AWR Design Magazine

Vol 19.2.6

Industry Spotlight:
5G, IoT, and Radar

Feature Story:
Glass and GaN PDKs

Success Stories:
Customer and Academic

Software Spotlight:
Latest Release

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NATIONAL INSTRUMENTS™

IMS2019 Perspective

It's Showtime…

After years of industry talk about the promising future of internet of things (IoT), 5G, and automotive radar systems, the hardware supporting these major technical efforts is finally here and NI AWR software is playing a central role in helping RF engineers develop these next-generation products. With the most recent release of the NI AWR Design Environment platform and complementary products such as AntSyn™ antenna synthesis, as well as the integration of AXIEM EM into the Cadence Virtuoso RF environment, our tools make "concept-to-product" design a reality.

Since last years IMS, our customers have been tackling the design challenges of the "three Ps" (power amplifiers, printed circuit boards, and phased arrays) with support from features added to our most recent product release, including the award-winning impedance-matching network synthesis, PCB import wizard, and phased array generation wizard.

In this issue of AWR Design Magazine, we spotlight real-world case studies that illustrate how our customers and partners are successfully implementing their product concepts with smarter design flows, robust simulation technologies, and time- and labor-saving wizards from the NI AWR software product portfolio.

So join us in **Booth #930** to see for yourself how our software is helping technologists develop innovative solutions to embed antennas and RF transceivers into their IoT devices, tackle millimeter-wave (mmWave) design challenges for 5G, and meet cost/performance requirements for their radar applications…and perhaps we'll be spotlighting your success in next year's issue of AWR Design Magazine.

Best regards,

David Vye
Director of Technical Marketing
AWR Group, NI

IMS
Connecting Minds. Exchanging Ideas.

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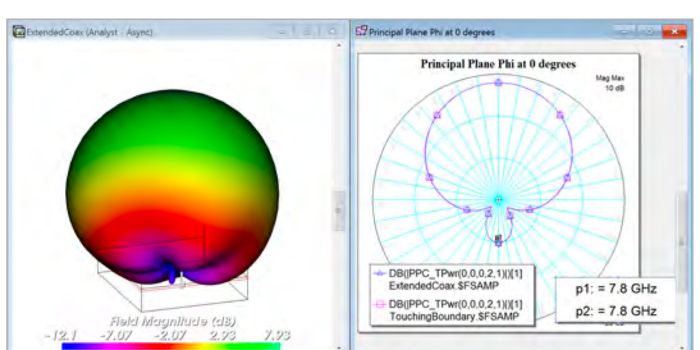
Advancing the Beam-Steering Revolution

Overview

Communications and radar systems are looking to exploit different advantages offered by the mmWave spectrum to support the bandwidths necessary for 5G performance targets and the radar range resolution for target recognition. These higher frequencies, however, come with greater over-the-air (OTA) propagation losses, which can be overcome through enhanced antenna directivity, achievable through phased-array beam-steering technology.

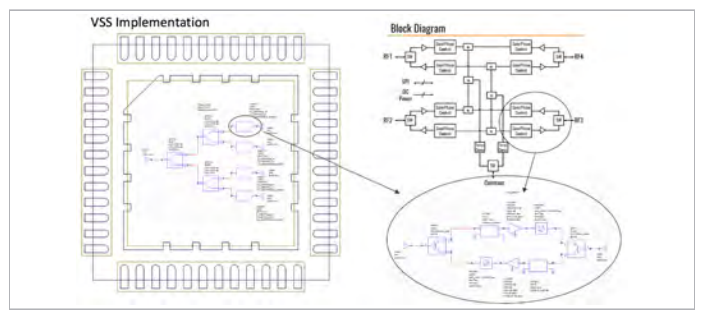
Recent advances in NI AWR software solvers and wizards deliver the modeling, simulation, and design automation for next-generation phased-array systems with antenna synthesis, electromagnetic (EM) analysis, and array configuration/generation. From antenna synthesis and EM simulation, engineers can create the antenna elements that provide the individual radiation patterns and geometries used by the phased-array generator wizard to produce user-configured arrays and the resulting beam and side-lobe information needed to further develop a physical beam-steering antenna system.



Case Study: Anokiwave Phased-Array Reference Design

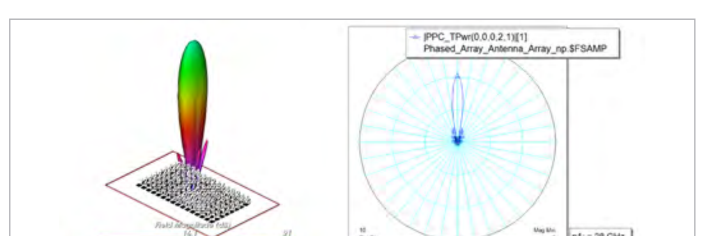
The phased-array generator wizard, part of the V14 release of NI AWR Design Environment software, creates a hierarchical network using a set of circuit/system schematics and EM structure representing the antenna array. The schematics can be updated with behavioral models or detailed circuit-level monolithic microwave integrated circuit (MMIC)/RFIC devices, depending on the design task at hand. Designers developing PCB routing from the beamforming RFIC to the antenna elements can represent the chip with a combination of bit-controlled phase-shifter and gain-controlled amplifier models (inclusive of nonlinearities) and frequency-dependent port impedances.

This approach was used, for example, in a four-channel simulation subcircuit providing 5-bit phase and gain control for analog RF beam steering to represent Anokiwave AWMF-0108. This highly-integrated silicon quad-core IC supports four Tx/Rx radiating elements for 5G phased-array applications.



In the PCB design, each channel was routed to a single antenna in an array, and the phase and gain were controlled independently through passed parameters to the subcircuit. The input ports of multiple beamforming devices were connected through a network of power splitters designed in Microwave Office circuit design software in order to provide the phase and amplitude control for the individual antennas in a 128-element array.

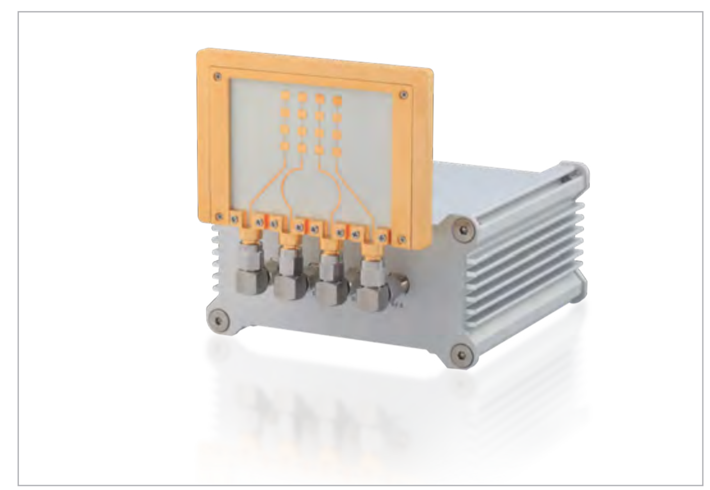
RF circuit simulation with EM analysis supports the analysis of the multi-layer PCB routing, providing the voltage standing-wave ratio (VSWR) and insertion loss information between each beamforming channel and the antenna element, as well as the overall antenna radiation as a function of frequency, input-power level, and beam-steering angle.

