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July 2018

Microwave Journal

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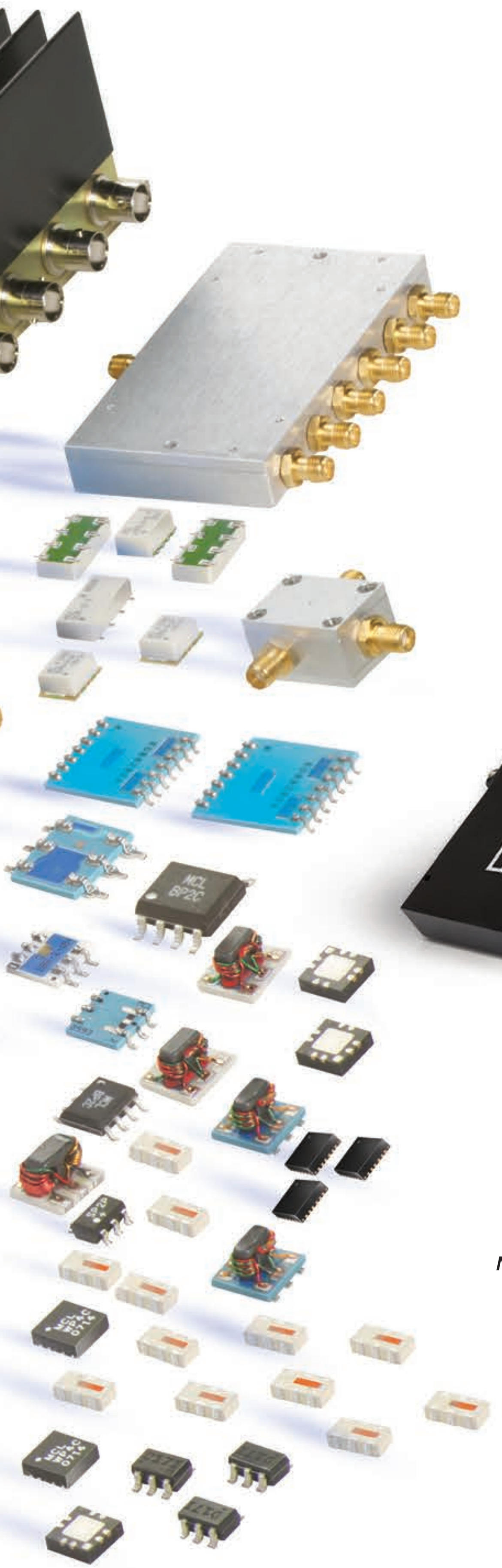

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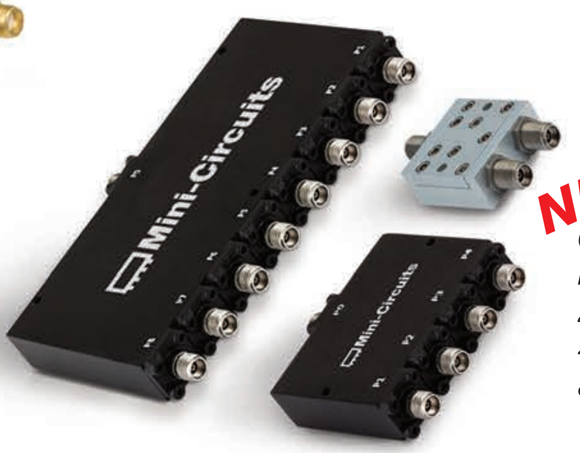

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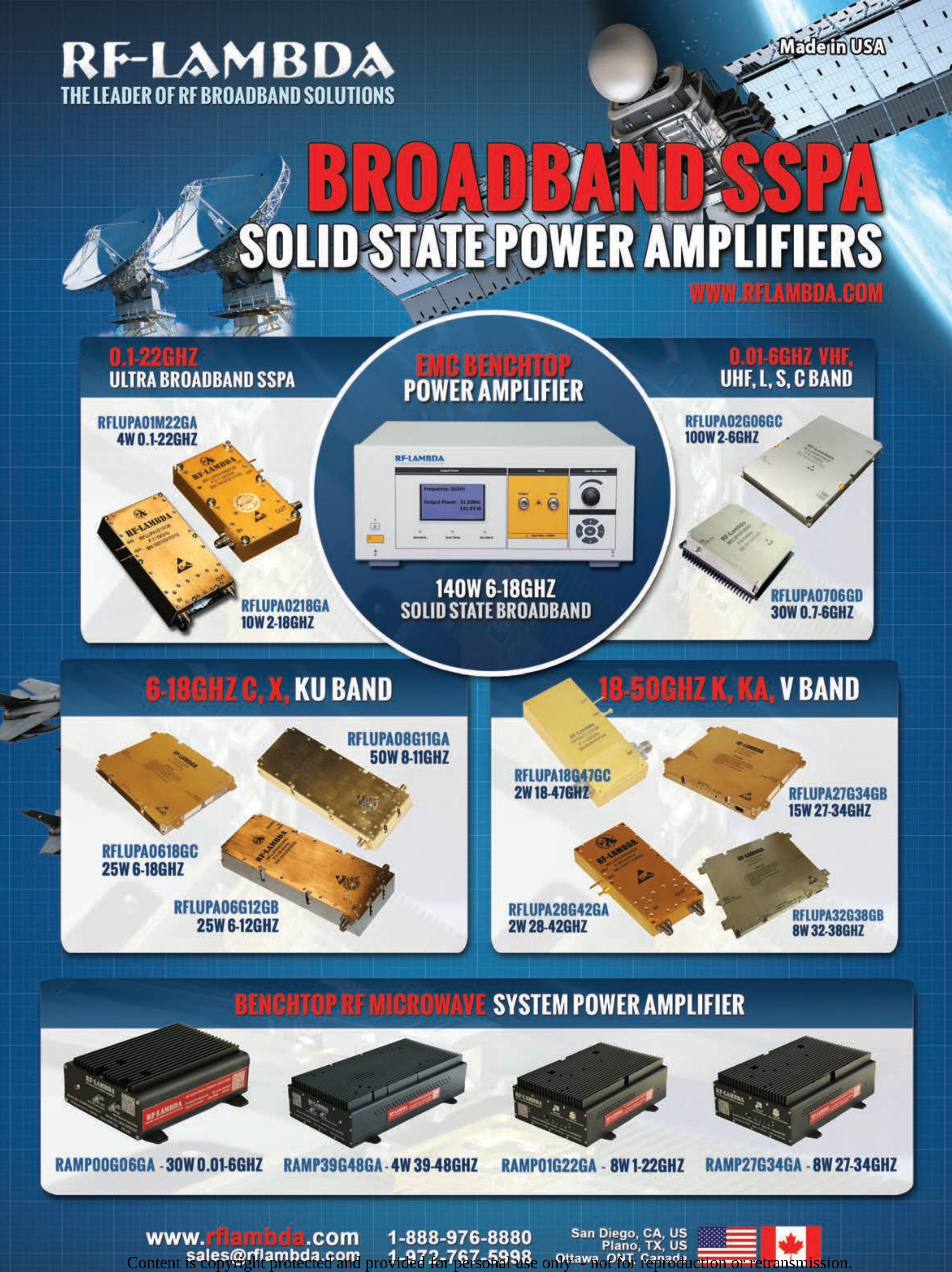
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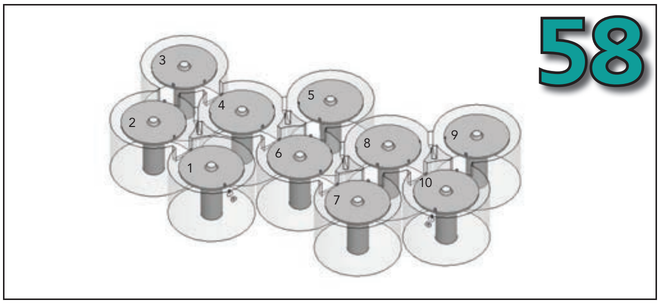
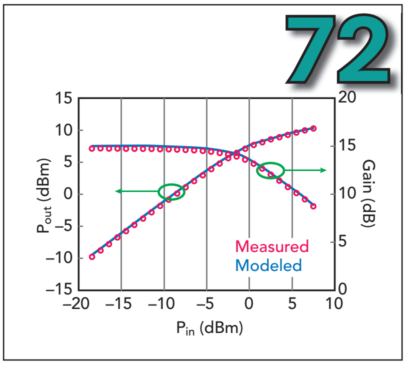


In Memoriam. Harvey Kaylie, Founder of Mini-Circuits



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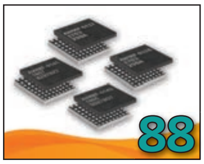

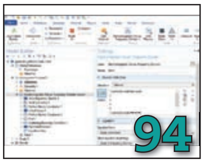

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Tech Briefs

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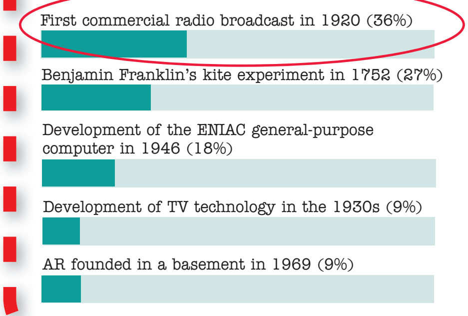
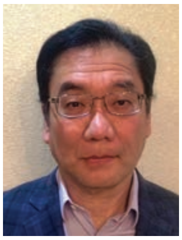
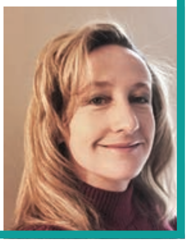


Executive Interviews

Hajime Yokota, president, and **Shigetoshi Yokota**, chief engineer, at **Exceed Microwave** discuss how their experience and passion for passive components created a line of filters, circulators, isolators and switches.



Debbie Nielson, **Tektronix** segment leader for the military and government market, discusses RF measurement trends and challenges in sensing, satellite communications, electronic warfare and the impact of new applications like the IoT.

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AUGUST

1

Call for Papers Deadline

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- Sensors and MEMS devices
- Package-device level interactions
- Electron device simulation and modeling
- Advanced characterization, reliability and noise
- Optoelectronics, displays and imaging systems

https://ieee-iedm.org

8-10

NEMO 2018

Reykjavik, Iceland

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https://nemo-ieee.org

13

Call for Papers Deadline

emv

EMV 2019 will provide a comprehensive overview of the latest trends and developments within electromagnetic compatibility (EMC). Topics for submission include: EMC regulations and liabilities, EMC products and specific phenomena, aspects and issues, EMC and biological effects, among others.

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www.congress2018.metamorphose-vi.org

15-17

RFIT

Melbourne, Australia

RFIT 2018 provides a forum for the integrated circuit and RF technology communities to meet and present the latest developments in integrated circuit design, technology and system integration, with emphasis on wireless communication systems and emerging applications, such as biology and healthcare, as well as emerging THz and 3D integration technologies. **http://rfit2018.org**

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August 1, 2018

EMV 2019
August 13, 2018

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September 14, 2018

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December 1, 2018

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ERI Summit 2018
July 23–25, 2018 • San Francisco, Calif.
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AUGUST

IEEE MTT-S NEMO 2018
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August 15–17, 2018 • Melbourne, Australia
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Metamaterials 2018
August 27–Sept. 1, 2018 • Espoo, Finland
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SEPTEMBER

PCB West 2018
September 11–13, 2018 • Santa Clara, Calif.
www.pcbwest.com/

MWC Americas 2018
September 12–14, 2018 • Los Angeles, Calif.
www.mwcamericas.com

IEEE AUTOTESTCON
September 17–20, 2018 • National Harbor, Md.
www.autotestcon.com

EuMW 2018
September 23–28, 2018 • Madrid, Spain
www.eumweek.com

OCTOBER

2018 IEEE BCICTS
October 14–17, 2018 • San Diego, Calif.
https://bcicts.org/

EDI CON USA 2018
October 17–18, 2018 • Santa Clara, Calif.
www.ediconusa.com

MILCOM 2018
October 29–31, 2018 • Los Angeles, Calif.
https://events.afcea.org/MILCOM18/Public/enter.aspx

ESC Minneapolis
October 31–Nov. 1, 2018 • Minneapolis, Minn.
www.escminn.com

NOVEMBER

AMTA 2018
November 4–9, 2018 • Williamsburg, Va.
https://amta2018.org/

Global MILSATCOM 2018
November 6–8, 2018 • London, U.K.
www.globalmilsatcom.com

APMC 2018
November 6–9, 2018 • Kyoto, Japan
https://apmc2018.org/

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November 13–16, 2018 • Munich, Germany
https://electronica.de/index.html

IEEE IMaRC 2018
November 28–30, 2018 • Kolkata, India
https://imarc-ieee.org

DECEMBER

IEDM 2018
December 1–5, 2018 • San Francisco, Calif.
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JANUARY 2019

CES 2019
January 8–11, 2019 • Las Vegas, Nev.
https://www.ces.tech/

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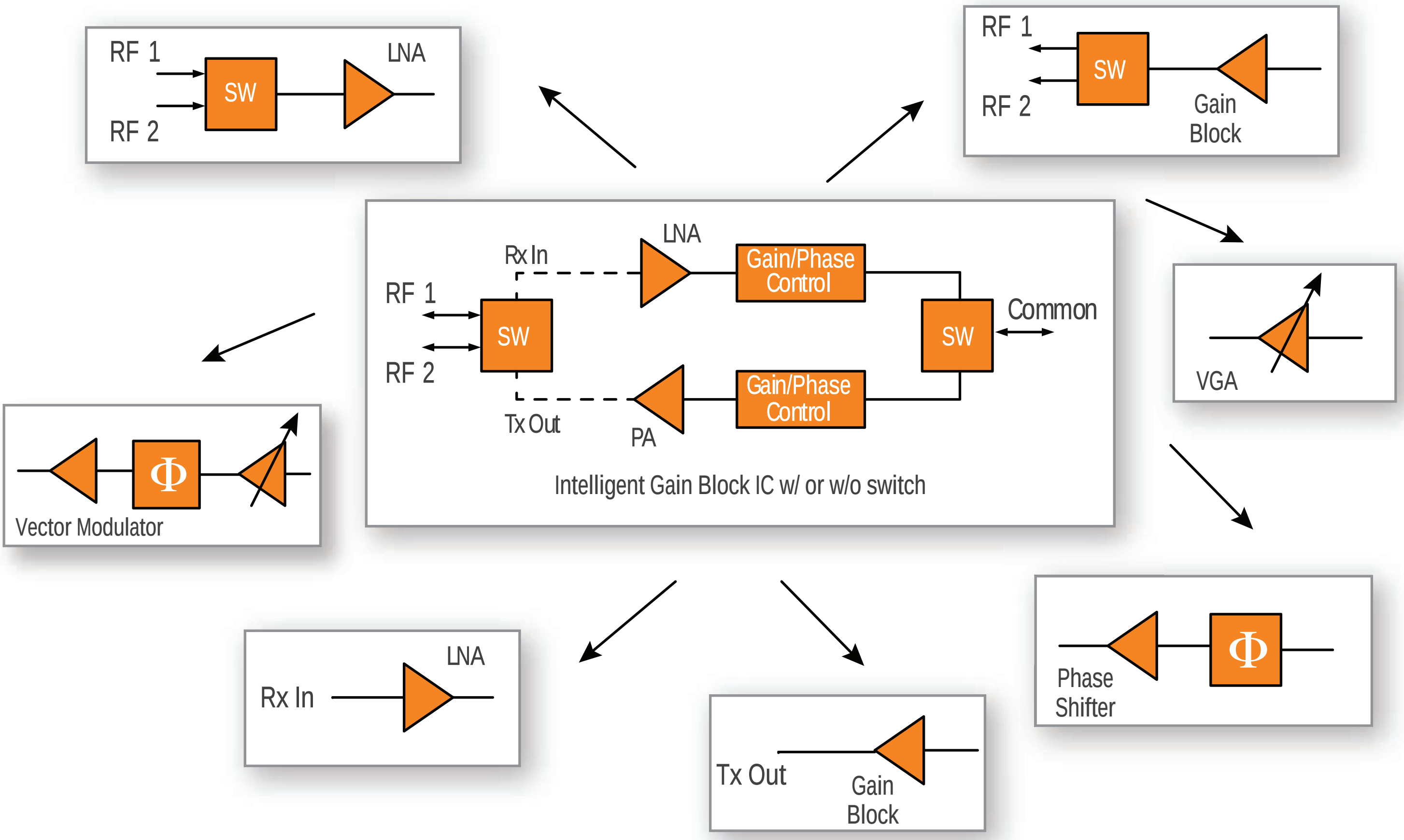

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Design Platforms Maximize Performance and Reduce Time-to-Market

Patrick Hindle
Microwave Journal *Editor*

Microwave Journal asked some of the leading EDA software companies to describe their respective holistic approaches that help design engineers optimize across multiple tools, to accomplish high performance, reliable designs quickly and efficiently. Here are some comprehensive platforms that can accomplish multiple design tasks in one interface or environment to rapidly get your designs to market.

Altair FEKO, Part of HyperWorks Platform

Altair, Troy, Mich.

Altair's vision is to transform design and decision making by applying simulation, machine learning and optimization throughout product lifecycles. This is achieved by a combination of simulation software within the HyperWorks platform of innovation, complemented by software related services and consultancy offerings. Engineers are able to accelerate next-generation mobility solutions to meet the challenges of e-mobility development. From smart control design to powertrain electrification and vehicle architecture studies, these solutions enable optimization throughout the development cycle.

Altair FEKO, a computational electromagnetic (EM) software aimed at telecommunications, automobile, aerospace and defense industries, is an integral part of HyperWorks suite. FEKO offers several frequency and time domain EM solvers under a single license. Hybridization of these methods enables the efficient analysis of a broad spectrum of EM problems, including antennas, microstrip circuits, RF components and biomedical systems, the placement of antennas on electrically large structures, the calculation of scattering and the investigation of electromagnetic compatibility (EMC). FEKO also offers tools that are tailored to solve more challenging EM interactions, including dedicated solvers for characteristic mode analysis and bi-directional cable coupling. Special formula-

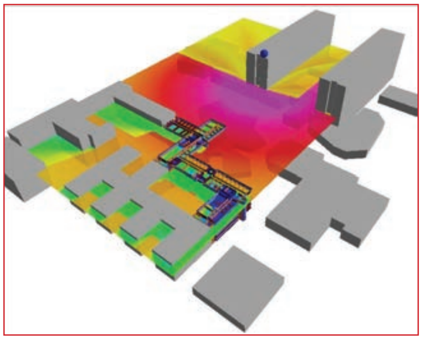
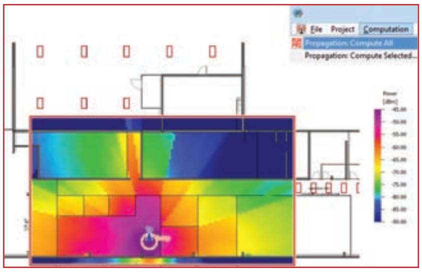


Fig. 1 Path loss prediction in hybrid urban/indoor scenario.


18 DOWNTOWN

tions are also included for efficient simulation of integrated windscreen antennas and antenna arrays. Combined with the multilevel fast multipole method and the true hybridization of the solvers, FEKO is considered a market leader for antenna placement analysis.

One of the most notable features of the recent 2018 release is the inclusion of WinProp with FEKO as part of the standard HyperWorks installation. WinProp is a dedicated tool for wave propagation modeling and radio network planning interfacing with FEKO. WinProp's accurate and fast empirical and deterministic propagation models are available for a wide range of scenarios: rural, urban, indoor, tunnel, vehicular (see ***Figure 1***). WinProp supports arbitrary transmitters including cellular and broadcasting sites, satellites, repeaters and leaky



▲ Fig. 2 **Full polarimetric analysis.**

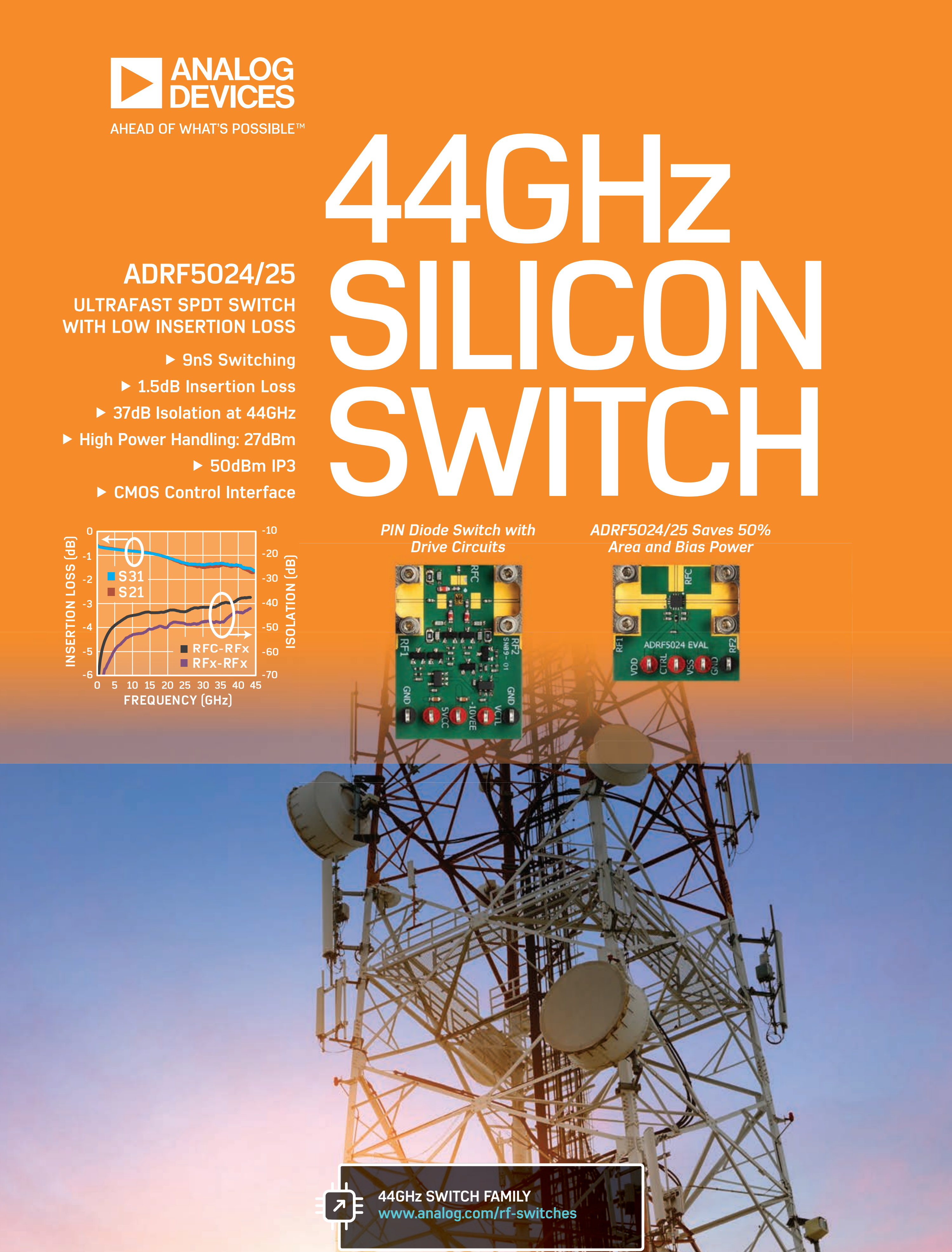
feeder cables. WinProp's propagation engines include empirical and semi-empirical models (calibration with measurements possible), 3D ray tracing models, as well as the unique dominant path model. Besides the prediction of the path loss, the delay and angular spread can be computed, as well as LOS/NLOS, directional channel impulse response, angular profile and propagation paths (see ***Figure 2***).

A few key differentiators of FEKO include:

- A broad and deep technology offering: pre- and post-processing, different solver technologies, multiphysics coupling, strong focus on optimization technology, HPC integrations.
- Units-based subscription licensing model: all the Altair software tools including many third-party products in the Altair Partner Alliance, available under a uniform licensing scheme.
- Unique blend of software and services: complementing the software offering through consultancy that also helps Altair to understand customer needs for future software development.

Some of the highlights in the FEKO 2018 release features:

- Characterized surfaces for the ray launching geometrical optics (RL-GO) solver greatly speeds up RL-GO analysis of complex multilayer structures (see ***Figure 3***).
- Cable modeling extensions, including defining a reference direction for a cable path, providing precise control over cable orientation, instead of letting the solver search for the closest ground to the cable path.
- Numerous meshing improvements, including automatic meshing, which now yield different meshes for models, where the mesh size is governed by the



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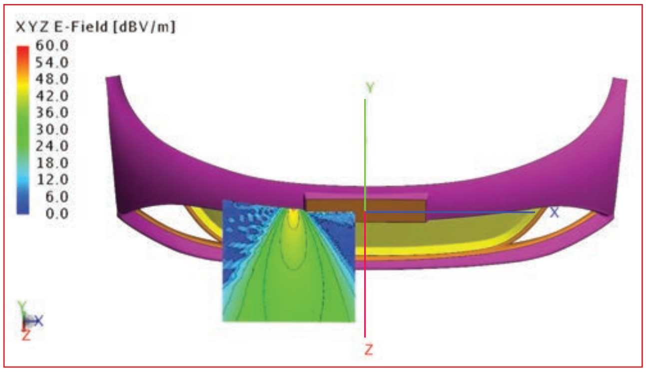

Fig. 3 **Adaptive Cruise Control (ACC) Radar System in a Bumper with Paint Layer.**

geometry curvature rather than EM properties like frequency.

- Support for characteristic mode analysis without mode tracking across frequency.

EM applications vary in complexity and electrical size, and no single numerical method can handle the entire range efficiently. By offering a selection of different solvers, FEKO users can choose the methods most suitable to the problems they are trying to solve, or use more than one solver for cross validation purposes. All solvers are included in FEKO as one package.

ANSYS Electronics Desktop Platform

ANSYS, Canonsburg, Pa.

The ANSYS Electronics Desktop is a design platform created for the electrical engineer. It is a single interface for engineers to access the ANSYS physics solvers (HFSS, HFSS SBR+, Maxwell, Icepak, Q3D Extractor, SIwave) and circuit/system simulators (Nexxim, Simplorer, EMIT) with direct import of ECAD/MCAD geometry. In addition, the desktop includes direct links to the full ANSYS portfolio of thermal and mechanical solvers for comprehensive multiphysics analysis. With ANSYS Electronics Desktop, designers can integrate rigorous EM, thermal and mechanical analysis with system and circuit simulation in a comprehensive, easy-to-use design platform.

ANSYS HFSS is built in the ANSYS Electronics Desktop. The traditional MCAD interface is used by engineers to create 3D models, such as antennas, connectors, enclosures, lead frame IC packages and waveguides. The ECAD interface is for layered design as found in PCBs, IC packages and RF laminates. A unique feature is the desktop's ability to mix MCAD with ECAD to create assemblies for wireless and electronic products with full 3D HFSS simulation accuracy. HFSS solvers, including the classic finite elements, integral equation, physical optics and shooting and bouncing rays (SBR), can be intermixed as multi-domain (hybrid) solutions to simulate from the electrically small to large in a single project (see ***Figure 4***).

The Electronics Desktop's Solver on Demand technology enables engineers to combine EM simulators with circuit- and system-level simulations to explore complete system performance. Users can insert high frequency and signal integrity analyses into projects that co-exist, with drag-and-drop dynamic links between EM and circuit simulations, for simple problem setup and reliable performance. Working within a single interface, rather than moving back and forth between several different programs, eliminates the need to export data from one program to another. For example, users can insert VRMs, S-parameter elements or IBIS-AMI models into a circuit simulation very easily (see ***Figure 5***).

