





In-Person Event: June 7-10, 2021 Atlanta, GA



DAVID MALINIAK Technology Editor Microwaves & RF

The 2021 edition of the **INTERNATIONAL MICROWAVE SYMPOSIUM** (IMS 2021) is now behind us, and it was a seminal event. It represented a re-entry into the live format (June 7-9, Atlanta), which the industry welcomed with gratitude after a long period of hibernation. What the show lacked in size and attendance (both being down from pre-pandemic levels), it made up for in enthusiasm amongst those who made the effort, as well as in the quality of the technical program. And, like last year, there was a virtual component to IMS 2021 (June 20-25), which provided a platform for exhibitors and technical presenters who were not able to join the live event.

Whether you were present in Atlanta or logged on for the virtual event, this ebook is our effort to bring IMS 2021 to you. Enjoy our collected coverage of the conference, workshops, MicroApps talks, and the myriad of new products introduced during the event. See you next year in Denver?

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CHAPTER 1:

IMS 2021 Prepares for mmWave Applications

JACK BROWNE, Technical Editor

or the RF/microwave industry, this event is one not to forget, the largest placeholder on the calendar. In years past, the IEEE International Microwave Symposium (IMS) has
been the technical conference and exhibition that brought the industry together for a week. But this isn't just any year—the pandemic caused by the COVID-19 coronavirus has forced most industries to be cautious how they do business.

However, the RF/microwave industry has always adapted to change and the way the internet is now used as a key channel of communications. The industry will support a traditional version of "Microwave Week" at the face-to-face version of the IEEE IMS 2021 Conference and Exhibition scheduled for June 7-10, 2021 at the Georgia World Congress in Atlanta, Ga. There's also an online version taking place June 20-25, 2021, wherever they have internet access.



Many companies have expressed great enthusiasm at the opportunities to meet face-toface with customers at their exhibitor booths. But, as with many public events, attendance has been hindered by the threat of the COVID-19 virus, often reaching only 20% of expected totals.

In the hopes of meeting customers in Atlanta, the RF/microwave industry has contributed to a strong IMS show lineup of more than 300 exhibitors for the face-to-face and virtual versions of the exhibition. As usual, there's a diversified assortment of technologies and products from components, circuit materials, and multifunction assemblies through design software and test equipment.

The exhibition has always represented almost a week of constant activity, meeting new clients, and catching up with existing customers and friends. Visitors have a chance

Interest in components, circuit materials, and test solutions for millimeterwave frequencies looms large as the RF/microwave industry readies for two versions of the annual IEEE IMS. to connect with their current suppliers and find new sources of products for aerospace, commercial, defense, industrial, and medical marketplaces. In addition to the exhibition, the IMS 2021 features a strong conference of RF/microwave engineering speakers with technical lectures, white papers, and workshops.

Two Conferences in One

The first day (June 7) of the face-to-face IMS 2021 technical conference opens with a pair of plenary talks. Suresh Venkatarayalu, Chief Technology Officer of Honeywell, will welcome guests to the IMS 2021 with a special IMS keynote lecture. That same day, Dr. Ahmad Bahai, Chief Technology Officer and Senior Vice-President of Texas Instruments, will present a keynote talk introducing the 2021 IEEE Radio Frequency Integrated Circuit Symposium (RFIC 2021), co-located with the IMS 2021 technical conference in the nearby Omni Hotel.

For those interested and involved in high-frequency, high-speed measurements, the technical portion of the face-to-face conference closes with a long-running tradition: the 97th meeting of the Automatic RF Techniques Group (ARFTG) Thursday, June 10, also in the Omni Hotel. This session will have a strong focus on mmWave measurements.

Those traveling to Atlanta can enjoy a strong primary technical conference as part of IMS 2021, with technical sessions on transmitters and power amplifiers (PAs); RF through millimeter-wave (mmWave) filtering; advances in materials, including frequency-selective materials and metasurfaces; circuit materials for mmWave frequencies; physical-layer security, including radio channel modeling; antenna arrays for wireless applications; conserving energy in low-power circuits; and advanced waveguide designs.

Later in the month, from June 20-25, the virtual technical conference features an intriguing collection of online presentations. It may not offer the same opportunities for interaction and feedback as the live event, but, if anything, covers a more widely diversified list of topics, from filter fundamentals to biomedical design issues.

The first day of technical sessions at the virtual conference (June 22) offers presentations on advanced technologies for transceivers, machine learning (ML) for computer-aideddesign (CAD) tools, electromagnetic (EM) fields for security applications, and acoustic filters for communications. The following day (June 23) continues the strong focus on mmWave design, with online presentations about wireless sensor systems, frequency conversion circuits, waveguide and composite structures, instruments for biomedical measurements, and mmWave PAs. The final day of sessions (June 24) covers advances in radar systems, mmWave circuits and components, beamforming array antennas, and low-noise amplifiers (LNAs).

Exhibitor Showcase

The areas of interest in the face-to-face and virtual technical conferences are mirrored by the variety of products on display during both versions of the IMS 2021 exhibition. Exhibitors scheduled for the face-to-face and virtual exhibitions comprise a representative sample of the RF/microwave industry, providing products from as basic as inductors to as elaborate as "smart" signal analyzers.

With the widespread adoption of mmWave devices and modules into automotive electronic systems such as advanced driver-assistance systems (ADAS) and 5G cellular wireless networks, both show floors are expected to have "higher-frequency" feels to them

at many of the booths. Attention paid to frequencies of 24 GHz and higher is expected to impact most of the product areas at the exhibitions, including active and passive components, design software, materials, semiconductors, and test equipment.

Long-time amplifier supplier <u>Empower RF Systems Inc.</u> (**booth 1225**) will show visitors a sampling of its high-power amplifiers (HPAs) for communications, military, radar,



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Fig 1. Broadband coaxial LNAs covering a total range of 1 to 40 GHz are available with integrated attenuators, couplers, and detectors. (Courtesy of Ciao Wireless) satcom, and test-and-measurement applications. Some of these are solid-state replacements for the oversized vacuum-tube amplifiers powering military jammers and radar systems, such as the model 2210 HPA. It provides 12-kW saturated pulsed output power from 150 to 450 MHz in a rack-mount enclosure. The 2210 consists of two amplifiers based on silicon (Si) laterally diffused metaloxide-semiconductor (LDMOS) transistors teamed with a power converter and a power-control and combining assembly. Empower is expected to have many smaller amplifiers at its booth, with less output power at higher frequencies.