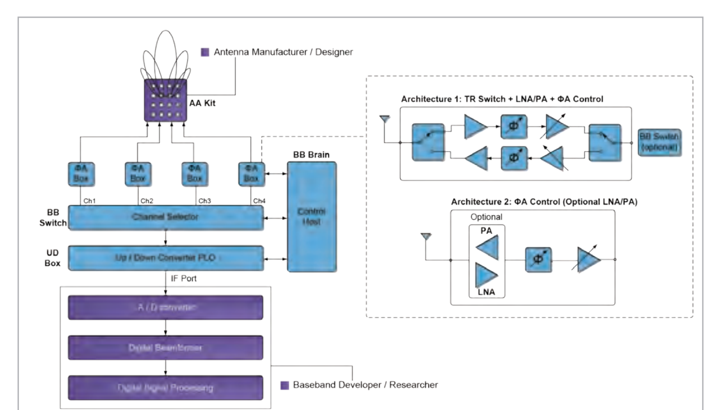


Case Study: TMYTEK 5G NR Phased Array Solutions

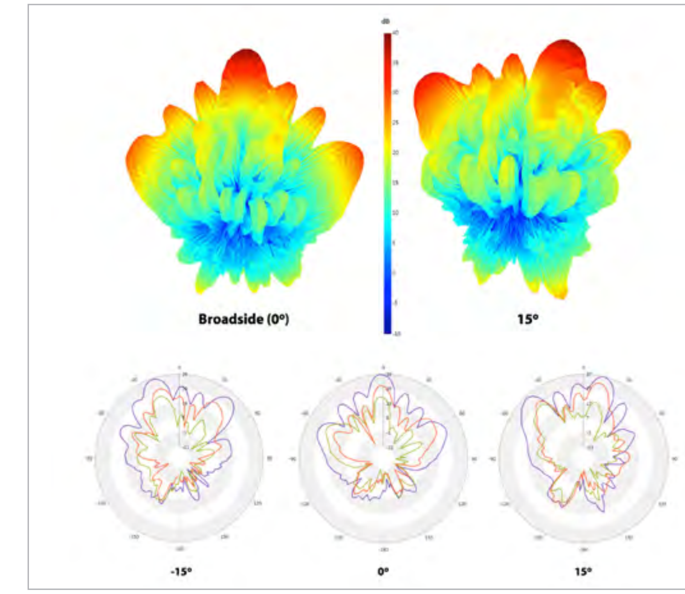
5G New Radio (NR) mmWave, unlike previous standards, uses dynamic-beam steering to maximize connectivity by directing as much of the signal directly to the mobile device as possible. As a result, beamforming antennas represent a new area of development for many commercial manufacturers. TMYTEK used NI AWR software to develop its groundbreaking BBox beamformer box product line, a highly modulized 28/39-GHz beamforming system that enables 5G developers to successfully develop innovative antenna designs and baseband technology.

The BBox™ system provides reliable steerable beams to test and support development of phased array antennas and associated electronics, which must undergo rigorous calibrations and measurements under a large number of configurations through advanced OTA testing to ensure optimum connectivity. BBox™, a scalable and flexible system which includes a standard antenna kit, phase and amplitude controller, channel selector, up/down conversion and control host, is the right tool not only for 5G NR mmWave antenna designers, but also a comprehensive solution for baseband and protocol developers. Many research institutes around the world use BBox as a 28/39 GHz RF front end with beamforming capabilities.





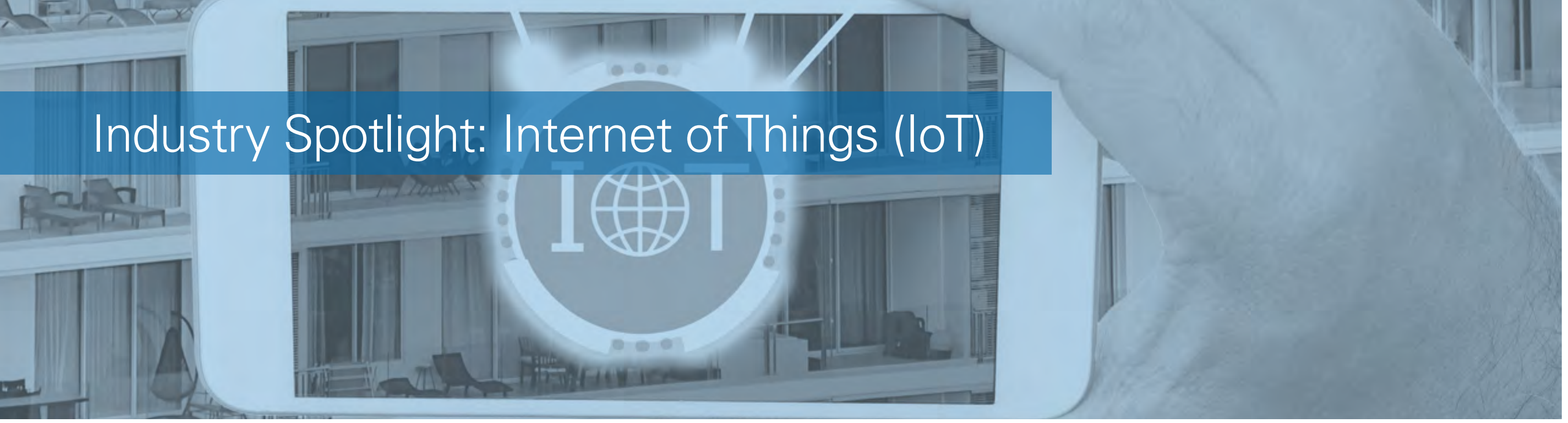
Using Microwave Office software, inclusive of the APLAC harmonic balance (HB) simulation engine and Analyst™ 3D EM simulator, TMYTEK engineers successfully implemented the custom phase shifter, PA, low-noise amplifier (LNA), and T/R switch MMICs and RFICs critical to their high-performance, mmWave beam-steering technology.



Images courtesy of TMYTEK

TMYTEK, as a fabless RF/microwave MMIC design team, leverages the NI AWR Design Environment platform with solid-state IC technologies, including silicon germanium (SiGe), bipolar complimentary metal-oxide semiconductor (BiCMOS), gallium arsenide (GaAs) high-electron mobility transistor (HEMT), gallium nitride (GaN), indium phosphide (InP), and CMOS, from world-leading foundries to develop state-of-the art performance. Supported by process design kits (PDKs) developed for NI AWR software in partnership with leading MMIC foundries, TMYTEK technologists can offer high reliability for military, space, and mmWave commercial applications.

NI AWR software provides innovative wizards and synthesis technologies that enable engineers designing next-generation communications systems to deliver cost-effective, high performance, and high-reliability products to market. For more information on NI AWR software solutions for 5G, visit awr.com/5g.



Industry Spotlight: Internet of Things (IoT)

Making IoT Devices Smart

Overview

The wide range of IoT applications in development today are made possible by smart devices operating across different network configurations, frequencies, power requirements, and protocols. Developing cost-effective IoT solutions requires a smart, organized approach to radio and antenna integration within a design flow that may have little to do with traditional RF product development. Many IoT designers are utilizing off-the-shelf, pre-certified modules to circumvent, technical challenges such as RF integration and emission compliance and development costs associated with such a wide range of devices and networks. Even with this modular approach, integrating a transceiver modem, RF front-end components, and antenna(s) within a size-restricted enclosure is a sensitive design effort that is increasingly being tackled by engineers with little or no RF design experience.

A Methodical IoT Flow

NI AWR software provides engineers with the RF simulation, automation, and access to knowledge (through online training videos and tutorials) to tackle these challenges from a methodical and low-risk approach. Using modular design, engineers can focus on combining all the relevant components in the RF signal path, including the supporting PCB substrate and/or the device enclosure, into a hierarchical simulation network for analysis prior to manufacturing and test.

Case Study: Fractus Antennas
Design of Antenna Products for Mobile and Wireless Connectivity

Connected devices serve a number of vertical markets, including connected healthcare, industrial IoT (IIoT), energy, agriculture, wearables, and smart buildings, homes, and cities. Specific applications drive the required range, power consumption, and frequency modulation and the security, latency, and expected lifetime requirements of IoT devices and their antenna(s). Faced with endless product configurations, the IoT antenna integrator needs as much design support as possible.

Fractus Antennas designs and manufactures miniature, off-the-shelf antennas for IoT, mobile connectivity, and short-range wireless devices that address this need. The company combines a respected R&D team with proven manufacturing capabilities and scale to offer a new generation of antenna products for the mobile and wireless connectivity needs of original equipment manufacturers (OEMs).