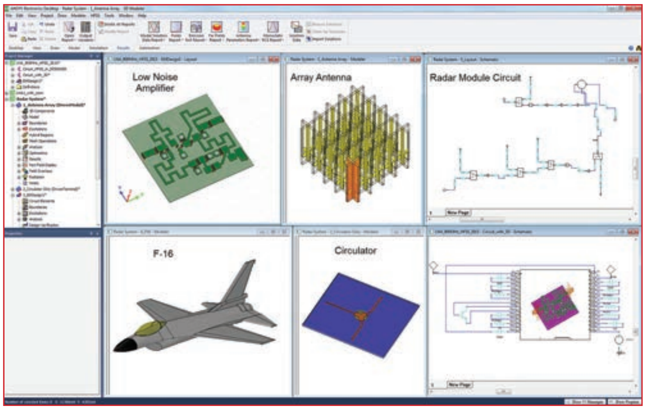

Fig. 4 **ANSYS Electronics Desktop is a powerful platform with the capability to combine multiple physics, circuits and systems into a single simulation such as the radar system depicted.**


Has Amplifier Performance or Delivery Stalled Your Program?
Noise Figure In Select Frequency Bands
Noise Figure (dB)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
4.5dB
4.0dB
2.8dB
2.8dB
2.5dB
1.8dB
1.5dB
1.3dB
1.2dB
1.2dB
0.9dB
0.7dB
0.7dB
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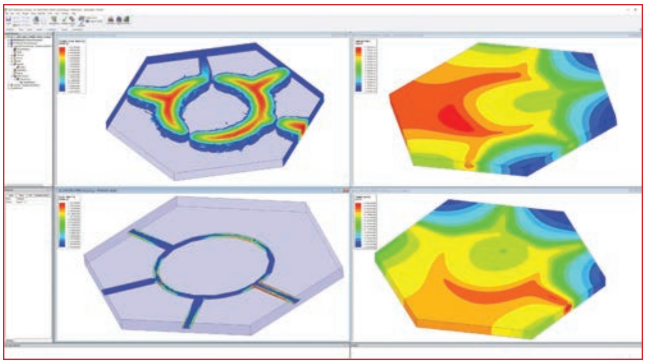


Fig. 5 ANSYS Electronics Desktop integrates ANSYS HFSS calculated loss data with ANSYS Icepak to produce a temperature profile of a ring hybrid coupler.

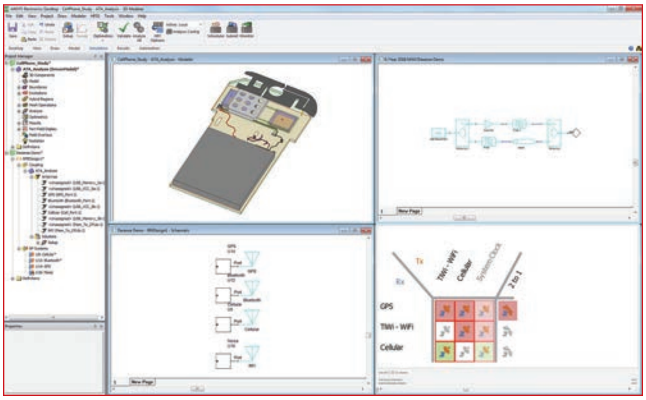
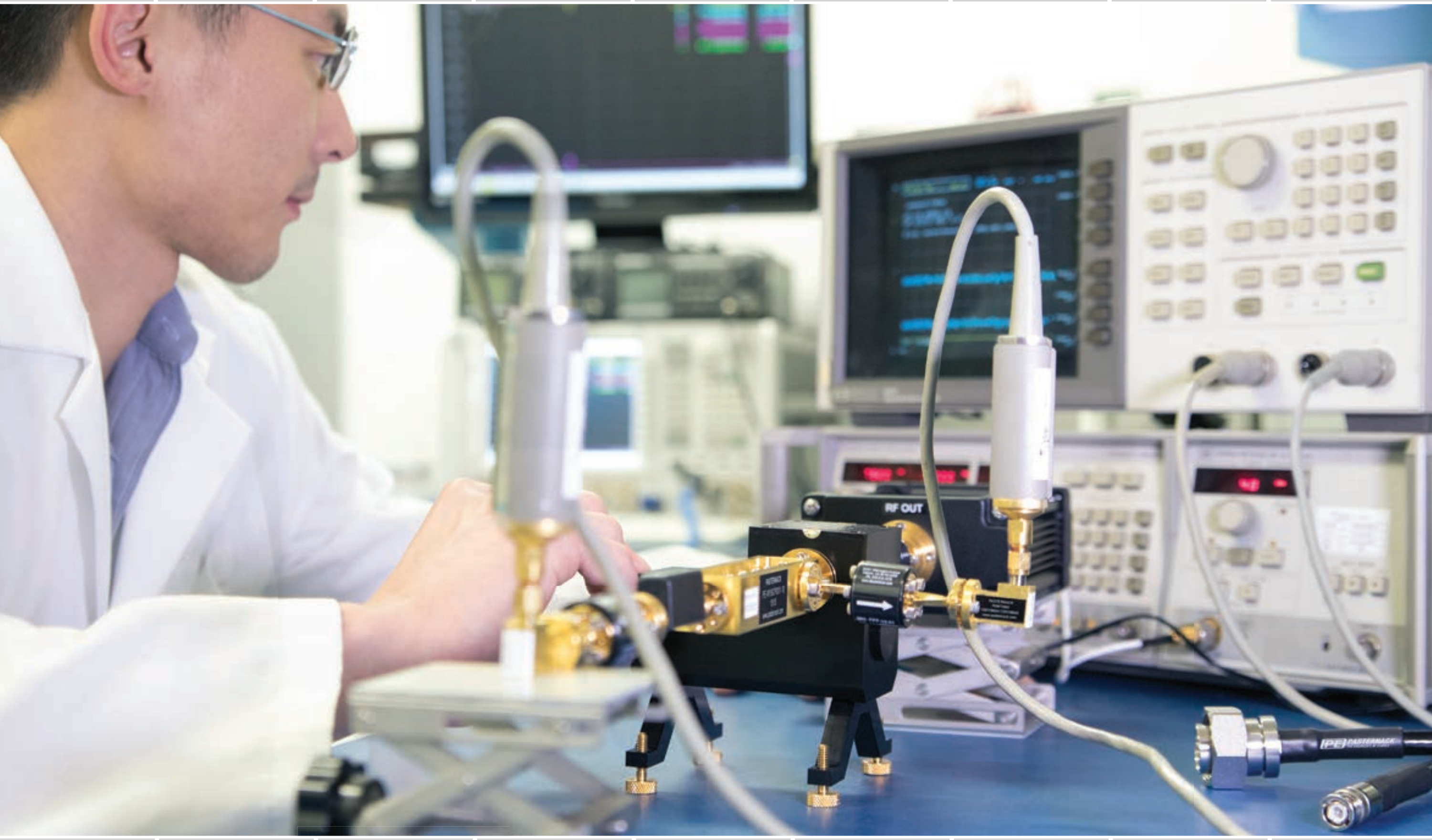


Fig. 6 ANSYS Electronics Desktop platform can predict RF interference and simulate radio de-sense in electronic devices.

In addition to its multi-domain and multi-technology design capability, the ANSYS Electronics Desktop includes capabilities such as 3D component library models with encryption, assembly modeling and radio frequency interference (RFI) systems modeling. As communication systems push the limits of component size, weight and performance, engineers must adopt new technologies and smarter workflows. The resulting component engineering and associated intellectual property become increasingly valuable to the component developer and end-user. The ability to share accurate 3D design data among engineering groups while protecting this IP is critical to developing next-generation complexity in a practical manner. The patented 3D EM component technology is a breakthrough in model sharing, allowing engineers to create encrypted, password-protected user models that provide all the information to successfully design RF and microwave systems.

Predicting RFI in complex environments has become an essential part of the design process. The ANSYS Electronics Desktop integrates ANSYS EMIT for modeling installed antenna-to-antenna coupling. The result is a complete solution to reliably predict the effects of RFI in multi-antenna environments with multiple transmitters and receivers. EMIT's powerful analysis engine computes all important RF interactions including nonlinear system component effects. These effects can produce high order intermodulation products that often lead to RFI. Diagnosing RFI in complex environments is notoriously difficult to perform in a testing environment, but with EMIT, the identification of the root-cause of any interference is rapidly accomplished via graphical signal trace-back and diagnostic summaries that show the exact origin and path that interfering signals take to each receiver (see ***Figure 6***).

The ANSYS Electronics Desktop fully integrates world-class physics solvers with circuit and system solvers, patented encrypted 3D component libraries for data sharing and RFI prediction capability into a common platform. Using this design platform, RF/microwave designers will be successful addressing the next level of wireless product complexity and system integration.



CST STUDIO SUITE Complete Multi-Domain and Multiphysics Solution

Dassault Systèmes, SIMULIA CST, Darmstadt, Germany

SIMULIA's CST STUDIO SUITE is a 3D design environment that enables access to EM and multiphysics simulation. Fully parametric models can be constructed in CST STUDIO SUITE or imported through the interface with leading CAD and EDA design tools. Entire EM systems can be designed from their constituent components using the CST System Assembly and Modeling (SAM) framework. Parameter sweeps allow different design configurations to be analyzed in a single simulation flow, while the built-in automatic optimizers can be used to tune and improve the performance of devices.

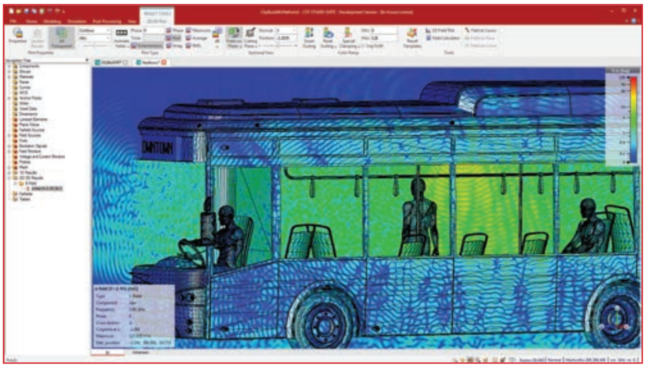


Fig. 7 Simulated electric fields of an antenna placed on a bus in the CST STUDIO SUITE interface.

With Filter Designer 3D, CST STUDIO SUITE features a dedicated design flow, allowing even extremely complex filters to be tuned, with multiple passbands and transmission zeroes, if required. CST's fast resonant solver and innovative moving mesh method offer smooth convergence, allowing even very sensitive filters to be optimized efficiently. These approaches can save both time and money compared to traditional physical testing, by reducing the number of prototypes required to achieve a design that meets the requirements.

Multiphysics simulation can be important for high-power devices, where excess heat due to EM losses in materials can cause damage and expansion and deformation that detune sensitive components such as filters and resonators. To allow these effects to be simulated and mitigated from the earliest stages of the design process, CST STUDIO SUITE offers integrated thermal and structural mechanical solvers capable of simulating temperature distribution, heat flow, cooling, biological heat effects and thermal expansion.

Once the individual components have been designed, the work of the system integrator begins. For a complex product such as a car, multiple components can be imported from different tools—the car body from one source, the cable harness network from another, the circuit boards from yet another and the communication

and radar antennas from the CST antenna tool Antenna Magus—and assembled into a simulation project using SAM.

Antennas and other parts need to be placed in the system in such a way that they work as intended, in what is often a challenging and crowded environment. The metal body of a car or aircraft will affect the radiation pattern of antennas placed on its surface, while the human body can absorb or reflect energy from handheld and wearable devices. CST STUDIO SUITE includes several methods suited to simulating antennas on electrically large platforms, which can be used to calculate the performance of individual antennas and the coupling between multiple antennas (see ***Figure 7***).

EMC and EM interference (EMI) are significant concerns in product design. If not caught as early as possible, installed performance and interference problems can significantly delay the development of a product or require costly and reputational damaging recalls. With the new CST Interference Task, potential interference problems can be identified at the design stage, helping ensure compliance with legal regulations and reducing the risk of unexpected issues emerging during testing.

For devices used near the body, there are also legally-mandated limits on the exposure to RF fields, measured as specific absorption rate (SAR). These, too, can be simulated with CST STUDIO SUITE to check design compliance with regulations.

By integrating all these features into one user interface, CST STUDIO SUITE helps engineers optimize their designs quickly and efficiently and avoid problems that can add to the development time and cost of a project. With CST STUDIO SUITE 2018, CST, now part of the SIMULIA brand of Dassault Systèmes, is integrating its software with the 3DEXPERIENCE platform, which connects CAD, PLM, collaboration and other leading edge simulation software, to provide a complete multi-domain and multiphysics solution.

Keysight PathWave Design—More Creativity, Less Busywork

Keysight Technologies, Santa Rosa, Calif.

Board designs are becoming increasingly complex, with increased substrate layer counts, smaller form factors and limited design space. Additionally, once a design is complete, the designers still need to handle all the logistics, handoffs and liability, making it difficult to spend enough time actually designing and creating new products. To avoid frustration and spend more time innovating, engineers need a way to streamline their workflows.

Keysight's design platform enables designers to focus on their favorite part of the job: the creative design process. Keysight PathWave Design is a new design environment that gives engineers the space for creativity, data displays for validation and common data formats to share ideas with colleagues. It provides integrated system, circuit and EM simulators, plus optimizers and layout capabilities that seamlessly integrate to save time and frustration in investigating various aspects of the design (see ***Figure 8***).

Keysight PathWave Design is built on Keysight Advanced Design System (ADS) and other software offered by Keysight EEsof EDA, including EMPro for EM analysis, SIPro for signal integrity analysis and PIPro for power integrity analysis. A benefit of designing with Keysight is the measurement expertise, depth of understanding the standard specifications and breadth of component libraries. The industry-compliant wireless libraries enable verifications of designs to all the latest wireless standards: 5G, LTE-A, 802.11ac, PCI Express, USB 3—and whatever standards the future brings will be added.

A design engineer's work is not done once the design is complete. The handoff to the design verification test team is not just a simple handshake. Years ago, designs were less complex and specifications less stringent and a simple linear product development lifecycle pipeline worked. But today, the product development lifecycle has been transformed into a matrix of complex relationships between the design, verification and test teams. This is where the power of the Keysight PathWave Platform shines: it not only contains a design environment, but a test environment with common data formats, a consistent user experience and similar control interfaces. It is this integration that bridges the design and test engineers' worlds, allowing them to speak the same language and interact in a completely new way (see ***Figure 9***).

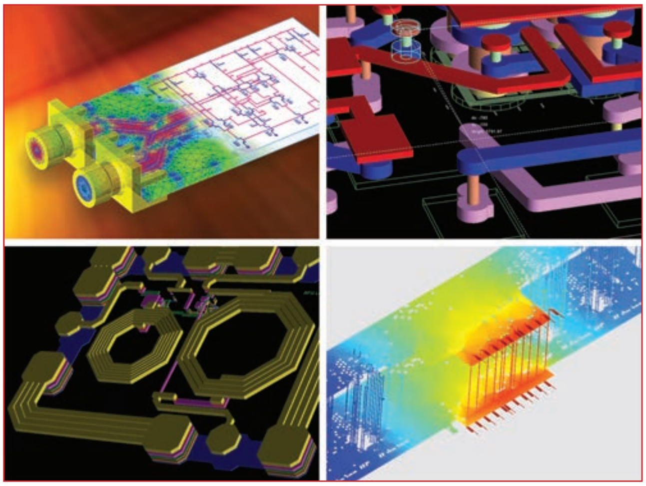


Fig. 8 Keysight PathWave Design offers a variety of libraries, simulators, optimizers, layout views and data displays so design engineers can focus on creating and designing.

Fig. 9 PathWave Design and PathWave Test eliminate silos between design, verification and test teams, allowing engineers to share data between multiple software programs as shown here for 5G NR signals.

PathWave Test is a test automation environment that optimizes test plans and operates with third-party hardware to provide seamless data transfer and analytics to the design environment and to the manufacturing teams. This makes it much easier for the test teams to go back to the design engineers and let them know of possible problems. This reduces time spent and eases communication in design iterations and troubleshooting, for both design and test engineers.

Both the PathWave Design environment and PathWave Test environment live inside the PathWave Platform, a systems engineering platform that eliminates silos between design, test and manufacturing teams, providing data and immediate insights to accelerate the product development lifecycle. In the future, PathWave will be what a student thinks of when visualizing a design becoming reality.

National Instruments AWR Design Environment Platform

NI AWR Group, El Segundo, Calif.

The NI AWR Design Environment platform was conceived and developed with RF designers in mind, empowering the individual engineer and engineering teams to address all phases of the design process (exploration, simulation, optimization and verification) prior to manufacturing, while also providing a smooth transition to fabrication and test, with minimal design rework.

Microwave Office circuit design software was introduced 20 years ago at IMS1998 in Baltimore, with a Windows-based user interface and a real-time tuning bar (see ***Figure 10***) that caught the attention of many attendees, putting AWR and its product on the map. From its inception, the overall framework of the software was architected to readily support third-party tools and technologies, to supplement product functionality and offer designers power of choice, as well as maximum flexibility and productivity.

The NI AWR software platform has expanded to offer more innovations such as AXIEM and Analyst™ native EM solvers, Visual System Simulator™ system simulation software and AntSyn™ antenna synthesis technology, as well as wizard-based features and third-party add-ons that further enhance RF designers' productivity.

The NI AWR Design Environment user interface is a Windows-based, PC-only platform that has always leveraged application programming interfaces (API) and object-oriented programming with a unique underlying unified data model architecture that links electrical and physical design in a revolutionary way. A change to one is instantly a change to the other and vice-versa, eliminating the manual manipulation required with alternative tools.

The environment's framework is further constructed as a socket for ready plug-and-play of tools and technologies that can be native or from third-party partners. For in-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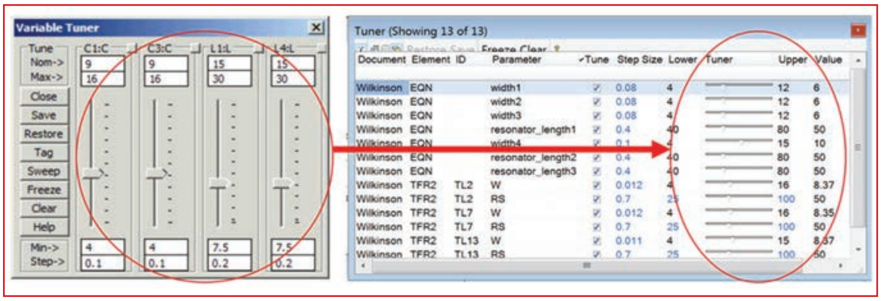

Fig. 10 **Parametric tuning introduced in Microwave Office software in 1998 has evolved to support large-scale tuning of complex structures.**

stance, the EM Socket™ interface within the NI AWR Design Environment platform integrates AXIEM 3D planar and Analyst 3D EM solvers, as well as those from other EM vendors such as Sonnet, SIMULIA CST and ANSYS. Numerous other wizards and add-on modules, whether developed in house or by partner firms, will "socket" into the NI AWR software framework to further enhance engineering productivity.

The high frequency circuit, system and EM capabilities of NI AWR Design Environment software address the key design steps of RF/microwave product development, from characterization and simulation to exploration, optimization, compliance and verification, always mindful of the software team's mantra to "accelerate customer design success."

One of the next fronts of innovation for the platform is accelerating design starts and exploration via synthesis technologies and techniques. A new network synthesis capability for creating optimized two-port matching networks with discrete and distributed components, based on user-defined performance goals, is being introduced this year (see ***Figure 11***). The proprietary synthesis algorithm searches for the best circuit typologies and optimizes the component parameter values. This feature joins existing synthesis tools within the NI AWR portfolio that include products such as iFilter™ filter synthesis and AntSyn automated antenna design, synthesis and optimization.

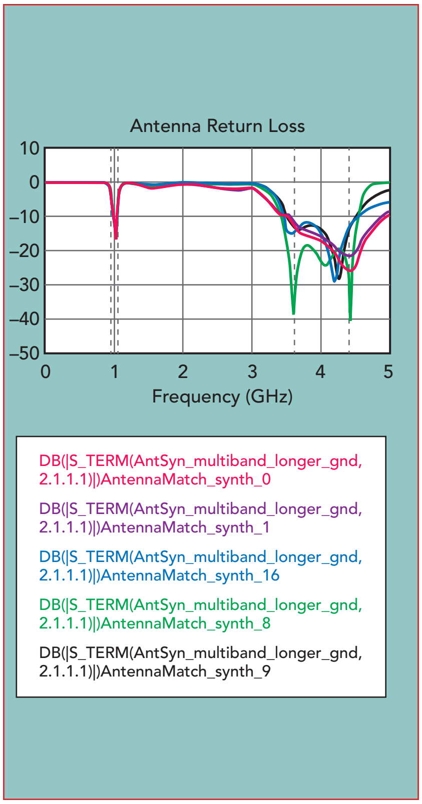

Fig. 11 **Network synthesis addresses multi-band matching challenges.**

The new-to-market synthesis tool will assist RF design engineers in developing new products directly from performance specifications, greatly accelerating the earliest phases of the design process. The first release of this new module, available as an add-on to the V14 release, will be particularly helpful for challenging broadband single- and multi-stage amplifiers and antenna/amplifier matching networks.■

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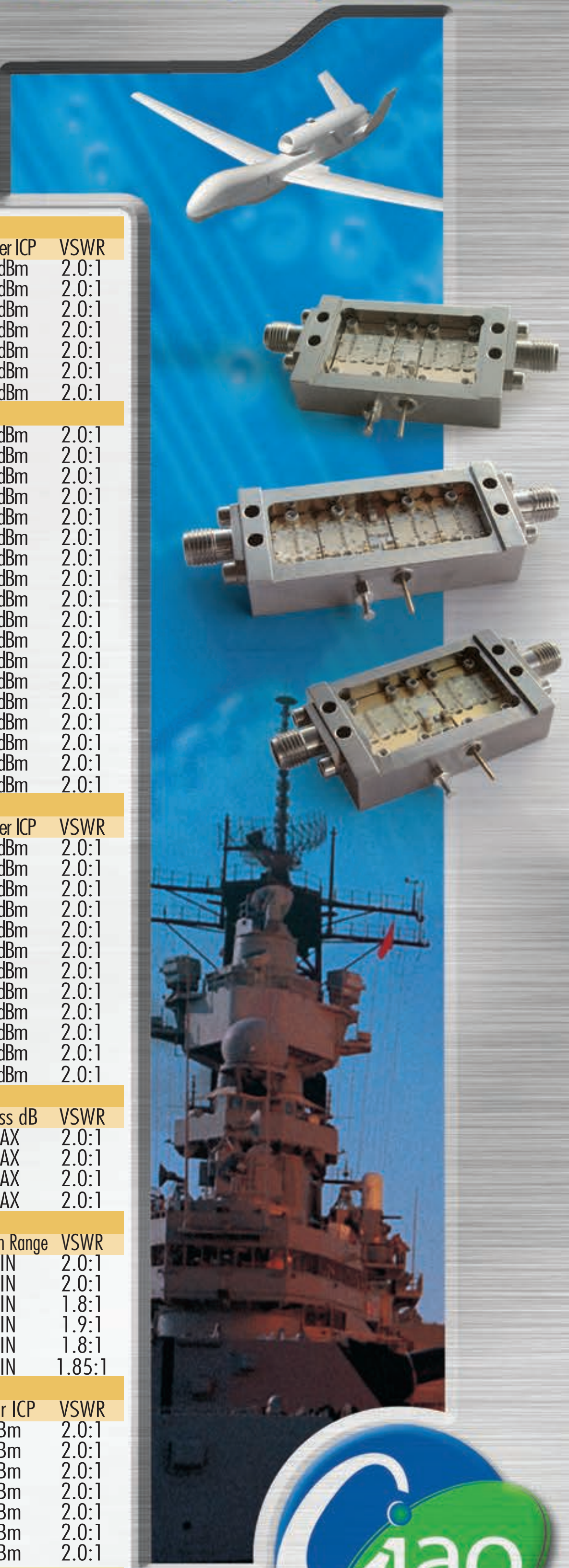

OCTAVE BAND LOW NOISE AMPLIFIERS

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

NARROW BAND LOW NOISE AND MEDIUM POWER AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA01-2111	0.4 - 0.5	28	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA01-2113	0.8 - 1.0	28	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA12-3117	1.2 - 1.6	25	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA23-3111	2.2 - 2.4	30	0.6 MAX, 0.45 TYP	+10 MIN	+20 dBm	2.0:1
CA23-3116	2.7 - 2.9	29	0.7 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA34-2110	3.7 - 4.2	28	1.0 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA56-3110	5.4 - 5.9	40	1.0 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA78-4110	7.25 - 7.75	32	1.2 MAX, 1.0 TYP	+10 MIN	+20 dBm	2.0:1
CA910-3110	9.0 - 10.6	25	1.4 MAX, 1.2 TYP	+10 MIN	+20 dBm	2.0:1
CA1315-3110	13.75 - 15.4	25	1.6 MAX, 1.4 TYP	+10 MIN	+20 dBm	2.0:1
CA12-3114	1.35 - 1.85	30	4.0 MAX, 3.0 TYP	+33 MIN	+41 dBm	2.0:1
CA34-6116	3.1 - 3.5	40	4.5 MAX, 3.5 TYP	+35 MIN	+43 dBm	2.0:1
CA56-5114	5.9 - 6.4	30	5.0 MAX, 4.0 TYP	+30 MIN	+40 dBm	2.0:1
CA812-6115	8.0 - 12.0	30	4.5 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA812-6116	8.0 - 12.0	30	5.0 MAX, 4.0 TYP	+33 MIN	+41 dBm	2.0:1
CA1213-7110	12.2 - 13.25	28	6.0 MAX, 5.5 TYP	+33 MIN	+42 dBm	2.0:1
CA1415-7110	14.0 - 15.0	30	5.0 MAX, 4.0 TYP	+30 MIN	+40 dBm	2.0:1
CA1722-4110	17.0 - 22.0	25	3.5 MAX, 2.8 TYP	+21 MIN	+31 dBm	2.0:1

ULTRA-BROADBAND & MULTI-OCTAVE BAND AMPLIFIERS

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

LIMITING AMPLIFIERS

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

AMPLIFIERS WITH INTEGRATED GAIN ATTENUATION

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

LOW FREQUENCY AMPLIFIERS

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

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US Navy Selects Naval Strike Missile as New, Over-the-Horizon Weapon

The U.S. Navy has selected the Naval Strike Missile (NSM), offered by Raytheon Co. and Kongsberg Gruppen, to meet its over-the-horizon requirement for littoral combat ships and future frigates. The NSM will advance the U.S. Navy's vision of distributed lethality, ensuring sea control and freedom of the seas. Raytheon will manufacture and deliver over-the-horizon weapon systems under a $14.8 million contract for offensive missiles loaded into launching mechanisms and a single fire control suite. The contract includes options which, if exercised, would bring the cumulative value to $847.6 million.

NSM is a long-range precision missile that strikes heavily defended land and sea targets. The missile, which can defeat enemy defenses up to 100 nautical miles away, uses advanced seeker and target identification technology.

Naval Strike Missile (Source: Raytheon Co.)

"Raytheon and Kongsberg are providing the Navy with a proven, off-the-shelf solution that exceeds requirements for the over-the-horizon mission," said Dr. Taylor W. Lawrence, president of Raytheon Missile Systems. "Because it is operational now, NSM saves the U.S. billions of dollars in development costs and creates new high-tech jobs in this country."

Raytheon will manufacture NSM launchers, missiles and components in the U.S. The company has begun launcher production at its factory in Louisville, Ky. and will perform missile final assembly and test at its Tucson, Ariz. facility. The contract will generate business for more than two dozen U.S. suppliers. The missile program is the latest product of a longtime partnership with trusted ally Norway and its defense leader Kongsberg.

LM's Long-Range Anti-Ship Missile Scores Again in USAF B-1B Flight

Lockheed Martin (LM) successfully fired two production representative Long-Range Anti-Ship Missiles (LRASM) from a U.S. Air Force B-1B. In the event over the Sea Range at Point Mugu, Calif., a U.S. Air Force B-1B from Dyess Air Force Base, Texas, released the pair of LRASMs. The missiles navigated through all planned waypoints, transitioned to mid-course guidance and flew toward the moving maritime target using inputs from the onboard sensors. The missiles then positively identified the intended target and impacted successfully.

"The success of this second dual-LRASM test event speaks volumes," said David Helsel, LRASM program director at Lockheed Martin Missiles and Fire Control. "As LRASM moves toward early operational fielding for the U.S. Air Force and U.S. Navy, the weapon system continues to demonstrate critical capabilities that our warfighters need."

LRASM is designed to detect and destroy specific targets within groups of ships by employing advanced technologies that reduce dependence on intelligence, surveillance and reconnaissance platforms, network links and GPS navigation in contested environments. LRASM will play a significant role in ensuring military access to operate in open ocean/blue waters, owing to its enhanced ability to discriminate and conduct tactical engagements from extended ranges.

