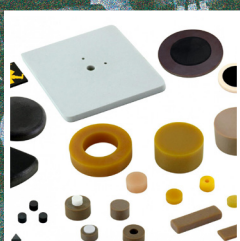
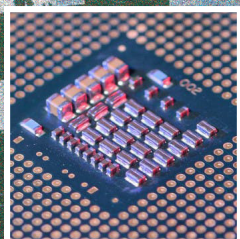
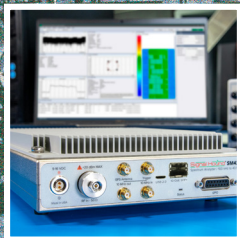


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A compendium of articles from
the editors of *Microwaves & RF*



International Microwave Symposium 2024 *in Review*

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International Microwave Symposium 2024 *in Review*

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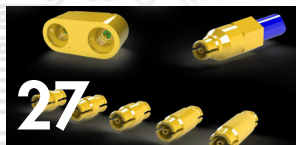
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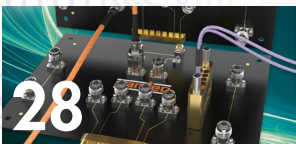
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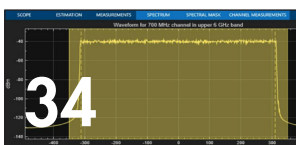
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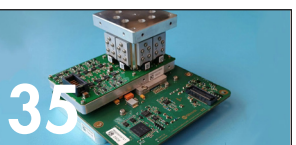
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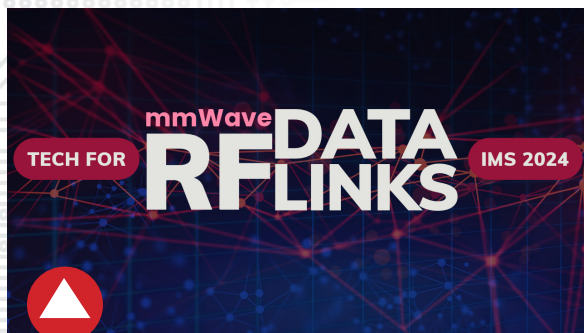
03

FEATURED COMPANY PROFILE:

smiths
interconnect



IMS 2024 Video/Podcast Coverage



SAMTEC DEMOS VARIOUS TECHNOLOGIES FOR HIGH-SPEED RF DATA LINKS

In this demo, cable assemblies team with high-density, open-field arrays and glass substrates to comprise a high-speed RF data link.



CORNING'S GOLD-PLATED PLASTIC MWAVE CONNECTOR

In a first, Corning now offers a connector that reduces costs and maximizes installation flexibility for telecom and aerospace applications.



INSIDE ELECTRONICS: RECAPPING IMS 2024 HIGHLIGHTS

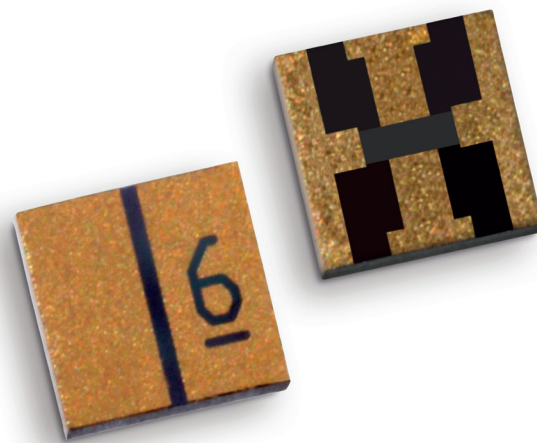
Editors David Maliniak and Bill Wong join Alix Paultre for an Inside Electronics podcast recounting highlights of their weeks at IMS 2024.



smiths interconnect

TSX Wire Bondable Fixed Chip Attenuator

Smiths Interconnect has extended its offering of high frequency surface mount chip attenuators with the release of its new TSX Wire Bondable Fixed Chip Attenuator Series, a small, easy-to-implement, high-reliability product qualified for space and defense applications. The new TSX Series WB2 Series is qualified to MIL-PRF-55342 and designed to offer excellent broadband performance up to 50 GHz, while delivering increased power handling in a small 0404 wire bondable package. It allows wider coverage than traditional components while providing optimized return loss for multiple frequency ranges. This allows the customer to use a single chip in multiple applications, reducing the Bill of Material (BOM) item count and consequently, the cost of ownership.



Specs and/or features:

- **Small form factor** – Reduces overall footprint
- **Space Qualified** – Per MIL-PRF-55342
- **Wire Bondable** – Ideal for chip and wire applications
- **Broad frequency range** – Reduces BOM count
- **Low VSWR** – Increases transmitted power
- **Wide range of attenuation values** – 1-10, 15, 20 and 30dB
- **Tight attenuation tolerance** – For optimal performance





Introduction

International Microwave Symposium 2024 in Review



DAVID MALINIAK, *Executive Editor, Microwaves & RF*

Now that 2024's edition of the **International Microwave Symposium** (IMS, Washington, D.C., June 16-21) is a fond memory, we can look back at it with some perspective and consider what it meant for the design community as it moves forward. Despite it being a very hot week in our nation's capital, IMS 2024 filled the Walter E. Washington Convention Center with a large coterie of more than 500 exhibitors. In any given year, it's hard to come away from IMS without renewed enthusiasm for our industry and its ongoing creativity. A busy exhibit hall and packed technical sessions indicates that the RF/microwave industry is alive, well, and primed for growth.

It's important to take a good look at the exhibits and absorb the fine points of technical presentations as discrete points of interest. Perhaps, though, it's more important still to try to piece together those discrete points into discernable trends. That's what I've attempted to do in the opening trends article of this eBook.

Within this eBook, you'll find a selection of the most impressive product launches at IMS as well as links to some of the many videos we captured of interesting demonstrations. All told, we hope it provides you with at least a glimpse of the broad palette that IMS brings each year.



credit: Avmedved | Dreamstime.com

CHAPTER 1:

The Microwaves & RF Industry Converged at IMS 2024

JACK BROWNE, Technical Contributor, *Microwaves & RF*

The latest in components, MMICs/RFICs, PCB tech, CAD software, and RF test were all at the industry's main event in Washington, D.C.

Representing an industry that's grown steadily with the world's adoption of radio waves prior to World War II, the annual IEEE MTT-S International Microwave Symposium (IMS) offers the opportunity to catch up with friends and competitors. The exhibition floor is crowded with small and large RF/microwave companies and visitors hoping to learn more about their products and services.

For specifiers, the 2024 IMS Exhibition (June 18-20, 2024, Walter E. Washington Convention Center, Washington, DC) afforded the chance to explore products that may make a difference in the latest communications, electronic-warfare (EW), radar, and other high-frequency systems. It's a popular portion of the [IEEE MTT-S International Microwave Symposium](#), which ran from June 16-21, 2024 and included a host of practical educational events such as the Automatic RF Techniques Group (ARFTG) meeting to broaden RF/microwave measurement expertise.

The 2024 IMS Exhibition promised to simulate an RF/microwave "department store" of products and services, from the smallest semiconductor integrated circuits (ICs) and surface-mount-technology (SMT) components to complete systems and test-and-measurement equipment.

Walking the floor in hopes of finding a solution for a set of specifications for a design in progress takes time, especially with the many attention-grabbing booth displays promoting new levels of performance over extended frequency ranges. More companies than ever offer products into the millimeter-wave (mmWave) frequency range to meet the growing needs of applications such as 5G wireless communications networks and advanced driver-assistance system (ADAS) equipment.

Personnel at company booths on the IMS exhibition floor are typically knowledgeable and courteous, often presenting "live" demonstrations of new products under exhibition often contain new hardware and software for visitors to operate and evaluate with a

connected device under test (DUT). Researchers can collect stacks of datasheets and application notes to assist with a future project.

With over 500 exhibitors, not all will be included in this short roundup of the 2024 IMS Exhibition. But some exhibitors with recent product introductions are featured here, organized by product categories to aid specifiers in search of a particular product or service. As specifiers usually learn, walking a show floor with such a variety of products, many of them developed for introduction at the event, could easily take a day or two. But when the search leads to a meaningful relationship with a future supplier, it can be time well spent.

Components: MMICs, Filters, Passives, and Transmission Lines

Visitors in search of high-frequency active and passive components found a sampling of one of the industry's most comprehensive lineups from [Mini-Circuits](#). With a long history of reliable discrete and monolithic-microwave-integrated-circuit (MMIC) active and passive components, the company has built a sizable inventory of low-temperature-cofired-ceramic (LTCC) filters and switches, including surface-mount bandpass filters in packages as small as 0603 size.

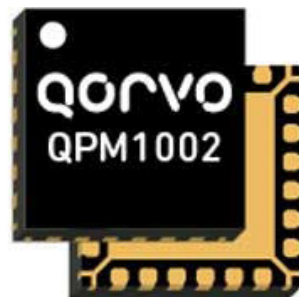


1. The SSG-44G-RC is a modular signal generator with low phase noise from 0.1 to 44.0 GHz. Mini-Circuits

Though best known as a component supplier, Mini-Circuits also offers practical test equipment such as the SSG-44G-RC signal generator (**Fig. 1**). Capable of pulsed and continuous-wave (CW) output signals from 0.1 to 44.0 GHz, the source features a dynamic range of -40 to $+17$ dBm. Controllable with a PC and free software via USB or Ethernet ports, it produces CW signals and pulses as narrow as $0.5 \mu\text{s}$ available at a 2.92-mm female connector. Typical phase noise is -102 dBc/Hz offset 10 kHz from a 10-GHz carrier.

Component specifiers were treated to an exhibit hall full of coaxial and SMT components at the 2024 IMS exhibition. They ranged from building-block components such as resistors, capacitors, and inductors from [Kyocera AVX](#) to a low-loss Butler matrix from [Krytar](#) supporting beamforming and direction-finding (DF) systems from 0.5 to 40.0 GHz.

[Herotek](#) displayed a variety of wideband amplifiers spanning 10 MHz to 20 GHz in drop-in packages. Among them were the AF0012073A low-noise amplifier (LNA) with 3-dB noise figure and 17-dB gain flat to ± 1.0 dB from 10 MHz to 20 GHz. [Narda-Miteq](#) highlighted components and integrated assemblies into the mmWave frequency range in support of 5G and radar systems.



2. Qorvo's QPM1002 front-end module (FEM) targets X-band radar systems from 8.5 to 10.5 GHz. Qorvo

Among its assortment of surface-acoustic-wave (SAW) filters and power amplifiers (PAs), [Qorvo US](#) showed GaN-on-SiC technology with its model QPM1002 MMIC front-end module (FEM). For X-band radar systems from 8.5 to 10.5 GHz, it combines a low-noise amplifier (LNA), PA, and transmit/receiver (T/R) switch in a 5.0×5.0 mm, surface-mount QFN package (**Fig. 2**). It handles input signals as high as $+33$ dBm (2 W) without a limiter.