Images courtesy of Fractus Antennas

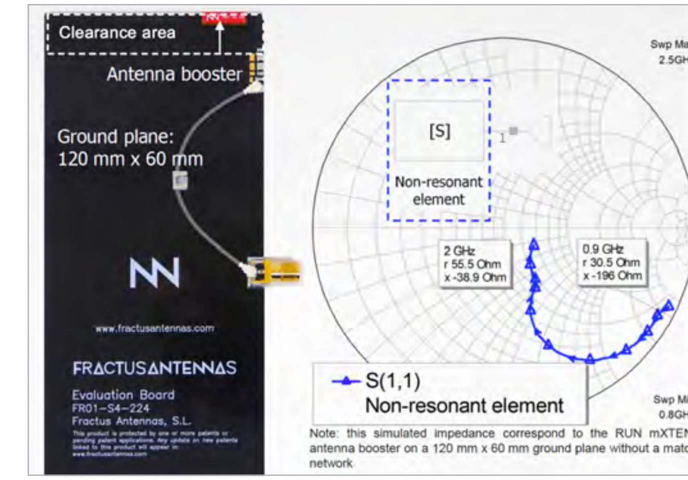
Fractus Antennas innovative antenna products are now available for simulation within the NI AWR Design Environment platform as an extensible markup library (XML) set, inclusive of the mXTEND product line, further supporting antenna integration and driving an easier and more complete wireless device design process.

Using the library, designers can easily select and populate their IoT board design with the component best-suited for their application, such as the RUN mXTEND antenna booster, which provides multiband performance throughout a large range of frequencies, enabling worldwide coverage in support of multiple IoT-related communication standards such as narrowband IoT (NB-IoT), LoRa, Zigbee, SigFox, Neul, Thread, Z-Wave, Weightless, all mobile GSM/UMTS/LTE bands for 2G, 3G, 4G, 5G, Bluetooth, and WiFi.

The inclusion of these antenna models in NI AWR software enables RF designers to rapidly address component integration on a PCB substrate through direct simulation of the Fractus Antennas part of choice, along with front-end components such as PAs, LNAs, and filters, as well as any required impedance matching.

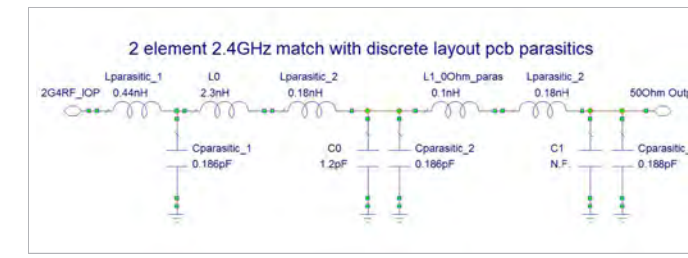
Front-end component-to-antenna matching can also be developed using the network synthesis module in Microwave Office circuit design software to ensure maximum power transfer between RF driving circuitry and the antenna. From this ideal impedance-matching network, designers can substitute the equivalent "real" surface-mount technology (SMT) vendor components from the software's library and incorporate the effects of the PCB from EM analysis of the imported board layout.

A webinar presenting the impedance-matching network synthesis capabilities within Microwave Office software for the design of the input impedance for Fractus Antennas devices can be viewed in the NI AWR software resource library at awr.com/resource-library.



Case Study: Silicon Labs
IoT Design Guide

The Silicon Labs EFR32 Wireless Gecko radio transceiver module provides 2.4 GHz, sub-GHz, or dual-band (2.4 GHz and sub-GHz) operation for Bluetooth low-energy (BLE) technology, as well as Zigbee, Thread, and proprietary wireless connectivity. Applications range from wearables, home, industrial, and building automation, and smart metering to lighting and asset tracking. To help customers reach the production phase more quickly, the company provides an application note (AN930) describing the matching techniques applied to the EFR32 Wireless Gecko portfolio in the 2.4 GHz band. This design guide presents four different matching topologies for different transceiver power levels and matching configurations based on the application.



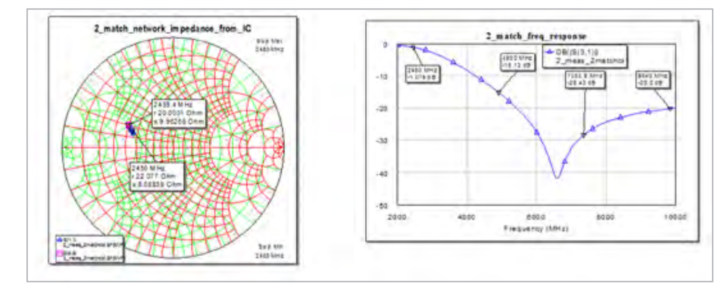
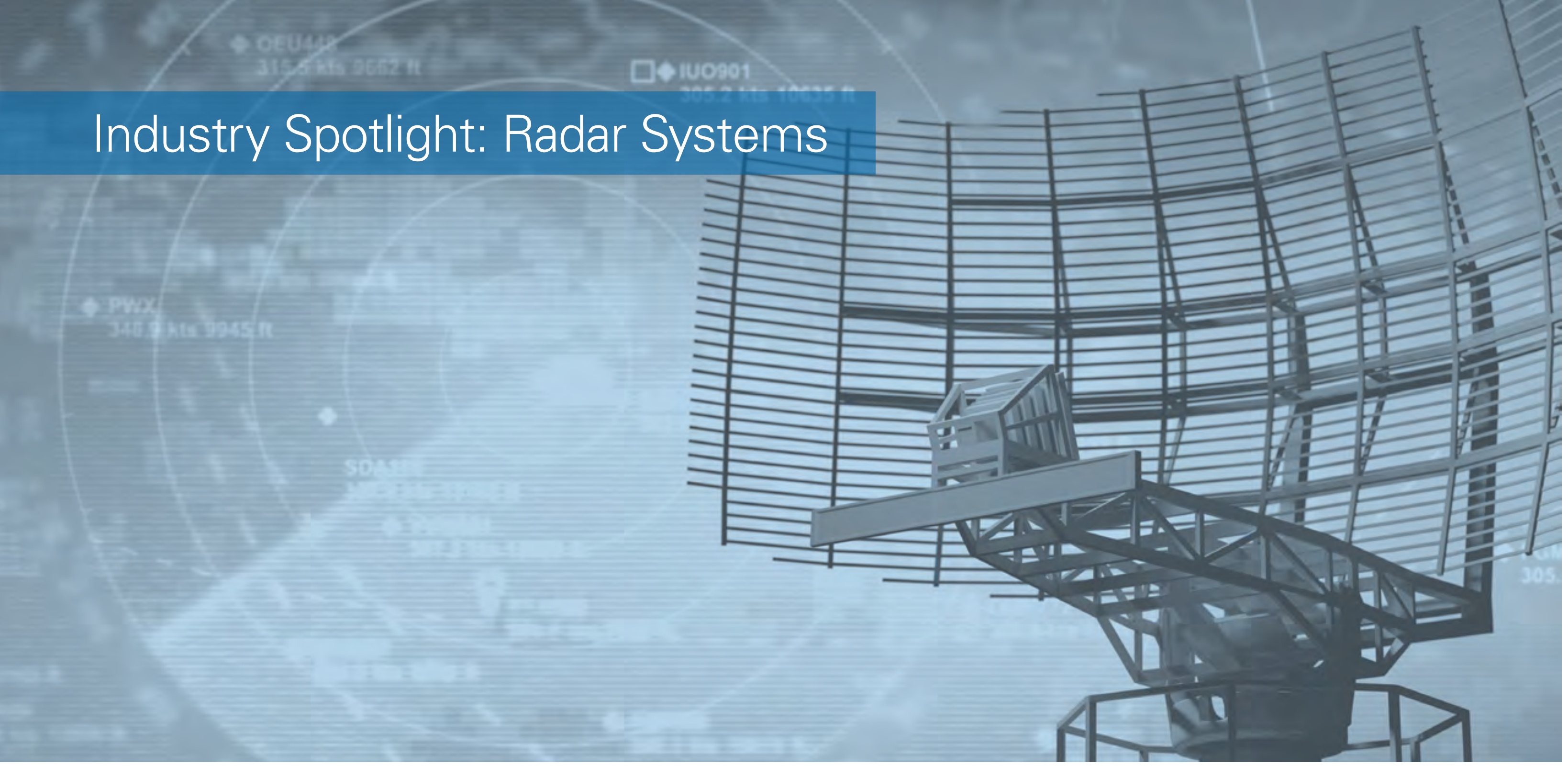