On a smaller scale, Ciao Wireless (booth 1812) will show broadband, high-gain, and low-noise amplifiers (LNAs) (*Fig. 1*), with models covering total bandwidth of 1 to 40 GHz with flat gain levels of 20, 25, 30, or 35 dB and noise figure as low as 4 to 5 dB through 40 GHz. Well-suited for commercial and military applications, the coaxial amplifiers are



Fig 2. Model ZVA-24443G1 is a mmWave LNA with typical noise figure of just 1.7 dB from 24.0 to 43.5 GHz. (Courtesy of Mini-Circuits) available with integral power detectors, voltage-variable attenuators, and output couplers covering the full frequency range and as much as +20-dBm output power at 1-dB gain compression.

<u>Mini-Circuits</u> (**booth 1921**) will greet visitors in Atlanta with a sampling of its diversified product portfolio, including its model ZVA-24443G1 mmWave LNA, with typical noise figure of just 1.7 dB across its wide frequency range of 24.0 to 43.5 GHz (*Fig. 2*). Designed for a single supply voltage of +9 to +15 V dc, the coaxial amplifier delivers typical output power of +20 dBm across the full bandwidth and features integrated overvoltage and reverse-voltage protection.

To satisfy a growing need for frequency conversion at mmWave frequencies, Mini-Circuits will also highlight its model MDB653H-D+ double-balanced mixer die. Well-suited to fit in the tightest PCBs, such as in SWaP applications, the frequency mixer has an RF frequency range of

20 to 65 GHz, mixing with local-oscillator (LO) signals over the same frequency range to produce intermediate-frequency (IF) signals from dc to 20 GHz for signal processing. It can also be used in the reverse direction for frequency upconversion, transforming IF signals to mmWave signals from 20 to 65 GHz at its RF port.

For those interested in some of the smallest, highest-power amplifiers at X-band frequencies but not inclined to travel, <u>Wolfspeed/Cree</u> (virtual booth VO3053) will feature its gallium-nitride-on-silicon-carbide (GaN-on-SiC) monolithic microwave integrated-circuit (MMIC) amplifiers for pulsed and CW applications. Designed for +28-V dc supplies, the tiny amplifiers fit into surface-mount-technology (SMT) packages. For example, the model CMPA901A0205 provides typical gain of 31 dB with 20-W saturated output power and 45% power added efficiency (PAE) from 9 to 10 GHz, while model CMPA80180305 offers



Fig 3. Phase-locked DROs from the KSFLOD series offer low-noise signals from 6 to 15 GHz for system and test applications. (Courtesy of Synergy Microwave Corp.) 40 W saturated output power with 20-dB gain and 40% PAE from 7.9 to 11.0 GHz.

Also at the virtual exhibition, <u>Herotek</u> (virtual booth VO3220), in keeping with the growing interest in mmWave frequencies, will highlight its model A2640205010A LNA. It maintains 20-dB small-signal gain with typical gain flatness within ± 2.5 dB from 26 to 40 GHz and maximum noise figure of 5 dB across the full frequency range. Suitable for receivers and test equipment, the amplifier also can deliver +10-dBm output power at 1-dB compression.

For signal generation, <u>Synergy Microwave Corp.</u> (virtual booth VO3025) will show visitors its KSFLOD series of phase-locked dielectric resonator oscillators (DROs), with fundamental-frequency outputs starting at 6 GHz through 15 GHz, and as high as 45 GHz when tripled. With low phase noise and spurious outputs, the compact coaxial DROs (*Fig. 3*) are well-equipped to provide LO and other signals in 5G, radar, and test systems.

Passives

Specifiers of passive components will also find a wide variety of components at both versions of the IEEE IMS 2021, from the most basic to the most elaborate. For those in need of inductors and transformers, <u>Coilcraft</u> (virtual booth VO3340) will show examples of its extensive lines of RF and power magnetic components, including inductors and transformers for commercial, automotive, military, industrial, and space applications.

The company has developed AEC-Q200-qualified inductors for the growing number of automotive electronic applications, such as ADAS-based LiDAR and radar systems, tire-pressure monitoring systems (TPMS), and electric power-steering (EPS) circuits. The components are designed for operating temperatures from -140 to +125°C.

<u>Ironwood Electronics</u> (booth 2140) will show Atlanta visitors versions of its high-speed, high-frequency sockets well-suited for interconnections through 110 GHz. Available in standard and custom versions to replace obsolete interconnections and packaging, the sockets are designed for operating lifetimes as long as 500,000 insertions. The company will also show its Giga-snaP BGA SMT adapters for reliable interconnections to BGA SMT pads. The adapters remain attached through many solder cycles, with a fraction of the insertion force of other SMT adapters.

Mini-Circuits will be in Atlanta and at the virtual exhibition with its own collection of passive components, including miniature low-temperature cofired-ceramic (LTCC) filters, such as lowpass model LFCN-3052+. Designed to reject mmWave signals to 50 GHz, the tiny filter measures just 3.2 × 1.6 mm with low insertion loss of typically 1.2 dB across a wide passband of dc to 30.5 GHz. It delivers as much as 40-dB rejection from 41.5 to 47.0 GHz and at least 26-dB rejection across a stopband of 36.5 to 50.0 GHz.

Also on tap is its model RCDAT-30G-30 programmable attenuator, which can be simply controlled by USB or Ethernet connection to a computer. With a frequency range of 100 MHz to 30 GHz, it adjusts attenuation from 0 to 30 dB in 0.5-dB steps.

Antennas are usually passive devices, but more and more phased-array antennas with active beamforming are being considered at mmWave frequencies. For those wishing to get a "jumpstart" on a mmWave phased-array antenna, <u>Anokiwave</u> (virtual booth

VO3042) will show virtual exhibition visitors its scalable active antenna kits. The kits feature phased-array antennas on PCBs, designed and constructed with the company's innovative beamforming and steering ICs. Antenna kits are available for different 5G NR frequency bands, such as the 28-GHz n257 and n261 bands. The antennas are ready for transmit and receive actions, as well as for testing with instruments such as a spectrum analyzer and test antenna.

Creating Circuits



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Fig 4. RO4835T laminates are low-loss, temperature circuit materials that help miniaturize multilayer PCBs through mmWave frequencies. (Courtesy of Rogers Corp.)

Basic materials are a starting point for most electronic designs, whether they're semiconductors, packages, or circuits, and the growing importance of mmWave frequencies has made an impact on materials development over the last few years.