RF/microwave specifiers found a diversified display of



component solutions on an exhibition floor that included trusted suppliers such as [RLC Electronics](#) with mechanical switches and filters and [Flann Microwave Ltd.](#) with passive waveguide components like adapters, power combiners/dividers, and transmission lines to 1.1 THz. Others included [Communications & Power Industries](#) with amplifiers and traveling-wave tubes (TWTs) for high-power radars, and [Micro Lambda Wireless](#) with electronically tunable YIG filters and oscillators.

RFICs, SIPs, SoCs, and Power Devices

Semiconductor-driven devices were shown in many forms, from chip and packaged power transistors to system-in-package (SiP) and system-on-chip (SoC) devices. [Analog Devices](#) presented some of its thermally efficient gallium-nitride (GaN) PA ICs as well as more highly integrated examples of its semiconductors like its new model ADSY1100 RF/microwave transceiver that operates to 20 GHz.

Housed in a compact package that meets Sensor Open Systems Architecture (SOSA) requirements, the transceiver includes Ethernet and Optical Ethernet computer interfaces to 100 Gb/s. It incorporates several high-performance field-programmable gate arrays (FPGAs). ADI's AD9084 SoC transceiver packs four receivers and four transmitters in a 24- × 26-mm, 899-ball ball-grid-array (BGA) package.

[Texas Instruments](#) also offered a wide range of highly integrated semiconductor devices, including GaN power stages like the recently introduced LMG2100R044 and LMG3100R017 100-V devices. Designers seeking mmWave radar sensors for guidance in automotive and robotic systems can turn to the firm's AWRL1432 and IWRL1432 single-chip 76- to 81-GHz radars that integrate multiple receive and transmit channels in miniature packages. Suitable for short-range applications, the devices have built-in power management, self-test, and calibration functionality.

With its acquisition of [Wolfspeed](#) late in 2023, [MACOM](#) added to its assortment of semiconductor products with GaN and GaN-on-silicon-carbide (GaN-on-SiC) RF power devices, both types capable of delivering high power outputs from small packages. As an example, the CGHV59350 GaN-on-SiC PA for 5.2- to 5.9-GHz C-band radar can be supplied in a ceramic-metal flange or pill package. It provides 10.7-dB power gain and 60% typical power-added efficiency (PAE) over that range while delivering 470-W typical pulsed output power.

At higher frequencies, the MAAP-001379 distributed PA employs gallium-arsenide (GaAs) pseudomorphic high-electron-mobility-transistor (pHEMT) technology for 22-dB linear gain and +30-dBm (1 W) saturated output power from 20 to 55 GHz. Additional high-power-density semiconductor devices were shown by [Polyfet RF Devices](#) with its silicon LDMOS and GaN FET devices.

PCBs, Laminates, and Packaging

Several of the IMS technical presentations explored the use of additive manufacturing and three-dimensional (3D) printing techniques to produce shape-sensitive circuits and components such as phased-array antennas. However, most specifiers will still need more traditional printed-circuit-board (PCB) materials.

They found such options from the Advanced Electronics Solutions (AES) group of [Rogers Corp.](#) The company's RO3010 and RO4003C laminates are widely used in RF/microwave circuits through mmWave frequencies. Ceramic-filled polytetrafluoroethylene



(PTFE) RO3010 laminates are usable to 77 GHz with a dielectric constant (Dk) of 10.2 and low dissipation factor (Df) of 0.0022 at 10 GHz. For circuit designers preferring to start with a lower Dk, RO4003C laminates have a Dk of 3.38 with Df of 0.0027 at 10 GHz.

With even lower Df values, TerraGreen 400G and TerraGreen 400G2 laminates from [Isola Group](#) are halogen-free materials that support analog PCBs into the mmWave frequency range and digital circuits at speeds to 100 Gb/s and more. The glass-filled circuit materials can be processed with FR-4 methods and standard PCB fabrication equipment.

TerraGreen 400G, with a typical Dk of 3.15 at 10 GHz, has a typical Df of 0.0017. It features a high-temperature composition, with glass transition temperature (Tg) of typically +200°C and decomposition temperature (Td) of typically +380°C. TerraGreen 400G2, the company's latest circuit material for 5G systems, high-end computing, and advanced wireless communications, has a typical Dk of 3.10 at 10 GHz with Df of typically 0.0015. Both circuit materials support PCBs with data rates past 100 Gb/s.

When faced with designing and producing large, multilayer circuits based on flexible and rigid circuit materials, [Amphenol Printed Circuits](#) provides the capabilities and experience to handle designs with as many as 70 circuit layers.

[Northrop Grumman](#) showed its novel hypersonic materials. Handling speeds greater than 1 mile/s, these materials must withstand temperatures exceeding +2000°F for hypersonic missiles as well as counter-hypersonic systems. Although showing materials, Northrop Grumman is well-known as a systems house and represented one of many systems suppliers at the 2024 IMS exhibition, including [Mercury Systems](#), [Teledyne Technologies](#), and [The Boeing Co.](#)

CAD Software: FEA, SI, and EMI Analysis

RF/microwave engineers in need of computer-aided-design (CAD) software were able to compare a variety of programs at the 2024 IMS exhibition from many developers, including [Ansys](#), [Cadence Design Systems](#), [COMSOL](#), [MathWorks](#), and [Sonnet Software](#). For example, among its many finite-element-analysis (FEA) software tools, Ansys showed SiWave software for signal-integrity (SI) analysis, power-integrity analysis, and EMI analysis of IC packages and PCBs.

COMSOL's MultiPhysics software can adapt to different forms of computer analysis with add-on modules that support functions such as mechanical and thermal analysis. MathWorks demonstrated several of its math-based tools, such as MATLAB and Simulink. And Sonnet's EM-based simulators are well-established for modeling high-frequency analog and high-speed digital PCBs.

Although best known for its test equipment, [Keysight Technologies](#) contributed to a strong CAE software showing at the exhibition. Its EM-analysis-based Pathwave ADS 2024 for RF & Microwave Circuit Design is well-suited for modeling ICs and highly integrated modules through mmWave frequencies.

RF Test & Measurement: VNAs, Signal Generators, and Scopes

In addition to powerful design software, Keysight led a strong lineup of test-equipment suppliers at the 2024 IMS exhibition. Along with its audio analyzers, digital storage oscilloscopes (DSOs), signal generators, and spectrum analyzers, Keysight visitors were able to see its PNA family of vector network analyzers (VNAs), which feature impressive 110-dB dynamic range through mmWave frequencies. The PNA N5290A two- and four-port VNAs

operate from 900 Hz to 110 GHz while the PNA N5291A two- and four-port VNAs add frequency extenders for coverage from 900 Hz to 120 GHz.

[Maury Microwave](#) showed examples of its load-pull systems working with VNAs. For its part, [Marvin Test Solutions](#) touted its digital multimeters (DMMs) and source measure units (SMUs) in PXI form.

Known for portable spectrum analyzers and digital storage oscilloscopes (DSOs), [Tektronix](#) generated test signals with its AWG70000B Series arbitrary waveform generators (AWGs). Models operate to 50 Gsamples/s with better than 20-GHz bandwidths and 10-bit resolution. Programmable signals exhibit -80 -dBc spurious-free dynamic range (SFDR).

For spectrum analyzer enthusiasts, [Signal Hound](#) displayed its compact but powerful SM435C spectrum analyzer (**Fig. 3**) with frequency range of 100 kHz to 43.5 GHz in booth 1209.



3. The SMA435C modular spectrum analyzer is controlled by a PC and software for measurements from 100 kHz to 43.5 GHz.

The exhibition floor abounded with test-equipment demonstrations from many notable suppliers. They included [Anritsu](#) with Spectrum Master portable spectrum analyzers to 170 GHz, [Boonton Electronics](#) with RF power meters, [Copper Mountain Technologies](#) with USB VNAs, [Focus Microwaves](#) with mmWave load-pull tuners, [GGB Industries](#) with 110-GHz Picoprobe probe cards, and [Rohde & Schwarz](#) with mmWave component testers.

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credit: Joe Ravi | Dreamstime.com

CHAPTER 2:

Expanding Your Cranium at IMS 2024 in Washington

DAVID MALINIAK, Executive Editor, *Microwaves & RF*

The annual International Microwave Symposium delivered its typically stellar technical program, offering an array of educational and career-boosting opportunities to attendees.

At any given industry convention or trade show, much of the convention center floor space is typically given over to the exhibits. There, you can wander through [aisle after aisle of booths](#) in which vendors will tell you all about their latest and greatest offerings.

I did just that at this year's [International Microwave Symposium](#) (IMS, Walter E. Washington Convention Center, Washington, D.C., June 16-21, 2024). Our [IMS show preview article](#), authored by industry veteran Jack Browne, provided a teaser of some of what was displayed on the show floor.

But the deeper value of IMS, year after year, is found on other floors of the convention center in the form of the [technical program](#). Whereas the exhibits were where you could learn about the “now,” the technical sessions were gatherings that offers previews of the future. At these sessions, the industry’s leading thinkers and movers dropped tantalizing hints to what’s coming three, five, and 10 years down the road.

The program also provided several “boot camps” at which one could catch up on the trends driving the industry. For example, the [Quantum Boot Camp](#) explored the ephemeral and still-developing nexus of quantum physics and microwave engineering. There, one could get a feel for where your skills fit into this emergent and dynamic niche.


In addition, a full slate of workshops targeted everything from [power-amplifier design](#) to [flexible arrays](#) to [“chipletization.”](#) If you were looking to explore employment opportunities or just make friends with like-minded peers, several [networking events](#) were helped for groups such as Women in Microwaves, Young Professionals, and Amateur Radio enthusiasts.

Bottom line: There was something for everyone at IMS 2024, whatever your interests or proclivities may be.