LRASM is a precision-guided, anti-ship standoff missile based on the successful Joint Air-to-Surface Standoff Missile–Extended Range. It is designed to meet the needs of U.S. Navy and U.S. Air Force warfighters in contested environments. The air-launched variant provides an early operational capability for the U.S. Navy's offensive anti-surface warfare Increment I requirement to be integrated onboard the U.S. Air Force's B-1B in 2018 and on the U.S. Navy's F/A-18E/F Super Hornet in 2019.

LRASM (Source: Lockheed Martin)

Raytheon Awarded $136M for US Navy Air and Missile Defense Radar Production

Raytheon Co. has been awarded a $136 million production contract for AN/SPY-6(V)1 Air and Missile Defense Radar (AMDR), the U.S. Navy's next generation integrated air and missile defense radar. The award is an option exercised under the current low rate initial production contract and funds the fourth ship set of radar mission equipment.

For More Information Visit mwjournal.com for more defense news.

Since its inception in January 2014, the AMDR program has met 20 of 20 milestones, ahead of or on schedule. The radar has achieved a series of successes during the U.S. Navy's AN/SPY-6(V)1 testing program, and remains on schedule for delivery to the Navy's first modernized DDG 51 Flight III, the future USS Jack H Lucas (DDG 125), in 2019.

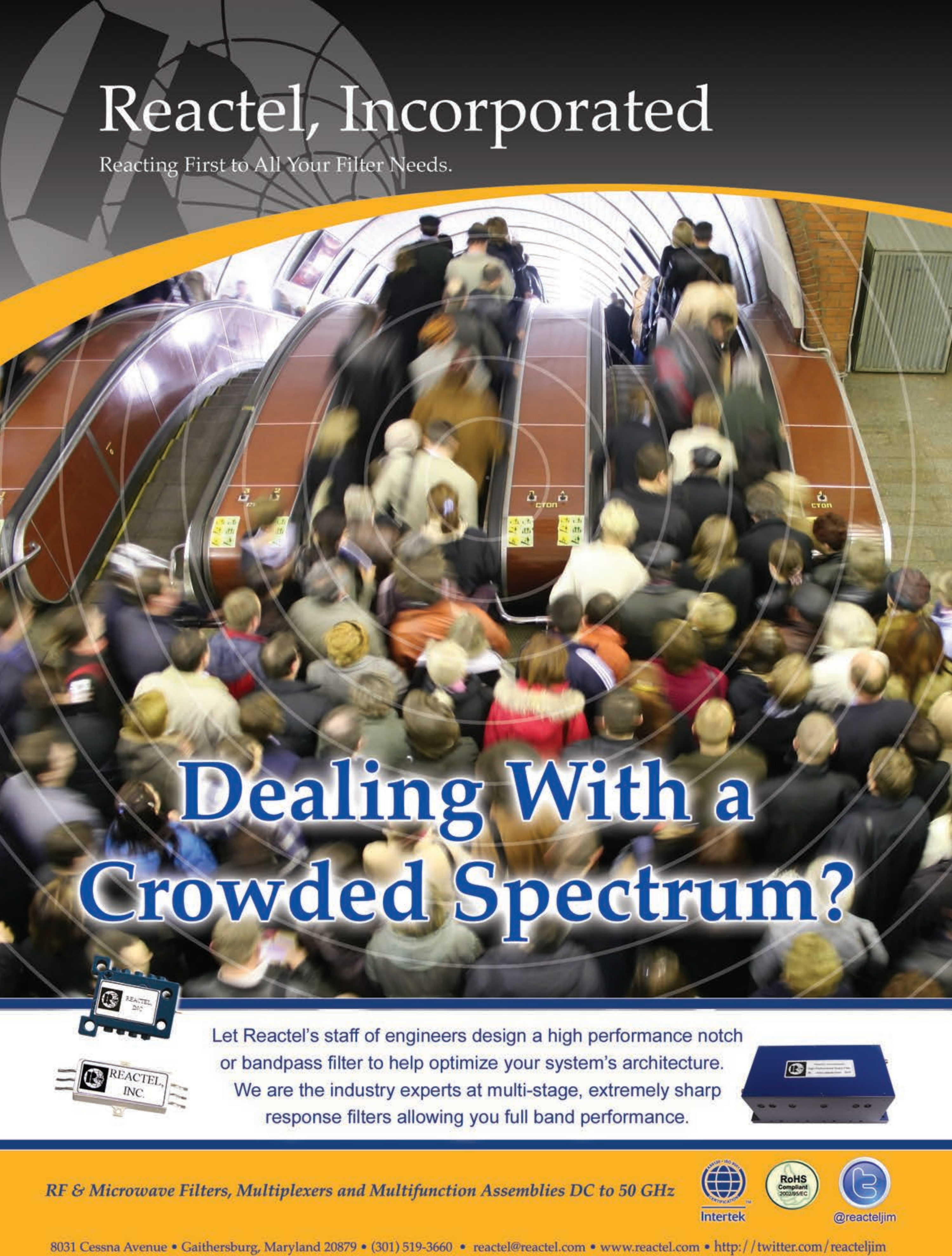
"AN/SPY-6(V)1 milestones and test successes continue to build, proving the maturity of its design and its exceptional capabilities," said U.S. Navy Captain Seiko Okano, Major Program Manager for Above Water Sensors, Program Executive Office Integrated Warfare Systems. "Now in production, we are closer to delivering the nation's most advanced integrated AMDR—the new cornerstone capability of the surface fleet."

Throughout testing at the Pacific Missile Range Facility, Kauai, Hawaii, AN/SPY-6(V)1 has proven its multi-mission capability to extend the battlespace and safeguard the fleet from multiple, simultaneous threats. The radar has demonstrated its performance against an array of single and multiple targets of increasing complexity in dedicated flights tests as well as ballistic missile, satellites and aircraft targets of opportunity.

AN/SPY-6(V)1 provides greater range, increased accuracy, greater resistance to environmental and man-made electronic clutter, higher reliability and sustainability than currently deployed radars. The radar's demonstrated sensitivity provides greater coverage for early and accurate detection which optimizes the effectiveness of the Navy's most advanced weapons, including all variants of Standard Missile-3 and Standard Missile-6.

> "The nation's most advanced integrated air and missile defense radar..."

The inherent scalability of the radar—based on 2 ft x 2 ft x 2 ft Radar Modular Assemblies, individual radar "building blocks"—allows for new instantiations without significant new radar development costs. Scaled variants of AN/SPY-6(V) already designated as U.S. Navy programs of record, include the back-fit radar for existing DDG 51 Flight IIA destroyers, the new and back-fit radars for aircraft carriers and amphibious ships, as well as the radar for the new guided-missile frigate, FFG(X).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The 2018 Defence, Security & Space Forum

At European Microwave Week

EuMA | Microwave Journal

Wednesday, 26 September – IFEMA Feria de Madrid, Spain – Room N101-N102, 08:30 to 18:30

A one-day focused Forum addressing the integration of unmanned aerial vehicles (UAV) into defence and security scenarios.

Programme:

08:30 – 10:10 EuRAD Opening Session

10:10 – 10:50 Coffee Break

10:50 – 12:30 New Concepts, Technologies and Systems for UAV Integration and Their Role in Future Hybrid Scenarios.

Technological Demonstrator of Enhanced Situation Awareness in Naval Environment with the use of Unmanned Systems
Dr. Tony Arecchi, Ocean 2020 Project Coordinator, Leonardo S.p.A. Italy.

- *UAV Integration into European Airspace: The U-Space Vision* – **Single European Sky ATM Research (SESAR) Project.**
- *Anti-UAV Defence Systems* – **Miguel Acitores, Director of Security Business Development, Indra. Spain.**

12:40 - 13:40 Strategy Analytics Lunch & Learn Session

The Implications of Expanding the UAS Mission Envelope in Military and Civilian Airspace
Asif Anwar, Strategy Analytics, UK

13:50 – 15:30 *Microwave Journal* Industry Panel Session

This session offers a perspective on the endeavour, innovation and investment that industry is committing to the development of Unmanned Aerial Vehicles in the defence and security sector. Speakers will offer an insight into such areas of activity as microwave sensors/sub-systems, the test and measurement challenges that are being addressed and the issue of UAV identification and detection.

15:30 - 16:10 Coffee Break

16:10 - 17:50 Round Table: Efforts & Investment Needs to Drive UAV Technologies to Market

High level speakers from key governmental agencies and commercial companies involved in the integration of UAV air traffic into non-segregated air spaces in the future will offer their opinions and outline the opportunities and challenges that can be expected in coming years. Speakers will also focus on the research needs and technological trends that will define the structure and technical characteristics of future unmanned systems.

17:50 - 18:30 Cocktail Reception

Registration and Programme Updates

Registration fee is €20 for those who registered for a conference and €60 for those not registered for a conference.

As information is formalized, the Conference Special Events section of the EuMW website will be updated on a regular basis.

Register online at www.eumweek.com

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EC Launches Phase 3 of 5G PPP

The European 5G Infrastructure Public Private Partnership (5G PPP) is launching the third phase of its 5G initiative, announcing three new projects at the recent 2018 European Conference on Networks and Communications (EuCNC). Selected from 16 submissions, the three projects are to begin on 1 July and run for three years, funded by more than €50 million from the European Commission (EC) and several times that amount from industry. Collectively, the three projects will support the development and rollout of a 5G platform across Europe. Phase 3 follows phase 1, which sponsored fundamental research of 5G technologies, and phase 2, which applied the research to help develop vertical applications within European industry.

The 5G PPP, which is part of the European Commission's Horizon 2020 Programme, funds research aimed at developing European leadership in 5G, research supported with an investment of more than €4.2 billion—€3.5 billion from private sources and up to €700 million in public funding.

The three phase 3 projects that were announced at the 2018 EuCNC are:

- **5G EVE**, which will "create the foundations for a pervasive roll-out of end-to-end 5G networks in Europe." The project aims to help validate network performance and the services offered by vertical industries and all phase 3 project facilities.
- **5G-VINNI**, intended to accelerate 5G adoption in Europe by providing an end-to-end facility to validate 5G performance and conduct trials of vertical services.
- **5GENESIS** will help integrate the diverse technology developments and results across companies, the EU and worldwide to better realize the potential of a "full-stack, end-to-end 5G platform."

Commenting on the initial three awards, Bernard Barani, who serves as the deputy head of network technologies at the EC, said phase 3 "will allow the PPP to put in place three large-scale structuring projects that will make available a pan-European, large-scale, 5G test platform for a multiplicity of vertical use cases, in support of the EU 5G vision and of the deployment objectives outlined in the 5G action plan. We expect this platform to be largely used to build the 5G case with vertical industries, and we very much encourage a multiplicity of industrial sectors to use it for validating 5G technology in the context of their specific use case and business model."

More information about the 5G PPP initiative's projects, accomplishments and plans is available in "The European 5G Annual Journal, 2018," available online.

China's Mobile Phone Subscribers Nearing 1.5B

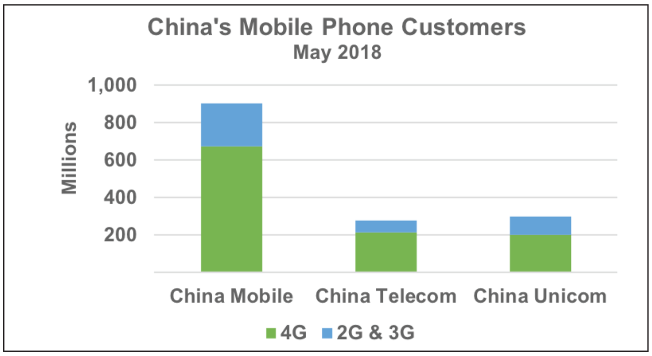
Total subscribers for China's three mobile phone operators grew by over 10 million in May to 1.48 billion, according to company reports. Seventy-three percent of the subscribers are using 4G, as users convert from 2G and 3G to the higher data rates available with LTE. The number of subscribers is larger than the number of people, as some people have more than one account.

With more than 900 million subscribers, China Mobile has 61 percent overall market share, more than 3× its two rivals. China Unicom and China Telecom are nearly tied at 20 and 19 percent share, respectively.

Following the 3GPP's adoption of Release 15, containing the 5G standalone (SA) specification, China's Ministry for Industry and Information Technology (MIIT) said it will establish policies to accelerate the commercialization of 5G. Chen Zhaoxiong, the vice minister of industry and information technology, said, "We will unveil a radio frequency spectrum map and grant licenses to telecom carriers in time, so as to meet the demand for 5G network construction and increasing efforts to widen applications," quotes in a report in China Daily.

Wang Zhiqin, head of the IMT2020 (5G) promotion group, which was established by the MIIT to accelerate 5G development in China, was quoted by China Daily, saying, "5G devices will be mature for commercial applications in China in 2019. We will be among the first batch of nations to issue 5G licenses in the world, most likely between the second half of 2019 and the first half of 2020."

With the 5G SA specification now approved, Wang's estimate of at least a year before 5G licenses are issued seems like a long time, particularly for fast-moving China. China Mobile has begun 5G trials in five cities, projecting the number of cell sites will be more than 100 in each city by July and 300 by October. To evaluate interoperability, the trials are using equipment from all four network equipment manufacturers: Ericsson, Huawei, Nokia and ZTE. Separately, Huawei said it completed China's third phase of 5G R&D testing, based on the 3GPP's earlier non-standalone (NSA) specification, which was approved in December 2017.



For More Information

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France, Germany to Develop Fighter Aircraft

France and Germany have signed a letter of intent to develop a new fighter, called the Future Combat Air System (FCAS), intended to replace the Rafale and Eurofighter by 2040. The agreement states that France will be the leading nation for the development, which will begin with a study phase kicked off by the end of this year. The study will define the operational performance of the new aircraft, with development initiated by 2025.

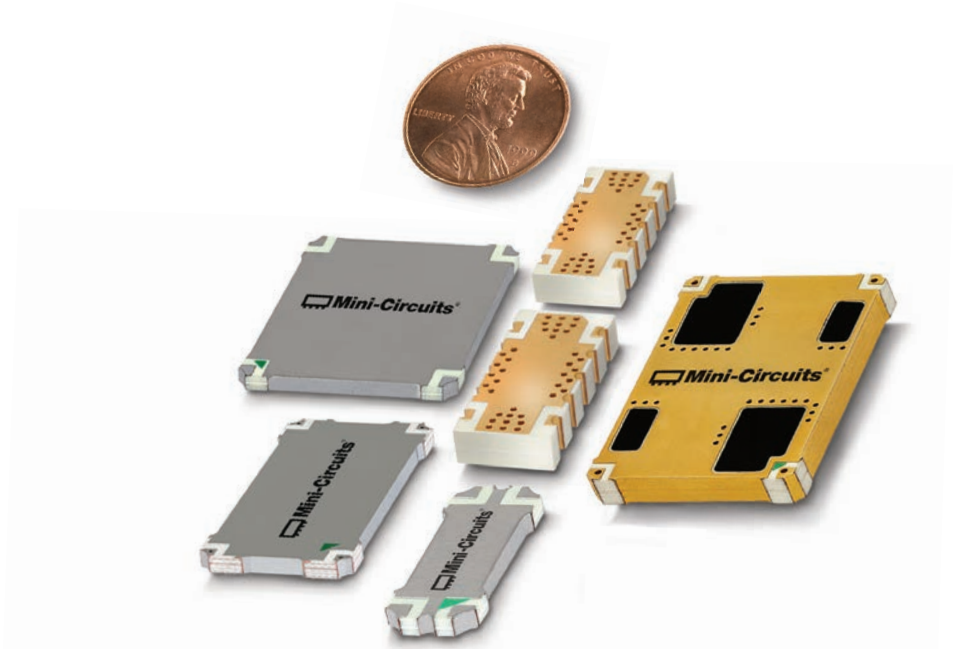
The French Defence Ministry released a statement saying the FCAS will be "a new multi-purpose combat aircraft, adapted to contemporary air threats and exploiting the potential of artificial intelligence, network-based combat capabilities, including drones of various types." The FCAS is envisioned to be a "system of systems" that will include unmanned aerial vehicles, secure communications and connectivity among all elements of the system.

Even before the letter of intent was signed, Airbus and Dassault Aviation announced the two companies will work together to develop and produce the aircraft. Dirk Hoke, CEO of Airbus Defence and Space, said, "Never before has Europe been more determined to safeguard and foster its political and industrial autonomy and sovereignty in the defence sector."

Source: Airbus

Eric Trappier, chairman and CEO of Dassault Aviation, said, "Our joint roadmap will include proposals to develop demonstrators for the FCAS programme as of 2025. I am convinced that European sovereignty and strategic autonomy can and will only be ensured through independent European solutions."

Europe developing the FCAS challenges the notion that the U.S. F-35 will replace the Eurofighter, an idea favored by Lt. Gen. Karl Müllner, the former chief of the Luftwaffe. In an article in Defense One, Ulrich Kühn, a German political scientist and senior research associate at the Vienna Center for Disarmament and Non-Proliferation, said adopting the F-35 would "eliminate the need for a next-gen European fighter and possibly cripple Europe's capacity to develop such a system for years to come." With the strained relationship between Europe and the U.S. following the election of Donald Trump, it is logical that Europe feels compelled to preserve its autonomy and capability to develop and manufacture strategic tactical aircraft.



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Sky's the Limit for the sUAS Industry

In its most wide-reaching and comprehensive market analysis of the small Unmanned Aerial Systems (sUAS) market to date, ABI Research finds that from 2017 to 2027, the number of yearly shipments of drones will increase from 13 to over 23 million, and collective revenues from platforms, accessories and services will increase from $6 billion in 2017 to just under $70 billion by 2027, with a CAGR of 31 percent. The commercial market accounts for the lion's share of this increase, rising from 34 percent of the total industry revenue in 2017 to 74 percent in 2027.

"This growth in the commercial drone market rests on growth opportunities across a range of verticals, particularly those in which the drone's ability to loiter, work indoors, provide high-resolution and supply constant updates, makes it a preferable platform to other aerial imaging sources," said Rian Whitton, research analyst, ABI Research. Key potential verticals include construction, insurance, infrastructure inspection, warehouse logistics and oil and gas. Other large market opportunities are to be found in agriculture and film & entertainment.

ABI Research argues that most of the revenue for commercial drones comes not from the platform itself, but from application services such as data analytics and processing. While most platforms are rudimentary, the need to process and derive insights from huge amounts of aerial imaging data is a considerable challenge, and very hard to develop in-house.

The expansion in commercial drone opportunities is undergirded by substantial growth in revenue from civil and military applications. In line with wider trends, the civil sUAS market will continue to see strong growth, reaching a revenue of over $5 billion in 2027 and enjoy a CAGR of 25.2 percent. The force behind this growth is a strong interest and growing adoption from law enforcement and public safety.

While the most attention and capital are focused on developing more sophisticated and larger UAS for long-range intelligence, reconnaissance and surveillance (IRS) and combat roles, there is high demand for sUAS solutions in IRS and targeting. With defense budgets growing globally and the development of autonomous drones that can act in swarms being touted by military thinkers as a major innovation, ABI Research expects the military market to grow from $1.8 billion in 2017 to $8.4 billion in 2027.

While the Consumer sUAS industry will continue to grow, its relative importance will decline—from 33 percent of total revenues in 2017 to 6 percent in 2027. There are many reasons for this, including initial over-hype, increased regulation against consumer flight, a race to the bottom through price decrease and a general exodus from the market following the understanding that Shenzhen-based DJI has near-complete dominance of the platform market. DJI is the undisputed market leader in both consumer and commercial markets. Other major players include Aerovironment, Aurora Flight Sciences, Parrot, Kespry, Aeryon Labs, Yuneec Precision Hawk and Atlas Dynamics.

Sensor Data Crowdsourcing to Transform Connected Car Services

Connected car services are approaching a market inflection point, as datasets from the millions of connected, sensor-equipped vehicles on the road are leveraged to enable new and compelling connected car services. OEM revenues from monetization of automotive sensor data are expected to reach $706 million, representing a CAGR of 46.8 percent.

"The crowdsourcing paradigm sits at the epicenter of the major automotive megatrends, with the rapid growth in ADAS and connected infotainment expanding the installed base of connected and sensor-equipped vehicles to the point of critical mass," said James Hodgson, senior analyst, ABI Research. "By leveraging the experience of the crowd, rich semantic datasets can be used to improve legacy applications, such as parking and traffic information services, or to enable brand new use-cases, such as user-generated maps for autonomous driving."

> **Cars contributing sensor data to ingestion platforms to grow to over 60 million by 2023.**

While parallel automotive megatrends are driving adoption of the core enabling technologies, crowdsourcing requires a new level of openness and cooperation across the automotive industry. "Coopetition" allows for the sharing of datasets across OEM and supplier boundaries, ramping up adoption of the paradigm by broadening the real-world experience on which new services are based. This has driven the development of neutral, third-party platforms for data set ingestion, anonymization, enrichment and dissemination such as HERE's Open Location Platform, or the data marketplaces of dedicated startups like Otonomo and CARUSO. Some OEMs have also begun developing in-house platforms, such as BMW's CarData platform launched in partnership with IBM. Outside of cooperative frameworks, some industry players are actively leveraging their massive software presence at the edge to develop new services. Mobileye has announced that from 2018 connected vehicles from Nissan, BMW and Volkswagen will contribute sensor data to the Road Experience Management user-generated mapping platform.

For More Information Visit mwjournal.com for more commercial market news.

"As OEMs transition into mobility service providers, their revenues will shift from product sales to monetization of fleet-based assets," Hodgson concluded.

Mixed Reception for Augmented Reality in Brick and Mortar Retail

Augmented reality (AR) will see major adoption in the retail sector, but not in the way many have predicted. According to ABI Research, AR will struggle to take root among customers in the brick and mortar environment. Instead, AR uptake in the sector will be driven by the retail workforce and online shoppers.

AR experiences can prove extremely useful for online customers unable to interact with the physical products they intend to purchase. "For consumers in brick and mortar stores, however, it can disrupt the customer journey and provides little additional value overall," said Nick Finill, senior analyst, ABI Research.

For the in-store employee, AR promises to deliver operational efficiencies and raise the quality of the service delivered. As has been occurring across other industrial sectors, retail will see a steady rise in the adoption of AR devices. Smart glasses from manufacturers such as Vuzix are already starting to be used by retail employees to assist with front- and back-of-store operations. ABI Research forecasts that by 2022 over 120,000 stores will be using AR smart glasses globally, with deployments evenly split across Europe, North America and Asia-Pacific. This will be driven by the need for efficiency savings to compete with rival retailers and the online sector generally.

By 2020, 3 percent of e-commerce revenue will be generated because of AR experiences—$122 billion in revenue worldwide. "The relative ease of integrating AR into existing m-commerce platforms and the impact this can have on the user experience will largely drive customer demand," Finill said. The benefits of using AR will be unable to overcome the barriers which exist in physical retail, however, which is inherently less reliant on the use of a mobile device.

For retailers and AR solution providers, the challenge is now changing the perception of AR from a novelty gimmick into a technology which can truly engage customers online and improve the bottom line in-store.

Around the **Circuit**

Barbara Walsh, Multimedia Staff Editor

MERGERS & ACQUISITIONS

With the completed acquisition of **OPTIS**, **ANSYS** now delivers the industry's most comprehensive solution for simulating autonomous vehicles. By adding OPTIS' optical sensor and closed-loop, real-time simulation to ANSYS's leading multiphysics portfolio, ANSYS offers the broadest toolset for validating the safety and reliability of autonomous vehicles. The leading provider of software for scientific simulation of light, human vision and physics-based visualization, OPTIS delivers physics-based optical simulation solutions.

ON Semiconductor Corp. announced its acquisition of **SensL Technologies Ltd.** The acquisition is expected to be immediately accretive to ON Semiconductor's non-GAAP earnings per share. SensL, based in Ireland, specializes in Silicon Photomultipliers (SiPM), Single Photon Avalanche Diode (SPAD) and LiDAR sensing products for automotive, medical, industrial and consumer markets. This acquisition positions ON Semiconductor to extend its market leadership in automotive sensing applications for ADAS and autonomous driving with expanded capabilities in imaging, radar and LiDAR.

Emerson announced it has agreed on terms to acquire **Aventics** from **Triton** for a cash purchase price of €527 million. Aventics is among the global leaders in smart pneumatics technologies that power machine and factory automation applications. Emerson is a leader in fluid automation technologies for process and industrial applications, and Aventics significantly expands the company's reach in this growing $13 billion market. Aventics builds upon and strengthens Emerson's capabilities and solutions in key discrete and hybrid automation markets, including food and beverage, packaging, automotive assembly and medical equipment.

COLLABORATIONS

NEC Corp. announced an agreement with **NTT DOCOMO INC.** to provide control units for 5G base station equipment aiming for the commercialization of 5G services. NEC is slated to carry out development that enables existing communication equipment, such as high-density base station equipment, to be fully compatible with 5G. These developments will contribute to the successful provision of 5G services that DOCOMO aims to launch in 2020. Currently, high-density base station equipment that NEC began providing in February 2015 is already compatible with the advanced Centralized Radio Access Network (C-RAN) architecture advocated by DOCOMO, and is now being utilized as a base station control unit.

Peraso Technologies Inc. strengthened their partnership with **IgniteNet** to revolutionize the fixed wireless marketplace. With Peraso's advanced X710 WiGig phased array chipset, designed specifically for the wireless infrastructure market, IgniteNet continues to offer first-to-market, super high performance base stations and CPEs that enable ISPs to deliver multi-gigabit connectivity both quickly and cost-effectively. Peraso and IgniteNet have already announced numerous solutions together, including the latest 10 Gbps MetroLinq Tri-Band Omni outdoor base station announced in late 2017, which utilizes Peraso's point-to-multipoint (PTMP) X710 Chipset.

Rohde & Schwarz is collaborating with **PoLTE Corp.**, a leader in cellular-based location solutions, to accelerate the robustness and accuracy of cellular location technologies. R&S and PoLTE are enhancing the cellular IoT ecosystem and expanding the opportunity for new IoT use cases.

Cadence Design Systems Inc. and **NI** announced a broad-ranging collaboration to improve the overall semiconductor development and test process of next-generation wireless, automotive and mobile integrated circuits (IC) and modules. To meet customers' needs for a streamlined and comprehensive solution, Cadence and NI have pursued projects that integrate key design tool technologies into a common user environment to improve the design, analysis and testing of analog, RF and digital ICs and system-in-package (SiP) modules spanning from pre-silicon design to volume production test.

ACHIEVEMENTS

NuWaves Engineering, a veteran-owned small business providing advanced RF and microwave solutions, announced that the company has been selected for a Small Business Innovative Research (SBIR) Phase I award for the S-Band Transmit/Receive module Advancements For Efficient radars (STRAFE). The six-month Phase I project will involve R&D activities resulting in an innovative MMIC architecture that, once fully developed, will be integrated into a high performance transmit/receive module that will be delivered to the U.S. Navy during Phase II.

Using extensive quantum mechanical computations of all electron-phonon scattering mechanisms and Monte Carlo method, researchers have shown for the first time that silicon can host **Gunn Effect** if it is shaped as nanowire and mechanically strained. Making a nanowire out of silicon modifies the energy bands in such a way that the distance between two electron energy bands can be much less that the already unwanted amount of 1 eV. Interestingly this low energy difference (~100 to 280 meV) is also adjustable using mechanical strain. They observed that applying tensile strain of +3 percent helps the nanowire to show NDR at the applied electric field of 5000 V/cm.