On the Atlanta exhibition floor, <u>Rogers Corp.</u> (**booth 1841**) will display examples of its growing lines of materials to constructed PCBs from RF through mmWave frequencies, including its RO4835T laminates (*Fig. 4*). Designed to work with RO4835 laminates as thin inner layers for multilayer PCBs, they provide designers some control of the overall thickness of a multilayer PCB—even when stacking many circuit layers into a densely integrated design—whether for commercial, industrial, medical, or military electronic designs.

With a dielectric constant (Dk) of 3.3, RO4835T laminates can be fabricated with the same processes used for FR-4-based PCBs. The laminates feature low loss, with dissipation factor of 0.0030 to 0.0036 depending on thickness. Thermal properties are excellent, too, with coefficient of thermal expansion (CTE) of 17 ppm/°C or less, again depending on thickness.



Fig 5. The N9042B UXA signal analyzer can sweep analysis bandwidths as wide as 11 GHz across a frequency range of 2 Hz to 110 GHz. (Courtesy of Keysight Technologies)

At the virtual exhibition, Isola (virtual booth VO2949) will show its Tachyon 100G circuit materials for mmWave applications to 100 GHz and high-speed digital circuits to 100 Gb/s. Also available in a wide range of thicknesses for construction of compact multilayer circuits, the materials exhibit low CTE values and excellent stability for operating temperatures from -55 to +125°C. Its spread-glass construction contributes to low jitter and reduced rise/ fall times in digital circuits and its smooth copper helps minimize conductor losses.

Testing the Limits

Keysight Technologies recently released a handy 22-page application note on using different signal analyzers, titled "Signal Analysis Measurement Fundamentals." It provides guidance on improving the measurement accuracy of a test setup and how different settings, such as resolution bandwidth, will affect measurement speed. In Atlanta, Keysight (**booth 1321**) will bring visitors up to speed on signal analysis, with several high-performance instruments on hand. The model N9042B UXA signal analyzer (*Fig. 5*) features a phenomenal analysis range of 2 Hz to 110 GHz and wide dynamic range. Ideal for finding and analyzing signals in 77-GHz automotive radars and short-range mmWave links in 5G wireless networks, the signal analyzer can sweep across its full frequency range with analysis bandwidth as wide as 11 GHz, to search for and find expected as well as unknown signals.

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Keysight will also display its FieldFox portable microwave analyzers in Atlanta. The compact, waterproof instrument brings signal analysis to the field, in a package weighing less than 8 lbs. Models are now available with top frequencies to 54 GHz, such as the 52-GHz model N9952B with maximum analysis bandwidth of 120 MHz and dynamic range as wide as 105 dB. The portable signal analyzers are supported by test software packages such as the firm's PathWave vector-signal-analysis (VSA) software to analyze high-frequency signals with complex modulation formats, such as quadrature amplitude modulation (QAM).

Rohde & Schwarz (booth 1821) will be in Atlanta with an assortment of high-performance RF/microwave test equipment, including its R&S ZVA vector network analyzers (VNAs). Versions are available from 10 MHz to 26.5, 43.5, 50, and 67 GHz to characterize active and passive components for many emerging mmWave applications. The hybrid test instrument/computer and its advanced user interface has a front panel with a 12.1-in. touchscreen display that can be divided into two independent display screens for detailed analysis and control.

As part of the virtual exhibition, <u>FormFactor</u> (virtual booth VO3245) will show how it applies microelectromechanical-systems (MEMS) technology to the fabrication of its fine-pitch probe cards for semiconductor testing. As an example, its Altius vertical MEMS probe card enables high-speed, high-frequency testing of high-density interconnections on semiconductor packaging. <u>Anritsu</u> (virtual booth VO3353) will also assist mmWave testers, displaying its ME7838A4 VectorStar series of microwave/mmWave four-port VNAs, with models from 70 kHz to 110, 125, 145, and 150 GHz.

This is a small sampling of the face-to-face and virtual exhibition floors expected for the IEEE IMS 2021, but the trend toward a need for higher mmWave products is clear. Visitors to Atlanta are urged to follow all COVID-19 health and safety protocols, even when playing with some of the latest in mmWave test instruments.

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There's many reasons to

attend IMS 2021's live

event in Atlanta, not the

least of which is the juicy

smorgasbord of technical

article glimpses just a few

sessions on offer. This

of the highlights.



CHAPTER 2:

IMS 2021 Delivers A Deep and Varied Live Technical Program

DAVID MALINIAK, Senior Editor. Microwaves & RF

he coin that is the <u>International Microwave Symposium</u>, the live portion of which takes place next week in Atlanta, has the same two sides as any other coin. On one is the <u>exhibition</u>, where one can see, touch, and learn about the multitude of new products and services that will make their debuts at the event. This year's IMS show floor will feature over 300 exhibitors showcasing their offerings. That's always a prime attraction at any industry event, of course, and perhaps the most stimulating from a sensory perspective. A busy exhibition floor can be an exciting experience, with new and interesting things galore on which to get up to speed.

On the other side of the IMS coin is its <u>technical program</u>, which promises to be a memorable one in this year of rebound from the pandemic that drove last year's IMS to a total virtual format. Technical conferences may not be as fun as walking an exhibition floor, where one can see and greet industry colleagues and renew relationships. But for the technically curious minds of RF/microwave engineers, it's where you'll find the meat that attendees anticipate: new ideas and concepts that could spark subsequent waves of innovation in a field that thrives on invention.

Monday, June 7

The first day of the live IMS 2021 technical conference opens with a pair of plenary talks. Suresh Venkatarayalu, Chief Technology Officer of <u>Honeywell</u>, will welcome guests to the IMS 2021 with a special keynote talk. That same day, Dr. Ahmad Bahai, Chief Technology Officer and Senior Vice-President of <u>Texas Instruments</u>, will introduce the <u>2021 IEEE</u> <u>Radio Frequency Integrated Circuit Symposium</u> (RFIC 2021), co-located with the IMS 2021 technical conference in the nearby Omni Hotel.

Monday will also feature a pair of invited lectures, the first of which will be delivered by

Prof. Tim Brothers of the <u>Georgia Institute of Technology</u>. His talk, titled "Software Defined Radio Hardware and Software," comprises an overview of software-defined radio (SDR). In addition to a discussion of basic hardware, software, and firmware building blocks, Prof. Brothers will provide a hardware demonstration of a commercial SDR. He'll conclude with a discussion of enabling technologies behind the next generation of SDR systems.