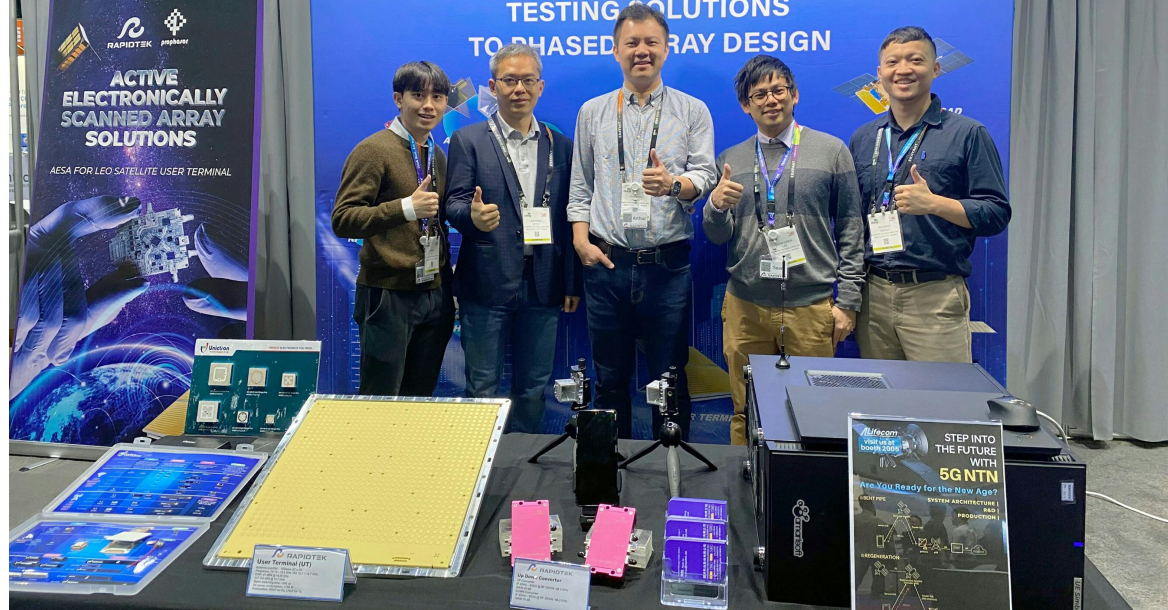


An Overview of the IMS 2024 Technical Program:

- [IMS Plenary Session](#)
- [IMS Closing Session](#)
- [Technical Sessions and
Interactive Forum](#)
 - [Workshops](#)
 - [Panel Sessions](#)
- [Tutorial Preview Series](#)
 - [Quantum Boot Camp](#)
 - [AI/ML Boot Camp](#)
 - [WPT Boot Camp](#)
 - [RF Boot Camp](#)
- [MicroApps Seminars](#)
- [Industry Workshops](#)
 - [Future G Summit](#)
- [Women in Microwaves](#)
 - [StartUp Program](#)

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CHAPTER 3:

What You Missed at IMS 2024

MWRF STAFF

So you weren't able to join us for IMS this year? Dive into this tour of the show-floor aisles and we'll get you caught up.

Here, we offer a roundup of coverage from the 2024 edition of the [International Microwave Symposium](#) (IMS) in Washington, D.C.

[Reactel](#) offered its full line of application-specific RF, microwave and mmWave filters, multiplexers, and multifunction assemblies, with an emphasis on devices at up to 67 GHz. The AS9100-accredited vendor's devices are well-known among prime military contractors such as Lockheed Martin, L3Harris Technologies, BAE Systems, and Northrop Grumman in ground, airborne, and space applications.

Visit [Reactel's website](#) to grab the company's new short-form catalog of bandpass, lowpass, highpass, and notch filters in various topologies including tubular, LC, cavity, waveguide, ceramic, and suspended substrate.

[Analog Devices](#) had its typically dominant presence at IMS, both on the show floor and in the technical sessions. The booth was bursting with demos of products for the aerospace/defense, instrumentation, power, and cloud/communications markets. One that was particularly interesting is an 8T8R Open RAN radio-unit reference design. Aimed at helping reduce design times, the Kerberos reference design is for O-RAN-compliant split 7.2A applications.

On the aerospace/defense side, there was a selection of demos of ADI's [Apollo MxFE](#), a mixed-signal front-end that was the talk of IMS 2023 in San Diego. One year hence, ADI returned to display the device's depth and breadth of application versatility. It offers sampling rates of up to 40 Gsamples/s.

[Nuvotronics](#) In its booth, the company displayed its line of mmWave/RF systems for high-frequency applications. In its booth, the company staged demos of:

- *Filters* delivering narrowband machined filter performance or wideband performance using the company's PolyStrata suspended substrate technology. The easy-to-integrate devices come in an SMT form factor with a 100X smaller volume than

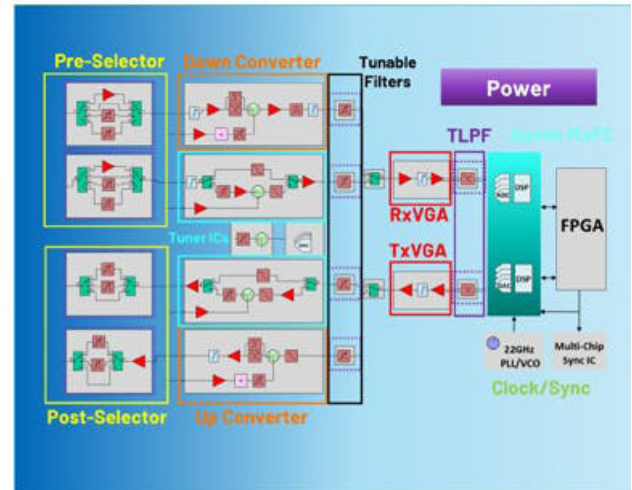
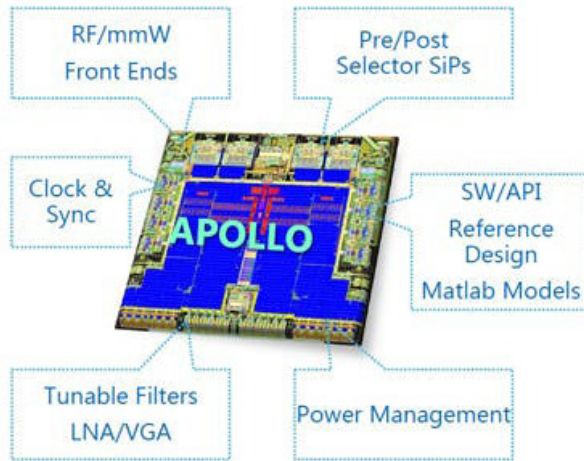


Apollo MxFE - Ecosystem



ADI's Apollo MxFE mixed-signal front end will be demonstrated in a variety of contexts at IMS 2024.

Analog Devices



conventional filters,

- *Combiners* for solid-state power amplifiers in ultra-broadband and mmWave applications; these devices come in a connectorized fixture that is 100X smaller at 1% of the weight compared to conventional waveguide combiners, and
- *Couplers* that provide size, weight, and performance advantages in SMT form factors with 6X to 10X size reductions.

[Jariet Technologies](#) has expanded its flagship Electra-MA family of data-converter transceivers. The expanded portfolio addresses the needs of radar, satellite communications, test equipment, and quantum computing with offerings from 100 MHz to 36 GHz and

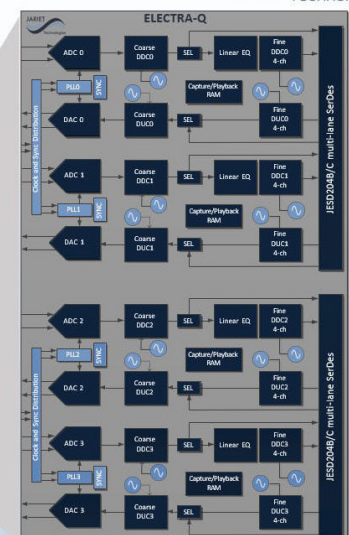
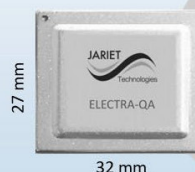
Jariet's Electra family of transceiver ICs includes the Electra-Q, a 64-GS/s device with up to 6.4 GHz of instantaneous bandwidth.

Jariet Technologies

Electra-Q 64 GSPS, 4x4, Digital RF Transceiver IC



- 4 Channel Rx, 4 Channel Tx
- 40-64 GS/s, 10-bit ADC/DACs
- 0.1 – 36 GHz frequency coverage
- Up to 6.4 GHz instantaneous bandwidth
- Excellent analog performance
 - SFDR ~ 80dB in X band in 170MHz IBW
 - NSD ~ -153 dBFS/Hz at X band
- On-chip calibration
- Capture/Playback RAM
- DDCs, and DUCs
 - x8 to x1024 (IBW of 39 MHz to 6.4 GHz)
- Multi-chip synchronization
- 2x 16 lane, 30 Gbps JESD204B/C





increased port density. The Electra platform provides direct RF sampling from VHF to Ka-band at ADC/DAC sample rates up to 64 Gsamples/s.

The devices' 36-GHz bandwidth enables software-defined radio (SDR) applications at double the frequency previously possible and with signal instantaneous bandwidth (IBW) up to 6.4 GHz per converter. Electra is said to more than triple the clock rate of the nearest competitor's ADC, and more than double the nearest DAC. The 10-bit, 64-Gsample/s ADCs deliver 10 dB better noise spectral density (NSD) and 17 dB better noise figure (NF) at 9.5 GHz than the best 14-bit ADCs.

[Keysight Technologies](#) hosted several demonstrations of its capabilities in test methodologies and EDA tools:

Wideband active load-pull: Showcased [Keysight's](#) newly introduced [wideband active load-pull](#) (WALP) capability using a dual-channel VXG-C vector source and a PNA-X network analyzer to demonstrate the error-vector-magnitude performance of a power amplifier when presented with arbitrary frequency-dependent load impedances created without an impedance tuner.

AI/ML-enabled EDA: Demonstrated Keysight's [ADS 2025](#), which offers 3D Circuit-EM-Thermal multi-physics co-design, high-performance automation enabling AI/ML and robust

**Keysight's F9652A
vertical compact
antenna test
range performs
several phased
array performance
verification tests.**

Keysight Technologies





design validation for RF and millimeter wave, and provides support for wideband power-amplifier design techniques, including nonlinear load pull.

Phased-array antenna test: Showcased Keysight's phased-array control and calibration test solution inside the [Vertical Compact Antenna Test Range](#) (CATR), which accommodates a wide variety of phased-array antenna performance verification tests including fast gain and phase calibration, effective isotropic radiated power (EIRP), antenna radiation pattern, antenna gain-to-noise-temperature (G/T), modulation distortion, and radio frequency to direct digital measurements.

Signal-source characterization: Demonstrated how to perform sub-THz phase-noise measurements with Keysight's new [E5058A 54-GHz SSA-X signal source analyzer](#) and an E5051AW phase-noise measurement downconverter for 6G applications and microwave amplifier residual phase-noise and AM-noise measurements.

IQ data characterization: Highlighted how Keysight's [vector signal analysis software](#) uses a new feature to precisely characterize a homodyne (IQ) system by characterizing and digitally correcting the frequency-dependent dispersion and imbalance of a Marki IQ mixer.

[Quantic Electronics](#) rolled into IMS 2024 with its bevy of brands spanning EMI/RF filters, frequency-control devices, magnetics, passive waveguides, coaxial components, passives, and much more. Intended for mission-critical systems, Quantic's off-the-shelf and custom products bring benefits in terms of speed, power handling, and density.

The company displayed the performance under vibration of its ultra-low phase-noise frequency-control and timing components. Visitors were also able to try Quantic X-Microwave's layout tool for signal chains built with its X-MWblock elements, as well as analyze measured data for the devices.