Rosenberger has been recently certified according to the new automotive standard IATF 16949:2016 by DQS-Deutsche Gesellschaft zur Zertifizierung von Managementsystemen mbH. In comparison to the existing

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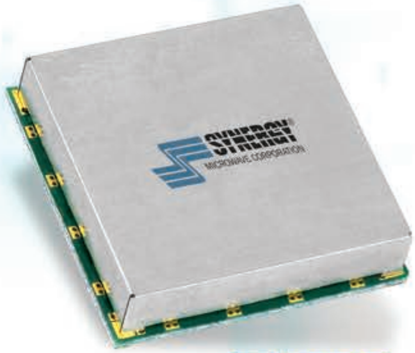

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HFSO776R82-5	776.82	0.5 - 12	+5 VDC @ 35 mA	-146
HFSO800-5	800	0.5 - 12	+5 VDC @ 20 mA	-146
HFSO800-5H	800	0.5 - 12	+5 VDC @ 20 mA	-150
HFSO800-5L	800	0.5 - 12	+5 VDC @ 20 mA	-142
HFSO914R8-5	914.8	0.5 - 12	+5 VDC @ 35 mA	-139
HFSO1000-5	1000	0.5 - 12	+5 VDC @ 35 mA	-141
HFSO1000-5L	1000	0.5 - 12	+5 VDC @ 35 mA	-137
MSO1000-3	1000	0.5 - 14	+3 VDC @ 35 mA	-138
HFSO1200-5	1200	0.5 - 12	+5 VDC @ 100 mA	-140
HFSO1600-5	1600	0.5 - 12	+5 VDC @ 100 mA	-137
HFSO1600-5L	1600	0.5 - 12	+5 VDC @ 100 mA	-133
HFSO2000-5	2000	0.5 - 12	+5 VDC @ 100 mA	-137
HFSO2000-5L	2000	0.5 - 12	+5 VDC @ 100 mA	-133

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ISO/TS 16949:2009 the new standard describes a quality management system with significantly more complex standards. Other Rosenberger sites in Laufen/Germany, Hungary and China also manufacturing automotive products will be audited according the new standard, and the Rosenberger India plant will be certified by IATF 16949 in near future as well. The successful certification confirms that Rosenberger—as a manufacturer and supplier of coaxial and high voltage connectors—fully satisfies the very stringent requirements to quality management systems of the automotive industries.

Ooredoo has announced that the company is the first operator in the world to launch a live 5G network on the 3.5 GHz spectrum band.

RFMW Ltd. has been recognized by **API Technologies** as their 2018 Technical Distributor of the Year during the Electronic Distribution Show (EDS 2018) held in Las Vegas. Accepting the award was Joel Levine, president and CEO of RFMW. This award follows API/Weinschel's recognition of RFMW as their 2017 Distributor of the Year at EDS 2017.

CONTRACTS

Merlin International announced that it has won major enterprise-wide technology contracts from the **Department of Homeland Security**, specifically within the U.S. Customs and Border Protection and the Transportation Security Agency, and from the U.S. Department of Veterans Affairs valued at approximately $200 million. Through these contract awards, Merlin will help maximize existing technology investments while simultaneously providing access to significant new technologies that will enable modern innovation to be rapidly deployed in support of each agency's mission. The company was selected for its track record of providing government organizations with a holistic approach to addressing their cloud and cybersecurity needs and high volume data processing, analytics and automation challenges.

The U.S. Navy has awarded **BAE Systems** a $175 million contract for more than 7,000 cost-efficient Advanced Precision Kill Weapon System (APKWS©) laser-guided rockets. This latest award was made under the Navy's 2016 $600 million IDIQ contract, which is the contracting vehicle to supply APKWS to the Navy, Marine Corps, Army and Air Force, as well as an increasing number of allied nations. This award extends that contract's initial unit production cap and total value to meet the growing demand. The company expects additional orders to bring the total number of units for this production lot to 17,500.

Harris Corp. has been selected to modernize India's air traffic management communications infrastructure and support one of the world's fastest growing aviation markets, which is expected to double in size over the next 10 years. The announcement was made during a contract signing held at the 6th U.S.-India Aviation Summit, May 9 to 11, at the Taj Mahal Palace Hotel in Mumbai. The Airports Authority of India (AAI), which owns and maintains 129 airports, awarded Harris a 15-year, Rs 944 Crore, $141 million contract to serve as the prime contractor and systems integrator for AAI's Futuristic Telecommunications Infrastructure initiative.

PAR Technology Corp. announced that its subsidiary, **Rome Research Corp. (RRC)**, was awarded a U.S. Navy SeaPort-e task order to provide telecommunications operations and maintenance services at the Global Information Grid facility at Camp Lemonnier in Djibouti, Africa. The task order value is approximately $19.8 million over a 12-month base period of performance and four one-year options, inclusive of the FAR 52.217-8 Option to Extend Services. RRC operates communications facilities for the U.S. Department of Defense and other agencies throughout the world.

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Around the **Circuit**

Mercury Systems Inc. announced it received a $3.8 million order from a leading electronics manufacturing services provider for mmWave transceiver subsystems integrated into a high-resolution imaging system used for homeland security. Mercury is recognized as a leader in mmWave technology, successfully commercializing its portfolio of RF/microwave solutions for homeland security and defense applications. All of the company's RF/microwave innovations, from 1 MHz to 140 GHz, are designed and manufactured in its scalable, advanced microelectronics centers located throughout the U.S. The mmWave transceiver order was booked in Mercury's fiscal 2018 third quarter and is planned to be shipped over the next several quarters.

Orbis Technologies Inc. was awarded a multimillion dollar production contract with the **Department of Defense** for its Redaction and Exploitation Releasability (REnDER) Tool. REnDER enables the U.S. military to efficiently and effectively share multi-source intelligence information with coalition partners. The contract provides support for the integration of the REnDER software into the client environment for the purpose of providing GEOINT work products to partner nations. The REnDER Tool is a one-of-a-kind software application designed to automate the content redaction and product release workflow processes. The software enables users to automatically redact content based on defined rules and procedures.

PEOPLE

▲ *Amaro Oliveira*

▲ *Michael Kletchko*

Tempest Telecom Solutions announced the addition of three new high level executives. **Glenn Edwards**, as VP and general manager of repair and logistics, brings valuable telecom equipment repair and services experience from a long career with respected industry leaders such as Nortel, CTDI and Telmar/iQor. As VP of business development, **Amaro Oliveira** will work with network operators globally to help them reduce costs by utilizing Tempest for their legacy network support and TAC requirements. **Michael Kletchko**, as senior VP of sales & marketing, will lead Tempest's sales and supply organization and manage all marketing activities, while growing revenue and gross profit in all business units.

PLACES

Anokiwave announced the expansion of the Billerica, Mass. design center into a newly remodeled office to accommodate the company's rapid market growth. With the expansion, Anokiwave now features the capability for pilot production of mmWave wafer level chip scale packaged (WLCSP) ICs within the facility.

IN MEMORIAM
Mini-Circuits Mourns the Passing of Founder, Harvey Kaylie

RF/microwave industry pioneer, philanthropist, and Mini-Circuits' beloved Founder and CEO, Harvey Kaylie passed away peacefully May 30, 2018. He is survived by his wife, two daughters, eight grandchildren, and two brothers. He will be deeply missed by the thousands of colleagues, partners, and friends whose lives he enriched.

Innovator, Entrepreneur, and Visionary

Harvey Kaylie defined the vision and established the strong values that have propelled Mini-Circuits' success and growth for the last fifty years from a one-man startup in the kitchen of his Brooklyn apartment to the thriving global enterprise it is today. A native of Brooklyn, he earned his BSEE from the City College of New York and his MSEE from New York University. He held engineering positions at companies including IT&T, Amperex, Fairchild, and Airborne Instrument Laboratories (AIL) before making a bold decision to start his own company.

He founded Mini-Circuits in September of 1968 with an ambitious goal to manufacture RF and microwave products at substantially lower cost than the market offered at that time by focusing on quality and process. His early efforts led to the development of a new line of mixers, transformers, and passive RF components, which became an international success, fueling Mini-Circuits' precipitous growth while in many ways revolutionizing the industry itself. His success helped transform a niche, low-volume cottage industry into the sophisticated, process-driven industry that provided the volume, quality, and price needed to support the proliferation of wireless technology throughout the modern world.

Beyond his work as a business leader at Mini-Circuits, Harvey dedicated his life outside the company to philanthropy. In 1999, he and his wife, Gloria Kaylie established the Harvey and Gloria Kaylie Foundation to support organizations involved in education, health, cancer research, and support for individuals with disabilities, among other causes. In 2010, Harvey established the Kaylie Prize for Entrepreneurship at the City College of New York, awarding startup capital for students with promising electronic hardware inventions to launch entrepreneurial ventures. Also in 2010, he and Gloria opened Camp Kaylie, a summer camp in upstate New York devoted to inclusion of children with special needs.

Harvey was awarded an honorary doctorate of science from CCNY and an honorary doctorate of electrical engineering from the University of South Florida, both in 2012, and an honorary doctorate of humanities from Yeshiva University in 2013.

A Legacy of Dedication to Customers, Company, and Community

As Mini-Circuits has grown to meet the evolving needs of customers, offering the industry's largest selection of RF/microwave products, the company has stayed true to Harvey's simple formula for success: manufacture quality products, sell them at a very competitive price, and provide fast delivery with strong service and support. His relentless pursuit of innovation and continuous improvement, his commitment to world-class quality and customer service, and his passionate work ethic will always remain deeply rooted in Mini-Circuits' company culture, as will his strong values of personal integrity, respect for all people, and altruism.

Harvey's daughter, Alicia Kaylie Yacoby wrote in a letter to Mini-Circuits employees, "He believed strongly that Mini-Circuits is not just a company, but also a family, and that was how he treated his team members. As we mourn Harvey's passing together as a family, we draw purpose and inspiration from his remarkable life, and we celebrate all he accomplished for Mini-Circuits and for the greater good in the world."

Building Future Success on a Firm Foundation

Mr. Kaylie exercised great diligence to reinforce Mini-Circuits' future security and prosperity. Over the past several years, he focused on developing, implementing, and overseeing a seamless transition of company management to a professional leadership team while maintaining continuity and stability as a private company owned exclusively by Kaylie family members, who remain committed to supporting all of Mini-Circuits' partners, including customers, employees, and suppliers. With this firm foundation, Harvey set the groundwork for Mini-Circuits' further growth and expansion within its current markets.

PUBLISHER'S NOTE:

I met Harvey Kaylie some 30 years ago and worked directly with him on Mini-Circuits' advertising with MWJ for many of those years. As you no doubt have noticed, he was a very active advertiser, running multiple ad pages in all of the industry publications from the early years of the company. And his strategy worked brilliantly. Everyone knew the name Mini-Circuits and he backed it up with reliable products at competitive prices. He always drove a hard bargain, but when he shook hands on a deal, you could consider it gold.

I learned much from Harvey over the years and developed a friendship and true respect for him. He was legendary in the RF/microwave industry, the name "Harvey" being mononymous, like Elvis or Oprah. He was truly an industry pioneer and innovator who changed the industry and will be forever remembered for the many contributions he made. He will be dearly missed.

Carl Sheffres
Microwave Journal Publisher

Design of an Ultra-Wideband Combline "Brick Wall" Filter

Morten Hagensen
Guided Wave Technology ApS, Hilleroed, Denmark

Kristian Lotz, Kim Vienberg and Jesper Trier
Combilent A/S, Alleroed, Denmark

It is well known that three-dimensional electromagnetic (3D EM) solvers have had a tremendous effect on how passive microwave circuits are designed today. In the not-so-distant past, a typical microwave filter design cycle would start with modeling on a circuit simulator, followed by prototype manufacturing and measurement. Often, the coarse design phase did not lead to compliant prototypes, and the prototype had to be "redesigned," taking days or weeks with copper tape and modifications in the machine shop. Several such cycles were frequently needed before the prototype met requirements.

Today, the initial design phase is probably little changed, but we now build and modify the prototypes in 3D EM solvers instead of making measurements on machined models. A physical prototype fulfilling all requirements is most often achieved in just one pass, which underscores the impact of EM solvers on development time and cost.

With EM solvers, today's microwave engineer can develop much more complex, innovative and integrated solutions than before. "Wild" ideas can be tested and included in designs if they pass. Yet, even today, the direct analysis and optimization of complex mechanical filters in 3D EM solvers is often too resource intensive and time-consuming to be usable in practice. An often-used alternative is to combine 3D EM solvers with circuit modeling techniques.[1]

CO-SIMULATION

Most often, a filter project is initiated by synthesis and simulation in a circuit simulator or comparable tool. In this work, a filter and coupling matrix synthesis (CMS)[2] tool is used for this. The output is a coupling matrix that describes all the necessary couplings in the filter. The principal task of the work following synthesis is to convert the coupling matrix into a physical filter.[3] It is here that 3D EM simulators find their use. The main concern is couplings. The most common way to verify couplings in a manufactured prototype filter is to tune in all resonators until a "nice" filter characteristic is obtained. If bandwidth, stopband notches and return loss are as expected, the couplings are fine; if not, they need to be modified.

When a 3D EM simulator is used instead of a machined prototype, tuning of the resonators in the 3D EM model is still necessary to verify the couplings. Very often, resonator tuning is realized with tuning screws whose actual positions are not necessary to know in detail. The 3D EM simulator must, however, finish optimizing these screw positions to arrive at a usable filter characteristic. Since a change of only a few hundredths of a millimeter can greatly affect a filter characteristic, the EM simulator can waste a lot of computing time on this task. Even for moderately complex filters, the task of performing a full-wave optimization, which includes resonator tuning, may well be too time-consuming

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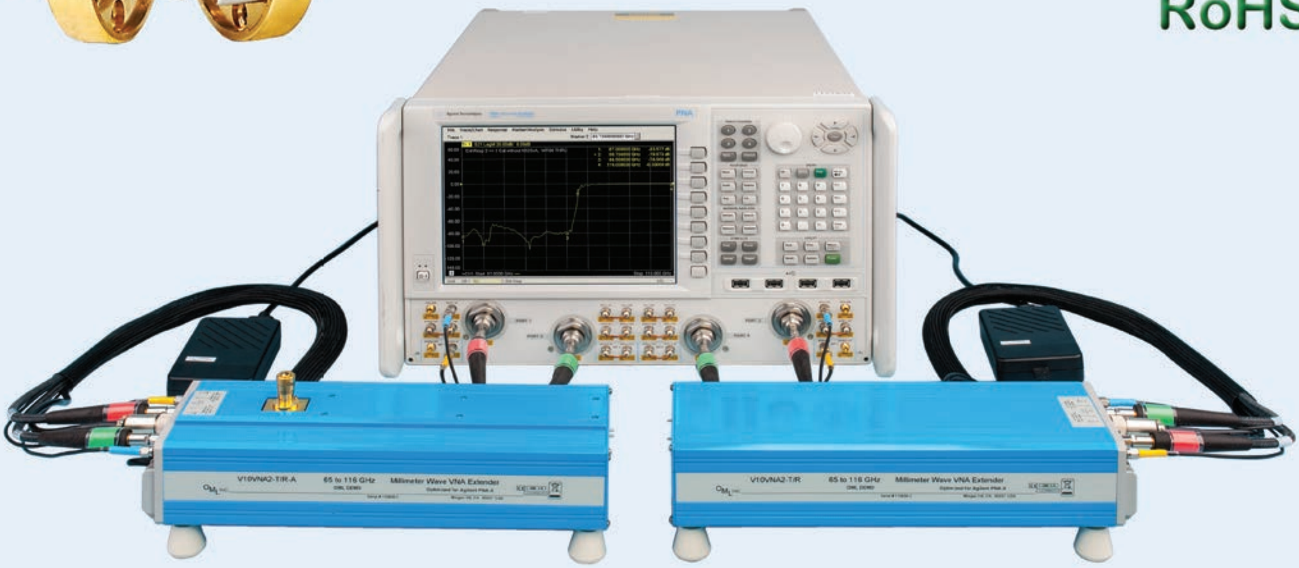

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to be feasible. It is for this reason that co-simulation is used.

This is demonstrated by Swanson and Wenzel for a 5-pole combline filter.[1] Internal lumped ports are placed at the end of each resonator in the 3D EM model, and the resulting 7-port S-matrix is exported to a circuit simulator, where lumped capacitors are connected to the internal ports. In the circuit simulator, these tuning capacitances are quickly optimized to reveal the filter characteristic, and hence the couplings. Co-simulation may also be implemented in other ways.[4-5] In this work, the method described by Swanson and Wenzel is used to analyze and design an extremely broadband, multi-pole, coaxial cavity filter with multiple cross couplings.

TABLE 1

FILTER SPECIFICATIONS

Parameter	Specification
Passband	564 to 1200 MHz
Insertion Loss	≤ 3 dB
Passband Ripple	≤ 2 dB Peak-to-Peak
Return Loss	≥ 15 dB
Attenuation	≥ 62 dB from 52 to 552 MHz
Impedance	75 Ω
Temperature Range	−20°C to +65°C
Maximum RF Power	27 dBm
Maximum Size	190 mm x 115 mm x 45 mm

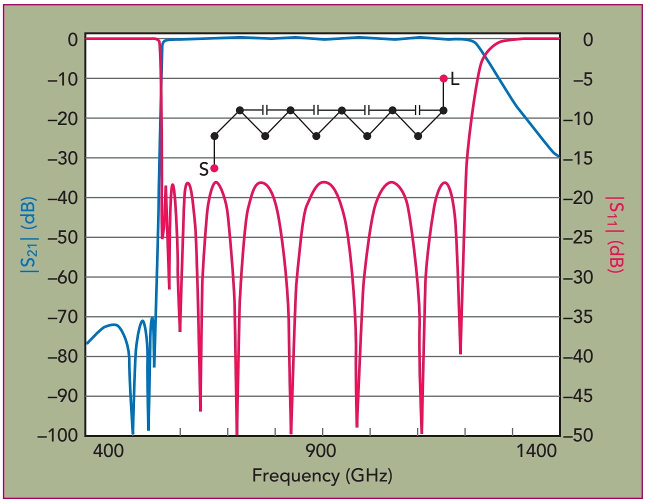

Fig. 1 CMS synthesized filter characteristic.

FILTER DESIGN

The filter, intended for a cable TV distribution system, has the specifications shown in ***Table 1***. With greater than 70 percent relative bandwidth and an extremely sharp cutoff, this filter type is sometimes referred to as a "brick wall" filter. The steep transition between the lower stopband and passband calls for resonators with high unloaded Q. It is at the edge of the passband—at the "shoulders"—that the filter performance mainly benefits from high-Q resonators. The temperature range makes it necessary to include some bandwidth allowance for temperature drift. The actual value depends on factors such as filter type, materials and resonator layout. A starting point could be 0.5 MHz, since the operating temperature range is quite limited. This means that the original 12 MHz transition band is reduced to 11 MHz. The power level is low enough that no special precautions are needed to avoid breakdown.

Accurate synthesis of strongly asymmetric, ultra-wideband filters is no easy task. As mentioned previously, CMS is used in this work, which yields results similar to lumped-circuit models but is only accurate for bandwidths up to approximately 10 percent. The greater than 70 percent relative bandwidth requirement is far beyond the range where CMS can be expected to provide reliable results for coupling values and resonant frequencies. The CMS synthesized filter is, however, a suitable starting point for an HFSS model,[6] the 3D EM solver used throughout this article. The shortcomings of CMS are overcome when the HFSS model is optimized in the ADS7 circuit simulator.

TABLE 2

FILTER COUPLING MATRIX
(VALUES IN MHz)

	S	1	2	3	4	5	6	7	8	9	10	L
S	882.0	605.7										
1		887.4	501.7									
2			887.9	279.1	−241.5							
3				691.3	250.6							
4					899.1	242.0	−238.3					
5						687.4	240.8					
6							899.1	214.5	−267.4			
7								669.2	220.9			
8									909.3	296.8	−260.1	
9										718.7	429.0	
10											887.4	605.7
L												882.0

A CMS synthesized, tenth-order bandpass filter to fulfill the specifications is shown in ***Figure 1***. Filter synthesis in CMS is not addressed here, but design information is available.[2] Given the order of the filter and the available space, it is realized as a coaxial cavity combline design. The four transmission zeroes are achieved with four triplets in series, positioned at 552, 548, 535 and 500 MHz, respectively. Triplets in series are much more robust than other more "advanced" topologies—for example, a folded topology—in terms of sensitivity to tolerances, tuning accuracy and temperature variation. ***Table 2*** shows the corresponding coupling matrix synthesized in CMS. All values are in MHz and empty cells correspond to zero coupling. Only values on and above the main diagonal are shown, where the main diagonal contains the resonant frequencies of the individual resonators. The four couplings above the main line are non-adjacent couplings (cross or x-couplings). These x-couplings are negative and, therefore, capacitive. Resonator 1, for example, has a resonant frequency of 887.4 MHz.

Reviewing Table 2 yields several conclusions:

- Some of the resonators are detuned quite a lot compared to the center frequency of 882 MHz. The resonant frequencies span from 669 to 909 MHz, indicating that different resonator layouts should probably be used in the filter.
- The values just above the main diagonal are the main line coupling bandwidths. All couplings are positive (inductive) and have very high values. Combline resonators do not couple as strongly as, for example, interdigital resonators. Combline filters are therefore normally used for small to intermediate bandwidths. This limited coupling strength is addressed later in this article.

3D EM MODELING

The first step in building the 3D model is to design a resonator that can be tuned over the desired range, has the right unloaded Q and does not violate any mechanical constraints. Dividing the available volume (190 mm x 115 mm x 45 mm) between 10 circular cavities and subtracting space for the walls, lids and headroom for tuning screws results in the filter layout shown in ***Figure 2***. The individual resonators have the dimensions shown in ***Table 3***.

The resonators are analyzed with the eigenmode solver in HFSS. The unloaded Q is approximately 2000 for aluminum. The layout can sup-

TABLE 3

INITIAL FILTER RESONATOR VALUES (mm)

Cavity Diameter	40
Cavity Height	29
Resonator Rod Diameter	10
Disk Diameter	30
Disk Thickness	1
Resonator Height	27.6
Tuning Hole Diameter	6
Tuning Screw Diameter	4

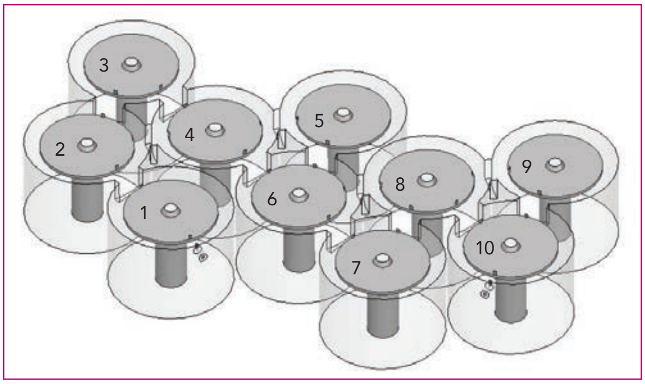

Fig. 2 Layout of 10 resonator HFSS model.

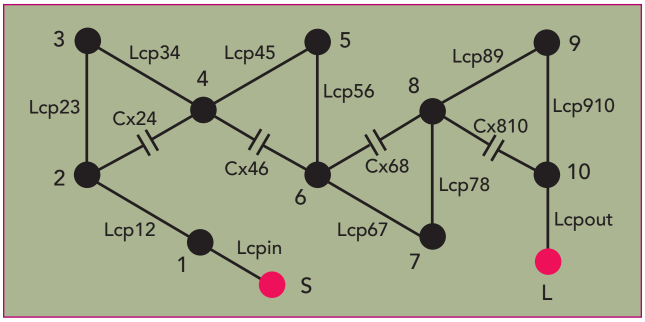

Fig. 3 Filter topology corresponding to Figure 2.

port the resonant frequencies in Table 2 below approximately 600 MHz. Three or more different layouts with smaller top disks are required for the resonators with resonant frequencies above 600 MHz.

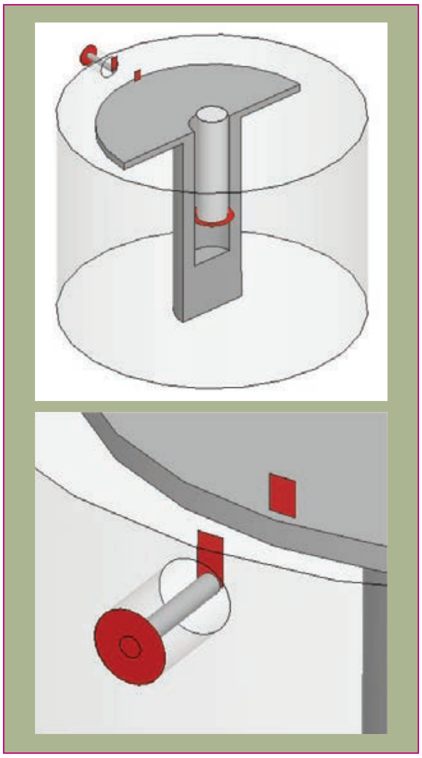

Fig. 4 Assignment of ports (red faces) in Resonator 1.

The first 3D model, however, uses the resonator design of Table 3 as a starting point.

The layout in Figure 2 has 75 Ω coaxial inputs at resonators 1 and 10. Due to the required strong couplings between the resonators, apertures are added in the sidewalls at the top of the cavities to allow lumped coupling between them. Simulation on two-pole boxes[3] revealed that the strong couplings cannot be achieved just by placing the resonators in close proximity. The couplings must be implemented in a more direct way: for example, by loops or wires tapped to the top of the resonators. A schematic overview of the topology is shown in ***Figure 3***.

In the HFSS model, lumped ports are placed at these tap points so that lumped components (inductors and capacitors) can later be inserted in the circuit model. Therefore, the coupling loops are not included in the HFSS model; they are added later in the circuit simulator.

Figure 4 shows the port details in resonator 1; the ports are marked in red. The port at the coaxial input is a wave port; all other ports are lumped ports. One lumped port is implemented as a circular disk at the end of the tuning screw. One of the rectangles is a lumped port defined between the upper surface of the resonator disk and the lid (ground). The other rectangular lumped port is defined between the tip of the inner conductor of the coaxial line and the lid. Between these two ports, an inductor is later connected in the circuit simulator. Common for all ports, they are defined between a point in the filter and a reference point, which is usually ground.

Lumped ports are placed on appropriate points in all resonators. Resonators 4 and 8, for example, both have four lumped ports placed along the top disk perimeter to account for two x-couplings and two mainline couplings on each resonator. For a complex filter such as this, a large number of ports are required. One for each tuning screw, two for each coupling, plus two input/output (I/O) waveguide ports equals 42 ports total.

With the HFSS model complete, a frequency sweep obtains the 42-port S-matrix for circuit simulation. In the initial design phase, the filter is considered lossless.

ADS CIRCUIT MODEL

An ADS model corresponding to the topology diagram in Figure 3 is shown in ***Figure 5***. The large box in the center of the diagram is the 42-port S-matrix, which contains the data previously calculated in HFSS. Each terminal in the box corresponds to a port in the HFSS model. The 10 capacitors shown to the lower left in the figure represent the tuning screws. The two coaxial I/O ports are placed at the upper left corner. The rest of the components represent the couplings in the filter. In general, the mainline couplings are implemented as lumped inductors, x-couplings as capacitors and corrections to the tuning screw penetrations in the resonators also as capacitors. All the lumped components shown are subject to optimization.

With the circuit model defined, the task is to optimize all the lumped components until the characteristic in Figure 1 is obtained as close as possible. Unfortunately, it turns out that this cannot be achieved with the described ADS model: the two coupling inductors Lcpin and Lcpout (see Figure 3), which connect the first and last resonators to the I/O connectors, reach their lower limits of 0 nH.