A second invited lecture by Jeff Hesler, CTO of <u>Virginia Diodes</u>, will cover Terahertz technology and its progression from a scientific endeavor to a commercial one. The potential for non-scientific applications of THz has been understood for many years, but technological limits slowed the advance of these applications. Hesler's talk will cover recent developments in transistor technology that are now enabling rapid progress in a variety of applications, ranging from basic test & measurement, ultra-wideband communications, and the use of THz radiometers in space for next-generation commercial weather forecasting.

Tuesday, June 8

Tuesday marks the kickoff for the slate of technical sessions. Most of the sessions are chaired, and talks delivered, by high-flying academics from the world's most prestigious technical institutions. Some highlights include the following:

- "Novel Electromagnetic Structures and MetaSurfaces" comprises three presentations on topics such as metamaterial-based wireless power transfer in smart-home applications; a 4D-printed, tunable, multi-layer, frequency-selective surface for mm-Wave IoT, RFID, WSN, 5G, and smart-city applications; and a study of nanowirebased integrated via technology for CMOS applications at mmWave frequencies.
- "Advances on Ultra-Low-Power Circuits and Systems" offers presentations on an instinctual, interference-adaptive low-power receiver design; a 5.8-GHz, low-power, tunnel-diode-based two-way repeater for use in RFIDs and wireless sensor networks; and a multi-Gb/s data-communication link for machine-to-machine (M2M) interaction.
- "Advanced Waveguide Designs" will describe such technical innovations as a flexible, non-radiative dielectric PCB-to-NRD coupler with 1-dB loss in mmWave array applications; a high-order accurate, integral, and equation-based mode solver for layered nanophotonic waveguides; and a distributed, mixer-based leaky-wave antenna for simultaneous transmit and receive.

Wednesday, June 9

The technical program closes on Wednesday, but not before attendees can avail themselves of sessions like:

- "N-Path Receivers and Filters" covers innovative work in areas such as a tunable, multi-mode, quadrature-balanced N-path diplexer with nonlinear cross-modulation distortion correction; a 20-to-40-GHz, high dynamic-range HBT N-path receiver; and a 6-to-31 GHz tunable, reflection-mode N-path filter.
- "Wideband Front-End Building Blocks" features discussions of wideband SPDT and SP4T RF switches using phase-change material in a SiGe BiCMOS process; a 27-to-46-GHz low-noise amplifier with dual-resonant input matching and a transformerbased, broadband output network; and a W-band Wilkinson power divider with 1-dB insertion loss that uses silicon-based integrated passive devices.
- "Advanced Manufacturing and Flexible Electronics for RF/mmWave Circuits and

Packaging" delves into back-end advances in such areas as batch-fabricated, substrate-embedded Ka-band circulators using screen-printed Strontium Hexaferrite/ PDMS composites; in-package, additively-manufactured sensors for bend prediction and calibration of flexible phased arrays and hybrid electronics; and additive manufacturing of a wideband-capable W-band packaging strategy.

Again, these are just a few highlights of a much broader and deeper overall technical program. IMS 2021, in its first live outing of what we all hope is the post-COVID era (at least here in the United States), will be brimming over with fascinating and stimulating presentations. **See you in Atlanta!**

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IMS 2021 Workshops: Focused and Intense

DAVID MALINIAK, Senior Editor. Microwaves & RF

If you're looking for a deep dive into a specific technical topic, the Industry Workshop program at IMS 2021 might be just what you need. n important feature of every <u>International Microwave Symposium</u> is Industry Workshops, and IMS 2021, taking place in Atlanta (June 7-10) and online (June 20-25) is no different. Industry Workshops at IMS are always highly rewarding to attendees interested in a long, deep dive into a specific technical topic.

The Industry Workshops are longer affairs held in a classroom setting, often with several presentations, live demonstrations, attendee participation, and hands-on opportunities. They're usually conducted by a single company (or sometimes a tandem), and get into a specific technical topic in much greater depth than the <u>MicroApps Seminars</u> being held on the show floor.

Here's a couple of examples of the kinds of Industry Workshops going on at IMS this year:

OTA measurements of EVM for phased-array antennas using VNA-based EVM test (conducted by Keysight Technologies): Active antenna arrays will be widely used in new 5G and Internet-from-Space applications. As such, their non-linear performance, and its effect on error-vector magnitude (EVM), a key metric of communications performance, becomes important. This workshop details new methods for characterizing the EVM of active antennas using an over-the-air (OTA) method, which can show EVM performance of the antenna, including EVM effects of the beam steering and, for the first time, showing the element-by-element contribution of the array through an EVM scan of the array. This scan, which is normally not possible due to signal-to-noise limitations of traditional test methods, uses a vector network analyzer (VNA) EVM measurement method.

Performance validation of 5G New Radio mmWave devices from chipset to production line (conducted by <u>ETS-Lindgren</u> and <u>LitePoint</u>): 5G New Radio technology presents unique challenges to device manufacturers to not only find space for the chipset, but also

to ensure they perform as intended in all possible use cases. This requires more validation testing at the design level prior to releasing prototypes for mass production. Productionline testing lowers the risk of missing a company's time-to-market and budget goals. This workshop will review testing of 5G New Radio mmWave devices, and help attendees visualize why performance validation testing is required in all steps of the design process from the chipset level to production line testing.

Emerging EMC Requirements for 5G mmWave Devices (conducted by ETS-Lindgren): Achieving electromagnetic compatibility (EMC) for 5G devices depends on not only the existence of achievable and appropriate regulatory requirements, but also meaningful test methods for demonstrating compliance. The primary body in North America focused on developing EMC test methods for wireless and 5G devices, for both licensed and unlicensed transmitters, is Accredited Standards Committee C63 of the American National Standards Institute (ANSI). Following an overview of C63 and the standards most relevant to manufacturers of 5G mmWave devices, the workshop will include presentations focused on wireless coexistence and transmitter performance characterization and validation.

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CHAPTER 4:

Blink and You'll Miss 'Em: IMS 2021's Microapps

DAVID MALINIAK, Senior Editor. Microwaves & RF

his year's International Microwaves Symposium will be in two versions, one live (Atlanta, June 7-10) and one virtual (June 20-25). The live event will feature an exciting slate of <u>full technical presentations</u> in a whirlwind three days (June 7-9). Likewise, the virtual event will do the same, the difference being that you can take in the sessions from wherever you happen to be, so long as you/ve got a good internet connection.