Quantic Electronics showed off its EMI/RF filters, frequency control devices, magnetics, passive waveguides, coaxial components, passives, and much more. Quantic Electronics



Rapidtek demonstrated its AESA prowess as well as a new mmWave communications test platform. Rapidtek Technologies

[Rapidtek Technologies](#), which designs active electric-scan antennas (AESAs), conducted live joint demonstrations of its next-generation test solution. The demo involved generating a sub-6G baseband signal using Amarisoft's [AMARI Callbox](#) and the jointly developed up-downconverter (UDC) system, which enables the generation of mmWave communication test frequency bands ranging from 6 to 48 GHz. It supports testing in frequency bands such as Ku-band, Ka-band, and n257~n262 while offering advanced signaling control. The solution has completed numerous 3GPP standard communication test verifications, including Wi-Fi 6E/7, 5G FR2, and B5G.

In addition, Rapidtek displayed its AESA designs and RF testing solutions, including phased-array antennas, communication payloads, and up-downconverters. These solutions offer reliable and high-performance connectivity for a wide range of low-Earth-orbit (LEO) satellite applications.

Rapidtek also showcased its passive solutions and products in collaboration with its strategic partner, [Unictron Technologies Corp.](#) Unictron Technologies offers antennas, antenna modules, and piezoelectric ceramic elements, widely used in various applications such as automobile parking sensors, weaving machine actuators, ultrasonic nebulizers, ultrasonic sensors, and a wide range of ultrasonic transducers.

[TransEON](#), a Canadian stealth-mode startup, has developed a new MOSFET-based GaN-on-SiC foundry process that enables fabrication of cutting-edge transistors and MMICs with significant benefits over existing GaN HEMT technology. Key advantages include up



TransEON's MOSFET-based, GaN-on-SiC foundry process is said to provide benefits over GaN HEMT technology in discrete devices and MMICs. TransEON

to 4X higher operating voltage and RF power density at frequencies ranging from HF up to W-band.

The process includes standard MMIC features to provide turnkey compatibility with existing GaN processes, including through-substrate vias, integrated passives, and Au-plated microstrip on thinned SiC. Other advantages of the devices include full process customization, design and NRE services, ITAR and ITAR-free compatibility, as well as multi-project wafer access.

[Altum RF](#) offered its lineup of broadband Q/V/E-band low-noise and medium-power amplifiers, which are intended for next-generation, high-capacity networks. Applications include test and measurement, SATCOM, sensing applications, and point-to-point wireless communication for 5G and 6G networks. These high-frequency amplifiers use advanced GaAs technology, which delivers a low noise figure and linear amplification with less signal distortion at medium power.

[Junkosha](#) brought its metrology-grade MWX871 cable, designed for applications such as vector network analyzer (VNA) calibration tests at frequencies up to 70 GHz. Alongside this

The MXW8 series of VNA test/calibration cables meets demands for phase stability under flexure

Junkosha





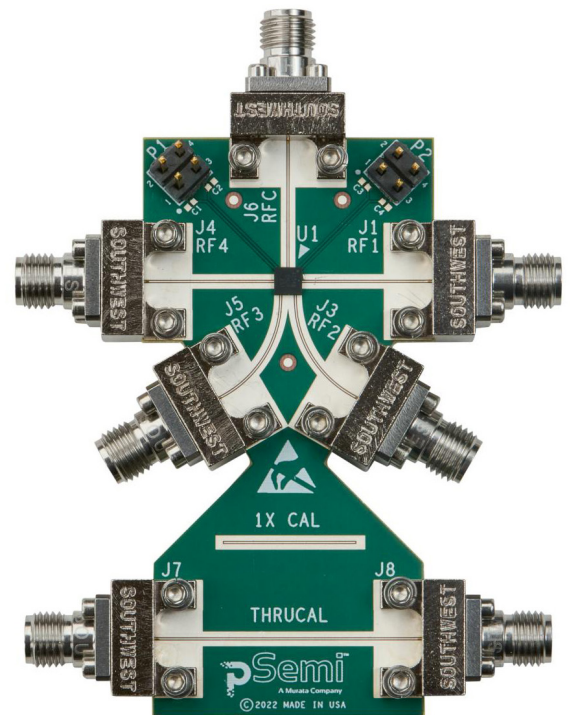
latest product, Junkosha will feature its ultra-phase stable cable lineup designed to meet the higher frequency demands of tomorrow's 5G/6G networks.

The industry's transition to higher frequencies has spawned demand for mmWave-compatible cables. Depending on effects of degradation and a given cable's characteristics, the cable's parameters with respect to signal amplitude and frequency can change when the cable is bent, leading to measurement errors and decreased stability.

To meet these challenges, Junkosha's microwave/mmWave VNA test cable offers exceptional phase (within $\pm 8.9^\circ$) and amplitude (within ± 0.10 dB) stability during flexure, along with robust phase stability and phase-return characteristics in varying temperatures. Equipped with a ruggedized port-side NMD connector for reliable and robust connections to the VNA, this new cable holds up to the most demanding testing environments.

[pSemi Corp.](#) showed its new [PE42548 SP4T RF switch](#), a packaged device that's an alternative to traditional flip-chip devices. It meets the growing demand for contract manufacturing-friendly devices, especially in test and measurement applications.

The PE42548 is a HaRP technology-enhanced reflective switch that supports a wideband frequency range from 9 kHz to 30 GHz. It delivers a low insertion loss of 2.0 dB at 26 GHz, rapid switching time of 60 ns, high power handling of 33 dBm, and exceptional isolation performance of 41 dB. As a result, it's a good candidate for applications including T&M, 5G mmWave, microwave backhaul, radar, and satellite communications. The device fares well in extreme environments with a temperature range of -40 to 105°C , and is housed in a compact 20-lead, 3×3 -mm LGA package.



pSemi's PE42548 is a 30-GHz SP4T RF switch that presents an alternative to flip-chip devices.

pSemi Corp.

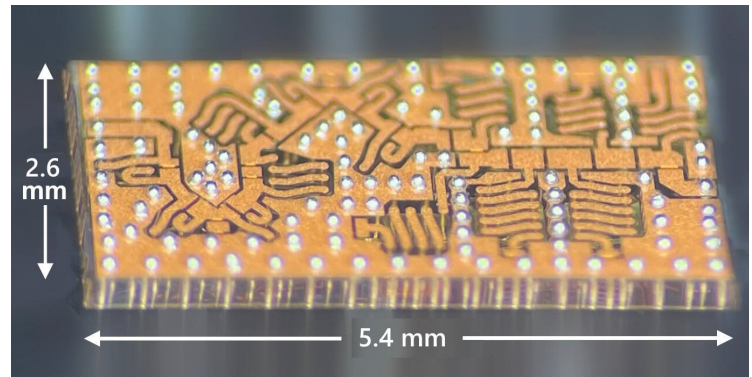
[Spectrum Control](#) debuted a new family of surface-mount, BGA RF filters that span 500 MHz to 10 GHz. This family of high-Q, anti-aliasing filters, developed in cooperation with [3D Glass Solutions](#), is manufactured at wafer scale on glass substrates. The devices measure just 2.6×5.4 mm.

The family includes filters for low-pass, high-pass, and bandpass applications with custom filters available for anywhere within the family's frequency range. Within the standard range, a standout is a 4-GHz IF filter (model MMG-4000-2000-B) with a passband from 3 to 5 GHz. Mid-band insertion loss is 2.2 dB with group delay of 0.8 ns from -55°C to 125°C . The device offers stop-band suppression of more than 60 dBc from



Spectrum Controls' high-Q, anti-aliasing filters, developed in cooperation with 3D Glass Solutions, is manufactured at wafer scale on glass substrates.

Spectrum Control

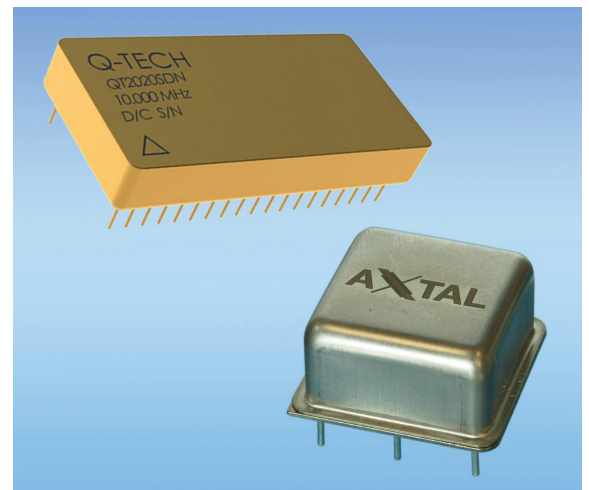


DC to 2.5 GHz and 5.8 GHz to 15 GHz.

This new family represents a foundational building block for Spectrum Controls' SCi Blocks range of RF and digital functional blocks, which can streamline the integration of functions into digital defense systems. Platform elements include SiPs, RF-on-mezzanine, and SOSA-aligned 3U OpenVPX modules.

[Q-Tech Corp.](#) came to IMS with its high-stability microprocessor compensated (MCXO) and oven-controlled (OCXO) crystal oscillators. These devices meet critical radiation tolerance specifications for reliable operation in New Space (low earth orbit or LEO) satellite timing and frequency generation applications.

Q-Tech's QT2021 Series of MCXOs and the AXIOM75Sx Series of OCXOs offer a wide range of standard frequencies; the QT2021 MCXOs from 10MHz to 100MHz and the AXIOM 75Sx OCXOs from 10MHz to 400MHz. All are available with either Sine Wave or CMOS logic outputs.



QT2021 MCXOs and AXIOM 75Sx OCXOs both meet 50kRad (TID) radiation tolerance.

Q-Tech Corp.

[Exxelia](#) touted its main [RF/microwave capacitor](#) ranges: Super High-Q & High-Power High-Q CP/CL series and its range of [microwave ferrites](#), including a pre-launch of a High-Epsilon microwave ferrite material.

The company's booth featured its Super High-Q series of RF ceramic capacitors. These capacitors offer ultra-low ESR and can operate at up to 1500 V. They come in sizes from 0402 to 1210 and in capacitance values from 0.1 to 1000 pF. They're suited for advanced RF applications such as power amplifiers, mixers, filters, and matching networks.