The problem is that stronger couplings are needed than can be realized. From Table 2, it is seen that these couplings (S1 and L10) are, by far, the strongest couplings in the filter; however, the coupling values decrease toward the center of the filter. This problem is solved by adding two lumped LC highpass sections outside the mechanical 10-

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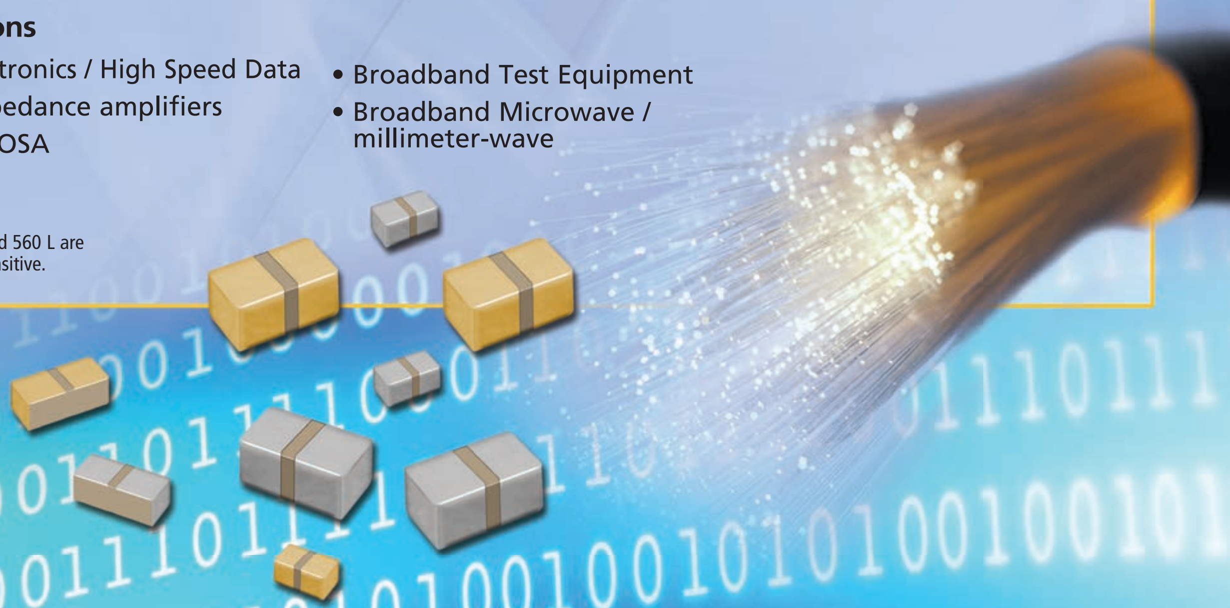

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550 U	0301	100 nF	16 KHz to 40+ GHz	<0.4 dB typ.	6.3 WVDC	No
550 L	0402	100 nF	16 KHz to 40+ GHz	<0.5 dB typ.	16 WVDC	Yes
560 L	0402	100 nF	16 KHz to 40+ GHz	<0.6 dB typ.	16 WVDC	Yes

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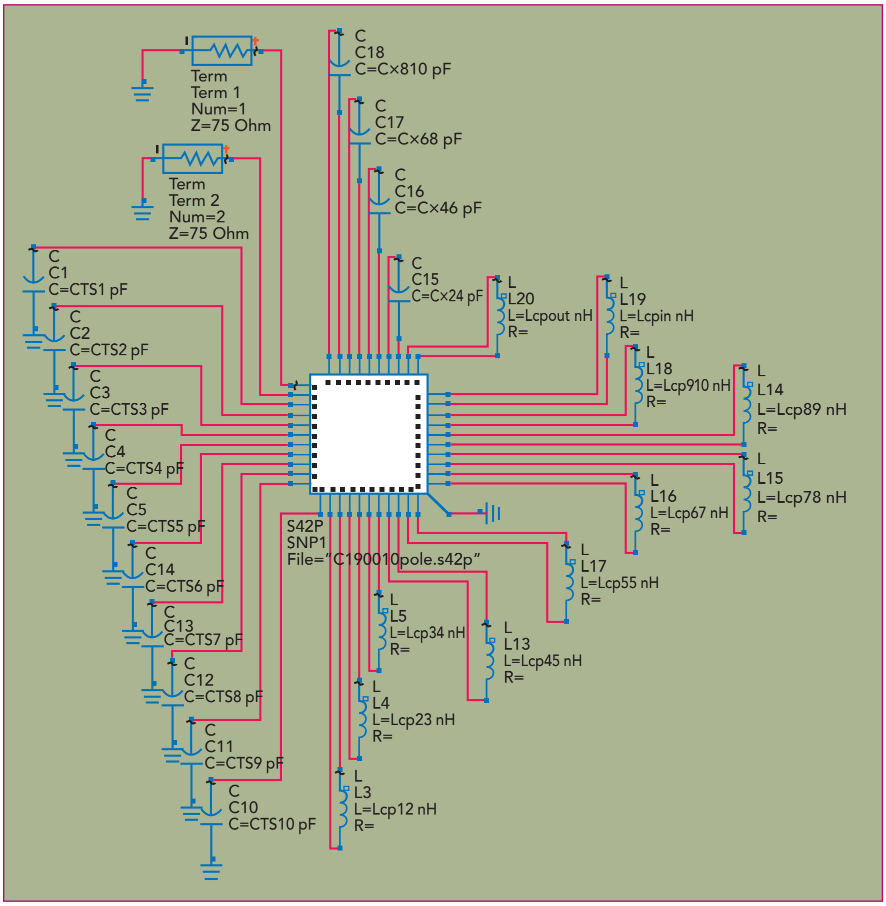

Fig. 5 **ADS circuit model of the 10 pole combline filter.**

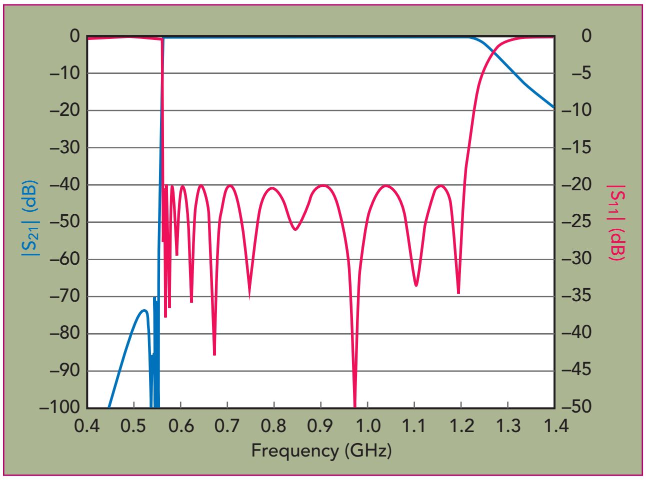

Fig. 6 **ADS optimized ideal result for the filter topology shown in Figure 3, with two added lumped LC highpass sections in front of the first and the last resonator.**

pole filter. The strongest couplings are shifted from the outermost combline resonators to the pair of lumped LC filters, where strong couplings are easier to realize. Adding the two lumped LC sections increases the overall insertion loss a bit, since their unloaded Qs may be 10x lower than the combline resonators. The lumped highpass sections are mounted on the printed circuit board's (PCB) connection with the combline filter. Two LC sections are easily added to the ADS model between the two 75 Ω ports and the 42 port S-block. The optimization now succeeds with the results shown in ***Figure 6***.

In the HFSS model, all tuning screws penetrate the resonator center holes with approximately 13 mm overlap. The values of the tuning screw lumped capacitances (CTS1 to CTS10 in Figure 5) are corrections to the capacitances of the tuning screws in these positions. The design strategy is first to vary the diameter of the resonator top disk in the HFSS model until the tuning capacitances (CTS1 to CTS10 in Figure 5) are close to zero. A zero value means that the corresponding resonator is tuned correctly with a 13 mm tuning screw depth. The tuning capacitance values obtained after optimization are shown in ***Table 4***. A negative value means that the resonator needs less capacitance and therefore a smaller top disk, while a positive value indicates the need for more capacitance and a larger disk.

TABLE 4

TUNING CAPACITANCE VALUES AFTER OPTIMIZATION (pF)

CTS1	–1.69
CTS2	–2.95
CTS3	4.23
CTS4	–7.85
CTS5	4.48
CTS6	–7.58
CTS7	4.09
CTS8	–8.43
CTS9	4.50
CTS10	–6.22

With the new capacitance values, the top disk diameters in the HFSS model are changed, a new HFSS simulation is performed, followed by ADS optimization. The new CTS values are interpolated linearly to obtain a new set of diameters. The cycle is repeated until CTS values are so small that the differences can be absorbed by the tuning screws. The final resonator geometries are found by running the HFSS model a few times. Each HFSS simulation took approximately two hours on our system, and the corresponding ADS optimization took between 45 and 60 minutes. It is clear that such a filter could never be optimized using HFSS alone, where many hundreds of iterations would be required.

FINAL HFSS MODEL

The characteristic obtained by the final ADS/HFSS model is shown in ***Figure 7***.

In this model, we have:

- Changed the resonator top disk diameters until the lumped tuning capacitance values (CTS) are around 0 pF.
- Modified the tuning screw penetrations to keep the number of different resonator geometries minimum. This resulted in only

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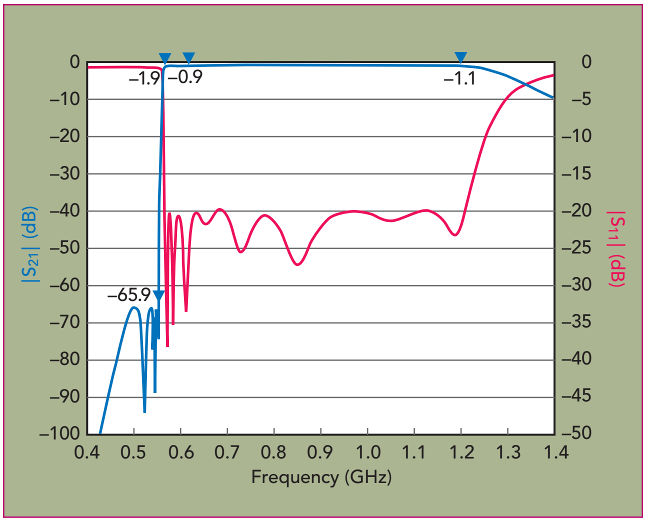


Fig. 7 **Resulting ADS/HFSS filter characteristic, including losses.**

four different resonator geometries, keeping the cost of manufacturing to a minimum.

- Replaced the inductive mainline couplings with standard inductance values. These inductors are represented by S-parameter models as provided by the manufacturer (Coilcraft). The inductance values range from 8 to 35 nH.
- Not assigned standard values to the x-coupling capacitors since these are represented by variable SMD capacitors.
- Included losses in both the cavity combline filter and in the lumped coupling network. The latter includes an approximately 100 mm FR4 transmission line in the main signal path.

During the optimization process, the order in which the x-couplings ended up being placed in the filter may have changed compared to the initial order indicated in Table 2. This was not controlled, since all four x-couplings had similar coupling bandwidths.

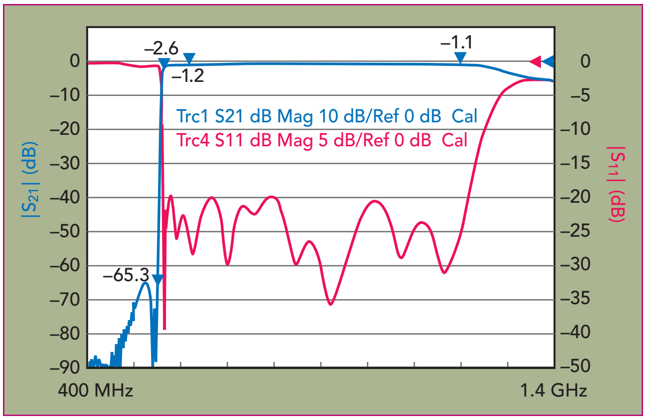


Fig. 8 **Measured filter characteristic of manufactured filter.**

PHYSICAL FILTER

The filter designed in the previous sections was manufactured, assembled and tuned, achieving the result shown in ***Figure 8***. Comparing the model characteristic in Figure 7, very good agreement was obtained between measured and simulated characteristics. The measured characteristic includes losses from two short coax cables (0.4 dB in total), which are not present in the model.

Some modifications were made to some of the lumped coupling inductor values (Lcp) to arrive at the performance in Figure 8. The reason that deviations from model values were necessary is believed to originate from the difference in the way the lumped ports are defined in the model and how the

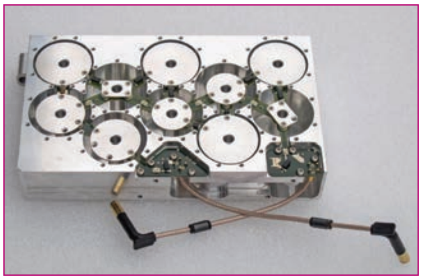
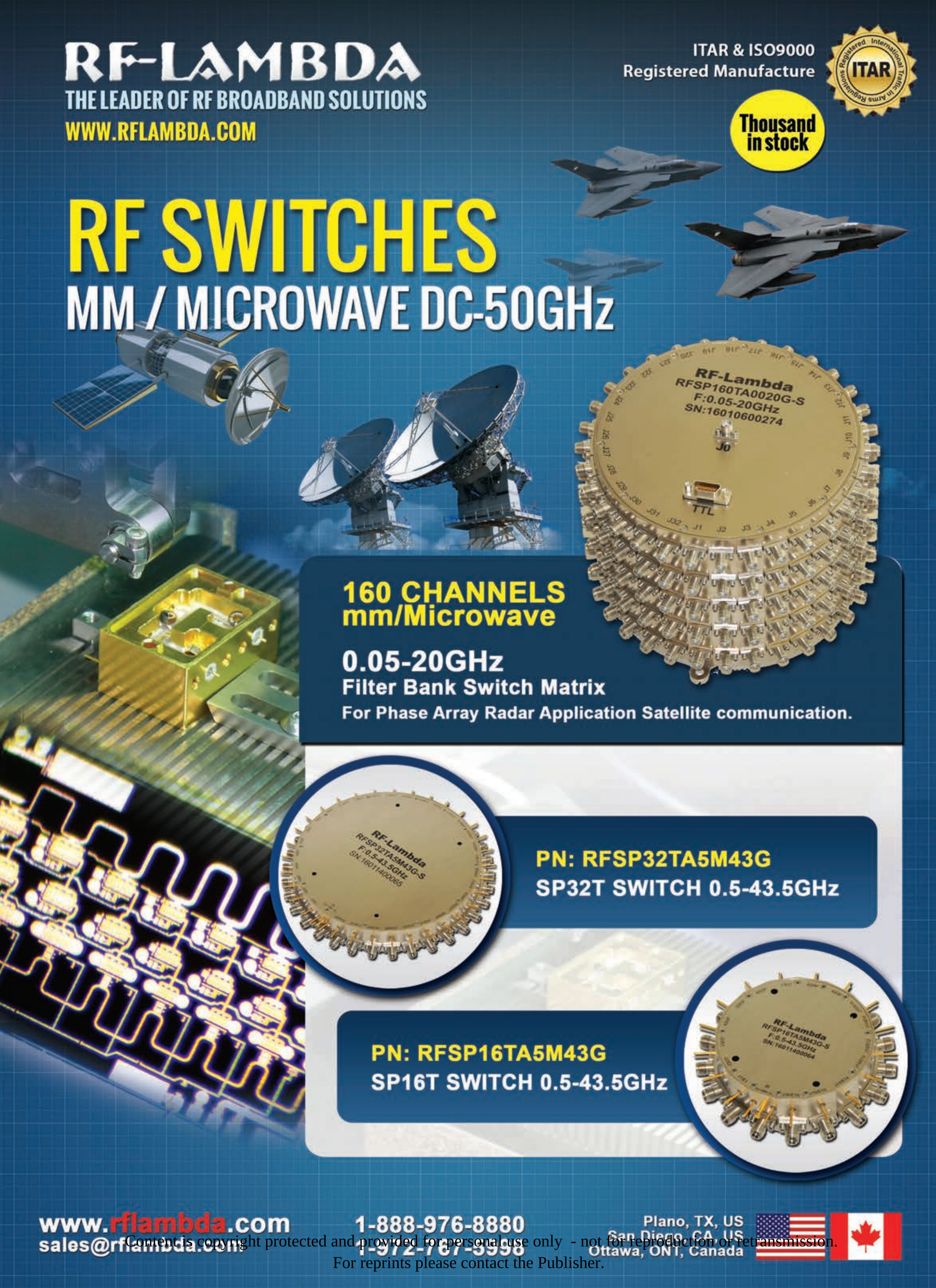


Fig. 9 **Manufactured filter without lid, showing coupling PCB, mushroom resonators, filter body and coaxial I/O lines.**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inductor tap points are realized in practice. All lumped couplings are mounted on a single FR4 PCB, as shown in the photo of the final filter in ***Figure 9***. This PCB is attached to the underside of the resonator top disks with SMD spacer tubes and screws; in the model, the inductors are tapped directly to the topside of the disks.

The two lumped highpass PCB sections at the I/O are visible in Figure 9 along the lower edge of the filter. The four lumped trimmer SMD capacitors used in the x-coupling network are visible along the horizontal middle of the filter.

CONCLUSION

This article describes the design and development of a compact, ultra-wideband, coaxial cavity, combline "brick wall" filter covering 564 to 1200 MHz. Normally, combline filters are used for relative bandwidths up to approximately 15 percent. In this work, the filter has more than 70 percent relative bandwidth, achieved using a combination of 3D EM simulation techniques and circuit simulation. For design, we used a combination of CMS and circuit simulation (ADS); for the 3D EM solver, we used HFSS.

Even though combline filters and CMS are normally not suitable for wideband applications, accurate results were achieved through co-simulation, even though this design was far outside the "comfort zone" for both filter type and synthesis tool.

The filter designed and manufactured in this work is a 10-pole, combline, cavity filter with mushroom-shaped resonators. All couplings were made with lumped components (inductors and capacitors) tapped to the top disk of the resonators. Four x-couplings were used to achieve the "brick wall" characteristic on the low-band side of the filter. A 42-port scattering matrix generated by HFSS was used to represent the mechanical part of the filter, for optimization in the circuit simulator. Excellent agreement was observed between measurement and simulation.■

References

1. D. G. Swanson and R. J. Wenzel, "Fast Analysis and Optimization of Combline Filters Using FEM," *IEEE MTT-S International Microwave Symposium Digest*, May 2001, pp. 1159–1162.
2. "CMS Software: Filter and Coupling Matrix Synthesis," *Guided Wave Technology*, www.gwtsoft.com.
3. M. Hagensen, "Narrowband Microwave Bandpass Filter Design by Coupling Matrix Synthesis," *Microwave Journal*, Vol. 53, No. 4, April 2010, pp. 218–226.
4. S. Shin and S. Kanamaluru, "Diplexer Design Using EM and Circuit Simulation Techniques," *IEEE Microwave Magazine*, Vol. 8, No. 2, April 2007, pp. 77–82.
5. M. Hagensen and A. Edquist, "Simplified Power Handling of Microwave Filters," *Microwave Journal*, Vol. 55, No. 9, September 2012, pp 130–139.
6. "Ansys HFSS," *Ansys*, www.ansys.com/Products/Electronics/ANSYS-HFSS.
7. "Advanced Design System (ADS)," *Keysight Technologies*, www.keysight.com/en/pc-1297113/advanced-design-system-ads.

New Symbolically Defined Model for InP Heterojunction Bipolar Transistors

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An accurate and compact large-signal model is proposed for modeling heterojunction bipolar transistors (HBT) fabricated on InP material. In DC mode, the model includes self-heating and soft-knee effects, as well as the temperature dependence of the model parameters. In small-signal mode, the model captures the variation of various AC parameters with bias. The procedure of extracting the model parameters uses DC and multiple bias S-parameter measurements. The validity and the accuracy of the large-signal model are assessed by comparing the simulation with measured DC characteristics, small-signal behavior and large-signal operation of an InP HBT.

The HBT is an attractive device for microwave and mmWave amplifier applications because of its high-power density. This is due to its vertical structure, which enables a large current handling capability.[1-2] For designers, it is important to use a reliable large-signal model, developed from the measurements under various bias conditions of the device, for an accurate prediction of circuit performance parameters, such as gain and distortion. This requires an accurate DC model, on the one hand, and a precise description of the variation of the small-signal intrinsic elements with bias and frequency, on the other. A number of articles have described the large-signal models of HBTs in an effort to create models that are valid over a wide range of operating biases and frequencies.[3-5] The basic physics of HBT operation can be described by back-to-back diodes and controlled current sources, as found in the Ebers-Moll (EM) and Gummel-Poon (GP) models. Following the same basic philosophy, a number of full-featured models are now available, such as the Agilent, Ferdinand-Braun-Institut fur Hochstfrequenztechnik (FBH) and University of California, San Diego models for III-V compound HBTs. Although these models are mature and allow for reliable simulations of nonlinear circuits, there are, and always will be, some challenges, such as operation under high-power conditions with distributed effects.[6]

The purpose of this article is to set up a self-built, flexible, nonlinear, large-signal InP HBT model implemented as a symbolically defined device (SDD) in a Keysight

ADS simulator. The large-signal model includes most characteristics of InP HBTs. The self-heating effect is expressed by a resistor-capacitor (RC) thermal sub-circuit. The soft-knee effect, which results from the potential spike in InP HBTs, is modeled with a bias-dependent collector resistance. With improving technology, new effects occurring in the device can be conveniently added to the SDD model. The validity and the accuracy of the large-signal model are assessed by comparing the simulation with measurements of DC characteristics, small-signal behavior and large-signal operation for a 1 x 10 μm² InP HBT.

HBT MODEL

The final model topology is shown in ***Figure 1***. At first glance, it resembles most HBT models, but the specifics of each component have been adapted to this transistor. Some elements have been borrowed from various studies and models by other researchers. The charge model is the same as that adopted by Rudolph and Doerner.[7] The base-collector, base-emitter and collector-emitter current formulations are based on classical temperature-dependent diode relationships. Self-heating is calculated using a simple, one-pole RC network, as is commonly used in nonlinear models such as Mextram, vertical bipolar inter-company (VBIC) and high current model (HICUM).

DC Characteristics

The DC equations are based on the VBIC model. The base-emitter and base-collector currents cover the ideal and non-ideal (recombination) behavior.

$$I_{bx} = I_{bxn} + I_{bxi} = I_{BXN}\left(\exp\left(\frac{V_{bxi}}{n_{XN}\cdot v_t}\right)-1\right) + I_{BXI}\left(\exp\left(\frac{V_{bxi}}{n_{XI}\cdot v_t}\right)-1\right) \qquad (1)$$

Two parallel diode currents are used: one for the "ideal" part (index I), the other for the "non-ideal" part (index N) of the base-collector or base-emitter current. The variable x in the formula is used to denote either base-collector (c) or base-emitter (e). I_{BXN} and I_{BXI} are the non-ideal and ideal saturation currents, respectively. n_{XN} and n_{XI} are the non-ideal and ideal current ideality factors, respectively. V_{bxi} is the junction voltage, and v_t is the temperature voltage. The diode current, I_{bcx}, is the extrinsic part of the base-collector current.

The collector current source I_{ce} is determined by the two transport current terms I_{cf} and I_{cr}:

$$I_{ce} = I_{cf} - I_{cr} = I_s\left(\exp\left(\frac{V_{bei}}{n_f\cdot v_t}\right)-1\right) - I_{sr}\left(\exp\left(\frac{V_{bci}}{n_r\cdot v_t}\right)-1\right) \qquad (2)$$

where I_s and n_f are the forward collector saturation current and ideality factor, respectively. I_{sr} and n_r are the reverse emitter saturation current and ideality factor, respectively.

For the DC characteristic, one of the most important physical effects of InP HBTs is the soft-knee effect. A physical reason for this phenomenon is that for high-level injection, the corresponding injected electron density increases, compensating for the collector doping concentration. When the electric field at the base-collector junction is sufficiently reduced, electron transport ceases to be primarily drift current. Meanwhile, the rising of the energy band at high current densities can block electron transport by band energy discontinuity. The effect is equivalent to an increase in collector resistance. The voltage drop in the collector resistance causes a reduction in the electric field at the base-collector junction. The resistor is modeled with a bias-dependent collector resistor R_{ci} in this work:

$$R_{ci} = aI_c^{\,b}\cdot\tanh\left(\frac{I_c}{I_0}\right) \qquad (3)$$

where a, b and I_0 are the fitting parameters.

Small-Signal Behavior

The charge model adopted is the same as that used in the FBH model, which itself is based on the Mextram formulation. Charge-based models tend to have better convergence properties and avoid nonphysical results, which may occur when using capacitance expressions. The depletion charge is given by:

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$$Q_{dep} = C_0 \left\{ \frac{V_d}{1-m}\left[\left(1-\frac{V_{j0}}{V_d}\right)^{1-m} - \left(1-\frac{V_j}{V_d}\right)^{1-m}\right] + \frac{V - V_j + V_{j0}}{\left(1-VF/V_d\right)^m} - \frac{V_d}{1-m}\right\} \quad (4)$$

where the voltage is limited to eliminate a pole in the charge function. Here, V_{jo} and V_d are the limited junction voltage and diffusion voltage, respectively, while C_0 is the junction capacitance at zero volts. There is also VF, a transition parameter related to the pole-elimination mentioned earlier. The junction grading coefficient, m, is typically between 0.3 and 0.5.

The diffusion capacitance/charge implementation is also based on the FBH model, as this model is intended for III-V HBTs, and considerable work has been done by its authors to accurately model HBT operation.[7-8] In this case, the diffusion charge is associated mainly with the base-emitter junction and is given by:

$$Q_{diff} = \left(\tau + \tau_t \Delta T\right) I_{cf} \quad (5)$$

where τ is the time constant of base-emitter diffusion capacitance, τ_t is the temperature parameter of τ and I_{cf} is the forward collector current. Although the temperature dependence is not very noticeable, the τ_t accounts for the temperature dependence of the base transit time.

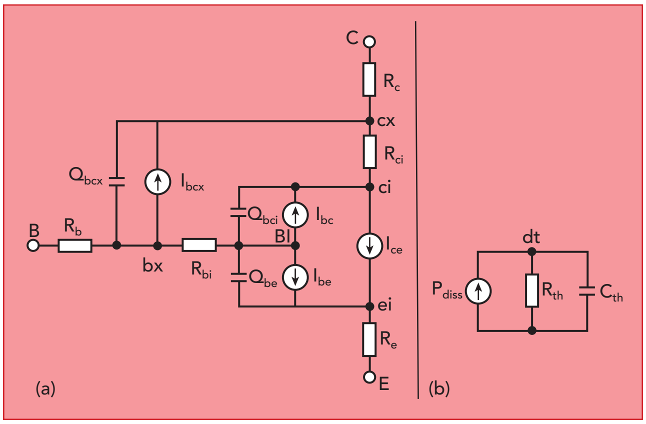


Fig. 1 Large-signal equivalent circuit (a) and thermal (b) models of an InP HBT.

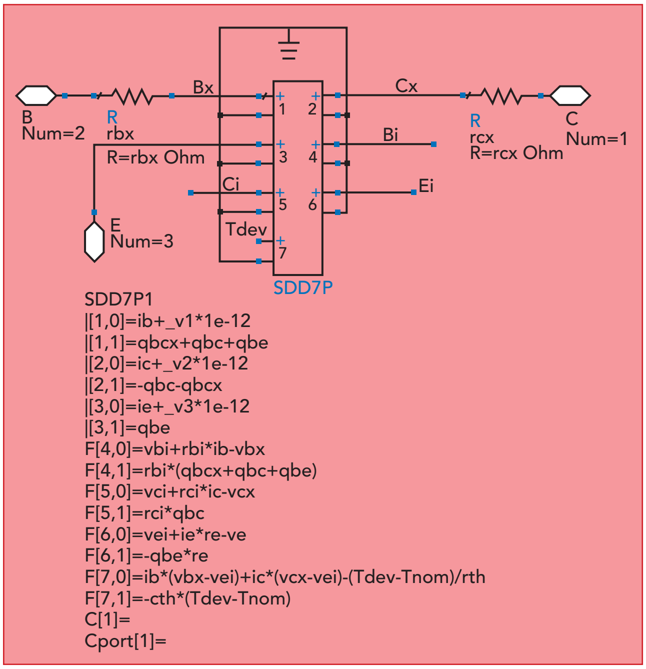


Fig. 2 ADS SDD model of the HBT.

The diffusion capacitance would normally apply to both the base-emitter and base-collector nodes. The reverse current is generally quite small (the base-collector junction is normally reverse biased), and most of the measurements were performed in the active region. It is not easy to extract this time constant for the base-collector diffusion charge, so an approximate value is used.

Thermal Network

The self-heating is defined by the thermal RC network (see Figure 1). The transistor's instantaneous dissipated power is used as the source for the thermal network. The RC network source and the temperature constitute a positive feedback. The phenomena can be expressed by the simulator to iterate a self-consistent solution. The equation is given as:

$$P_{diss} = \frac{\Delta T}{R_{th}} + C_{th}\frac{d\Delta T}{dt} \quad (6)$$

where $\Delta T = T_{dev} - T_{nom}$, T_{dev} is the transistor internal temperature and T_{nom} is the room temperature. C_{th} and R_{th} are the thermal capacitance and resistance, respectively.

MODEL VERIFICATION

The large-signal model shown in Figure 1 with the modeling equations were constructed in the Keysight ADS simulator using an SDD (see ***Figure 2***). The parameter extraction procedure starts with de-embedding the parasitic parameters, then extracts accessible resistances using fly-back measurements. The resistances are re-tuned to fit the S-parameters at cold-HBT conditions.[9-10] The small-signal intrinsic equivalent circuit parameters are extracted using direct techniques without the optimization reported previously. Large-signal intrinsic circuit parameters are extracted from a large number of small-signal S-parameters with multi-bias points.

