis.

Authentic people and places make Tampa Bay a treasure to discover. Feel the warmth of the sun as you explore a region sizzling with adventure – from stimulating attractions to inspiring arts and culture. This exciting city offers events and celebrations for every season. Pirates invade every January as part of the annual Gasparilla celebration. Known as the "Winter Strawberry Capital of the World," locals and visitors enjoy the annual Strawberry Festival. Travel to Tampa and enjoy the scene – thriving nightlife, world-class shopping and unique boutiques, delicious restaurants and waterfront experiences. Pack your bags – Tampa Bay is ready to welcome you!



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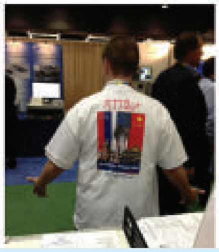

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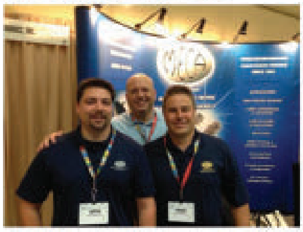

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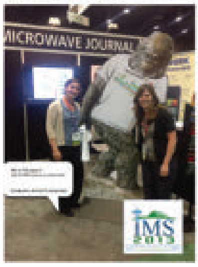

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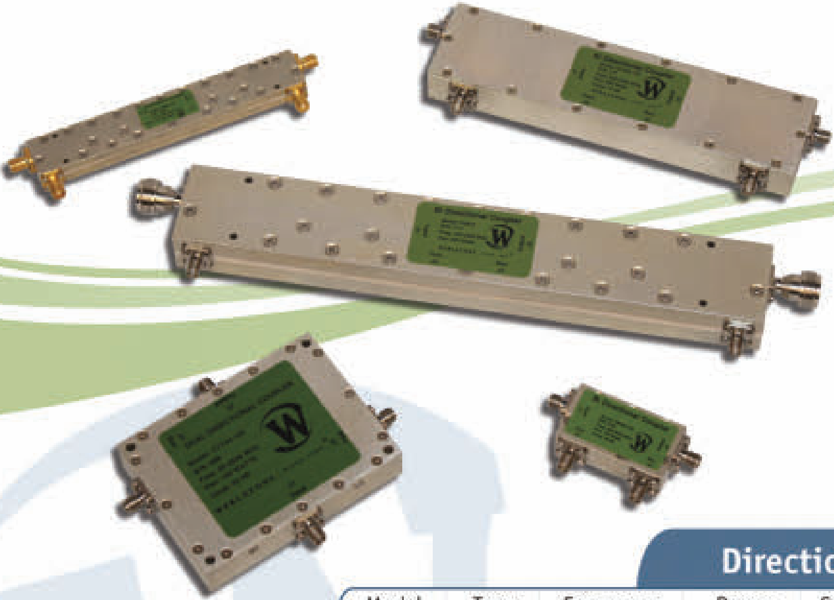

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C7734	Dual	30-2500	100	43	0.35	1.25:1	3.5 x 2.6 x 0.7
C8188	Uni	30-3000	20	20	2.4	1.35:1	6 x 1.5 x 1.1
C3910	Dual	80-1000	200	40	0.2	1.20:1	3 x 3 x 1.09
C8373	Bi	100-2500	200	20	0.8	1.25:1	9.58 x 1.48 x 0.88
C7711	Dual	100-3000	100	40	0.35	1.25:1	3 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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