Image source: Silicon Labs Application Note AN930

The impedance-matching network for the EFR32 Wireless Gecko, which incorporates PCB parasitics modeled as lumped elements, was developed with the NI AWR Design Environment platform. Using NI AWR software to develop an impedance-matching network includes the following steps:

Step	Design Flow Description	Recommended NI AWR Software Feature
1	Determine the optimal termination impedance for the PA.	Load pull analysis - for determining optimal load.
2	Choose the RF matching topology.	Network synthesis wizard - for impedance matching.
3	Create the initial design with ideal, loss-free elements.	Schematic capture - uses ideal components or real SMT components from vendor library.
4	Design with parasitics and losses. At 2.4 GHz, the parasitics of the surface-mount device (SMD) elements and the PCB have a major effect. Tuning/ optimization of the design is required unless EM simulation is used to characterize the board.	PCB import wizard - combines with AXIEM EM simulator to support parasitic extraction and embedding of SMT matching components.

Integrated simulation technology and smart design automation are redefining the possibilities for companies at the forefront of IoT technology. To learn more about IoT trends and challenges, the companies developing the next generation of innovative IoT products, and the software enabling their success, visit ni.com/awr.



Industry Spotlight: Radar Systems

Targeting Radar Applications

Overview

Radar applications are evolving in response to developments in semiconductor technologies, including advances in GaN, SiGe, and CMOS. CMOS can integrate more functionality, including digital processing and control on a single chip, providing cost and high-volume production advantages, while GaAs still offers performance advantages. Combined with advances in phased-array antennas and integration technologies, radars are moving beyond military/aerospace markets to address a host of commercial applications. NI AWR software provides researchers in industry and academia with the simulation technology to address these challenges. Embraced for its intuitive yet powerful interface, the NI AWR Design Environment platform is being used to train the next-generation of radar technologists.

Educating the Next Generation of Radar Designers

Several years ago, IEEE Microwave Magazine published an article detailing how the original design of a simple coffee-can radar from the Massachusetts Institute of Technology (MIT) OpenCourseWare online course was redesigned and optimized using NI AWR software.

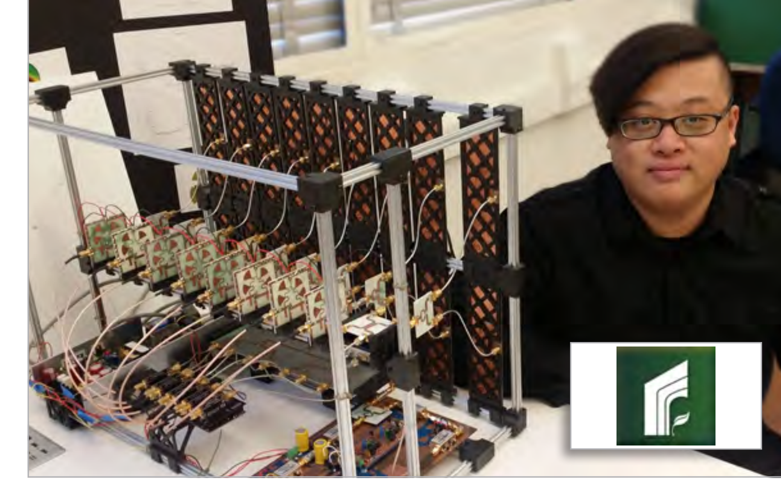
At the same time as the article was published, Dr. David Ricketts of North Carolina State University began teaching his Bits2Waves course, and, with the support of NI, launched a one-day, hands-on workshop at microwave conferences around the world wherein participants build a modern digital radio using NI AWR software.

Together, the "Coffee Can Radar Optimized in NI AWR Software" article and the Ricketts workshop have inspired students and industry professionals alike to gain a practical understanding of radio and radar design.

Case Studies

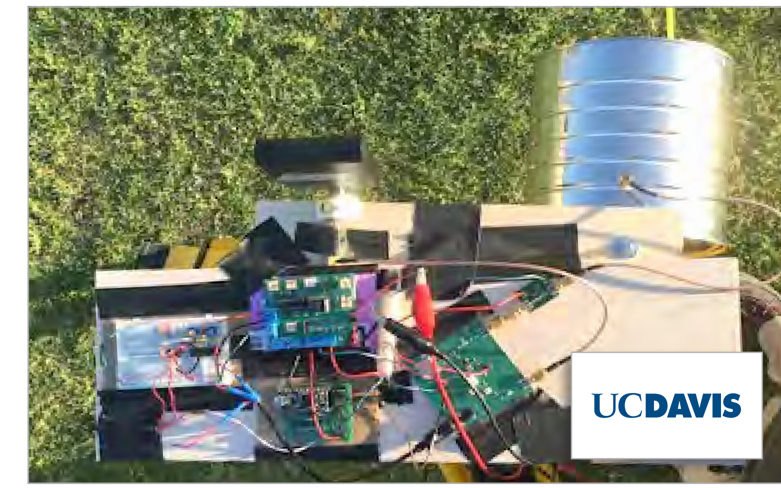
California State Polytechnic University

Wilson Chung, a senior at the California State Polytechnic University, Pomona (CPP) College of Engineering, was gifted a seat at one of Dr. Ricketts' workshops. After participating in the workshop, Chung put his experience to work developing an S-band phased-array radar system based on more than 100 microstrip circuits, including antennas, amplifiers, couplers, phase shifters, and more.



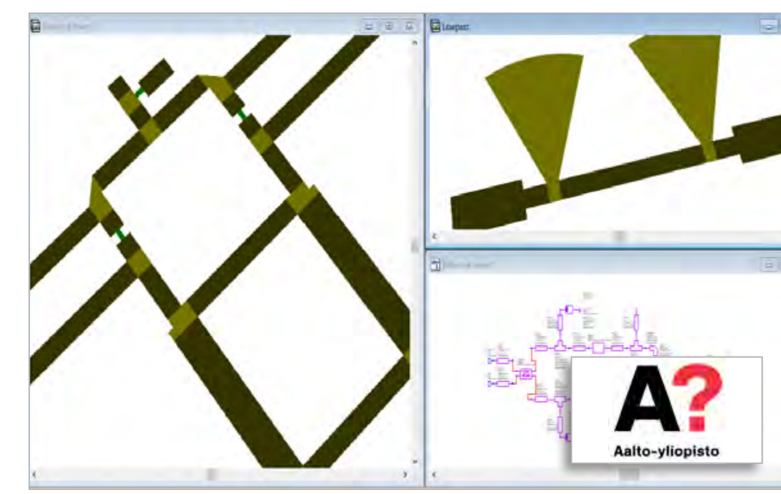
University of California, Davis

Other academics have pursued similar projects on radar design. For instance, Professor Xiaoguang "Leo" Liu of the University of California, Davis teaches a senior project course, "Design of RF/Microwave Systems" in which students build small radars in the class. The course emphasizes system-level design concepts and provides a hands-on experience, including system engineering, antenna design, analog circuit design, embedded systems, and digital-signal processing (DSP) by implementing a frequency-modulated continuous-wave (FMCW) radar system that can perform range, Doppler, and synthetic aperture radar (SAR) measurements, as described in the OCW course.