Exxelia's High-Power High-Q series is designed for lower-frequency applications with power handling up to 7200 V and capacitance value up to 10 nF. These capacitors are available in NPO and P90 dielectrics and deliver low ESR and ESL. The CP (P90) and CL (NP0) series serve applications like defense communications (VHF/UHF), medical MR



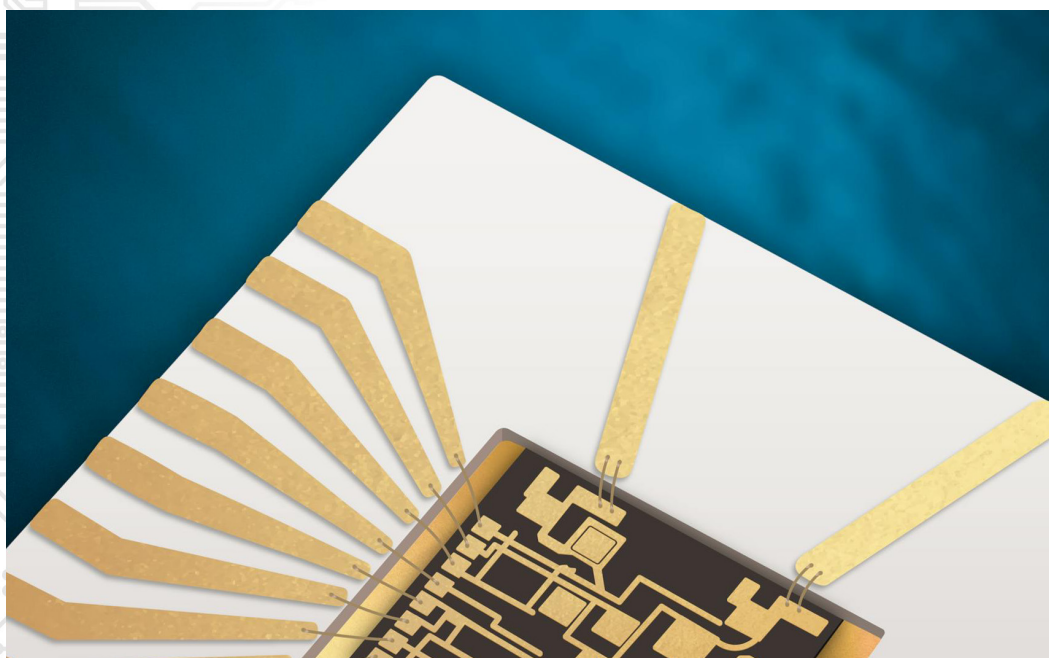
Exxelia's RF/microwave capacitors and ferrites meet demanding applications in power amplifiers, RF generators, AESA radar, and more.

Exxelia



body coils, and RF generators for plasma, semiconductor manufacturing, and extreme ultraviolet (EuV) lithography.

Exxelia also brought to IMS its comprehensive range of materials and tuning components, with a special focus on high-performance microwave ferrite products. It pre-launched a new high-epsilon microwave ferrite. This material features permittivity of 21 and is available in two versions (YK21 and DK21) to address all power applications. It's designed to enhance the performance of high-frequency radar systems, especially in active electronically scanned array (AESA) radar applications. The device's magnetic properties and stability are crucial for the optimal performance of isolator and circulator devices.



StratEdge's post-fired and molded ceramic IC packages efficiently dissipate heat from GaN, GaAs, and SiC devices. StratEdge

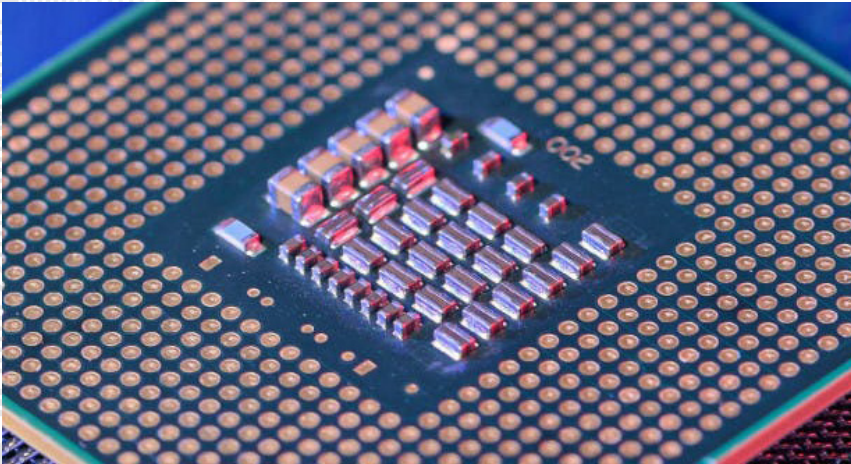
[StratEdge](#) exhibited its range of packages for high-frequency, high-power, and high-reliability semiconductor applications. Purpose-built for microwave, mmWave, and high-power devices, the [post-fired and molded ceramic packages](#) operate from DC to >63 GHz. They efficiently disperse heat from GaN, GaAs, and SiC devices.

These packages enable compound semiconductor devices to meet the critical requirements of markets such as telecom, mixed signal, VSAT, broadband wireless, satellite, military, test and measurement, automotive,



and down-hole.

In space or defense applications, the packages can be manufactured with thermally enhanced metal bases that ensure efficient heat dissipation. The post-fired ceramic packages feature electrical transition designs that minimize losses.



Element Six and Orbray have collaborated to produce world-leading wafer-scale, single-crystal synthetic diamond materials. Element Six

[Element Six](#) (E6) made waves with the work it's done in partnership with [Orbray](#) on synthetic diamond substrates. The pair has announced what it claims as the world's highest-quality wafer-scale, single-crystal synthetic diamond. Such materials offer high breakdown fields and thermal conductivity, making them a strong contender for future applications in 6G wireless components, advanced power and RF electronics, sensing, thermal management, and quantum devices.

E6's contribution is in a chemical vapor deposition (CVD) platform that supports large-area, uniform polycrystalline diamond growth up to 150 mm in diameter. The company has recently opened a world-class CVD facility in

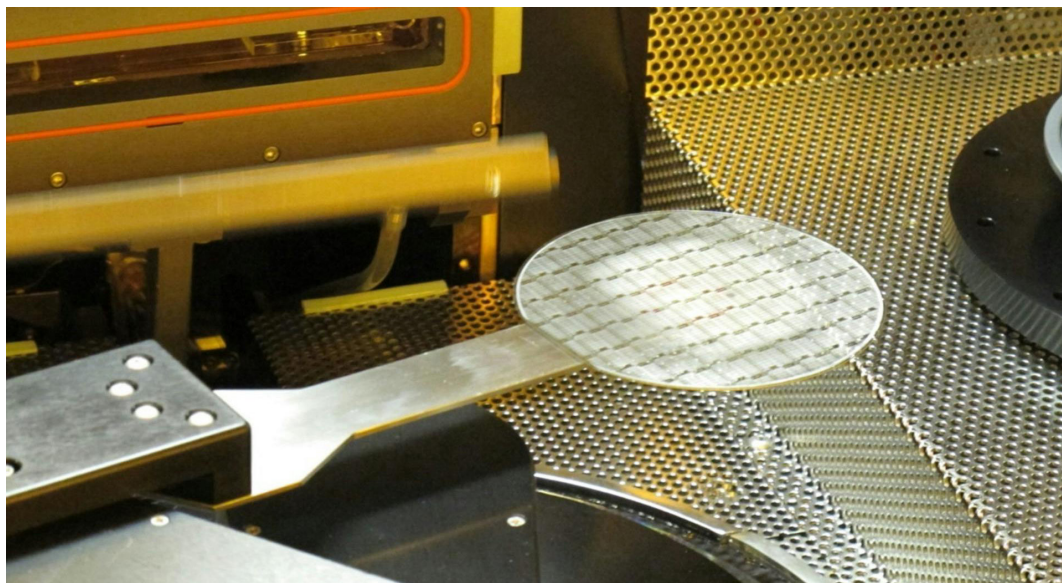
Gresham, OR. For its part, Orbray has pioneered a heteroepitaxial process to grow single-crystal diamond on cost-efficient sapphire substrates.

[Teledyne e2v HiRel](#) featured its enhanced ultra-low-power and low-noise amplifier (LNA) for new space applications from UHF to S-band (0.3 GHz to 4 GHz. [Model TDLNA0840SEP](#), which comes in a 16-pin QFN plastic package, is suited for use in high-reliability applications where ultra-low power consumption, low noise figure, and small package footprint are critical.

The LNA is fabricated on a 150-nm, enhancement-mode, pseudomorphic high-electron-mobility transistor (pHEMT) process. The device leverages monolithic microwave integrated circuit (MMIC) design techniques and consumes just 27 mW of power while delivering a gain of 29 dB from 0.3 GHz to 4 GHz. It does so while maintaining a noise figure of less than 2 dB and an input P1dB of -35 dBm. The internally self-biasing device runs on VDD = +1.5 volts and IDDQ = 17.8 mA typical.

A customer evaluation kit is available for this LNA, which fits well in satellite communication systems featuring increased power of radio signals with minimal noise and distortion which can degrade digital signals. The TDLNA0840SEP is TID radiation tolerant to 100 krad (Si) and is qualified per Teledyne's Space enhanced plastic flow. It's available for sampling in third quarter 2024 and will be available for shipment in December 2024.

[WIN Semiconductors](#) has expanded its RF GaN technologies portfolio with a beta release of its NP12-0B mmWave GaN-on-SiC process. At its heart is a 0.12- μ m-gate RF GaN HEMT technology with refinements that enhance DC and RF ruggedness while adding die-level moisture resistance. NP12-0B also encompasses multiple transistor improvements that provide high ruggedness when operated in deep-saturation/high-compression pulsed



WIN Semiconductors' NP12-0B mmWave GaN-on-SiC process features a 0.12- μ m-gate RF GaN HEMT technology with enhanced DC and RF ruggedness and die-level moisture resistance. WIN Semiconductors

and CW conditions.

This new rugged technology eliminates the pulse-droop behavior observed in GaN HEMT power amplifiers, which boosts the range and sensitivity of pulsed-mode radar systems. What's more, the technology is available with an enhanced moisture ruggedness option. This lends devices with high humidity resistance when used in plastic packaging.

The NP12-0B platform, which supports fabrication of full MMICs, allows customers to develop compact pulsed or CW saturated power amplifiers for applications through 50 GHz. This process is qualified for 28-V operation; in the 29-GHz band, it generates saturated output power of 4.5 W/mm with 12 dB of linear gain and over 40% power-added efficiency. The NP12-0B technology is a strong candidate for rugged pulsed-mode, high-power amplifiers used in advanced radar systems.



[dB Control](#) came to IMS 2024 to launch two new products. One, the [dB-9006 Magnum Opus microwave synthesizer](#), delivers phase-noise performance that's said to be from 10 to 20 dB better than competing units. It also offers a frequency range from 100 MHz to 27 GHz with 1-Hz resolution mode, -80 dBc non-harmonic spur performance, and fast tuning (<50 μ s), with a secondary output tuning from 1 MHz to 2000 MHz. This instrument-grade synthesized signal source supports three interfaces, including 4-wire SPI and two SCPI interfaces using either RS-232 or USB. Applications include communications

The dB-9006 Magnum Opus frequency synthesizer is said to beat competing units on phase-noise performance by from 10 to 20 dB. dB Control



Delivering up to 1.5 kW of output power from 2.9 to 3.3 GHz, dB Control's dB-8048 GaN solid-state amplifier suits high-performance MIL-STD applications. dB Control

intelligence (COMINT), ECM, low-jitter ADC and DAC clocks, radars, satellite links, test and measurement, and radio astronomy.