A 1 x 10 μm^2 emitter InP HBT device was used to validate the model. DC, multi-bias, small-signal and large-signal microwave power characteristics were measured. The measured data was obtained on-wafer with an HP4145B semiconductor analyzer for DC, an HP8510C vector network analyzer for small-signal S-parameters from 0.5 to 40 GHz and a Focus microwave tuner at 15 GHz for source- and load-pull power measurements. The measurements were performed after the substrate was thinned to 100 μm, and the backside electroplated with gold.

Figure 3a shows the forward Gummel plots simulated from the model and the measured characteristics. Reverse Gummel plots are shown in ***Figure 3b***. Simulated and measured DC I_c-V_{ce} characteristics under constant I_b bias conditions are shown in ***Figure 4***. To demonstrate the validity of the model for small-signal microwave performance, the calculated S-parameters using the model are compared with the experimental results at two dif-

ferent bias points in ***Figure 5***. Reasonably good agreement is shown between the simulated and measured S-parameters. ***Figure 6*** shows measured and simulated large-signal microwave power characteristics at 15 GHz. Simulated data using the developed model agrees well with the measured data.

CONCLUSION

A new, large-signal InP HBT model that accounts for self-heating and soft-knee effects has been de-

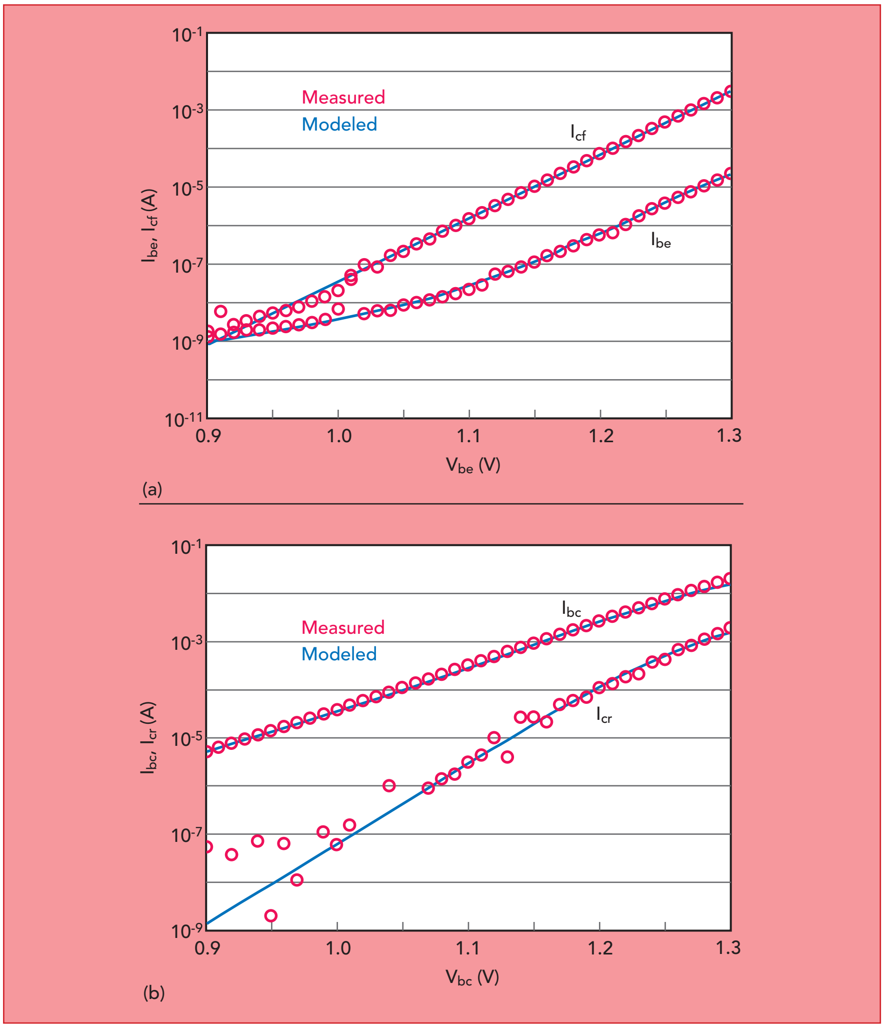


Fig. 3 Measured vs. modeled Gummel plots: forward (a) and reverse (b).

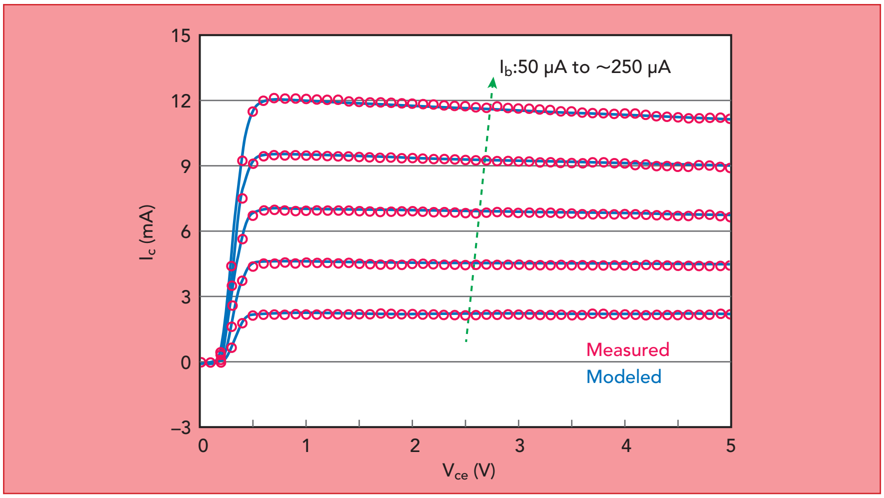
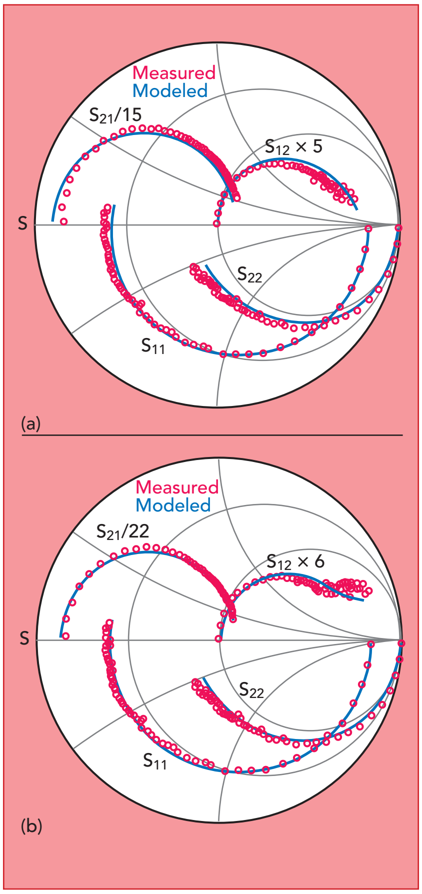
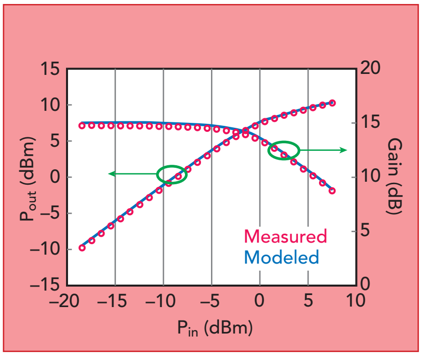


Fig. 4 Measured vs. modeled I_c vs. V_{ce}.

veloped and implemented in ADS. The impact of the soft-knee effect is successfully modeled with a bias-dependent collector resistor, R_{ci}, implemented as a function of three fit parameters and collector current. Good agreement between measurement and simulation using the developed model was achieved for DC, multi-bias small-signal and large-signal microwave power characteristics.■



▲ **Fig. 5** Measured vs. modeled S-parameters from 0.5 to 40 GHz for operating conditions of I_c = 9 mA, V_{ce} = 3 V (a) and I_c = 4.4 mA, V_{ce} = 3 V (b).



▲ **Fig. 6** Measured vs. modeled gain and output power vs. input drive at 15 GHz, with the HBT biased at I_c = 9 mA and V_{ce} = 3 V.

ACKNOWLEDGMENT

This work was supported by the Advance Research project of China and the Advance Research project of the People's Liberation Army (PLA) in China.

References

1. H. W. Liu and F. Tong, "Performance Improvement of Power Amplifiers Using an Asymmetrical Spurline Structure," *Microwave Journal*, Vol. 53, No. 1, January 2010.
2. W. L. Chen, X. Z. Liu, H. D. Wu and G. J. Wang, "A Wideband Chaotic Colpitts Oscillator with Negative Resistance Enhancement for UWB Applications," *Microwave Journal*, Vol. 58, No. 9, September 2015, pp. 88–96.
3. C. I. Lee, Y. T. Lin, B. R. Su and W. C. Lin, "SiGe HBT Large-Signal Table-Based Model with the Avalanche Breakdown Effect Considered," *IEEE Transactions on Electron Devices*, Vol. 62, No. 1, January 2015, pp. 75–82.
4. A. R. Testera, A. P. Perez, M. F. Barciela and P. J. Tasker, "Design of Injection-Locked Oscillator Circuits Using an HBT X-Parameters™-Based Model," *IET Microwaves, Antennas & Propagation*, Vol. 9, No. 4, March 2015, pp. 380–388.
5. B. R. Wier, K. Green, J. Kim, D. T. Zweidinger and J. D. Cressler, "A Physics-Based Circuit Aging Model for Mixed-Mode Degradation in SiGe HBTs," *IEEE Transactions on Electron Devices*, Vol. 63, No. 8, June 2016, pp. 2987–2993.
6. M. Rudolph, "Compact HBT Modeling: Status and Challenges," *IEEE MTT-S International Microwave Symposium Digest*, May 2010, pp. 1206–1209.
7. M. Rudolph and R. Doerner, "Consistent Modeling of Capacitances and Transit Times of GaAs-Based HBTs," *IEEE Transactions on Electron Devices*, Vol. 52, No. 9, September 2005, pp. 1969–1975.
8. M. Rudolph, R. Doerner, K. Beilenhoff and P. Heymann, "Scalable GaInP/GaAs HBT Large-Signal Model," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 48, No. 12, December 2000, pp. 2370–2376.
9. Y. B. Sun, J. Fu and J. Yang, J. Xu, Y. Wang, J. Cui, W. Zhou, Z. Wei and Z. Liu, "An Improved Small-Signal Model for SiGe HBT Under Off-State, Derived from Distributed Network and Corresponding Model Parameter Extraction," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 63, No. 10, October 2015, pp. 3131–3141.
10. T. K. Johansen, R. Leblanc, J. Poulain and V. Delmouly, "Direct Extraction of InP/GaAsSb/InP DHBT Equivalent-Circuit Elements from S-Parameters Measured at Cut-Off and Normal Bias Conditions," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 64, No. 1, January 2016, pp. 115–124.

Signal Generators Combine Performance and Usability

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The R&S SMB100B analog RF signal generator and the R&S SMBV100B vector signal generator set new standards in their class, offering unprecedented output power and outstanding spectral purity. The intuitive graphical user interface with a high-resolution touchscreen makes the instruments easy to use. Covering 8 kHz to 1, 3 or 6 GHz and offering various optional performance enhancements, the instruments can be tailored for applications in RF semiconductor development, telecommunications and aerospace and defense.

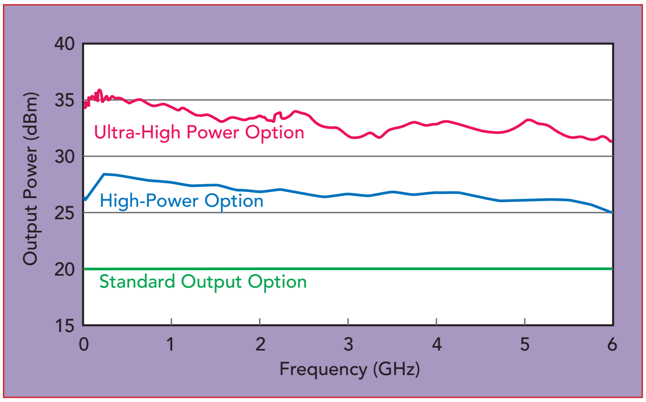

Fig. 1 **Two options enable the output power of the signal generator to be increased from the basic configuration.**

OUTPUT POWER OPTIONS

Applications such as interference testing or compensation of loss in test setups often require very high output power. This means that a signal generator must be combined with an amplifier connected to its output. The R&S SMB(V)100B offers a better alternative: three different RF output power stages can be chosen to increase the output power. The generators offer a calibrated one-box solution delivering up to +34 dBm output power at 1 GHz without an external amplifier (see ***Figure 1***). This integrated solution simplifies the test setup and eliminates downtime for calibration.

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The R&S SMB(V)100B features excellent absolute level accuracy: less than 0.5 dB between 200 kHz and 3 GHz and under

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ISO13316	Hermetic, GaAs SPST Non-Reflective Switch	DC to 6.000
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For applications including CBRS, FDD and TDD 2G/3G/4G LTE systems, small cell, micro and macro base stations, active antenna arrays and massive MIMO.

Part Number	Description	Freq. Range (GHz)
SKY6629x Series	High Efficiency Power Amplifiers	0.700 to 6.000
SKYFR-xxx	Circulators and Isolators	–

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For applications spanning fitness/smart watches, trackers, wireless headphones, in-home appliances, smart thermostats, alarms, lighting, sensors, access points, routers, automotive infotainment, telematics, and more.

Part Number	Description	Freq. Range (GHz)
SKYA21003	SPDT Switch (AEC-Q100 Level 2 Qualified)	0.100 to 6.000
SKYA21041	802.11ac Switch/Low Noise Amplifier Front-end Module (AEC-Q100 Qualified)	4.900 to 5.900
SKY66111-11	Front-end Module with Low Power, Bluetooth® Low Energy Range Extension	2.400 to 2.485
SKY66114-11	Front-end Module with Bluetooth® Low Energy / 802.15.4 / ZigBee® Support	2.400 to 2.483
SKY68001-31	LTE Universal Multiband Front-end Module for IoT	0.699 to 0.915 1.710 to 1.910
SKY85310-21	256 QAM WLAN/Bluetooth® Front-end Module	2.400
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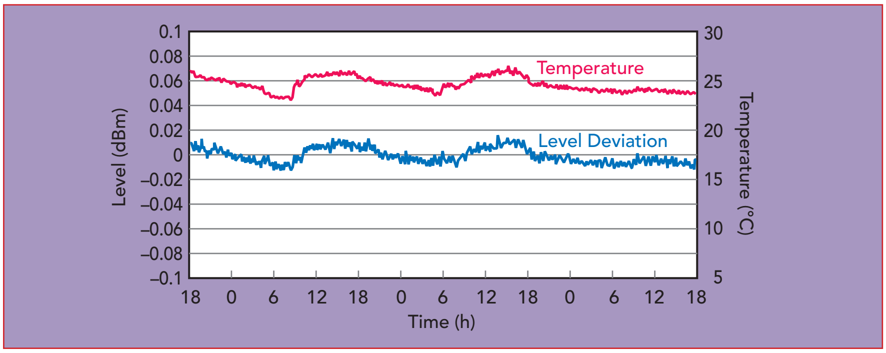
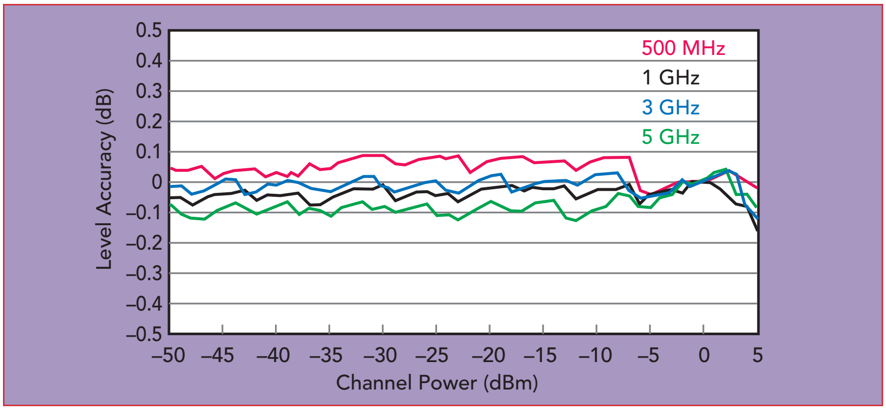
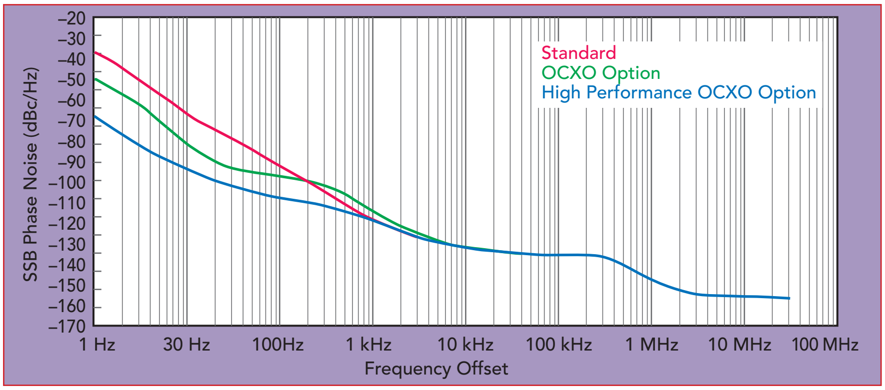


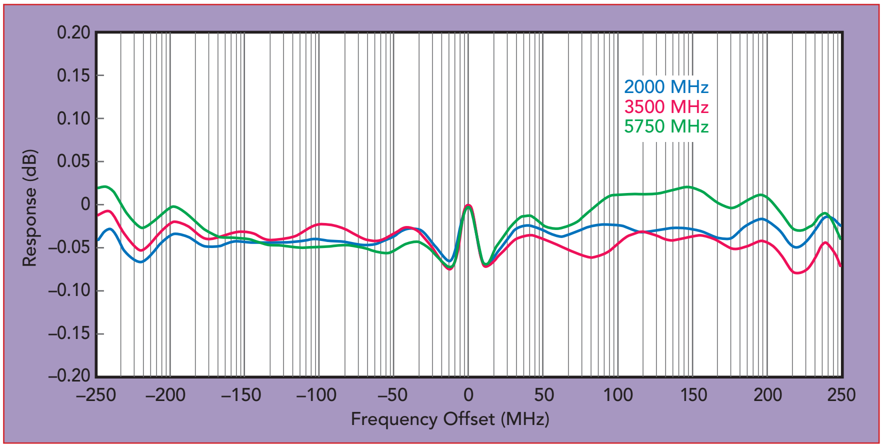
▲ Fig. 2 Measured power repeatability over three days, showing the accuracy of the 0 dBm level at 1 GHz. The output was alternated between 0 dBm (shown) and other power levels. The temperature variation vs. time is also shown.



▲ Fig. 3 Measured level linearity vs. test frequency, using an internally generated LTE downlink signal.



▲ Fig. 4 SSB phase noise of the base unit and OCXO options.



▲ Fig. 5 Measured frequency response vs. modulation bandwidth at three carrier frequencies.

0.7 dB above 3 GHz at levels above -90 dBm, which is best in class. Devices under test (DUT) are rarely connected directly to the generator; cables and other components typically connect the generator to the DUT, which shifts the reference plane from the generator's RF output to the DUT. Connecting an R&S NRP power sensor to the R&S SMB(V)100B via USB allows extremely precise calibration—to 0.1 dB—at the new reference plane, and the measured power can be read directly from the generator's display. The RF output power can be adjusted until the desired power at the new reference plane is reached.

LEVEL REPEATABILITY AND LINEARITY

After calibration, it is important for the generator to repeatedly set RF power levels for each test sequence with high precision. Here, the R&S SMB(V)100B delivers top performance with a level repeatability better than 0.02 dB (see ***Figure 2***).

Another critical parameter is level linearity; it is crucial for the generator to keep the deviation from the nominal power level extremely low across a wide amplitude range. Here the generator also excels, with an accuracy of better than 0.2 dB (see ***Figure 3***).

SIGNAL QUALITY

Single-sideband (SSB) phase noise and wideband noise are key parameters determining signal quality. Not only important in CW applications such as LO substitution, noise plays a significant role in digitally modulated signals, directly influencing the error vector magnitude (EVM). Thanks to its innovative synthesizer design, the R&S SMB(V)100B has very low SSB phase and wideband noise in the standard configuration, making it suitable for generating CW and digitally modulated signals with excellent quality.

The R&S SMB(V)-B1H high performance oven controlled crystal oscillator (OCXO) options further reduce the close-in SSB phase noise (see ***Figure 4***). This makes the R&S SMB(V)100B well-suited for demanding applications that require extremely low SSB phase and wideband noise. Other benefits of this option are significantly improved long-term stability of the reference frequency and greatly reduced temperature dependency.

WIDE MODULATION BANDWIDTH

To satisfy the need for broadband signal generation, the R&S SMBV100B is equipped with a high performance baseband with "intelligent" internal real-time frequency response correction, achieving extremely high amplitude flatness—better than 0.1 dB—over the entire RF modulation bandwidth of 500 MHz (see ***Figure 5***).

The R&S SMBV100B combines the large RF modulation bandwidth with the high signal quality, making it excellent for testing and characterizing wideband receivers and multicarrier amplifiers. With EVM less than 0.2 percent for 20 MHz LTE signals and less than 0.4 percent for 160 MHz IEEE 802.11ac signals, the R&S SMBV100B offers far better EVM performance than required for measuring a DUT. This ensures the true performance of the DUT is measured, allowing engineers to focus on the development, without having to worry about the performance of the signal generator.

A feature unique to the R&S SMBV100B is its excellent EVM performance at high output power levels: less than 0.4 percent for an LTE downlink signal with +18 dBm RMS output power.

EASY UPGRADING = SAFE INVESTMENT

The R&S SMB(V)100B signal generators feature a well-conceived upgrade concept, with options mainly added via software keycodes. Functions such as output power, frequency range and modulation bandwidth (in the case of the R&S SMBV100B) can be upgraded without requiring customers to send the instrument to a Rohde & Schwarz service center. This easy upgrading saves time and money and gives maximum flexibility. It makes the R&S SMB(V)100B signal generators a secure investment, well prepared to meet the needs of tomorrow.

VENDORVIEW

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Ku- and Ka-Band Intelligent Gain Blocks

Anokiwave
San Diego, Calif.

Anokiwave has introduced a family of four, single-channel, Ku- and Ka-Band silicon ICs offering complete transmit/receive functionality, including active gain and phase control. The architecture enables the ICs to be used as traditional gain blocks with the addition of gain and phase control—hence the name "Intelligent Gain Blocks" (IGB). This new family enables designers to use the same IC for multiple functions across the RF signal chain, achieving equivalent or better performance than traditional, discrete GaAs ICs and with increased software control. The versatile IC family can be used in a wide range of applications, including SATCOM, radar, 5G and sensing. The integration and small size allow the ICs to be used in radar or communications phased arrays, as well as replacing discrete, single function blocks.

Two of the four ICs in the IGB family cover 10.5 to 16 GHz (Ku-Band), and two cover 26 to 30 GHz (Ka-Band). Each IC contains a PA, LNA, 6-bit gain and phase control; two of the ICs—one in each band—have an integrated T/R switch at the front-end (see ***Figure 1a***). The two others eliminate the T/R front-end switch (see ***Figure 1b***), offering users the option to eliminate the switch loss. The performance of the IGB family is summarized in ***Table 1***.

Consider a few of the ways the IGBs can be used:

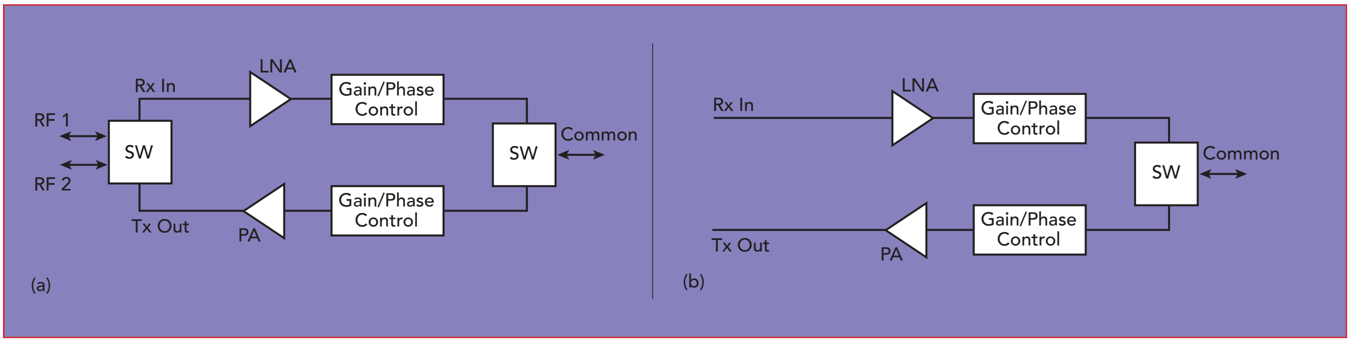
Core distribution ICs in active arrays: In 5G and SATCOM active antenna arrays, the challenge of compensating the array is unique because the RF input is split and combined multiple times to feed the beamformer ICs. Each split and combination causes gain and phase mismatch. While the beamformer ICs have built in gain and phase adjustment, they are typically designed to just steer the antenna beam. The IGBs can be used to provide the required gain and phase compensation within the array where the RF signal is distributed or combined (see ***Figure 2***).

Integrated blocks for alternate 5G architectures: For 5G architectures using a traditional column-fed architecture, the single-channel IGB can be used to replace the front-end control section with just a single IC for each column, as shown in ***Figure 3***. An IGB in this architecture simplifies the overall design, reducing size, parts count and the bill of materials cost compared to discrete parts.

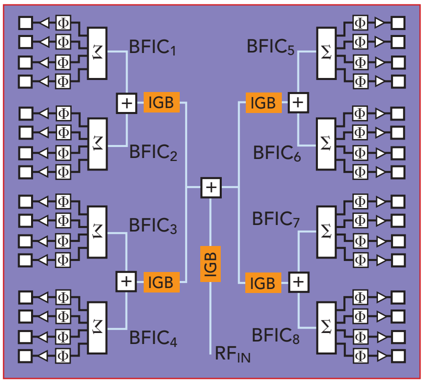
Single function blocks: The IGB integrates multiple RF functions within the same silicon IC; however, each can be used as a

TABLE 1
INTELLIGENT GAIN BLOCK PERFORMANCE

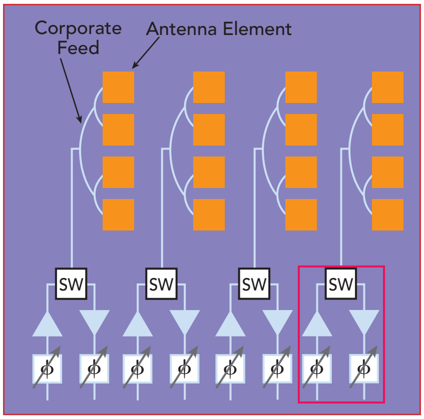
	With Antenna T/R Switch		Without Antenna T/R Switch	
	AWMF-0117	**AWMF-0116**	**AWMF-0141**	**AWMF-0143**
Frequency (GHz)	10.5 to 16	26 to 30	10.5 to 16	26 to 30
Tx P_{1dB} (dBm)	+12	+12	+13.5	+13
Tx Gain (dB)	24	18	24	18
Rx Noise Figure (dB)	3	5	1.5	3
Rx Gain (dB)	30	24	30	24
Rx IIP3 (dBm)	–19	–16	–19	–16
Gain Control	6-bit (LSB = 0.5 dB)			
Phase Control	6-bit (LSB = 5.625°)			
DC Power (mW)	200 Rx 250 Tx	220 Rx 370 Tx	200 Rx 250 Tx	220 Rx 370 Tx
Package	2.5 mm x 2.5 mm WLCSP			
ECCN	5A991.G	5A991.G	5A991.G	5A991.G



▲ Fig. 1 Functional block diagram of the Ku- and Ka-Band IGBs with (a) and without (b) the T/R switch at the LNA input and PA output.