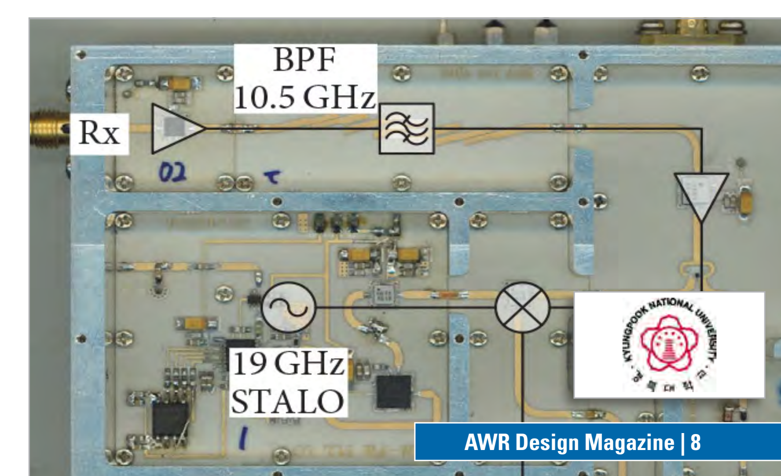
Aalto University

At Aalto University in Helsinki, Finland, Professor Ville Viikari used NI AWR Design Environment software to teach his masters-level students how to design a 1.5 GHz Doppler radar on a single PCB using surface-mount passive and active components. The students designed the building blocks required to realize the radar (oscillator, amplifiers, a mixer, couplers, and filters) and at the end of the course, the entire design was assembled, fine-tuned, and its operation verified with system-level simulation tools.



Kyungpook National University

Students from the Department of Electronic Engineering at Kyungpook National University in South Korea used NI AWR software to develop an AM-FM radar and tag module (TM) active reflector. An amplitude-modulated and frequency-modulated 10.5 GHz signal was transmitted through the TX antenna of the base module (BM) and received by the RX antenna of the tag module (TM) at the target location. The TM converted the center frequency of the received signal from 10.5 GHz to 8.5 GHz with the help of a 19.0 GHz stable local oscillator (STALO) and retransmitted the filtered and amplified signal using the TX of the TM. Finally, the BM received the 8.5 GHz AM-FM signal and demodulated it into the phase-delayed signal produced by the envelope detector, and into the beat signal with the help of the frequency mixer.

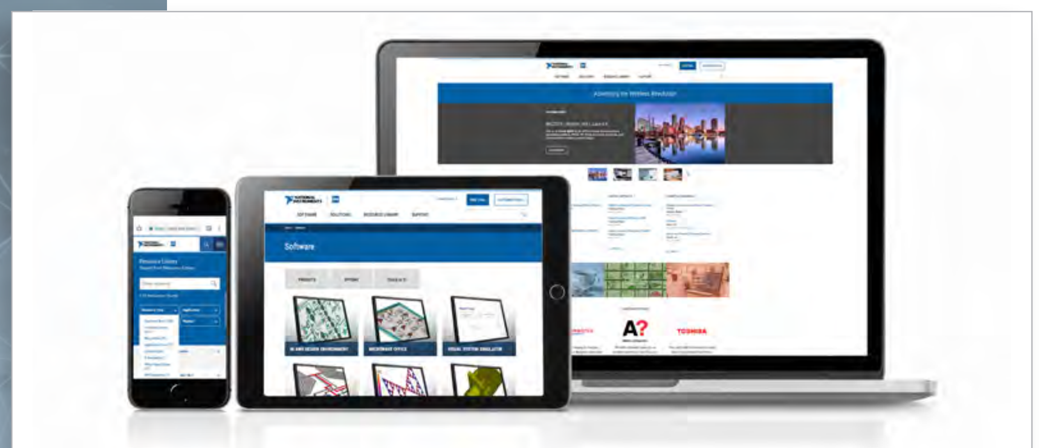


NI AWR software provides the models necessary to represent the RF and signal processing components in today's radar systems, as well as the simulation technology to analyze radar systems from end to end, visit awr.com/radar.

Viewpoint: ni.com/awr

A Reimagined Website Enhances the User Experience

A reimagined and redesigned ni.com/awr website was launched recently to enhance the user experience. This launch continues our commitment to enhancing RF/microwave design productivity for our customers by making content easier to access from any device. The new site features a streamlined, modern design with a responsive interface. This provides the NI AWR software community of users, whether viewing from a cellphone, laptop, or desktop, with a dedicated portal from which to learn more about NI AWR software products and the solutions they deliver.



Highlights of the new site include:

- Improved functionality and an enhanced, more responsive user experience for both desktop and mobile devices
- Reimagined product, solution, and support menus offering fast and easy access to the content users seek
- Rich graphics that help viewers easily visualize the software and its many applications
- Expanded resource library including additional industry content as well newsletters and the popular AWR Design Magazine
- New cross-promotion feature providing fast and easy access to related content on article and customer stories pages
- New and updated datasheet and product collateral

While using the wireless network sponsored by NI during IMS, please take some time to experience our new site at ni.com/awr and share your thoughts/comments with us about what you like and perhaps ways to improve it further. You can send your impressions to us at awr.marketing@ni.com.

Best regards,

Sherry Hess
Vice President of Marketing
AWR Group, NI

Feature Story: Glass and GaN PDKs

mmWave Designs Start With Enabling Technology

Overview

Before 5G communication systems and automotive radar can benefit from the bandwidth and range resolution offered by mmWave spectrum, RF front-end designers will need to develop PAs, LNAs, filters, switches, and other critical radio components that work at these frequencies. Technologies developed for sub-6 GHz communications or X-band radar simply won't meet the performance requirements at 28, 39, or 77 GHz. Fortunately, semiconductor process engineers, material scientists, and their fellow researchers have developed and/or enhanced technologies with the performance that designers need to address mmWave applications. Short-gate length GaN on silicon carbide (SiC) and glass-based passive microelectronics are two emerging technologies that deliver the performance to meet these mmWave system requirements.

Going hand in hand with the emergence of these new technologies, designers rely on supporting simulation models, schematic symbols and layout/manufacturing information in the form of process design kits (PDK) to develop front-end products. 3D Glass Solutions, Inc. (3DGS) and United Monolithic Semiconductor (UMS) are working directly with technologists from the AWR Group of NI to provide foundry-authorized PDKs for their respective mmWave processes. The PDKs allow designers to develop critical front-end components such as amplifiers and filters for 5G, automotive radar and other mmWave applications.

Case Study: 3D Glass Solutions (3DGS) High-Performance mmWave IPDs and SiPs

3DGS focuses on the fabrication of electronic devices using photo-definable glass-ceramics, producing a wide variety of glass-based system-in-package (SiP) and integrated passive devices (IPDs) using its patented low-loss photosensitive APEX® Glass technology for applications in RF electronics, automotive radar, medical, aerospace, defense, wireless infrastructure, mobile handset, and IoT industries.

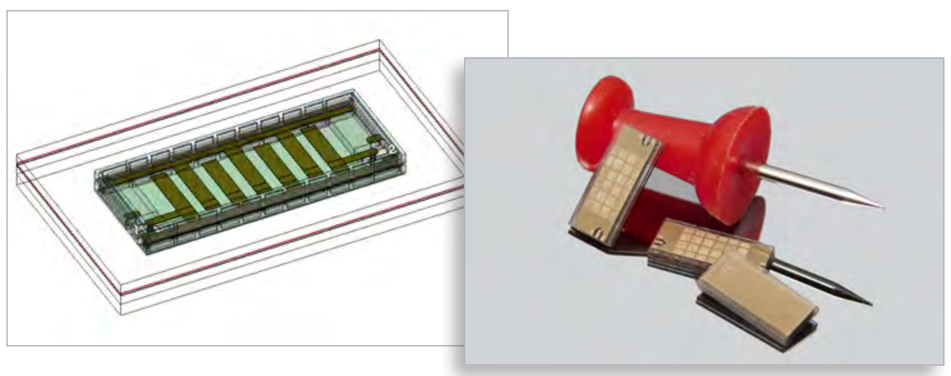


Image courtesy of 3D Glass Solutions

The new 3DGS mmWave PDK contains electrical models and parameterized layout cells (PCells) that work with the NI AWR Design Environment platform, inclusive of Microwave Office circuit design software and the Analyst finite-element method (FEM) EM simulator. This parameterized extraction flow provides EM accuracy within a circuit design tool for seamless product development of IPD and SiP devices built using the 3DGS foundry process.