If it's amplifiers you're interested in, the [dB-8048 GaN solid-state power amplifier](#) operates from 2.9 to 3.3 GHz, delivers 1.5 kW of peak output power in pulsed operation with instantaneous pulse operation over the entire band, and has a duty cycle up to 10%. The amplifier also provides a 0.5- μ s pulse width and 50- Ω input/output impedance. A modular design and scalable architecture allow for phase combining to achieve up to 6 kW and 10 kW output power. Small and lightweight with built-in fan cooling, the dB-8048 is designed for high-performance MIL-STD applications such as radars; high-resolution SAR systems; and ground, naval, and airborne platforms where high reliability and ruggedness are critical to system performance.

[MACOM Technology Solutions](#) presented more than 14 technology demonstrations at IMS 2024, spanning its various product lines including diodes, RF power devices, MMICs, and linear modules and subsystems. MACOM also highlighted its expanded foundry services offerings.

Demonstrations and new product announcements included:

- *GaN-on-SiC MMIC Ka-band power amplifier:* This demonstration showcased a 6-W driver and a 10-W PA operating in the 33- to 37-GHz band. These parts are fabricated using MACOM's 140-nm, GaN-on-SiC technology.
- *300-W X-band GaN-on-SiC matched power amplifier:* This new amplifier is fully matched to 50 Ω at both input and output ports. Suitable for pulsed radar applications such as marine, defense, and weather radar, it combines output power, signal gain, and drain efficiency in a small form factor at 9 GHz.
- *C-Band 100-W GaN-on-SiC power amplifier with 57% power-added efficiency (PAE):* This GaN power amplifier combines high gain and high efficiency for pulsed power



applications within a small footprint (7×7 mm). This demo also featured MACOM's [XP1044 driver amplifier](#) and [MACP-011113 surface mount directional coupler](#).

[Mini-Circuits](#) displayed a variety of [high-quality VNA cables](#) designed to interface directly with the rugged/NMD ports of industry-standard VNAs. The cables are resistant to crushing and torquing and are protected by flexible stainless-steel sheaths. They feature excellent VSWR and low insertion loss as well as phase stability and repeatable performance.

The model selection features connector types including 1.85, 2.4, and 2.92 mm



Mini-Circuits' precision VNA cables come in frequency ranges up to 67 GHz. Mini-Circuits

with upper frequencies of 67, 50, and 40 GHz, respectively. These cables represent a cost-effective alternative to expensive OEM cables with outstanding performance for demanding measurements.



MilliBox's MBX32CTR CATR is the product of cooperation with Eravant and Maury Microwave. Millibox

[MilliBox](#) unveiled its [MBX32CTR](#), a full compact antenna test range (CATR) that's capable of producing a 3D radiation pattern in the sub-THz spectrum. CATRs are a type of over-the-air (OTA) antenna test system that use a parabolic reflector to eliminate the far-field measurement distance requirement. When frequency increases, so does the far-field distance, making direct far-field measurements impractical for large antenna-array applications. In such cases, the use of a parabolic reflector and a precisely placed probe make the test system practical as a benchtop setup.

MilliBox's MBX32CTR provides a complete test apparatus for mmWave and sub-THz OTA measurement with a quiet zone of 150 mm. The system includes an MBX32 chamber, a GIM04H-300E 2-axis positioner, a laser alignment



system, and a 300-mm parabolic reflector and its focus probe antenna.

The CATR is the fruit of cooperation between MilliBox and [Eravant](#). MilliBox contributes the chamber and the 3D antenna positioner, while Eravant developed the 300-mm reflector and probes for the required frequency band. Eravant also contributes frequency extenders for spectrum usage above 50 GHz. [Maury Microwave](#) provides the [StabilityPlus low-profile cable assemblies](#) needed to carry the signals out of the 3D positioner.

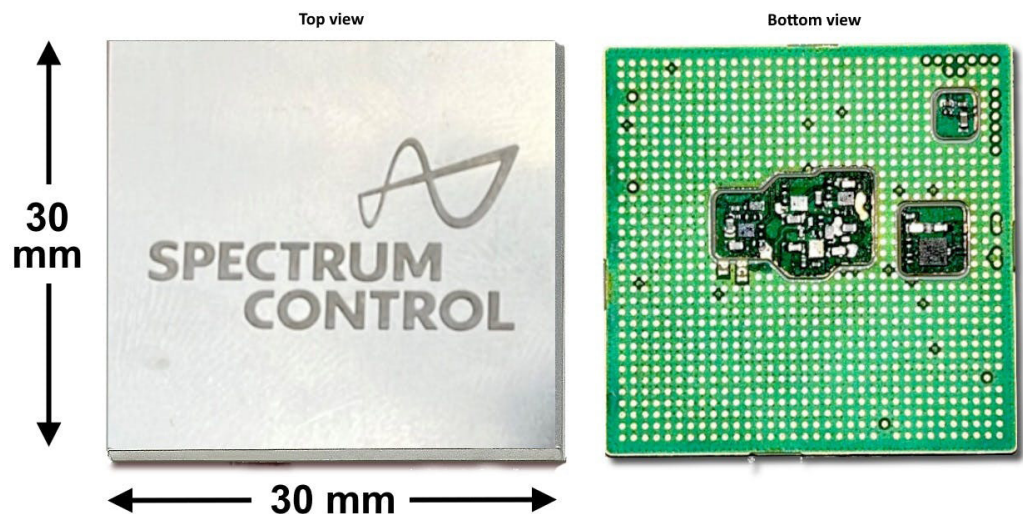
[TDK Corp.](#) launched a line of ultra-thin, lightweight permalloy film sheets to shield low-frequency-band noise. The IPM01 Series is the latest in TDK's lineup of [Flexield permalloy thin-film sheets](#); these products feature high permeability and high loss in a 0.006-mm ultra-thin design. The material effectively shields low-frequency noise, which is a growing issue in electric vehicles.

Typically, noise suppression in the kilohertz range is achieved using thick shielding materials, some of which are metallic. They're often too bulky and heavy for use in EVs, in which minimizing size and weight is a highly sought-after design goal. The IPM01 Series sheets are said to do the job more effectively than those conventional materials while reducing weight. Compared with conventional products in TDK's lineup, thickness is reduced by about 80%, weight by 90%, and the shielding effect is +65% at 1 MHz.

Products in the IPM01 Series are offered as sheet material and in custom shapes.

[Spectrum Control](#) unveiled its new RF front-end SiP platform at IMS, the latest addition to its [SCi Blocks family](#). The device comprises a complete wideband RF front-end in a 30-mm² BGA package. This extensible, customizable, and digitally enabled SiP platform delivers the capabilities of an integrated microwave assembly (IMA) in a surface-mount package. It's been conceived as a co-processor to Direct RF FPGAs and mixed-signal control processors, but can be used in any application where size, weight, power consumption and cost (SWaP-C) are a factor, such as smart antennas or high-fidelity RF signal conditioning in defense applications.

The first product in the SCRS series is a complete RF front-end with a filtered range of



The first product in the SCRS series is a complete RF front-end with a filtered range of 6 to 18 GHz and unfiltered range of 2 to 20 GHz. Spectrum Control



6 to 18 GHz and unfiltered range of 2 to 20 GHz with 2-GHz instantaneous bandwidth and full signal isolation—and there's no packaging-induced signal degradation. It delivers 15 dB of gain with a noise figure of 6 to 10 dB. Within the device is an on-board FPGA for software-controllable signal conditioning, signal-level detection, self-tuning, on-chip power regulation/sensing, temperature sensing, and a standard digital control interface.

The first SCRS series RF+ SiP is sampling now. Several customization options are available including frequency band, power amplification, and block conversion.



Soitec's engineered substrates will enable UMC's 3D ICs for RF-SOI technology.

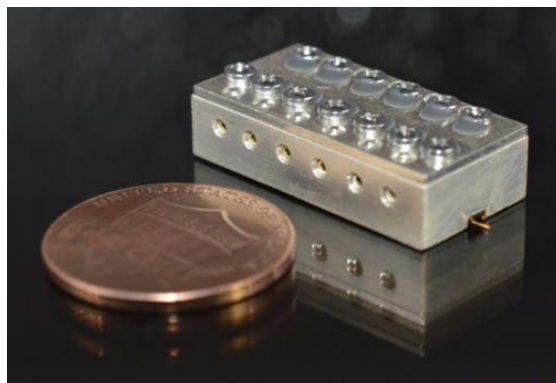
Soitec

[Soitec](#) talked up its extended partnership with UMC, in which Soitec will provide engineered substrates in support of UMC's industry-first 3D IC solutions for radio-frequency silicon-on-insulator (RF-SOI) technology. UMC's 3D ICs will take on the challenge of getting more RF front-end modules into a single device by vertically stacking dies and using wafer-to-wafer bonding techniques.

As a result, it's claimed, overall die size will shrink by more than 45%, enabling designers to integrate more RF components to address 5G's burgeoning bandwidth appetite. Soitec's RF-SOI substrates provide the requisite mechanical and electrical performance to ensure large-volume manufacturing of UMC's 3D ICs without degrading RF performance.

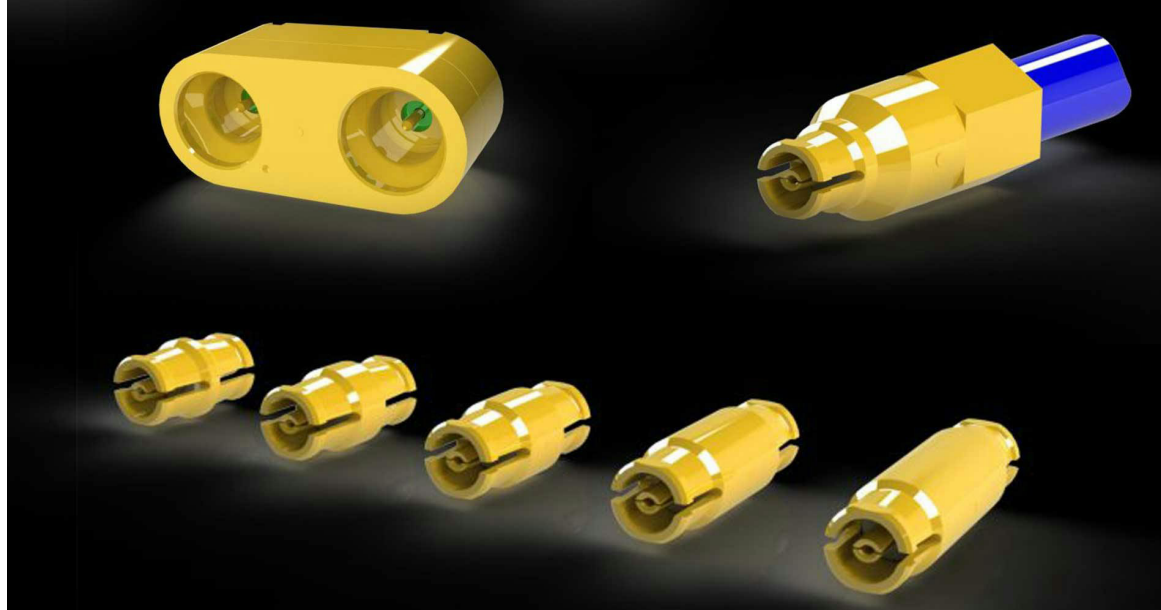
[Networks International Corp.](#) touted its new [9750-MHz surface-mount cavity filter](#) for X-band applications. The device, which is built with high-temperature (Sn95/Sb05) solder, can easily withstand typical PCB reflow profiles of 215°C.