Both versions of IMS 2021 will also feature something the organizers are calling Microwave Application Seminars, or MicroApps. These 15-minute sponsored presentations, which, in the case of the live-event IMS, will take place at the MicroApps Theatre on the exhibition floor, are a bit like tech speed dating. You get just enough time with a presenter and the topic to get a flavor of what it's about. The presenters are discouraged from hitting attendees with a sales or marketing pitch but pointing out specific features of their products that might solve specific problems is OK. And, it might be enough to get attendees to stop by their booth later for a follow-up discussion in more detail.

The MicroApps seminar presentation materials, typically PowerPoint files converted to .pdf format, will be available electronically through a cloud distribution service at the IMS website and the <u>IMS Microwave Week mobile app</u>.

MicroApps are intentionally brief, but the organizers are grouping them based on subject matter. On one hand, that gives attendees a chance to hear more than one presentation on a topic of particular interest to them in a sitting. On the other, companies that are looking for industry partners or supply-chain links have an opportunity to network behind the scenes.

Sometimes you want a whole meal, and sometimes just an appetizer. IMS 2021 aspires to provide the latter with MicroApps tech presentations.

Tuesday, June 8

Some of the highlights among Tuesday's MicroApp sessions include:

- Technical considerations for testing 5G base-station finals for digital pre-distortion (DPD) characterization (sponsored by <u>AR RF/Microwave Instrumentation</u>): Bandwidth and peak-to-average ratios for 5G modulation requires accurate DPD characterization. An oft-overlooked aspect of the characterization is a near-distortion-free 3GPP test model for presentation to the final device-under-test. With Class A amplifiers typically recommended in these applications, this presentation will cover whether the typical Class A spec of P1dB is a sufficient selection criteria.
- Fixture removal technique with a 1-port reflect model on a VNA (sponsored by <u>Copper</u> <u>Mountain Technologies</u>): De-embedding the test fixture using a 1-port reflect mode traditionally requires an identical 2X thru-line. CMT will show an alternative method to overcome fixture limitations when testing surface-mount components.
- Miniaturized SIW using high-K ceramics (sponsored by Knowles Precision Devices): DLI has merged substrate-integrated waveguide (SIW) technology with a high-precision, repeatable, thin-film process using high-permittivity material. This helps to create small, temperature-stable, high-performance filters in a surface-mount package. The presentation will cover size and performance benefits vs. common PCB materials, as well as flexibility in configuration and implementation. A demonstration will show modeled to measured performance at 28 GHz.
- •*Pulse-to-pulse phase stability measurements* (sponsored by <u>Rohde & Schwarz</u>): Advanced radar systems use signal processing to detect and suppress unwanted reflections from trees, buildings, and so on by comparing the phases and amplitudes of successive echoes. The greater the phase and amplitude stability of the transmitted pulses, the better the radar's performance. The presentation will cover the precise measurements required to determine overall system performance.

Wednesday, June 9

IMS's MicroApps presentations continue Wednesday; here are a few standout examples:

- Broadband bias-tee design using accurate models at mmWave frequencies (sponsored by <u>Modelithics</u>): Bias tees are often used to apply DC bias to RF circuits. This presentation will cover how to design bias tees using models accurate out to mmWave frequencies, including design details and simulation results. Then, presenters will compare measured data to simulated performance with an eye toward good performance up to, if not beyond, 40 GHz.
- Modular implementation of the latest RFSoC chip from Xilinx: (sponsored by Pentek): The paradigm shift from discrete components connected via parallel LVDS, or highspeed differential pairs on various mezzanine cards, to an FPGA has shifted to a more integrated design. The latest generation of devices includes analog I/O and multi-core ARM processors with high-speed PHY protocol components hardened in the traditional FPGA fabric. This presentation will illustrate key design criteria to properly implement this system-on-chip technology on the latest commercial-off-the-shelf (COTS) modules.
- Pulse-shape duplication for high-power SSPAs (sponsored by <u>Empower RF Systems</u>): High-power amplifiers struggle to duplicate input signals without distortion, with their

transient response introducing overshoot, ring, and droop. Modern pulse shaping seeks to restore signal fidelity using a combination of imperfect methods, mostly external to the amplifier. This presentation outlines a new approach that matches input pulse signal shape and minimizes undesired distortion.

• 5G connectivity: Challenges and gold solutions (sponsored by Indium Corp.): The high-speed and bandwidth needed within the 5G network result in two common issues facing companies that are producing this mobile technology: controlling thermal management of solder joints while also maintaining their strength. This presentation will discuss the challenges and present solutions that can improve the thermal transfer of high-output lasers, as well as solving the weak solder-joint issue on the gold-rich substrate of gallium nitride (GaN) dies.

There's plenty more where those highlighted presentations came from, and it all happens at next week's live IMS in Atlanta. *See you there!*

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CHAPTER 5: What's New at IMS 2021: Live Day 1

DAVID MALINIAK, Senior Editor. Microwaves & RF

Check out our full coverage of IMS 2021.

he <u>International Microwave Symposium</u> is the RF/microwave industry's premier event, one that is anticipated nearly from the day the last one ended. It's long been an event at which the industry gathers to hear a technical program packed with new and exciting breakthroughs, to introduce its important new products, and to take stock of itself by getting together, face to face, and positioning itself for the coming year.

Of course, last year's IMS was a) delayed and b) driven to adopt a virtual format, as did many technical conferences and exhibitions across all industries thanks to the pandemic that we're still struggling to put behind us. Thankfully, we've made a great deal of progress in that direction—enough so that we can have a real, live-and-in-person IMS this year (June 7-10; Atlanta). In this Media Gallery, we present some of the exciting new products making their debuts at the live exposition.

Binary-Step RF Attenuator Covers 8 GHz for Wi-Fi 6E Test

JFW Industries (Booth 1712) comes to IMS this year sporting a new 50-Ohm USB attenuator to help automate your Wi-Fi 6E testing. Model 50P-2111 SMA operates from 200 MHz to 8 GHz with an attenuation range of 0 to 95 dB settable in 1-dB steps. The test software provided with the



Maybe you're at the International Microwave Symposium live event this week, or maybe you're not but you wish you were. Either way, we've got you covered with some of the hottest new products being shown this week in Atlanta. USB attenuator can control multiple JFW USB attenuators to allow for handover signalfade testing. A Python library, available on request, enables users to integrate the USB attenuator into script-driven test routines.