▲ Fig. 2 The IGBs can be used to independently compensate amplitude and phase variations within the signal distribution section of a phased array.



▲ Fig. 3 In a column-fed phased array, a single IGB can control the amplitude and phase for a column, replacing multiple discrete functions.

discrete single function. The same IC can be used as a discrete LNA, with or without a front-end switch; a driver amplifier, with or without the switch; variable gain amplifier (VGA); phase modulator or full vector modulator. Fabricated with advanced silicon technology, the IGBs meet or exceed the performance of many traditional GaAs products.

Used as an LNA, the IGBs provide 1.5 dB noise figure at Ku-Band and 2.5 dB at Ka-Band, consuming only 200 mW DC at Ku-Band

and 220 mW at Ka-Band. With the added SPDT input switch, the noise figure increases to 3 dB at Ku-Band and 5 dB at Ka-Band. The DC power consumption remains the same.

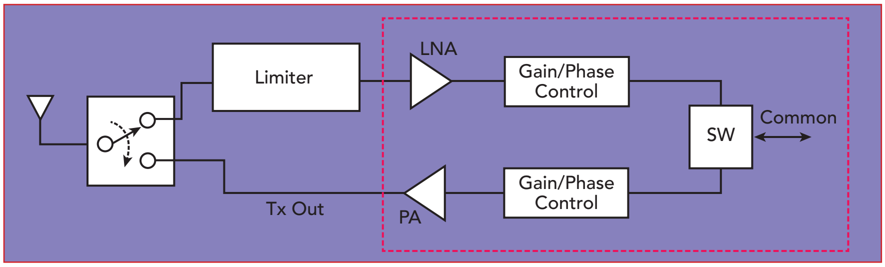


Fig. 4 The IGB integrates seven functions in a single, 2.5 mm x 2.5 mm IC.

Used as a driver amplifier, the IGBs provide high gain and medium output power: 13.5 dBm at Ku-Band and 13 dBm at Ka-Band at 1 dB compression, with gains of 25 and 19 dB, respectively. For system architectures requiring the SPDT switch, the output power at 1 dB compression is 12 dBm in both bands, with 24 dB gain at Ku-Band and 18 dB at Ka-Band. The ICs consume 250 mW at Ku-Band and 370 mW at Ka-Band.

As a variable gain amplifier, the ICs provide 25 dB maximum gain at Ku-Band and 19 dB at Ka-Band, and 31.5 dB dynamic gain control. The 6-bit design provides an LSB of 0.5 dB with a typical RMS amplitude error of 0.5 dB. The 1 dB compression point is 13.5 dBm at Ku-Band and 13 dBm at Ka-Band.

As a phase modulator, the IGBs have 6-bit phase resolution, i.e., an LSB of 5.625 degrees, with a typical RMS phase error of 5 degrees. The gain is 25 dB for the Ku-Band design and 19 dB for the Ka-Band version, with 1 dB compression points of 13.5 and 13 dBm at Ku- and Ka-Band, respectively.

Used as a vector modulator, the ICs have maximum gains of 25 dB at Ku-Band and 19 dB at Ka-Band, with 1 dB compression points of 13.5 and 13 dBm, respectively. The gain control range and resolution are the same as the VGA: 31.5 dB with 0.5 dB step size and 0.5 dB RMS error. Similarly, the 6-bit phase control has an RMS phase error of 5 degrees.

Integrated block: Taking advantage of the integration, the IGB can replace multiple RF functions with a single, small IC. As shown in ***Figure 4***, one IGB replaces seven, separate GaAs components with a single 2.5 mm x 2.5 mm IC, without compromising performance.

Anokiwave's new IGBs will redefine Ku- and Ka-Band designs. They are available in developer kits, small quantities for development programs and volume production quantities.

VENDORVIEW

Anokiwave
San Diego, Calif.
www.anokiwave.com

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Up to 30 GHz*

Applications:

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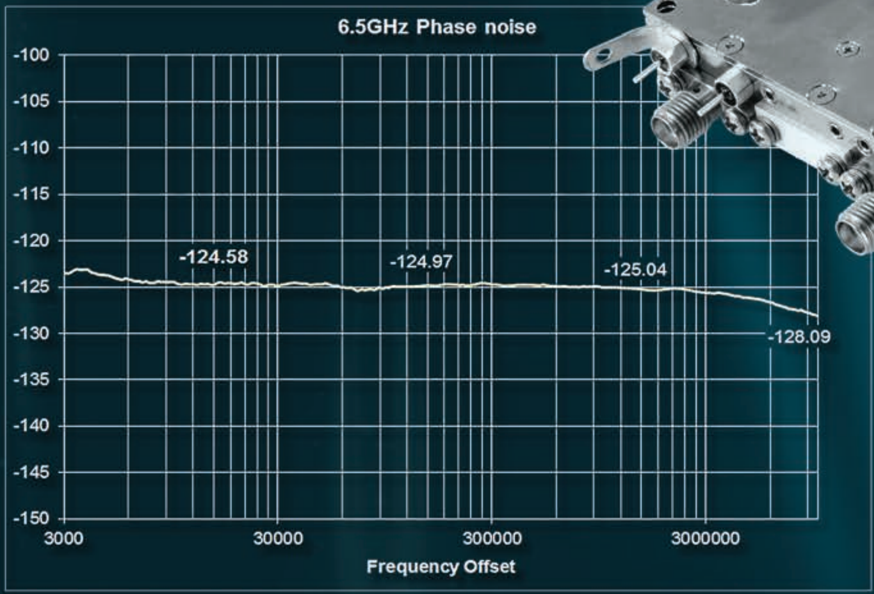
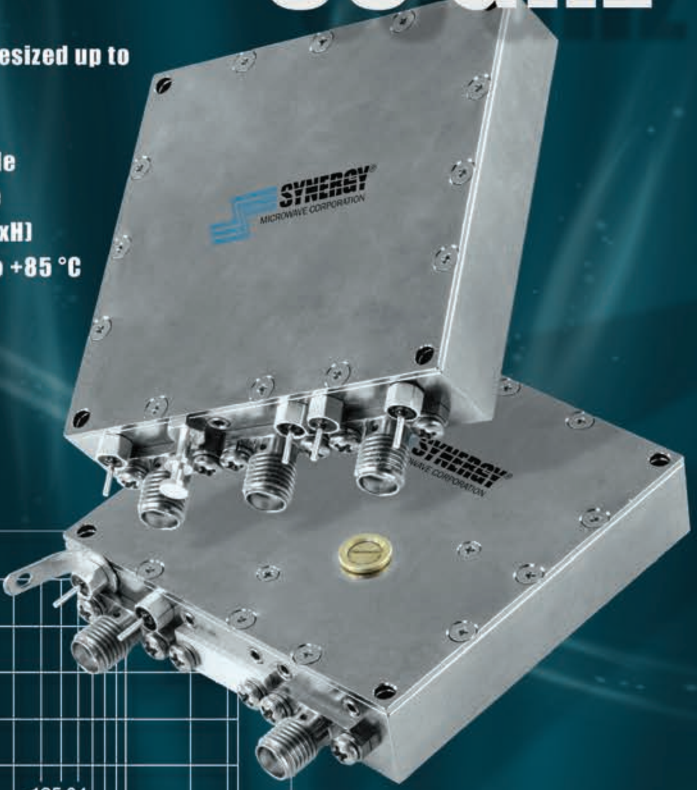
16 - 30 GHz with added x2 module < 1" in height.





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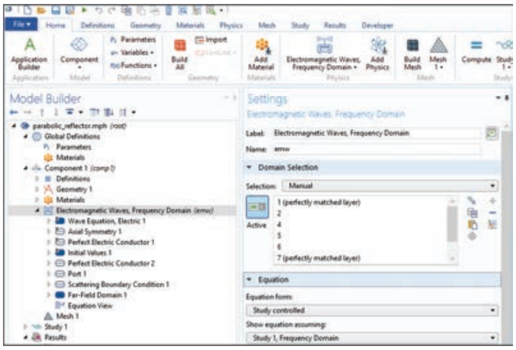

Efficient EM Simulation Using 2D Axisymmetric Modeling

COMSOL Inc.
Burlington, Mass.

In high speed communications, defense, SATCOM and Internet of Space applications, signal integrity matters and high gain antennas are needed to send signals over great distances while maintaining decent signal-to-noise ratio. To enhance the gain and directional properties of an antenna, engineers are frequently required to enlarge its physical size. When computing an electromagnetic (EM) wave propagation and resonance analysis, to address the increased computational cost for larger antennas, the latest version of COMSOL's Multiphysics® software exploits 2D axisymmetric modeling, using a technique available in the add-on RF Module.

SIZE MATTERS

Performing a full-wave simulation on a huge antenna can be very time consuming if every detail of the geometry is included. Even reducing the size using symmetric conditions, such as a perfect electric conductor and a perfect magnetic conductor based on the polarization and electric field distribution around the antenna, the analysis can still be memory intensive.

For example, ***Figure 1*** shows a small inflatable sphere structure with a radius of two wavelengths, partially plated with a conductive material. Simulation of this geometry requires more than 20 GB of memory to solve the full-wave equations using the finite element method. Analyzing the antenna accurately, including the effect of spillover, blockage from a feed horn and the secondary reflector, requires the full-wave equation. The calculated backscattering, far-field radiation pattern shows the size is not big enough to generate a high gain beam pattern.

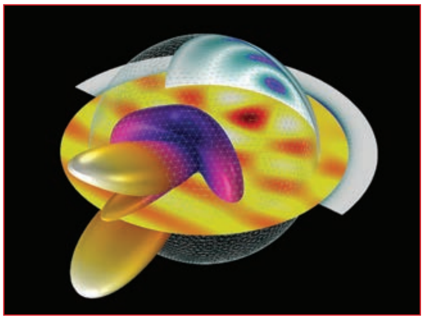

Fig. 1 Simulated scattering properties of a 3D inflatable reflector structure.

When the shape of an antenna is axially symmetric—for example, a parabolic satellite dish antenna, SATCOM inflatable antenna or circular or conical horn antenna with a corrugated dielectric lens—the entire 3D antenna geometry does not need to be modeled. The cross-sectional geometry information is sufficient to characterize antenna performance, such as the far-field radiation pattern, gain, directivity and impedance properties.

2D AXISYMMETRIC MODELING

When addressing a large antenna that is axially symmetric, the setup for the simulation becomes dramatically simple, requiring only the cross-sectional blueprint. The benefit of 2D axisymmetric modeling is the simplicity regarding the modeling configuration and computational cost.

Assume a reflector antenna with a radius greater than 20 λ and an axial feed circular horn antenna illuminating the reflector. Since the axial feed circular horn and parabolic re-

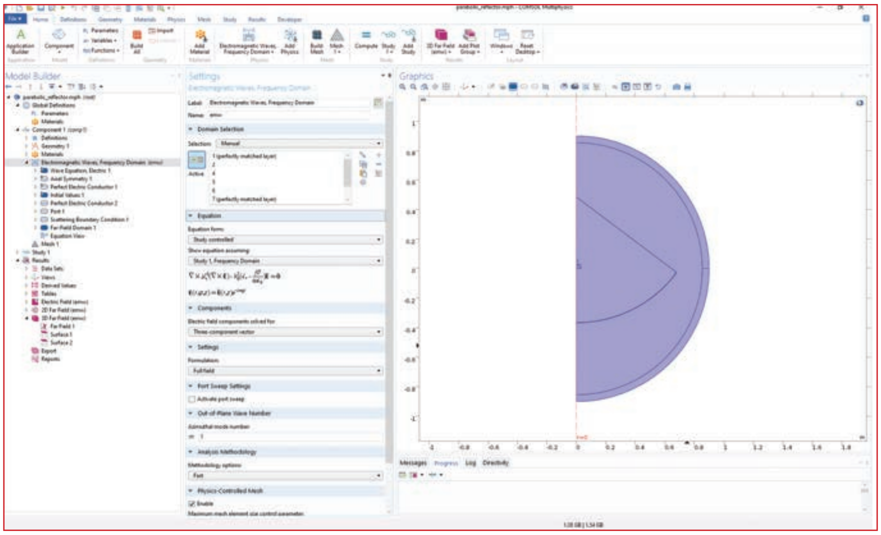

Fig. 2 Multiphysics 2D model of a reflector antenna with axisymmetric geometry.

flector antenna are solids of revolution, the antenna can be simulated using the 2D axisymmetric formulation of the EM wave equation (see ***Figure 2***).

Using a tutorial introduced with a recent update to the Multiphysics software, the metal surfaces are modeled as perfect electric conductors (PEC) and all domains are filled with air. The radius of the circular horn feed waveguide is 0.01 m and the cutoff frequency of the TE11 mode is approximately 8.8 GHz. The operating frequency of the antenna should be higher than the cutoff frequency. The horn aperture radius is 0.03 m, and the overall horn length is 0.06 m. A slit-conditioned interior circular port is assigned to the end of the waveguide to excite the antenna with the TE1m mode. The azimuthal mode number is set to one in the EM waves, frequency domain physics interface. The reflector is built using a 53 degree sector of a circle with a radius of 0.85 m. The conductive reflector body is removed from the model domain, where the EM wave cannot penetrate and, consequently, the PEC is automatically applied to its boundary. The model domains are enclosed by perfectly matched layers (PML) that absorb all the outgoing waves.

The far-field calculation boundary is specified to compute the radiation pattern. The mesh operation is performed based on the frequency used in the simulation (9.6625 GHz) via the physics-controlled mesh functionality in the RF Module, recently upgraded to handle frequency-dependent materials by way of interpolation functions. Through the physics-controlled mesh, the maximum mesh element size is set to 0.2 λ (five elements per wavelength) to ensure sufficient resolution of the wave. The PMLs are swept along the absorbing direction. With the relatively low degrees of freedom compared to a 3D model, the simulation takes less than 30 s to compute the S-parameter and far-field radiation pattern (see ***Figure 3***).

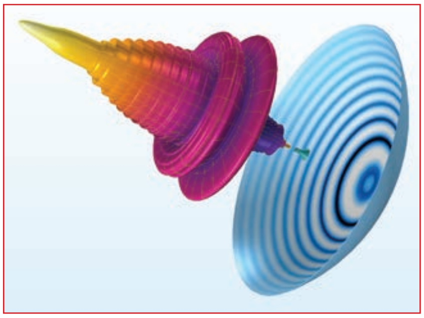

Fig. 3 Simulated radiation pattern of a parabolic dish antenna.

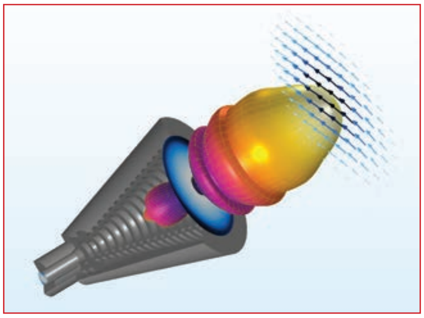

Fig. 4 Corrugated horn antenna simulation for minimizing the cross-polarization on the aperture.

3D ANALYSIS OF THE 2D AXISYMMETRIC SIMULATION

Post-processing the results in 3D takes advantage of the top-notch post-processing functionality included in the RF Module, which is more powerful with each new version release.

In a 3D model, the feed horn is excited by TE11, the dominant mode of a circular waveguide, while the 2D axisymmetric formulation with TE1 mode has the temporal and angular dependence of an exponential function defined by the azimuthal mode number m. Since the field propagates predominantly in the +z direction of the cylindrical coordinate, positive and negative values of m correspond to right-handed and left-handed circular rotation, respectively. A linear superposition of the m = +1 and m = -1 solutions leads to the 3D solutions excited by the TE11 mode, allowing examination of the cross-polarization to compare the linear polarization in the x and y directions at the exit of the horn (see ***Figure 4***).

FAST AND ACCURATE

Efficient modeling techniques with low computational cost and fast computational speed are critical for modern-day design and simulation of mmWave applications. The purpose of simulation is to describe real world devices and components as closely as possible through mathematical representation. When simulating and analyzing axisymmetric objects, such as spheres, conical dish antennas and circular waveguides, 2D axisymmetric modeling offers orders-of-magnitude faster computation compared to a full 3D model.

Simulating a simple-shaped structure may appear to be easy and fast without considering the impact of the electrical size of the model, in terms of wavelength. It is feasible to simplify the simulation process without losing accuracy with the support of 2D axisymmetric modeling, while sustaining the integrity required to analyze electrically large real-world components.

COMSOL Inc.
Burlington, Mass.
www.comsol.com

5 to 1218 MHz, 8 dB Coupler with 40 dB Isolation

MiniRF introduces the MRFCP0016, a patent-pending, high directivity coupler and the first in a planned family in the high directivity coupler (HDC) product line. The MRFCP0016 is a three-port, 8 dB coupler with 40 dB isolation across a very wide bandwidth: 5 to 1218 MHz. The coupler has excellent isolation and flatness, with less than 2 dB insertion loss and typical return loss of 20 dB. Coupling signals in either direction, the MRFCP0016 achieves high directivity between the receive and transmit channels over the full bandwidth.

Samples will be available in July, with evaluation boards available through RFMW Ltd., MiniRF's global distributor. MiniRF will release a four-port version of the coupler this fall and 16 and 20 dB versions are being developed. All HDC products will be offered in 0.375 in. long, 0.5 in. wide, 0.175 in. high surface-mount packages.

The MRFCP0016 coupler was developed for the new DOCSIS full duplex systems, yet can be used in numerous other applications. The HDC line is one of a broad range of high performance 50 and 75 Ω wire-wound magnetics products offered by MiniRF.

Passionate about passive components and committed to unequaled, quality reliability, MiniRF also offers custom designs and build-to-print manufacturing for the RF/microwave market. MiniRF designs and qualifies new products in the company's labs in Fremont, Calif.

VENDORVIEW

MiniRF Inc.
Fremont, Calif.
www.minirf.com
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EUROPEAN MICROWAVE WEEK 2018

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We're excited! European Microwave Week is coming to Spain for the first time ever! Being held in the effervescent and wildly exciting city of Madrid.

Bringing industry and academia together, European Microwave Week 2018 is a SIX day event, including THREE cutting edge conferences and ONE exciting trade and technology exhibition featuring leading players from across the globe. EuMW 2018 provides access to the very latest products, research and initiatives in the microwave sector. It also offers you the opportunity for face-to-face interaction with those driving the future of microwave technology.

EuMW 2018 will see an estimated 1,500 conference delegates, over 4,000 attendees and in excess of 300 international exhibitors (inc. Asia & US).

REGISTRATION TO THE EXHIBITION IS FREE!

- **Over 300 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
- **Industrial Workshops** - get first hand technical advice and guidance from some of the industry's leading innovators
- **MicroApps** - attend our annual European Microwave Week Microwave Application Seminars (MicroApps)

BE THERE

Exhibition Dates	Opening Times
Tuesday 25th September	09:30 - 18:00
Wednesday 26th September	09:30 - 17:30
Thursday 27th September	09:30 - 16:30

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

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- Receive a confirmation email with barcode
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- Alternatively, you can register onsite at the self service terminals during the Exhibition

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EUROPEAN MICROWAVE WEEK 2018
THE CONFERENCES

Don't miss Europe's premier microwave conference event. The 2018 week consists of three conferences and associated workshops:

- European Microwave Integrated Circuits Conference (EuMIC) 24th - 25th September 2018
- European Microwave Conference (EuMC) 25th - 27th September 2018
- European Radar Conference (EuRAD) 26th - 28th September 2018
- Plus Workshops and Short Courses (From 23rd September 2018)
- In addition, EuMW 2018 will include, for the 9th year, the Defence, Security and Space Forum on 26th September 2018

The three conferences specifically target ground breaking innovation in microwave research. The presentations cover the latest trends in the field, driven by industry roadmaps. The result is three superb conferences created from the very best papers submitted. For the full conference programme including a detailed description of the conferences, workshops and short Courses, please visit **www.eumweek.com**. There you will also find details of our Partner Programme and other Social Events during the week..

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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 up to and including 23rd August 2018
- **STANDARD RATE** – for all registrations made after 23rd August 2018

Please see the Conference Registration Rates table on the back page for complete pricing information. All payments must be in Euro – cards will be debited in Euro.

Online registration is open now, up to and during the event until 28th September 2018

DELEGATES

Registering for the Conference

- Register online at **www.eumweek.com**
- Receive an 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 22nd September (16:00 - 19:00)
- Sunday 23rd September (08:00 - 17:00)
- Monday 24th September (08:00 - 17.00)
- Tuesday 25th September (08:00 - 17.00)
- Wednesday 26th September (08:00 - 17.00)
- Thursday 27th September (08:00 - 17.00)
- Friday 28th September (08:00 - 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 2018, 23rd - 28th September, Madrid, Spain

Register Online at www.eumweek.com

ONLINE registration is open from 28th May 2018 up to and during the event until 28th September 2018.

ONSITE registration is open from 16:00 on 22nd September 2018.

ADVANCE DISCOUNTED RATE (up to and including 23rd August) STANDARD RATE (from 24th August & Onsite).

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

Eu*MA* membership fees: Professional € 25/year, Student € 15/year.

If you register for membership through the EuMW registration system, you will automatically be entitled to discounted member rates.

Reduced Rates for the conferences are also offered if you are a Student/Senior (Full-time students 30 years or younger and Seniors 65 or older as of 28th September 2018).

The fees shown below are invoiced in the name and on behalf of the European Microwave Association. Eu*MA*'s supplies of attendance fees in respect of the European Microwave Week 2018 are exempted from Spanish VAT.

ADVANCE REGISTRATION CONFERENCE FEES (UP TO AND INCLUDING 23RD AUG.)

CONFERENCE FEES	ADVANCE DISCOUNTED RATE			
	Society Member (*any of above)		Non Member	
1 Conference	Standard	Student/Sr.	Standard	Student/Sr.
EuMC	€ 470	€ 130	€ 660	€ 190
EuMIC	€ 360	€ 120	€ 510	€ 170
EuRAD	€ 320	€ 110	€ 450	€ 160
2 Conferences				
EuMC + EuMIC	€ 670	€ 250	€ 940	€ 360
EuMC + EuRAD	€ 640	€ 240	€ 890	€ 350
EuMIC + EuRAD	€ 550	€ 230	€ 770	€ 330
3 Conferences				
EuMC + EuMIC + EuRAD	€ 810	€ 360	€ 1140	€ 520

STANDARD REGISTRATION CONFERENCE FEES (FROM 24TH AUG. AND ONSITE)

CONFERENCE FEES	ADVANCE DISCOUNTED RATE			
	Society Member (*any of above)		Non Member	
1 Conference	Standard	Student/Sr.	Standard	Student/Sr.
EuMC	€ 660	€ 190	€ 930	€ 270
EuMIC	€ 510	€ 170	€ 720	€ 240
EuRAD	€ 450	€ 160	€ 630	€ 230
2 Conferences				
EuMC + EuMIC	€ 940	€ 360	€ 1320	€ 510
EuMC + EuRAD	€ 890	€ 350	€ 1250	€ 500
EuMIC + EuRAD	€ 770	€ 330	€ 1080	€ 470
3 Conferences				
EuMC + EuMIC + EuRAD	€ 1140	€ 520	€ 1600	€ 740

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.
Half day WITH Conference registration	€ 100	€ 80	€ 130	€ 100
Half day WITHOUT Conference registration	€ 130	€ 100	€ 170	€ 130
Full day WITH Conference registration	€ 140	€ 110	€ 180	€ 130
Full day WITHOUT Conference registration	€ 180	€ 140	€ 240	€ 170

Other Items

PRIVATE VISIT TO THE THYSSEN-BORNESMIZA MUSEUM & COCKTAIL DINNER – 26TH SEPTEMBER 2018

Tickets for the private visit and cocktail dinner at the Thyssen-Bornesmiza Museum are offered at the price of **€** 45. Tickets are limited and available on a first-come, first-served basis.

DELEGATE LUNCHBOXES

Subsidised lunchboxes for delegates, WS/SC, doctoral and student school attendees are being offered by EuMW at the reduced cost of **€** 5 per lunchbox (one per day).

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. The cost for an additional USB stick is **€** 50.

International Journal of Microwave and Wireless Technologies (8 issues per year)

International Journal combined with Eu*MA* membership:
€ 67 for Professionals or **€** 57 for Students.

EUMW 2018 WORKSHOPS & SHORT COURSES

SUNDAY 23rd September		
Full Day	WS-01	EuMC/EuMIC
Half Day AM	WS-02	EuMC/EuMIC
Half Day PM	WS-03	EuMC/EuMIC
Half Day AM	WS-04	EuMC
Half Day PM	WS-05	EuMC
Full Day	WS-06	EuMC/EuMIC
Half Day AM	WS-07	EuMC
Full Day	WS-08	EuMC/EuMIC
Full Day	WS-09	EuMC/EuMIC
Full Day	WS-10	EuMC
Full Day	WS-11	EuMC/EuMIC
Full Day	WS-12	EuMC/EuMIC
Half Day PM	SS-01	EuMC/EuMIC
Full Day	SS-02	EuMC/EuMIC
Full Day	SS-03	EuMC/EuMIC

MONDAY 24th September		
Full Day	WM-01	EuMC
Full Day	WM-02	EuMC
Full Day	WM-03	EuMC
Full Day	WM-04	EuMC
Full Day	SM-01	EuMC
Full Day	SM-02	EuMC
Full Day	SM-03	EuMC
Full Day	SM-04	EuMC

TUESDAY 25th September		
Half Day PM	WTu-01	EuMC

WEDNESDAY 26th September		
Half Day PM	WW-01	EuMC/EuRAD
Full Day	WW-02	EuRAD

THURSDAY 27th September		
Full Day	WTh-01	EuMC
Half Day AM	WTh-02	EuMC
Half Day PM	WTh-03	EuRAD
Half Day AM	WTh-04	EuMC/EuRAD
Half Day PM	WTh-05	EuMC
Half Day AM	WTh-06	EuMC
Half Day PM	WTh-07	EuRAD

FRIDAY 28th September		
Half Day AM	WF-01	EuRAD
Full Day	WF-02	EuMC
Full Day	WF-03	EuMC
Half Day AM	WF-04	EuRAD
Full Day	WF-05	EuMC
Full Day	WF-06	EuMC
Full Day	WF-07	EuMC
Half Day AM	SF-01	EuMC/EuRAD

SPECIAL FORUMS & SESSIONS

Date	Time	Title	Location	No. of Days	Fee	
Wednesday 26th September	10:50 - 17:50	Defence, Security & Space Forum	N101 + N102	1	€ 20 for delegates (those registered for EuMC, EuMIC or EuRAD)	€ 60 for all others (those not registered for a conference)
Monday 24th - Wednesday 26th September	08:30 - 17:50	European Microwave Student School	N107	One full day and two half-days	€ 40	
Monday 24th - Wednesday 26th September	08:30 - 17:50	European Microwave Doctoral School	N108	One full day and two half-days	€ 80	

Portable Cable and Antenna Analyzer Covering 560 to 2750 MHz

The iVA Cable & Antenna Analyzer is Kaelus' newest tool in a family of test & measurement equipment. This small, powerful analyzer dramatically reduces the test time to accurately measure and locate VSWR/return loss faults in RF infrastructure. The iVA is a rugged, battery-operated module that can be remotely controlled with any Bluetooth-enabled tablet, smart phone or any Kaelus iPA series PIM analyzer. This wireless connectivity enables greater measurement flexibility, opening up new possibilities for sweep and multi-port testing.

Covering 560 to 2750 MHz and able to perform a variety of measurements—return loss, distance-to-fault, cable loss, antenna isolation, spectrum monitoring and branch insertion loss—the iVA tests a wide range of cellular deployment scenarios. In most cases, the iVA connects directly to the device under test, eliminating the need for a phase-stable cable. The handheld iVA weighs only 1.5 lb (680 g) and is easily clipped to a tool belt for tower-top measurements, although the wireless remote control enables technicians to operate the device from the bottom of the tower.

An intuitive software interface enables users to generate complete test reports on site, eliminating post-site processing. The iVA includes an advanced geo-tagging feature, allowing users to plot all test measurements taken with any location-enabled device, to include in the test report. Recent software updates enable testing the recently-auctioned 600 MHz spectrum, which is being freed by TV broadcasters to add bands for LTE and 5G.