The filter provides a low passband insertion loss of <1 dB and high out-of-band rejection of >60 dB at up to 3X the center frequency. It's well-suited for applications in radar, electronic warfare, and space-borne systems. Its rugged PCB package offers a profile of <0.3 in. and is available in a hermetic configuration.



NIC's 9750-MHz cavity filter serves X-band applications in space, radar, and EW use cases.

Networks International Corp.



credit: Corning

CHAPTER 4:

The First Gold-Plated Plastic Microwave Connector

JAMES MORRA, Senior Staff Editor

Corning's Polylink connectors offer high performance of up to 26.5 GHz despite their plastic construction.

At IMS 2024, [Corning Incorporated](#) introduced what it called the world's first metal-plated plastic microwave connector ready to reduce costs and maximize installation flexibility in the telecom and aerospace sectors.

Based on its proprietary Polylink technology, the materials giant said the gold-plated plastic blindmate interconnects turn out to be lighter and less costly than traditional components manufactured out of beryllium copper. The parts also feature compatible interfaces and high performance that extends up to 26.5 GHz. The company also said that they're inherently more flexible, which is increasingly vital to the microwave connectivity field.

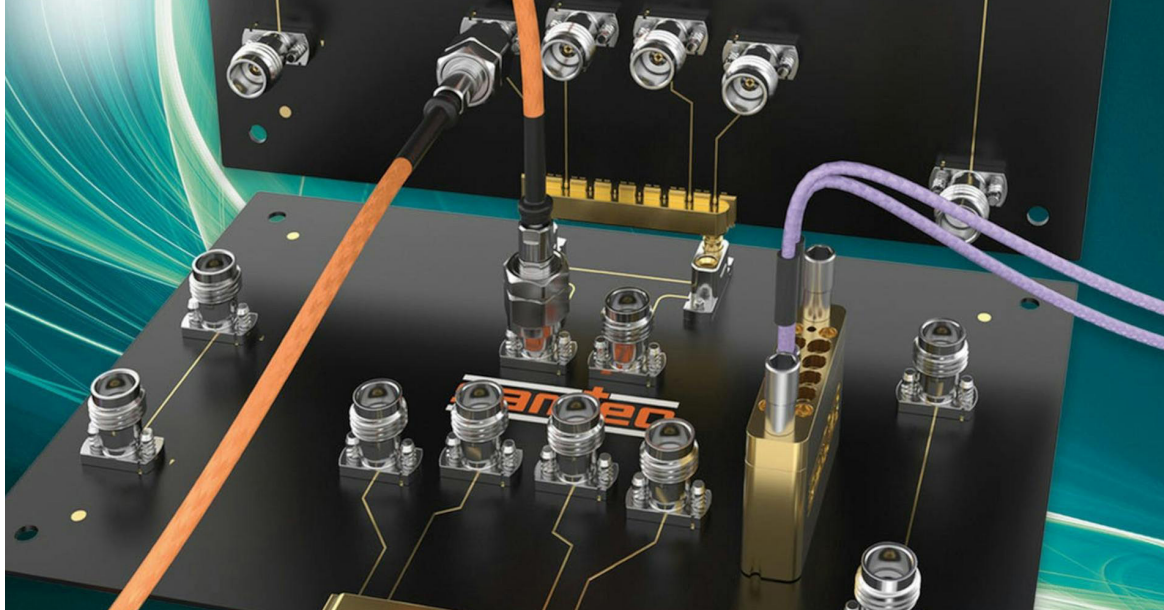
The Polylink technology saves more than 30% of the weight of Corning's copper-based interconnects in a similar form factor, weighing only 0.06 grams with a center-to-center spacing of 0.0135 in. The new connector family is also ideal for 5G networks as well as aerospace, defense, and automotive systems due to its high degree of flexibility. More specifically, the Polylink technology features up to 0.005 axial compression.

Corning said Polylink also features a faster manufacturing process. The quick molding speed for plastic polymer materials accelerates fabrication times compared to its traditional [interconnects](#). On top of that, the connectors offer cost advantages because they're based on plastic polymers instead of copper. All these features, said Scott Flint, business director of the aerospace and defense unit within Corning Advanced Optics, give it the edge in "low-to-medium frequencies, especially when payload and cost efficiency matter most."

The company's traditional metal blindmate interconnects were on display at IMS, too. These are widely used in telecom and radar systems as well as naval, airborne, and ground-based missile programs for the defense industry.

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credit: Samtec

CHAPTER 5:

Coaxial Cable Remains Stable with Flexure Over Time

DAVID MALINIAK, Executive Editor, *Microwaves & RF*

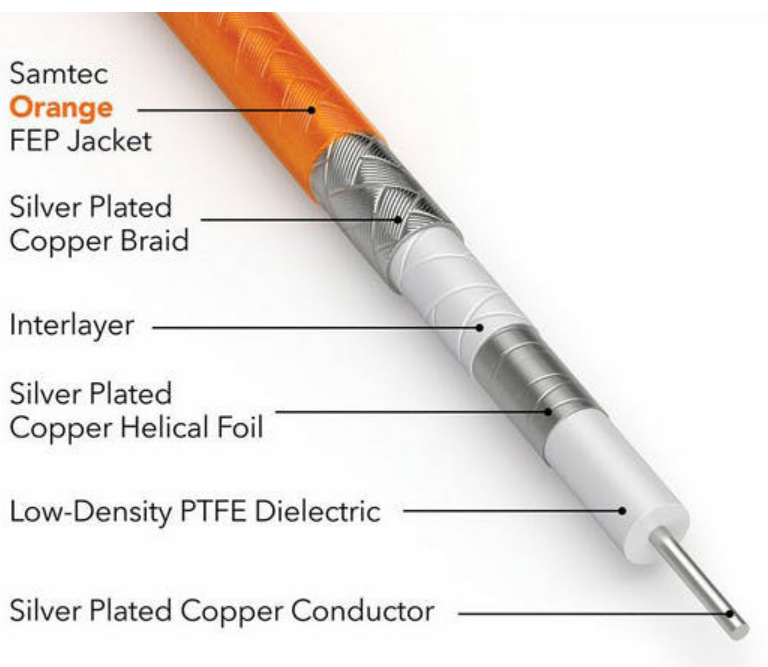
Samtec rolled out a new coaxial-cable structure that displays consistent phase and amplitude stability over time as it experiences flexing.

At IMS 2024, [Samtec](#) debuted its next-generation Nitrowave coaxial cable, which is targeted at meeting the steep demands of applications in the aerospace, defense, datacom, computer/semiconductor, and instrumentation sectors.

The cable is built with state-of-the-art shielding techniques and an interlayer ([see figure](#)). The resulting product offers high stability with flexure over time: $< 0.2^\circ \times F(\text{GHz})$.

At [booth demos](#) and in partner booths around the IMS show floor, visitors were able to see the company's LL043 (43.5 GHz) and LL071 (71 GHz) microwave cables in a

Samtec's Nitrowave coaxial cable sports next-generation shielding, an interlayer, and a colorful orange jacket. Samtec





distinctive orange jacket. VSWR for the LL043 variant is specified at 1.4:1 @ 43.5 GHz. Cabling is available in frequencies ranging from 18 to 110 GHz.

At IMS, Samtec also featured a booth demo of its new [BE90A Bulls Eye test assembly](#). The device, which is rated to >90 GHz, features a space-saving design for use on smaller evaluation boards with shorter trace lengths.

Other featured products included:

- The ganged [Magnum RF connectors](#) are multi-port devices for mmWave applications. Magnum RF is suited for space-limited applications at up to 65 GHz.
- Samtec's [flexible waveguide](#) technology is embodied in a cable design that conserves space while maintaining loss performance like that of a traditional waveguide.
- A new line of RF edge-launch connectors that covers DC to 67 GHz with a narrow body design 33% smaller than traditional edge-launch connectors. Interface types include 1.85, 2.40, and 2.92 mm.

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credit: Rohde & Schwarz

CHAPTER 6:

Microwave Signal Generator for Analog Operates Up to 40 GHz

ALIX PAULTRE, Editor-at-Large, *Microwaves & RF*

The R&S SMB100B from Rohde & Schwarz brings output power, spectral purity, very low close-in phase noise, and practically no wideband noise to analog microwave signal generation.

The [R&S SMB100B](#) analog microwave signal generator from [Rohde & Schwarz](#) performs analog signal generation up to 40 GHz in the mid-range class. It addresses applications requiring clean analog signals or high output power from 8 kHz to 40 GHz.

Useful for testing radar receivers, semiconductor components, upconverters, downconverters, or amplifiers, its high output power and low phase noise equip it as a source for simulating interferers for blocking tests.

Features include very low single-sideband (SSB) phase noise, excellent non-harmonics suppression, and low wideband noise for all carrier frequencies. For improved close-in phase noise and frequency stability, with less temperature-based variation in performance, a higher-performance version is available for all frequency ranges.

In addition to the 10-MHz reference frequency provided, users can choose optional 1- to 100-MHz as well as 1-GHz reference frequency signals. An optional high output power of 25 dBm at 20 GHz and 19.5 dBm at 40 GHz via keycode activation is available, too, so users can install it at any time. The light (10.7 kg) and compact device fits in a 19-in. rack and is only 2U high.

The R&S SMB100B supports features to compensate for path losses and variations in the signal caused by setups with additional test fixtures, cables or amplifiers. One of them, the user correction function, compensates if the frequency response of the setup is known and stable.

To address unknown factors, closed-loop power control can compensate for variations by continuously measuring the input level to the DUT. A suitable R&S NRP power sensor would feed its measured level back to the generator to adjust the output power accordingly.

With the R&S SMB100B, users can create their own customized menus, so that the parameters they most use are always available. They're also able to generate code to automate measurements first made manually with the SCPI macro recorder. It can then



Credit: Rohde & Schwarz


use the code generator to export the instructions in languages such as MATLAB.

Thanks to R&S Legacy Pro, the R&S SMB100B can be employed to emulate other instruments such as the R&S SMB100A or competitor instruments directly as a drop-in replacement using the existing code. The microwave signal generator expands the R&S SMB100 analog signal generator family with its established RF models up to 6 GHz.

Related links:

[Rohde & Schwarz](#)

[R&S SMB100B](#)

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With peak power output of 15 kW, Empower RF's model 2254 transmitter is ready for active duty in radar and EW applications.



credit: Empower RF Systems

CHAPTER 7:

Pulsed S-band Transmitter Leverages GaN-on-SiC

DAVID MALINIAK, Executive Editor, *Microwaves & RF*

Empower RF Systems was at IMS 2024 to show off its [Model 2254 S-Band pulsed transmitter](#). This air-cooled, high-power transmitter operates from 2900 to 3500 MHz and meets the demanding requirements of radar, electronic warfare, and directed-energy research applications.