For more information, visit <u>the product webpage</u>. If you're in Atlanta this week, visit JFW at Booth 1712.



n its new Talon Model RTR 2628 RF signal recorder, <u>Pentek</u> (Booth 1429) offers a spectrum-monitoring tool aimed squarely at beamforming, direction finding, phased-array radars, and multi-antenna diversity receivers. The 4U 19" <u>rackmount recorder</u> with integrated RF tuners and analog-to-digital (ADCs) accepts signals from eight antennas to provide eight channels of phase-coherent RF signal recording. Each channel is tunable up to 6 GHz and captures up to 80 MHz of instantaneous bandwidth.

Each input channel includes a 250-MHz, 16-bit ADC and an FPGAbased digital down-converter with programmable decimations from 2

to 65536 for instantaneous bandwidths from 80 MHz down to 3 kHz. RF signals up to 6 GHz in frequency can be tuned, sampled, digitally down-converted, and streamed to disk in real-time at sustained aggregate recording rates up to 3.2 GB/s. RF tuning frequencies, A/D sampling rates, DDC decimations, and trigger settings are among the selectable system parameters.

For more information, visit the <u>product webpage</u>. If you're in Atlanta this week, visit Pentek at Booth 1429.



Microwaves&RF E-BOOK

LNA Can Be Surface-Mount or Connectorized

ew at IMS 2021 from PMI (Booth 1206) is its <u>Model PLNA-30-10M20-292FF</u> low-noise amplifier, which operates over the frequency range of 10 MHz to 20 GHz and offers a minimum gain of +28 dB @ 20 GHz; gain flatness of ± 2.0 @ 18 GHz; and noise figure of 3 dB @ 0.5 GHz, 2.5 dB @ 18 GHz, and 3.3 dB @ 20 GHz. The device's housing measures 0.53" x 0.70" x 0.26" and it can be used as a 2.92-mm surface-mount module or as a connectorized component.

For more information, visit <u>the product webpage</u>. If you're in Atlanta this week, visit PMI at Booth 1206.

Instantaneous-Bandwidth Amp Covers 10 kHz to 1000 MHz

R RF/Microwave Instrumentation's Model 250U1000A CW amplifier offers 250 W of output power from 10 kHz to 1000 MHz. This Class A amplifier replaces the need for multiple amplifiers to cover the same bandwidth and eliminates dual-band operation and is fully mismatchtolerant. Ideal for EMC testing, medical/physics research, and many other applications, the unit is easily transportable or can be integrated into a rack.

For more information, visit <u>the product webpage</u>. If you're in Atlanta this week, see AR at Booth 1741.





2-Port, 44-GHz VNA Offers High Dynamic Range

This year, <u>Copper Mountain Technologies</u> brings to IMS its S5243 two-port, 44-GHz vector network analyzer (VNA) to IMS 2021. The S5243, which is CMT's highest-frequency compact VNA, features excellent dynamic range and fast measurement speed in a compact package with the maximum standard software feature set.

The S5243 VNA includes an RF measurement module and S2 Windows or Linux operating system on a PC, laptop, tablet, or x86 board computer connecting to the measurement hardware via USB interface. S2 software can be installed on multiple computers, making it

easy to share the use of the analyzer measurement module.

For more information, visit <u>the product webpage.</u> If you're in Atlanta this week, see Copper Mountain Technologies at Booth 1231.





CHAPTER 6: What's New at IMS 2021: Live Day 2

DAVID MALINIAK, Senior Editor. Microwaves & RF

Check out our full coverage of IMS 2021.

oing on at this moment in Atlanta, the *International Microwave Symposium* is the RF/microwave industry's premier event, one that is anticipated nearly from the day the last one ended. It's long been an event at which the industry gathers to hear a technical program packed with new and exciting breakthroughs, to introduce its important new products, and to take stock of itself by getting together, face to face, and positioning itself for the coming year. Of course, last year's IMS was a) delayed and b) driven to adopt a virtual format, as did many technical conferences and exhibitions across all industries thanks to the pandemic that we're still struggling to put behind us. Thankfully, we've made a great deal of progress in that direction—enough so that we can have a real, liveand-in-person IMS this year (June 7-10; Atlanta). In this Media Gallery, we present some of the exciting new products making their debuts at the live exposition.

Instrument Suite Takes Fast, Accurate Field Measurements

N ew at IMS 2021 from **Ametek** NSI-MI (**Booth 1107**) is its <u>VFA Performance Suite</u>, a harmonized system for fast, accurate RF and microwave field measurements. Included in the Suite are the following elements:

• The Vector Field Analyzer (VFA) is a measurement receiver, incorporating 10-ns timing resolution and coordinated motion control interfaces with multi-channel phase-coherent RF measurements for truly accurate understanding of electromagnetic fields. The VFA tests antennas, radomes, and other RF/microwave devices anywhere from 10 MHz to 1

In this Day 2 Media Gallery, we continue our coverage of exciting new products debuting at the live portion of IMS taking place in Atlanta.



THz.

• The Vector Measurement Controller (VMC) complements the VFA such that the test designer can apply the same 10-ns precision to other devices in the test setup. Example: the VMC coordinates pointing commands with VMC field measurements to fully characterize a steerable-beam antenna.

• Microwave Signal Sources power the test with dependable frequency hops of only 400 (optionally 40) microseconds between any two frequencies.

• Position Controller and Mechanical Positioner products bring the same precise approach to mechanical movement for antennas, field probes, or other assemblies.

For more information, visit <u>the product webpage</u>. If you're in Atlanta this week, visit Ametek NSI-MI at **Booth 1107**.



67-GHz Multiplexers Sport PXI, PXIe, and LXI Formats

Pickering Interfaces this week is expanding its range of microwave multiplexers with models sporting a maximum frequency of 67 GHz in both SP4T and SP6T form factors. The higher frequency PXI/PXIe multiplexers (model 40/42-785C) and LXI multiplexers (models 60-800 and 60-803) maintain the same physical dimensions as existing lower frequency products, enabling users to upgrade to 67-GHz products while maintaining the same slot count/rack height within their test systems.

The new 40/42-785C and <u>60-800</u> and <u>60-803</u> 67-GHz multiplexers are available in un-terminated SP4T and SP6T forms using the SMA-1.85 connector interface. The components used exhibit virtually identical performance up to 50 GHz when compared to existing 50-GHz switches. This helps to maintain performance characteristics for legacy test systems that were previously based on 50-GHz components. In addition, the relays used in Pickering's 67-GHz multiplexers have the same life

expectancy (2 million operations) as lower-frequency products from the company and twice that of competitors.

For more information, visit <u>the company's website</u>. If you're in Atlanta this week, visit Pickering Interfaces at **Booth 1841**.