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Fulfill All Your RF & EMC Needs

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AR RF/Microwave Instrumentation's comprehensive catalog includes virtually everything necessary for RF and EMC testing. Find important information on everything from RF and microwave amplifiers to antennas, probes, analyzers, accessories and integrated test systems that make testing quicker, easier and more accurate. Discover innovative new products like MultiStar Field Analyzers, Test Systems and Receivers that use groundbreaking technology to perform multiple tasks simultaneously, reducing test times from days to hours. The latest developments in hybrid power modules and dual band technology are also represented here.

AR RF/Microwave Instrumentation
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New Multicoax Testing Solutions Overview

VENDORVIEW

HUBER+SUHNER offers a broad range of high-end RF test components and assemblies, developed and optimised for high speed digital testing. The Swiss company has published its new overview with MXPM coax testing solutions. It contains the next-generation multicoax interconnect MXPM, which is a future-proof solution that supports testings up to 67 GHz (with option to 85 GHz). By offering a high density (2.5 mm) pitch, the MXPM guarantees a satisfying experience with its user-friendly magnet mount connection, making performance and reliability affordable. It allows eight or 16 channel measurements.

HUBER+SUHNER
http://hubersuhner.com

Interface Gauge Kits

VENDORVIEW

A small investment will help to avoid trouble, means checking interfaces of connectors. The connector gauge kits of Spectrum Elektrotechnik GmbH are easy to use with direct reading and self-checking, measure the interface dimensions of coaxial connectors. The kits consist of gauges with specially developed dial indicators to mate with the individual connectors. A master setting gauge adjusts the dial indicator to zero, before mating with a connector to measure the interfaces. The gauges are sold as kits, or individual components, or replacement parts. Calibration service is provided as well.

Spectrum Elektrotechnik GmbH
www.spectrum-et.com

Website Products Updated

VENDORVIEW

Exodus Advanced Communications is frequently developing new products, which are updated n their website regularly. The Search function can be used to find the best match for your needs. Should you have a custom product request, you can submit your requirement on their website at any time or via email at sales@exoduscomm.com. Their engineering service group provides full design support, starting from the conceptual phase to prototype verification.

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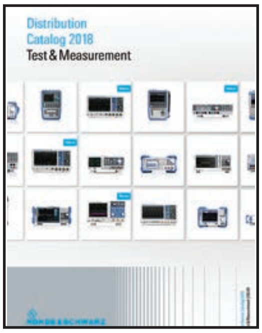
Innovative T&M Instruments, Budget-Friendly Price

VENDORVIEW



Whatever your job is, you do not always need the ultimate high-end test & measurement equipment. What you need are precise, reliable, universal measuring instruments. That is what you get from Rohde & Schwarz: their instruments combine practical features with excellent measurement characteristics; they are easy to use and easy on the budget. The Distribution Catalog 2018 presents a lot of new instruments of outstanding quality and innovation at a budget-friendly price. (Order number: PD 3606.6463.42)

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

Updated Mobile Communications Catalog

VENDORVIEW

SPINNER has just released a major update of its mobile communications catalog. It includes Site and In-Building products such as connectors, adaptors, jumpers, multiband combiners and systems for DAS, in addition to distribution products such as splitters, tappers and couplers, loads and attenuators, surge protectors and DC breaks. The update covers the entire 4.3-10 portfolio as well as combining and distribution products for up to 3800 MHz.

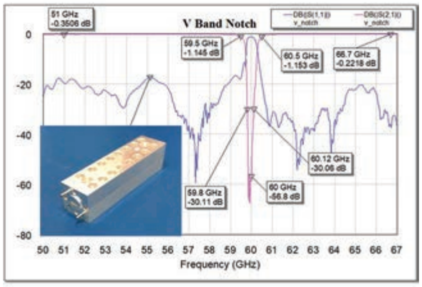
SPINNER
www.spinner-group.com

NEW PRODUCTS

FOR MORE NEW PRODUCTS, VISIT WWW.MWJOURNAL.COM/BUYERSGUIDE
FEATURING VENDORVIEW STOREFRONTS

COMPONENTS

V-Band Bandstop Filter
VENDORVIEW



Exceed Microwave's BSF-W-60000-1000-8-15 is a V-Band bandstop filter with a very narrow notch bandwidth and deep rejection. It provides more than 55 dB rejection at 60 GHz and the 1 dB roll off bandwidth is 1 GHz. The passband has very low insertion loss of less than 0.4 dB and return loss better than 17 dB. Exceed Microwave's narrowband bandstop filters can be custom designed for waveguide and coaxial at any frequency.

Exceed Microwave
www.exceedmicrowave.com

RF Combiner

Kaelus has released a new RF combiner that is suitable for outdoor and indoor applications. The DBC0113 dual-band combiner combines the 555 to 960 MHz and 1695 to 2690 MHz frequency bands and can be installed at either the BTS or antenna end of the feeder. The DBC0113 provides low insertion loss and high return loss with very low passive intermodulation performance in a lightweight package. The DBC0113 offers a traditional low/high diplexer function with DC Autosense functionality.

Kaelus
www.kaelus.com

MCV Suspended Substrate Filters
VENDORVIEW

MCV Microwave introduced a new series of suspended substrate bandpass filter, duplexer, triplexer and quadruplexer from 300 MHz to 30 GHz. These filters feature low PIM, low profile and high-power handling (100 W) in either surface mount or connectorized package. Wideband coverage such as 2 x Fc are particularly useful for 5G applications.

MCV Microwave
www.mcv-microwave.com

Broadband 2-Way TNC Power Dividers
VENDORVIEW

MECA Electronics' latest new product offering, 2-way compact broadband of power dividers covering 0.5 to 6 GHz (802-6-3.250) encompassing public safety through ISM bands. With typical performance of VSWR's of 1.20:1 and 1.25:1, isolation of 22 dB, insertion loss of 0.6 dB and exceptional amplitude and phase balance of 0.3 dB and 5 degrees max. This is in addition to the family of 2-, 4-, 8- and 16-way splitters in various connector styles and IP60 and 67/68 ratings. Made in the U.S., 36 month warranty.

MECA Electronics Inc.
www.e-MECA.com

USB/Ethernet Programmable Attenuator
VENDORVIEW

Mini-Circuits' RCDAT-30G-30 is a precision programmable attenuator covering an extremely wide bandwidth from 0.1 to 30 GHz with attenuation range from 0 to 30 dB in 0.5 dB steps. The device is controlled via either USB or Ethernet, allowing easy control directly from the user's PC or remotely over a network. It also allows daisy chaining of up to 25 attenuators through one USB or Ethernet connection to a single master unit.

Mini-Circuits
www.minicircuits.com

Cryogenic Waveguide Isolator

M Wave Design's cryogenic waveguide isolator line offers extremely low insertion loss. The WR42 isolator (Model #42IJ12xxK) boasts < 0.2 dB insertion loss over the 25 to 27 GHz band at 77°K, with improving response down to 7°K. Isolation and return loss are > 23 dB over the band. M Wave Design offers waveguide cryogenic isolator and circulator designs from 5 to 40 GHz.

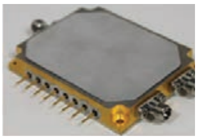
M Wave Design Corp.
www.mwavedesign.com

Bandpass Filter Skirts Telecom Bands

Response Microwave announced the availability of a new narrowband filter for use in specific telecom applications. The new RMFI.900-960Sf covers the 950 to 960 MHz band offering typical electrical performance of 1.5 dB max insertion loss, 18 dB min return loss and 50 dB min rejection over the 900 to 935 MHz band. The unit is operational over the -10°C to +85°C range and mechanical package is 3.6 in. x 2.0 in. x 0.7 in., plus SMA female connectors.

Response Microwave Inc.
www.responsemicrowave.com

18 to 40 GHz Frequency Doubler
VENDORVIEW



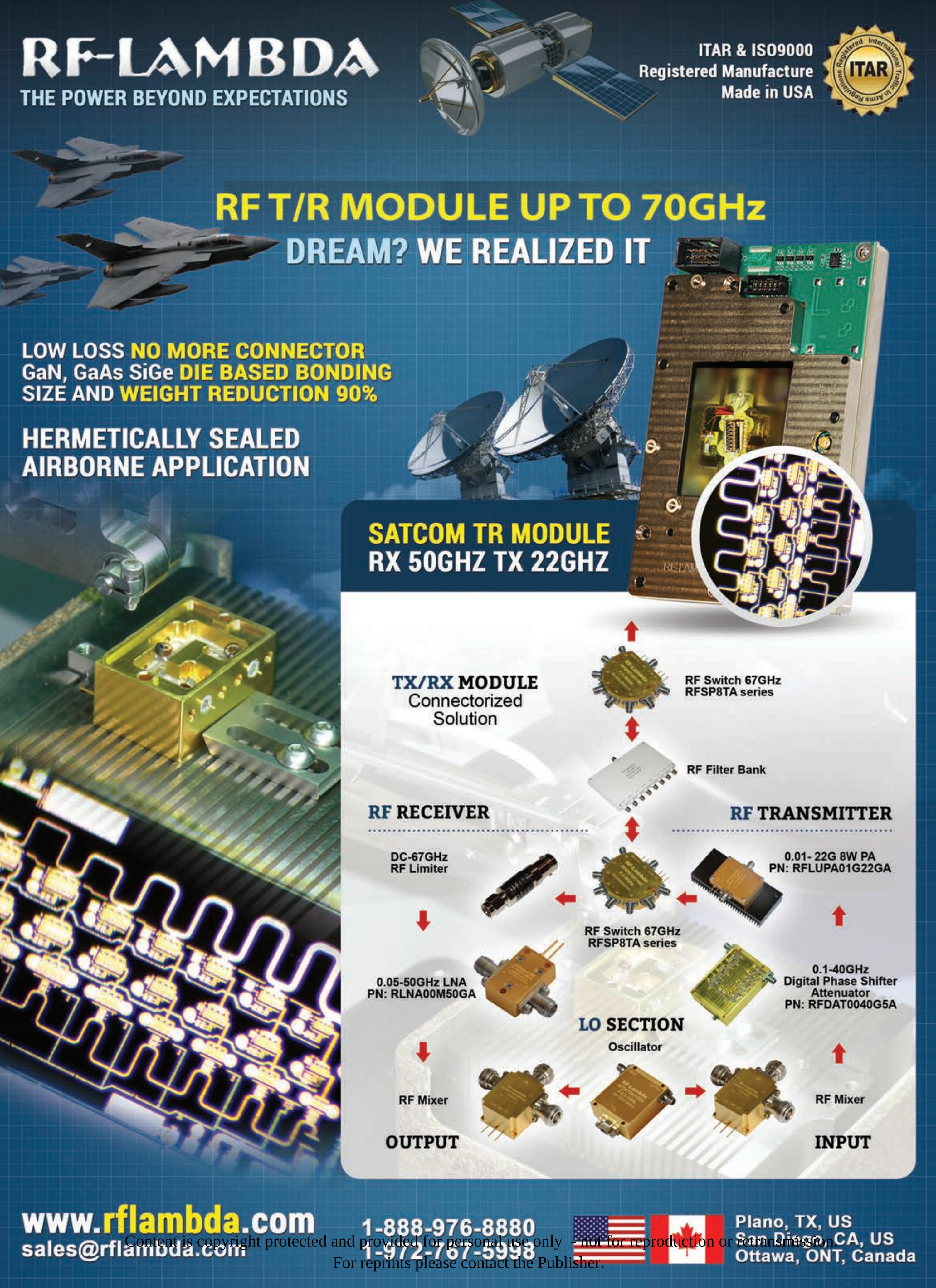
RFE has designed a convenient, cost-effective 18 to 40 GHz frequency doubler with a bypass mode. The input 0.5 to 20 GHz (+10 dBm input) is doubled using a passive multiplier with gain and filter blocks. The output 18 to 40 GHz produces +10 dBm with the Bypass mode having -5 dB loss. The output is divided into three sub-bands allowing harmonic filtering of -40 dBc. There is also fast blanking (10 usecs) of the doubled output.

RFE Inc.
www.rfe-mw.com

Absorptive Bessel Filters

RLC Electronics' fourth-order absorptive Bessel filters provide the excellent group delay response of Bessel filters, while maintaining impedance matching far into the stopband. Resistive elements are designed into these filters, resulting in a response that closely mimics the classic Bessel in both amplitude and phase. These filters are used in digital systems where truthful reproduction of waveforms is important. These filters are now available with -3 dB cut off frequencies as high as 30 GHz. A surface mount configuration is available to 4 GHz.

RLC Electronics Inc.
www.rlcelectronics.com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Solution
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RFSP8TA series
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RF TRANSMITTER
DC-67GHz
RF Limiter
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San Diego, CA, US
Ottawa, ONT, Canada

NewProducts

50 to 75 GHz Broadband Detector

Spacek Labs Model DV-2 is a full-band, 50 to 75 GHz detector. This detector is a very cost-effective way of measuring power in the V-Band spectrum. The RF input is WR-15 (UG385/U) and the output is SMA (F). These detectors can be used as fast data rate receivers, with up to 3 GHz bandwidth at the 3 dB point into a 50 Ohm load. Typical input sensitivity is 1500 mV/mW at -20 dBm input power.

Spacek Labs
www.spaceklabs.com

Conductive and Hybrid Conductive Aluminum Polymer Capacitors

Vishay Intertechnology introduced new conductive (184 CPNS, 185 CPNZ and 186 CPNT series) and hybrid conductive (182 CPHZ and 183 CPHT series) aluminum polymer capacitors in a variety of case sizes ranging from 4 by 4 by 5.5 mm to 10 by 10 by 12.4 mm. The Vishay BCcomponents devices offer longer lifetimes than do standard aluminum capacitors, and they provide higher ripple current and better impedance to save PCB space and lower costs.

Vishay Intertechnology Inc.
www.vishay.com

CABLES & CONNECTORS

High Speed Data Cables

GORE®Aerospace high speed data cables maintain stable communications on avionics networks in low-profile, flexible and routable designs. These high-speed copper and fiber optic cables support the latest open-source architectures and standardized protocols such as Ethernet, HDMI, USB, FireWire, Fibre Channel and more. Fully tested and qualified to stringent military specifications, Gore's extremely rugged products perform without failure in the most demanding environments they encounter such as complex routing and harsh operational conditions.

W. L. Gore & Associates Inc.
www.gore.com

AMPLIFIERS

GaN Solid-State Power Amplifier

Aethercomm model number SSPA 27.0-31.0-20 is a high-power, GaN solid-state power amplifier operating from 27 to 31 GHz. Nominal output power is 20 W typical. Typical power gain is 43 dB min. Input and output VSWR is 2.0:1 max. This SSPA can be blanked on and off in < 10 usec. OIP3 is 47 dBm min. This SSPA operates from a +28 VDC power supply. This power amplifier module operates from -40°C to +70°C base plate temperature.

Aethercomm
www.aethercomm.com

Hybrid Power Modules

VENDORVIEW

Now you can have Class A designs when linearity is the driving force, as in EMC and wireless applications or Class AB designs when increased power and efficiency is paramount for EW applications and reliability stress screening. Modular designs now provide up to 50 W Class A and 100 W Pout Class AB. Benchtop units can output up to 500 W CW.

AR RF/Microwave Instrumentation
www.arworld.us/html/11200_hybrid_modules.asp

Highly Integrated Amplifiers

Ciao Wireless features a line of highly integrated amplifiers for SATCOM and military/defense. Model CA0022-351560ADTCS exemplifies this product line with instantaneous frequency coverage from 10 MHz to 22 GHz, 35 dB gain, +15 dBm P1dB PT, low noise figure and includes temp comp, voltage variable gain attenuation (15 dB), integrated wideband output coupler and detected output with 10 dB min dynamic range and settling speed of 50 µs. Proven fielded reliability.

Ciao Wireless
www.ciaowireless.com

Full Band HF 1 KW Solid-State Amplifier

VENDORVIEW

Designed for enabling or disrupting HF signal transmissions, this durable and compact 1000 W, 1 to 30 MHz system amplifier is the newest member of Empower's next-generation product portfolio. Notably, the 2203 is built using the latest 50 V LDMOS device technology which lowers transistor count and reduces combining losses while increasing efficiency and reliability. The 2203 excels in multi-domain environments with optimized performance with any type of modulation including frequency hopping and complex digital modulation.

Empower RF
www.empowerrf.com


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NOT EXPENSIVE,
IT PAY$
ENGINEERS' RF SURGE
PROTECTION SOURCE
FOR TOTAL NETWORK
RELIABILITY.

NewProducts

High-Power Solid-State Amplifier

VENDORVIEW

The new AMP4065 18 to 26.5 GHz is a high-power solid-state amplifier. The AMP4065 system produces 40 W of CW power with a gain of 46 dB. This is a "state-of-the-art" power amplifier. The amplifier features its instantaneous wideband hybrid module design with built-in protection circuits for superb reliability and ruggedness. It is packaged in a 5U (8.75 in. H) chassis and is nominally 80 lb. This system is manufactured as standard with local/remote monitoring and control circuitry interfaces. Suitable for all lab applications.

Exodus Advanced Communications
www.exoduscomm.com

RF and Microwave Power Amplifier Accessories

Fairview Microwave has introduced a new family of RF and microwave power amplifier accessories that includes heat sinks, heat sinks with cooling fans and power control cable assemblies. The heat sinks in this line are ideal for thermal management of power amplifiers that can generate excessive levels of heat. These heat sinks are able to enhance heat dissipation from a power amplifier to ensure the internal circuit assembly does not overheat and optimum performance and reliability is maintained.

Fairview Microwave Inc.
www.fairviewmicrowave.com

SGA/SGN Series SSPA's

KRATOS General Microwave's SGA/SGN Series SSPA's offer GaAs/GaN technology reliability that can be customized to meet specific pulse or CW output powers. The product line supports both X- and Ku-Band applications with bandwidths up to 10 percent and offers peak power outputs up to 400 W. Designed for demanding defense, aerospace and SATCOM applications. General Microwave SSPA's have excellent power efficiency with demonstrated field proven performance and reliability. General Microwave's vertical integration process affords flexible layouts and architectures to meet individual specifications for electrical, mechanical and environmental parameters.

KRATOS General Microwave
www.kratosmed.com

Low Noise Amplifier

VENDORVIEW

PMI Model No. PE2-19-6G18G-1R6-16-12-SFF is a low noise amplifier that operates between 6 to 18 GHz. This LNA provides 19 dB of small signal gain while maintaining a low noise figure of only 1.6 dB. The P1dB output power of 15 dBm enables the LNA to function as a LO driver for balanced, I/Q or image reject mixers. This model also features I/O's that are DC blocked and internally matched to 50 Ohms.

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

High Performance CATV Amplifier

Richardson RFPD announced the availability and full design support capabilities for a low noise amplifier for CATV applications from MACOM Technology Solutions Inc. In a 75 Ω CATV application, the MAAL-011139 provides 21.5 dB of flat gain while biased from 3 to 5 V. It provides superior noise figure while maintaining excellent return losses, and gain and current may be optimized with adjustment of external component values. The new device is assembled in a SOT-89 plastic package.

Richardson RFPD Inc.
www.richardsonrfpd.com

SOURCES

Low Phase Noise Synthesizer

Synergy's low phase noise synthesizer model LFSW190410-12 offers wideband coverage of 1900 to 4100 MHz and has an interactive communication interface for easy use. This model provides typical low close-in phase noise of -82 dBc at 1 through 10 kHz offset and -105 dBc at 100 kHz. It also provides an excellent buffered output power of +7 dBm min., spurious suppression of 70 dB typ. and harmonics of 15 dB typ. Unit can be easily powered with +5 V supplies.

Synergy Microwave Corp.
www.synergymwave.com

SOFTWARE

Cadence® Virtuoso® RF Solution

The new Cadence® Virtuoso® RF Solution increases productivity and eliminates design failures caused by poorly integrated tools. It streamlines the RF design flow by using a single "golden" schematic to drive layout implementation, simulation and physical verification of the RF module while enabling simultaneous editing of multiple RFIC on the complex RF

New**Products**

module. The environment also includes smart integration of EM analysis tools that automates hours of manual work required to run EM simulations.
Cadence
www.cadence.com

ANTENNAS

Ka-Band Omnidirectional Antenna

VENDOR**VIEW**

Model SAO-2734030345-28-S1 is a full band, Ka-Band omnidirectional antenna that covers the frequency range of 26.5 and 40 GHz. This vertically polarized antenna offers 360 degrees azimuth coverage with a 3 dBi typ. gain and ±1 dB nominal gain flatness. The antenna features a half power beamwidth of 45 degrees in its vertical direction. The RF port of the antenna is equipped with WR-28 waveguide with UG-599/U flange. The version with a 2.92 mm (F) interface is offered under model number SAO-2734030345-KF-S1.

SAGE Millimeter
www.sagemillimeter.com

TEST & MEASUREMENT

Peak Power Measurement

Boonton strengthens its position as the peak power measurement leader with the introduction of the 4500C, its next-generation peak power analyzer. Designed to capture, display, analyze and characterize RF and microwave power in both the time and statistical domains, it is an ideal tool for design, verification and troubleshooting of pulsed and noise-like signals used in commercial and military applications. These applications include radar, EW, education and research, consumer electronics and wireless communications, including emerging standards such as LTE-A and 5G.
Boonton
www.boonton.com

New Signal/Spectrum Analyzers

VENDOR**VIEW**

The Ceyear AV4024 series handheld spectrum analyzer provides excellent performance at an affordable price. There are four different frequency ranges offered in this line-up to 44 GHz. Some of the features include field strength measurement, channel power, occupied bandwidth, adjacent-channel power ratio, tune and listen, carrier-to-noise ratio and emission mask. Some performance specs are 1 Hz to 10 MHz RBW, low DANL (-163 dBm at 1 Hz RBW), excellent phase noise (-106 dBc/Hz at 100 kHz frequency offset at 1 GHz carrier), full-band pre-amplifier and high speed sweep.
Ceyear
www.cc-globaltech.com

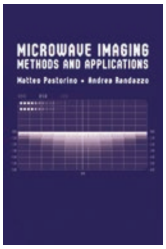
Calibrated Noise Standard NW346V Series

The NW346V series is the believed to be the broadest band calibrated noise standard available. The unit features a standard 15 dB nominal ENR value ideal for noise figure testing, operates with 28 V input and utilizes a V(m) output connector. Covering 10 MHz to 60 GHz, these units are compatible with standard noise figure meters as well as spectrum analyzers and networks analyzers. Applications include broadband test, MMIC noise figure and high speed serial digital characterization as well as satellite and military radio test.
Noisewave
www.noisewave.com

4-in-1 Calibration Kits

VENDOR**VIEW**

Pasternack has released a new line of 4-in-1 3.5 mm calibration kits for test and measurement, field testing, antenna measurement and cable verification applications. Pasternack's new series of calibration kits consists of two models, both with a compact, lightweight, 4-in-1 design package. These short-open-load-through (SOLT) calibration kits have a 26.5 GHz calibration capability. They feature gold-plated 3.5 mm connectors and a handy lanyard. Plus, they are available off-the-shelf and can be shipped immediately.
Pasternack
www.pasternack.com



Microwave Imaging Methods and Applications

Matteo Pastorino and Andrea Randazzo

Microwave Imaging Methods and Applications provides practitioners and researchers with a complete overview of the latest and most important noninvasive and nondestructive techniques for inspecting structures and bodies by using microwaves. Placing emphasis on applications, the book considers many areas, including medical imaging and security, industrial engineering and subsurface prospection. For each application, readers are presented with the objectives of the inspection and related challenges. Moreover, this groundbreaking resource discusses computational methods that can be used to solve inverse problems related to specific applications.

Including clear examples or the most significant practical results, this forward-looking reference focuses on systems that have been recently developed. Professionals gain the knowledge needed to compare imaging methods used in different applications and develop new uses of imaging apparatuses and systems.

Contents: Introduction; Basic Concepts of Microwave Imaging Systems and Electromagnetic Characterization of Materials; Fundamentals of Electromagnetic Imaging and Inverse Scattering; Microwave Imaging in Civil Engineering and Industrial Applications; Microwave Imaging for Biomedical Applications; Microwave Imaging for Subsurface Prospection; Microwave Imaging for Security Purposes; New Trends and Future Developments.

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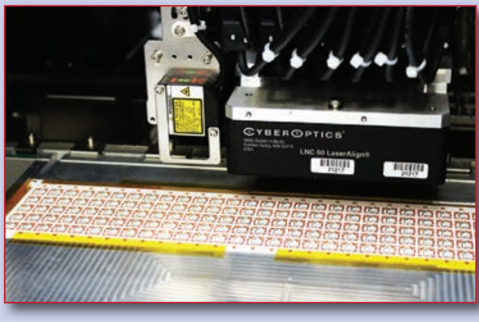
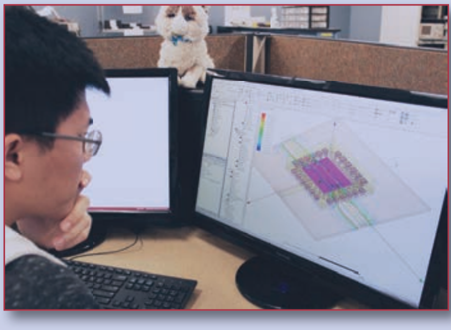
FABS and LABS

Focusing on the Technology, Marki Microwave Reinvents the Mixer





Say "mixers" and industry veterans will likely say "Marki Microwave." Founder Ferenc Marki spent his career designing mixers, beginning at Watkins Johnson in 1971, then starting his own company 20 years later. Now led by son Christopher, Marki Microwave has expanded its product portfolio and adopted MMIC technology, yet still nurtures the highly skilled assembly capabilities that differentiate the company's flagship mixers.

The MT3 mixer family is a good example of the marriage of hybrid and MMIC technologies. The original hybrid T3 (short for "two tone terminator") is a triple balanced mixer with hand-wound baluns, achieving multi-octave frequency coverage on the RF, LO and IF ports. A nearly ideal commutating mixer, the design optimizes intermodulation performance, with the input third-order intercept (IIP3) at least 10 dB—as high as 20 dB in some cases—above the LO drive level. Maintaining this performance, the MMIC version retains the hand-wound IF balun, while using planar circuits for the RF and LO baluns. Operationally, the MMIC design significantly boosts manufacturing capacity, reducing the backlog on the highly skilled assembly operators. In an industry driven to automate to reduce cost and increase volume, Marki takes a thoughtful approach, preserving its highly skilled assembly capability where it differentiates the performance of its products.

Marki's differentiation begins with design: a strong engineering team and a commitment to simulation. Since recruiting engineers mid-career is nearly impossible, given the cost of housing in the Bay Area, Marki has an active college intern program, drawing from top universities in California and around the country, such as Georgia Tech and the University of Illinois. For the engineering team, first-pass design success is the expectation, which is not unreasonable if the models are carefully constructed, particularly for EM simulation. Often, any discrepancy between measured data and simulation is traced to the measurement.

Except for circuit fabrication, Marki's manufacturing capabilities include all the processes required to build and test products internally. A hybrid line has highly skilled operators who hand wind cores and do precision soldering, a capability not available from outside contract manufacturers. Process steps that can be automated, such as epoxy and solder paste dispensing, resistor/capacitor placement and lid attachment, are performed with automatic manufacturing equipment wherever possible. The microelectronics lab assembles chip-and-wire circuits on GaAs, alumina, sapphire and Rogers substrates using ultrasonic wedge bonding. The deep-recess bonders have the capability to reach into packages and make short bonds, important for millimeter wave performance. Because Marki's products do not dissipate significant power, die are attached to the substrate or package with epoxy using automated pick and place equipment. Marki's test capabilities are also comprehensive, supporting both development and production and measuring from DC to 67 GHz.

GaAs foundries supply the passive circuits used in Marki's products, as well as fabricating several PHEMT distributed amplifiers designed by Marki and offered as catalog products. The designs were optimized to drive Marki mixers and achieve optimum linearity.

While the company name may be synonymous with mixers, this second-generation Marki is expanding beyond that legacy, adding amplifiers and passive products, strengthening millimeter wave capabilities and responding to market needs. As a company video states, "We focus on the technology, whatever it takes to make the best products with the biggest impact."

www.markimicrowave.com

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- Eg. RF Presence Status/Alarm (Safety Feature)
- Eg. Alarm, Activated Switch

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Interface (Via)

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- RS232, Serial
- RS485 - Form Addressable Serial Network
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✓ RoHS Compliant Design Available
✓ Custom Connector Configurations Available

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