Designers can develop their mmWave design using distributed simulation models (suspended-stripline transmission-line components) based on the 3DGS fabrication process (material stackup) and the PDK parameterized package enclosure and interconnect transmission line structures. Designs such as filter, matching circuits, couplers, and more can be placed within the parameterized enclosure and stripline-to-microstrip transition using schematic symbols in a Microwave Office subcircuit and simulated with Analyst 3D EM analysis.

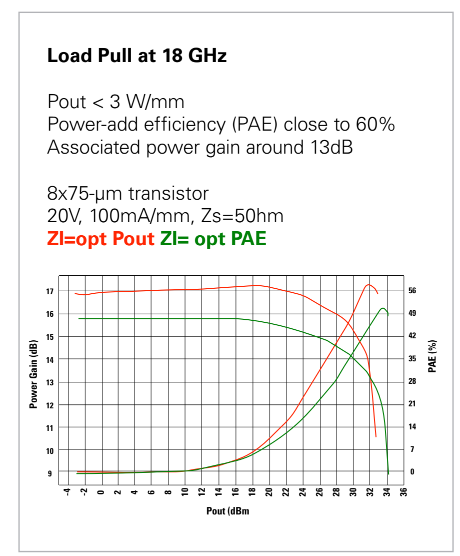
Availability

The new 3DGS mmWave PDK for NI AWR Design Environment software is planned for official release in Q3 and will be available directly from 3DGS. A reference design of a 28-Ghz bandpass filter, the technology for which can also be used for 24.4 and 39-Ghz designs, will be available to mutual customers and included with the PDK.

Case Study: United Monolithic Semiconductors (UMS) GaN on SiC for mmWave Designs

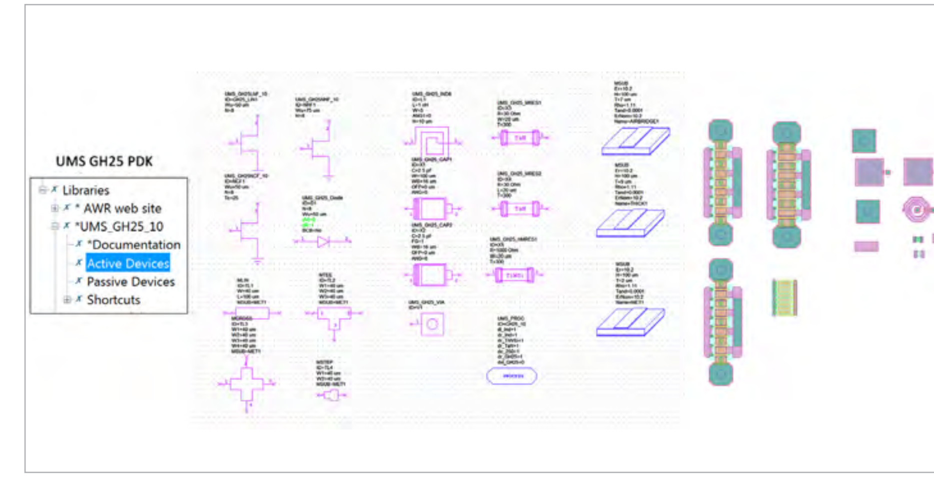
Short gate-length GaN devices have demonstrated excellent performance for mmWave PAs up to 40 GHz. With higher operating voltages (three to five times higher than those of GaAs) and reduced device parasitics using shorter gate lengths, these GaN transistors provide higher output power densities, wider bandwidths, and improved DC-to-RF efficiencies over their GaAs counterparts.

The UMS GH15 technology is fabricated on a 4-inch AlGaN/GaN on 70 µm thick SiC substrate wafer. The source-terminated field-plate transistors offer a 3.5watt per mm power density for high PA (HPA) designs. Using load pull to provide the optimum impedance termination for output power and power-added efficiency (PAE), the transistor exhibits 4 watts per mm output power, 13 dB associated power gain (with the Zsource = 50Ω), and PAE max. of nearly 60%.

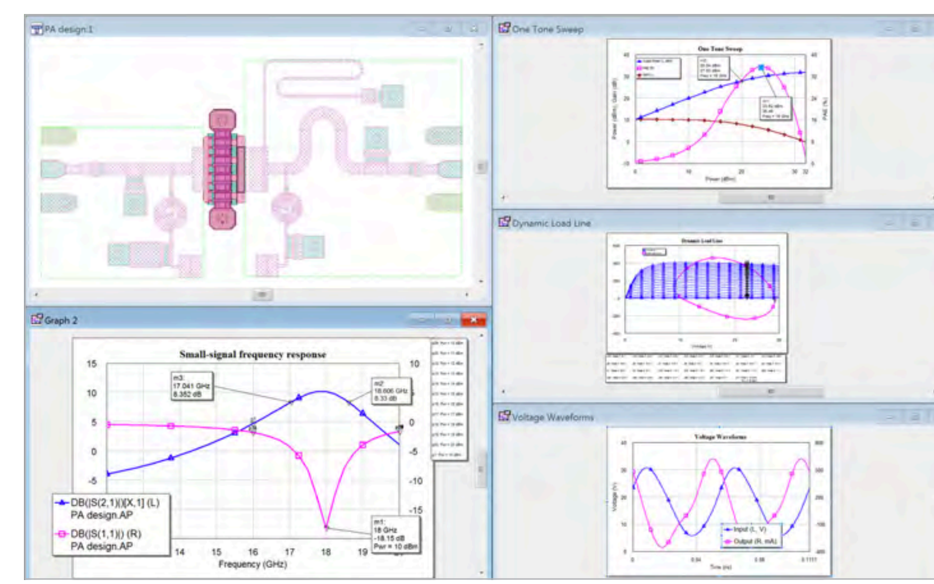


To support MMIC development using these technologies, PDKs for Microwave Office circuit simulator are available directly from UMS and include a layout process file (LPF), which defines the material stack-up and metallization layers for EM simulation and physical realization of the MMIC.

Select parameters of the active and passive device models, such as gate width/number of fingers or capacitor/inductor values, can be adjusted by the designer. In addition to parameterized PCells, models come with a symbol representation for schematic editing.



After adding the UMS PDK to the process library, the project layout browser will be populated with the UMS LPF file and a new global definitions file will be created with the supporting substrate definitions (met1, thick metal, and airbridge). The PDK models will appear in the elements browser tab for user placement in the schematic design window. The field-effect transistor (FET) characterization project is configured to simulate standard device measurements, including DC IV curves, small-signal vector network analyzer (VNA) frequency responses (S-parameters), single- and two-tone swept power (gain, output power, PAE) and power-dependent output load-pull contours, and can be used to characterize any transistor simply by replacing the default device under test (DUT) with the transistor from the PDK.



Availability:

The new UMS GH15 PDK will be available in Q4 2019 directly from UMS.

Customer Spotlight

Inverted-F Antenna

Challenge

Johannes Steigert, an RF engineer at multi-national network infrastructure provider CommScope, was challenged to develop an inverted-F antenna (Figure 1) for a mobile communications sub-1 GHz band. The dimensions of the PCB severely limited the available space for the antenna, requiring difficult tradeoffs between the theoretical design and gain, efficiency, and broadband performance.

Solution

The design entry and management capabilities of Microwave Office circuit design software combined with the speed of the AXIEM EM simulator helped the team cut the number of various prototype design spins and delivered a first-time-right solution. Microwave Office software and the AXIEM EM optimizer functionality (Figure 2) were used to match the antenna for the LTE Band 13.

Steigert found that NI AWR software, in comparison to similar products, provided the best modeling of the real antenna, thus saving significant development time and costs compared to conventional prototyping approaches. He highlighted the ease of use of the software combined with its simulation speed and ability to deliver highly complex solutions in a short time as key benefits of using NI AWR software. Of particular note were the outstanding technical support, exhaustive examples, and widespread knowledgebase.