Parts Library for Cadence AWR Sees Latest Update

Modelithics will be at IMS with version 21.3 of the Modelithics COMPLETE Library for use with the Cadence AWR Design Environment Platform. This release includes 31 new models representing nearly 1,850 additional microwave/mmWave components.

Version 21.3 contains over 775 highly scalable Microwave Global Models representing more than 22,000 passive and active components. This collection of models for discrete-die, surface-mount, and packaged devices is integral for developing PCB-based RF and microwave circuits. Included are new models for four AVX capacitor series, the Coilcraft

0402DC and 08085Ls inductor series, the Johanson L-14W inductor series, the KOA RK73H resistor series, three inductor series from Taiyo Yuden, three TDK capacitor families, two Passive Plus resistor series, three Vishay resistor series, and the Yageo RC0100 resistor family. There are also new models for the MACOM MA4E1317 Schottky

diode series, five HEMTs and two attenuators from Mini-Circuits, Qorvo's TGF2040 HEMT, and the 2SC3356 BJT from Silicon Supplies.

For more information, visit <u>the product webpage</u>. If you're in Atlanta this week, see Modelithics at **Booth 2133**.

EMI/RFI Filters Meet DoD's Stringent Standard

TE Filters, an affiliate of Gowanda Components Group, has announced that its "Instec ML61" EMI/RFI Filter Series is now qualified to the U.S. Department of Defense DLA Land and Maritime's MIL-PRF-28861/12H standard. The electrical characteristic ranges of these low-pass, feed-through, C-circuit, solder-in filters include rated voltage from 50 Vdc to 200 Vdc, capacitance from 10 pF to 15,000 pF, and minimum insertion loss from 3 dB to 60 dB. Operating temperature range is -55°C to +125°C.

This ML61 series is designed for use in military electronic systems to suppress and reduce broadband radio-frequency interference which would

otherwise compromise system performance. The 18 discrete parts in the ML61 series are hermetically glass sealed at one end and epoxied at the other end, with the location of the glass seal dependent on the configuration. In conformance with the Mil-spec, the company provides filters in Configuration A (ML610-) or Configuration B (ML611-).

For more information, visit <u>the product webpage</u>. If you're in Atlanta this week, visit TTE Filters at **Booth 1129**.



Microwaves & RF E-BOOK

SMPM Blocks Handle High-Density Board-to-Board Mating

At IMS in Atlanta, <u>Samtec</u> is showing a family of SMPM products designed to support the demands of emerging technologies where space is limited and a high operating frequency up to 65 GHz is required. Samtec offers ganged, multi-position board-to-board solutions with a highdensity single block design in varying retention forces (GPPB Series). Standard SMPM bullet adaptors enable mated board heights of 5.33 mm (0.210"), 8.31 mm (0.327"), and 12.70 mm (0.500"). Ganged, multi-position cable assemblies using 0.047" and 0.086" cable are also available (GC47 Series).

For more information, visit <u>the product webpage</u>. If you're in Atlanta this week, visit Samtec at **Booth 1241**.





CHAPTER 7: What's New at IMS 2021: Live Day 3

DAVID MALINIAK, Senior Editor. Microwaves & RF

Check out our full coverage of IMS 2021.

y the third day of a busy technical conference and exhibition like the <u>Inter-</u> national Microwave Symposium (IMS), attendees, exhibitors, and speakers alike are beginning to wear down a bit. Three days of "show (hot) dogs" will do that to you. But IMS is the RF/microwave industry's premier event, one that is anticipated nearly from the day the last one ended. So, we fight through the fatigue and press on to wade through another aisle of booths, hear another keynote address or technical presentation, or take in another workshop or networking event.

In this Media Gallery, we present some of the exciting new products making their debuts at the live exposition.

RF Conical Inductors Fit Into Multiple Applications

n IMS **Booth 1129**, <u>Gowanda Electronics</u> can fill you in on its new C070 series of RF conical inductors. This series was designed for use in communication applications for bias Tees, which filter signals and remove noise; broadband chip manufacturing; communication platforms; high-frequency microwave circuitry; RF test set-ups and



It's the third day of the IMS live event in Atlanta. Come along as we continue our coverage of exciting new products debuting on the exhibition's bustling show floor.

instrumentation; and transmission amplifiers.

The performance range provided by the C070 series includes inductance from 0.165 μ H to 1.050 μ H, DC resistance from 0.08 to 1.50 Ohms, and current rating of 150 to 625 mA DC. The series has been outgassing tested per ASTM E595 and meets the TML requirement of 1.0% max. Operating temperature range is -55°C to +125°C. Terminations are gold and RoHS compliant. The C070FL coil measures just 0.07" long; the C070SM version is slightly longer overall due to its SMT design.

For more information, visit <u>the product webpage</u>. If you're in Atlanta this week, visit Gowanda Electronics at Booth 1129.

Attenuator Programs 31.5 dB to 50 GHz

Stroll over to IMS **Booth 1921** for a look at <u>Mini-Circuits'</u> model RCDAT-50G-30, a programmable attenuator with an attenuation range of 0 to 31.5 dB in 0.5-dB steps from 100 MHz to 50 GHz. It can be controlled via USB or Ethernet connection, with a single interconnection enabling independent control of multiple attenuators in a master/slave configuration. Typical insertion loss at 0-dB attenuation is 3.25 dB from 100 MHz to 15 GHz, 6.0 dB from 15 to 35 GHz, and 8.0 dB from 35 to 50 GHz, while typical full-band VSWR is 1.50:1 or better from 25 to 50 GHz.

Ideal for measurement and communications systems, the RoHS-compliant attenuator features typical transition time of 100 ns. It operates from -40 to

+85°C and handles as much as +28 dBm input power. Full software support is provided, including a Windows GUI and full API for Windows and Linux.

For more information, visit the <u>product webpage</u>. If you're in Atlanta this week, visit Mini-Circuits at Booth 1921.



SMT Temp-Variable Attenuators Amp Up TCA

In IMS's **Booth 1507**, you can learn about <u>Smiths Interconnect's</u> new SpaceNXT K2TVA Thermopad series of surface-mount, temperature-variable attenuators. These devices offer up to four times the temperature coefficient of attenuation (TCA) of the company's original KTVA series. This series focuses on improved performance in specific frequency bands to target increased RF stability and temperature-shift response over the life of the system. The K2TVA platform offers significant heritage and proven performance in a cost-effective, commercial-grade product. High-reliability-tested options are available to ensure mission success in demanding applications. Applications for these SMT attenuators can be found in defense, aerospace, test and measurement, and wireless infrastructure use cases.