With its peak power output of 15 kW, the 2254 is said to be one of the most powerful S-band transmitters in its class. Thanks to a duty cycle of up to 20% and pulse widths of up to 500 μ s, this Class AB transmitter can drive sustained high-power pulses for extended periods, ensuring reliable performance in mission-critical scenarios.

The amplifier subsystem features multiple, high-power, gallium-nitride-on-silicon-carbide (GaN-on-SiC) power transistors that offer wide frequency response, high gain, high peak power, and low distortion. High reliability and efficiency are achieved through the use of advanced broadband RF matching networks and combining techniques, EMI/RFI filtering, and qualified components. Each drawer in the rack enclosure includes integral forced-air cooling. The system operates from 180 to 260 V AC, three-phase.

A built-in control and monitoring system includes protection functions, while remote management and diagnostics are handled via an Ethernet port to a LAN. Operators can manage functionality remotely using either a web browser or machine-to-machine interface, or they can use the system's built-in touchscreen.

Related links:

- [Model 2254 S-band pulsed transmitter](#)
- [Model 2254 datasheet](#)
- [Complete Empower RF Amplifiers lineup](#)

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credit: Pickering Interfaces

CHAPTER 8:

High-Channel-Count Microwave MUX Modules Span 8 to 40 GHz

DAVID MALINIAK, Executive Editor, *Microwaves & RF*


The multiplexer modules, which come in various switching configurations, reduce the number of switches and associated interconnects in high-channel-count applications.

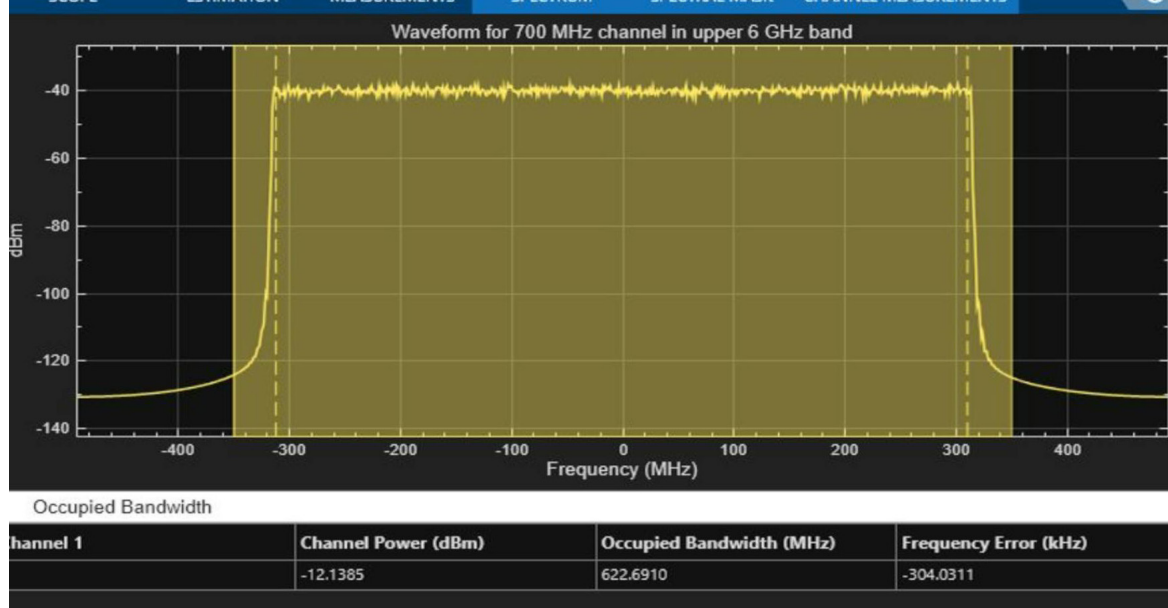
Pickering Interfaces came to IMS 2024 to tout its new family of high-channel-count, PXI/PXIe microwave multiplexer (MUX) modules. Models 40/42-788, based on high-quality Radiall mechanical microwave switches, offer bandwidth options from 8 to 40 GHz. The modules also come in versatile switching configurations, including single or dual SP8T, SP10T, or SP12T multiplexers.

The devices handle microwave switching applications along with many uses across the RF spectrum calling for extremely low insertion loss and ultra-high isolation. Their high channel counts mean fewer switches and associated interconnections being required for microwave switching applications, improving signal quality and ease of programming.

Other products featured in Pickering's IMS exhibit included:

- MEMS-based PXI/PXIe RF multiplexers that deliver 300X operational life and 60X test system throughput compared to existing electromechanical relay products.
- A 110-GHz PXI/PXIe microwave switch that supports 5G and semiconductor test.
- A configurable PXI microwave switch platform that enables RF test engineers to combine a wide range of high-performance relay types while minimizing chassis slot usage.
- Pickering's Microwave Design Tool, a free online tool for configuring flexible PXI and LXI microwave switch products.
- Flexible LXI microwave switch platform and turnkey services for LXI microwave switch and signal routing subsystems, as well as an LXI microwave switching matrix demo.

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credit: Mathworks

CHAPTER 9:

MATLAB Library Simulates 6G Technology

WILLIAM WONG, Senior Content Director, *Electronic Design & Microwaves & RF*

MathWorks' MATLAB gets a 6G library to help simulate advanced communications.

MathWorks' [MATLAB](#) was used extensively to design 5G systems, and now it's doing the same with the emerging 6G standard. The [MATLAB 6G Exploration Library](#) is a new addition to MATLAB to model and simulate test candidate 6G technologies. It can be used for all design aspects from 6G PHY design to channel and RF models.

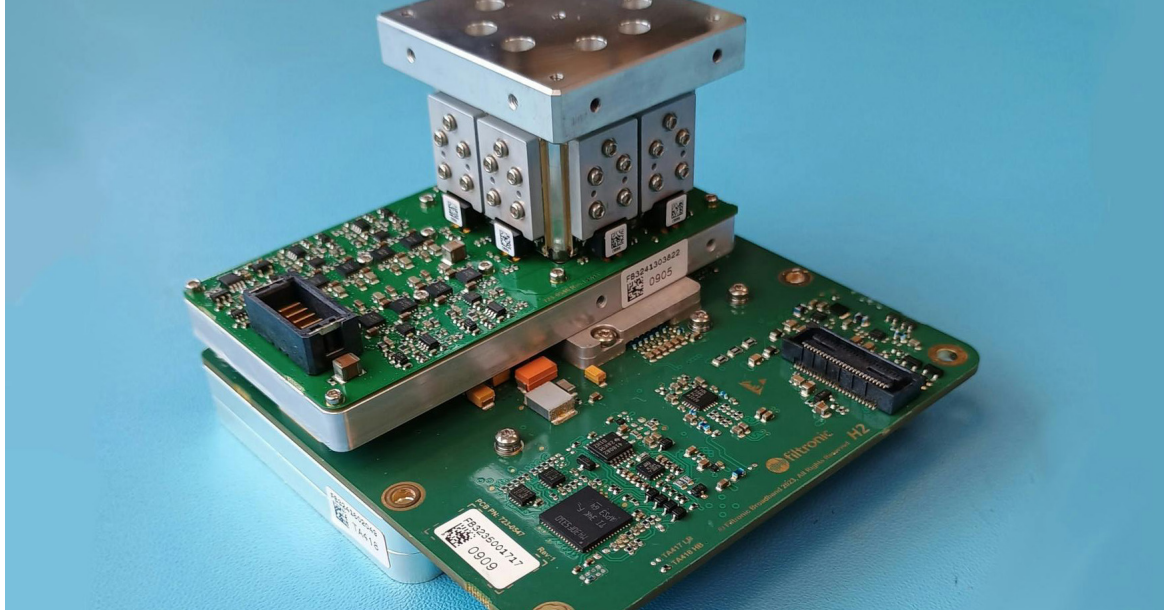
The library provides support to generate waveforms with parameters extending beyond the limits of the 5G NR specifications. It can be used to evaluate link performance in the 7- to 20-GHz, mmWave, and sub-terahertz ranges. Another possibility is modeling reconfigurable intelligent surfaces (RIS). [MATLAB artificial intelligence \(AI\)](#) can be brought to bear to enhance 6G implementations.

Simulation of 6G links will be high on a developer's list of tools. Simulation of transmitter operations, channel models, RF impairments, and reference receiver algorithms can be very useful. The library can also be utilized to enumerate metrics such as throughput and error vector magnitude (EVM).

Links

- [MathWorks](#)
- [MATLAB](#)
- [MATLAB 6G Exploration Library](#)

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credit: Filtronic

CHAPTER 10:

E-Band Transceiver and Amplifier Module Boost Backhaul Capacities

DAVID MALINIAK, Executive Editor, *Microwaves & RF*

Modules bring all the T/R functions of an E-band link and support spectrally efficient modulation schemes to underpin low-latency private networks.

Filtronic came to [IMS 2024](#) with its [Hercules II](#) system for E-band links. The turnkey package combines the company's [Morpheus II transceiver](#) and either a [Cerus 4 or 8 solid-state power amplifier](#) (SSPA) to bring high performance and versatility to high-speed backhaul networks and/or low-latency private networks.

By integrating the Morpheus X2 module, which contains all the necessary transmit and receive functions for the RF section of an E-band link, with the Cerus power amplifier, the Hercules II offers seamless integration and a host of exceptional benefits. This combination facilitates a straightforward and efficient connection to a high data rate full duplex modem while significantly boosting the available transmit power, ensuring extended reach and enhanced coverage.

The Hercules II also supports spectrally efficient modulation techniques, optimizing bandwidth usage and ensuring higher data throughput. Key features of the Hercules II include Tx saturated powers exceeding +35 dBm, low phase noise, and support for up to 512-QAM modulation.

The Cerus32 is a high-performance, E-band SSPA designed to meet the growing demands of high-capacity wireless communication networks, such as low-Earth-orbit satellite communications. The Cerus 32 is said to be the most powerful commercially available E-band SSPA, with up to +43 dBm of transmit power. Each Cerus 32 module incorporates Filtronic's in-house MMIC chip design and power-combining techniques, delivering maximum linear power. The high-power SSPA can be applied in a range of applications and is specifically suitable for commercial, military and satcom applications.

Additionally, the [Hades X2 e-band active diplexer](#) specifically targets applications that demand high power and efficiency. The diplexer achieves high efficiency and minimal



power consumption through advanced GaAs MMIC technology and state-of-the-art thermal management, making it suitable for sustainable network deployments.

Related links:

- [Filtronic home page](#)
- [Hercules II E-band transceiver](#)
- [Morpheus II transceiver](#)
- [Cerus 4 or 8 SSPA](#)
- [Hades X2 e-band active diplexer](#)

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