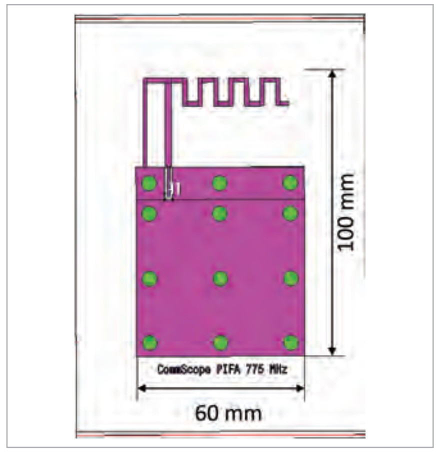


Figure 1: Planar inverted-F antenna.

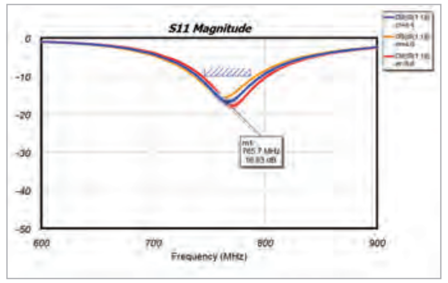


Figure 2: Yield analysis used to verify the LTE Band 13 matching performance.

"NI AWR software combines simplicity with the ability to deliver highly-complex solutions in less time compared to conventional development approaches."

Johannes Steigert, CommScope

24-GHz Radar Antenna Array

Challenge

Designers at Lexiwave Technology Ltd., a communications RF system and integrated circuit (RFIC) provider, required a sophisticated software platform that would enable them to efficiently design commercial sensors such as the 24-GHz short-range, object-detection, and distance-measurement radar antenna array shown in Figure 1.

Solution

The designers chose NI AWR Design Environment software, specifically AXIEM and Analyst EM simulators, as well as the AntSyn antenna design and synthesis tool, based on the design features, ease of use, and fast and robust meshing technology, as well as their confidence in the software's ability to efficiently run simulations and accurately predict performance. NI AWR software enabled Lexiwave designers to quickly and accurately predict the input impedance, radiation pattern, and efficiency of their antenna design. This enabled the designers to eliminate two design cycles, enhancing their productivity and lowering development costs. Figure 2 shows the AXIEM layout of the antenna array for the 24-GHz radar module design.

NI AWR software enabled Lexiwave designers to quickly and accurately predict the input impedance, radiation pattern, and efficiency of their antenna design. In addition, the company credits their design success to an RF design suite that offers design and simulation in one environment, as well as the AntSyn antenna design and synthesis tool, which accelerated their design start and helped them to more fully explore their design options.

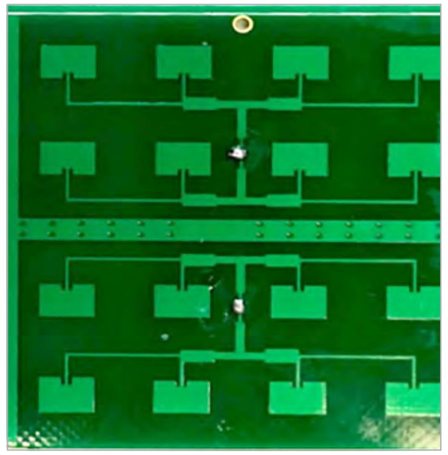


Figure 1: Photo of the 24-GHz antenna array.

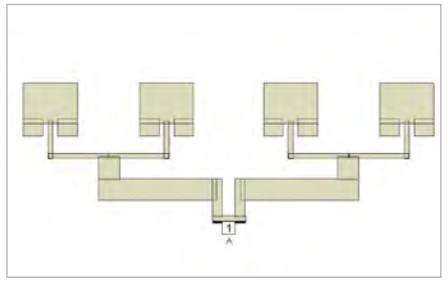


Figure 2: AXIEM layout of the antenna array for the 24-GHz radar module.

"NI AWR software is the only design platform that offers not only a complete suite of tools for efficient and accurate antenna design and simulation, but also an antenna synthesis tool, which shortened our design time significantly."

Henry Lau, Lexiwave Technology Ltd.

Academic Spotlight

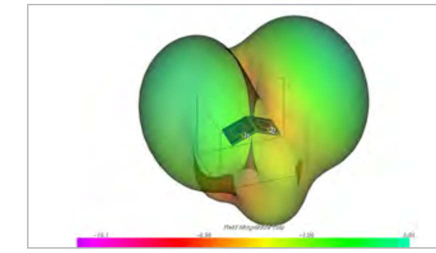
Antenna Array for Locating GPS Interference

Challenge

Elizabeth Lloyd, student at the University of Bath, was challenged in her doctoral research project to design a low-cost antenna array suited to the location of RF emitters that cause GPS interference.

Solution

Lloyd chose Microwave Office circuit design software, which provided both the AXIEM planar and Analyst 3D FEM EM solvers needed for her innovative array composed of two planar antennas and a third 3D antenna.



3D layout of antennas in Analyst showing the radiation pattern.

> *"For my 3D antenna design, it was easy to see the entire antenna pattern with the Analyst 3D EM software viewer, which revealed problems that never would have been noticed using just a 2D view.*
>
> *Elizabeth M. Lloyd, University of Bath*

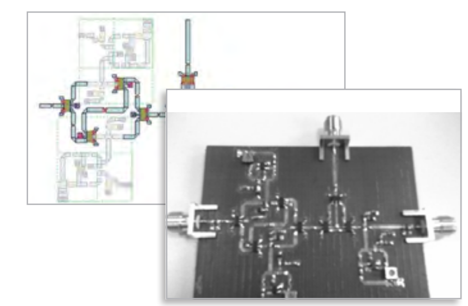
Active Filter Design Methodology

Challenge

Dr. Leonardo Pantoli, researcher at the University of L'Aquila, was challenged to develop a methodology for designing high-quality active filters with tunable center frequency, low loss, high-dynamic range, and low-power consumption, all within a small footprint.

Solution

As an example, a high-order tunable filter was chosen to provide a feasibility demonstration of the proposed approach whereby each cell was composed of a shunt L-C cell and two series capacitances. Low-loss switches were added between the cells, enabling individual tuning and characterization, as well as the cascading of the three cells for full filter action. AXIEM technology provided ~50% reduction in EM simulation time without compromising accuracy.



Microwave Office layout of the filter design and photo of the hybrid filter prototype.

> *"The optimization algorithms in NI AWR software provided a unique methodology for my active filter designs. I found it to be the only available software that was able to quickly converge on the correct solution and solve the design problem."*
>
> *Dr. Leonardo Pantoli, University of L'Aquila*

Software Spotlight

NI AWR Design Environment: Latest Release

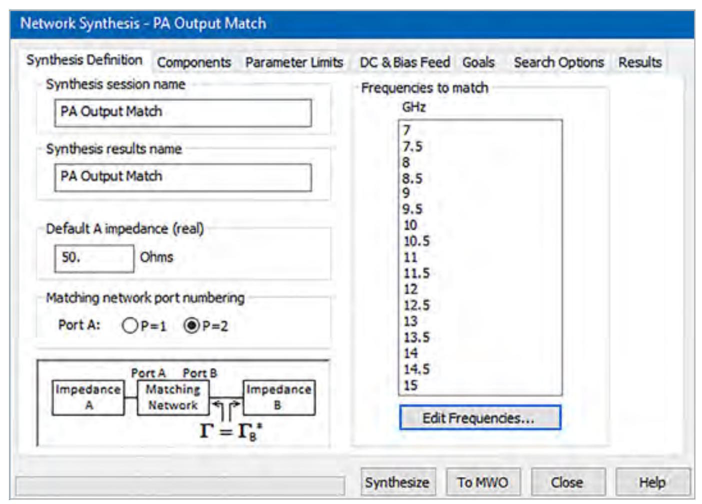
The V14.03 release of NI AWR Design Environment software is now available for current customers and evaluators to download on ni.com/awr. Enhancements to the software application programming interface (API), PCB import wizard, load-pull technology, and more are included in this update. Visit the dedicated V14 landing page at awr.com/whatsnew to learn more.