For more information, visit <u>the company's website</u>. If you're in Atlanta this week, visit Smiths Interconnect at Booth 1507.

RF-to-mmWave Eval Boards Available at Digi-Key

<u>Itum RF</u> is at IMS 2021 with new evaluation boards for the company's RF-to-mmWave semiconductor devices for next-generation markets and applications. Examples of the boards now available are the AR1306C5 (see the figure), a 2-to-18-GHz GaN distributed amplifier delivering greater than 2 W of output power, and the ARF1010Q4, a TTSW

TS7441L



22-to-30-GHz linear power amplifier achieving 28 dB of gain and 36 dBm of OIP3. Several low-noise amplifier evaluation boards are also available.

Altum RF has also announced that it has a <u>marketplace storefront</u> live on the Digi-Key website. The storefront features a selection of Altum RF's evaluation boards.

For more information, visit the product webpage. If you're in Atlanta this week, visit Altum RF at **Booth 1141.**

GaN Broadband SP4T Switch Handles 30 W CW

Tagore Technology brings to IMS its new TS7441L SP4T GaN IC switch and onboard driver IC. The 30-W CW device is packaged in a 4x4mm QFN and is a symmetrical SP4T switch designed to operate in a frequency range of 1 MHz to 2.7 GHz. The switch has a built-in controller IC and can be 10x smaller and have 50x lower current drain compared to a PIN diode discrete switch. Applications can be found in mobile-radio handsets, cellular infrastructure, and various military use cases.

For more information, visit <u>the product webpage</u>. If you're in Atlanta this week, visit Tagore Technology at **Booth 1830**.





CHAPTER 8:

What's New at IMS 2021: Live Day 4

DAVID MALINIAK, Senior Editor. Microwaves & RF

RFICs/MMICs Hasten Design of RF/mmWave Products

C <u>ML Microcircuits</u> is at IMS **Booth 1341** to debut its SµRF family of high-frequency, high-bandwidth RFICs and MMICs for RF and mmWave applications. The SµRF product family helps accelerate the design of RF products operating in the mmWave and GHz frequencies. The products being showcased at IMS2021 include:

• The CMX90A003 (1-W) and CMX90A004 (2-W) 860-to-960-MHz power amplifiers are two-stage, fully matched MMICs delivering +29.5 dBm (CMX90A003) or +32.5 dBm

(CMX90A004) of saturated power. Both use GaAs HBT technology. The CMX90A003 is ideal as a booster PA in sub-1-GHz applications to extend the range of low-power RF transceivers. The CMX90A004 is optimized as a high-power final PA in wireless ISM applications.

•The CMX90G301 (+1 dB) and CMX90G302 (+2 dB) 1.4-to-7.1-GHz positive gain-slope amplifiers compensate for frequency-related gain



loss. Fabricated on a GaAs pHEMT process, they combine low DC power, low noise, and high gain in a cascadable MMIC.

For more information, visit the product webpage. If you're in Atlanta this week, visit CML Microcircuits at Booth 1341.

Amp Module Pumps Out 40 W From 600 MHz to 6 GHz

mpower RF comes to IMS (**Booth 1225**) bearing its model 1219, a single-band, solidstate GaN amplifier module delivering a minimum 30 W (40 W typical) across its entire

Exhibits are closed at IMS 2021, but we continue our coverage of exciting new products that were launched on the exhibition's bustling show floor earlier this week.



0.6-to-6-GHz bandwidth. Empower RF tells us it's the first amplifier manufacturer to cover this bandwidth with an affordable COTS product.

The model 1219 utilizes 50-V GaN-on-SiC transistors, which have lower leakage currents and higher thermal conductivity and are more reliable than GaN-on-Si devices. An added benefit, 50-V devices require about half the input current as their 28-V counterparts, which reduces power-supply cost, size, and weight.

For more information, visit <u>the company's website</u>. If you're in Atlanta this week, visit Empower RF at Booth 1225.

Handheld Analyzer Helps Install Comms Systems



Visit IMS **Booth 1321** to get filled in on <u>Keysight's</u> new FieldFox microwave analyzer, which builds on the company's FieldFox B-series originally introduced in May of 2019, and delivers the following key customer benefits:

• Simplifies set-up and improves measurement results in any 3GPPspecified band in frequency range 2 (FR2) by extending the frequency range to 54 GHz without the need for external mixers.

• Supports advanced channel aggregation and complex interference troubleshooting with an increased analysis bandwidth range up to 120 MHz.

• Enables customers to confidently measure and analyze mmWave signals with complex modulation schemes such as 256 Quadrature Amplitude Modulation (QAM).

• Delivers reliable analysis of complex signals with industry-leading low phase noise, high sensitivity and amplitude accuracy.

• Offers 5G NR beamforming analysis using phased-array antenna control, critical in the deployment of multiple input, multiple output (MIMO) technology.

For more information, visit <u>the product webpage</u>. If you're in Atlanta this week, visit Keysight Technologies at Booth 1321.



S top by IMS **Booth 1020** to see <u>Junkosha's</u> metrologygrade microwave/mmWave VNA test cable assembly. Accuracy is crucial in any test setting, but particularly so for metrology-grade cabling, which offers ultimate precision and therefore demands the highest reliability for testing and calibration purposes. Utilizing Junkosha's precision engineered-PTFE tape-wrapping technology, the new cable exhibits excellent phase (within $\pm 4.5^{\circ}$ at 50 GHz) and amplitude (within ± 0.08 dB at 50 GHz) stability in flexure alongside strong phase stability in temperature.

The cable is flexible and can maintain this level of performance when bent 180° on a 2.25" radius mandrel, with no spring back. Able to reach 50 GHz and available in a 2.4-mm connector, the assembly also displays impressive performance durability (50,000 tick-tock cycles typical. The ruggedized port side NMD connector is also available to ensure reliable

connections to the vector network analyzer (VNA).

Microwaves & RF E-BOOK

For more information, visit <u>the company's website</u>. If you're in Atlanta this week, visit Junkosha at Booth 1020.

Ceramic Packages Blow Off Steam from Hot Chips

Stop by IMS **Booth 1014** to see StratEdge's thermally-efficient line of post-fired and molded ceramic semiconductor packages, which operate from DC to 63+ GHz and dissipate heat from compound semiconductor devices such as gallium nitride (GaN), gallium arsenide (GaAs), and silicon carbide (SiC). 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.

For more information, visit <u>the company's website</u>. If you're in Atlanta this week, visit StratEdge at Booth 1014.