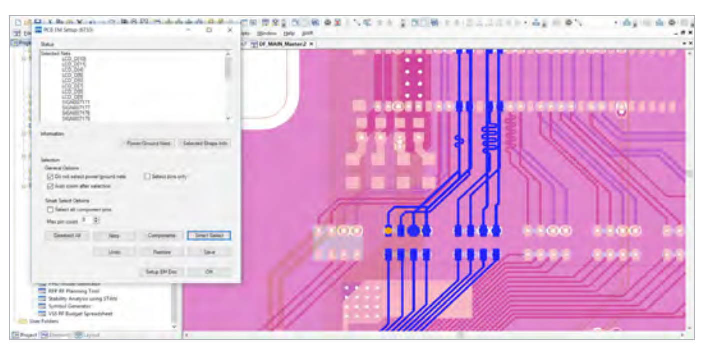
NI AWR software users are reminded that the V14 release of NI AWR Design Environment software continued our commitment to delivering software solutions that empower RF/microwave designers with a superior user experience, enabling them to focus on developing products that meet stringent performance and time-to-market requirements.

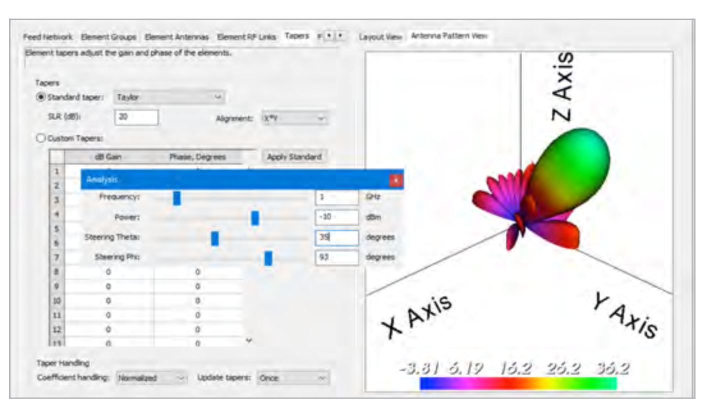
New technologies released in V14 included:

- Network synthesis wizard for expediting design starts by empowering engineers with the ability to interactively develop networks optimized for noise, power, or matching networks between amplifier stages or between different components, such as an amplifier and antenna
- PCB import wizard for smart editing and interactively isolating critical board sections/nets and multi-layer interconnects from imported data, generating simulation-ready EM structures
- Phased-array generator wizard for configuring phased-array antenna systems and generating a schematic-based circuit/ system/antenna network of the optimized array and feed network

To learn more about the breadth of capabilities in NI AWR software, stop by Booth #930, visit ni.com/awr, or reach out to your local sales representative.







E-Learning Portal

Online Training Modules

The E-learning portal offers self-paced video modules that enable users to learn at their own pace and as their schedule permits. Current modules include harmonic balance, layout, EM simulation, and more.

Visual System Simulator: ▪ Components ▪ Co-Simulation ▪ Model Option ▪ RF Link ▪ Phased Array

Microwave Office: ▪ Environment ▪ Hotkeys ▪ Drawing ▪ EM Extract

Harmonic Balance: ▪ HB Basics ▪ Measurements ▪ Two-Tone ▪ Sweeps/Power ▪ Mixer

Layout: ▪ Drawing Basics ▪ Import/Export ▪ Layout Cells

EM Simulation: ▪ Project Creation ▪ Properties/Setup ▪ AXIEM ▪ EMSight ▪ Analyst

EM Advanced Features: ▪ Process Creator ▪ Data Sets ▪ Shape Modifiers ▪ EM Extraction

Analyst 3D FEM EM: ▪ 3D Cells ▪ Coil ▪ Extrusion ▪ Intersection

Multi-Technology: ▪ Libraries/PDKs ▪ Multiple Libraries ▪ Units/Position ▪ EM Multi-Tech

Antenna Synthesis: ▪ Wi-Fi Antenna ▪ AXIEM Export ▪ Analyst Export

Meet the Trainer

Dr. John Dunn is a senior engineer/ EM technologist at AWR Group, NI and spearheads our training programs. Before entering the commercial electronics industry, Dr. Dunn was a professor of electrical engineering at the University of Colorado, Boulder, for 15 years. He earned his M.S. and Ph.D. degrees in applied physics from Harvard University, Cambridge, MA, and his B.A. in physics from Carleton College, Northfield, MN.

Recent Additions

RF PCB Import Wizard: ▪ Layout File Formats ▪ Design Import Example ▪ EM Setup Example ▪ Meshing Best Practices ▪ Point Ports

Planar EM in Depth I: ▪ EM Within Microwave Office ▪ Process Creator ▪ LPF Examined ▪ Drawing Layers ▪ LPF (ASCII)

Planar EM in Depth II: ▪ The STACKUP ▪ Material Setup ▪ Polygon Properties ▪ Boundary Conditions ▪ Grid Settings

Planar EM in Depth III: ▪ Creating an EM Layout ▪ Drawing Polygons ▪ Navigating Layout ▪ Controlling the Layout Browser

Learn more at awr.com/elearning.

Interoperability Solutions

AWR Connected

The AWR Connected™ product family integrates NI AWR software with third-party software/hardware tools to provide a breadth of solutions for the design of high-frequency products. AWR Connected offerings span application areas such as synthesis, PCB layout, verification, and EM/thermal, as well as test and measurement. For more information visit: awr.com/awr-connected.

Cadence
The Cadence Virtuoso RF Solution environment includes an integrated interface with the AXIEM 3D planar EM simulator within NI AWR software. This integrated Cadence and AXIEM EM solution equips engineers with fast and accurate EM analysis for designing RFICs and RF modules.

Foundry PDKs

- 3DGS
- AFRL
- ams
- BAE Systems
- GAETEC
- GCS
- GlobalFoundries
- HRL
- IHP Microelectronics
- Northrop Grumman Space Technology
- OMMIC
- ON Semiconductor
- Qorvo
- TowerJazz
- UMS
- WIN Semiconductors
- Wolfspeed

Synthesis
- AMCAD
- AMPSA
- DGS Associates
- Nuhertz
- Optenni Lab

EM/Thermal
- ANSYS
- CapeSym
- Sonnet
- WiPL-D

IC/ PCB
- Cadence
- DWT
- IPC2581
- Mentor Graphics
- POLYTEDA
- Zuken

T&M
- Anritsu
- Focus Microwaves
- Maury Microwaves
- National Instruments
- Rohde & Schwarz
- TestWave

Models and PDKs
- Foundry PDKs
- Modelithics
- XML Libraries

Academia

University Programs

Providing academic institutions with ready access to NI AWR software solutions, the NI AWR Software University Program was developed to make access easy and affordable.

The following programs are offered globally:

Students
- Student self-help license creation and software download
- Student design competitions and sponsorships

Faculty
- Software donations
- Professors in Partnership teaching materials

Graduates
- Graduate gift initiative to award new graduates with free software

Email us at awr.university.program@ni.com
or visit awr.com/academia to learn more.

Resource Spotlight

AWR.TV

AWR.TV is a comprehensive, multimedia resource for technical and product information pertaining to NI AWR software features, applications and solutions. Recent additions to AWR.TV include:

Software Features

- Layout and iNet™ Enhancements
- Phased-Array Wizard
- Communications Library Enhancements for 5G and LTE
- PCB Import Wizard
- Network Synthesis Antenna Matching
- Network Synthesis PA Matching
- Advancements in 3D EM
- Cadence Virtuoso and AXIEM
- Microwave Office/ANSYS Thermal Co-Simulation

How To

- Network Synthesis Wizard
- Design Verification with Wolfspeed PDKs
- Design of Power Amplifiers for 5G and MIMO Applications

Design Examples

- OMMIC GaN on Si for PAs
- UPC Acoustic Wave Filter
- RF Microtech Ultra Wideband (UWB) Filter
- Small-Loop Antenna Matching
- ADAS Automotive Radar System
- SARAS Broadband HPA
- Teledyne High-Efficiency PAs
- Planar Inverted-F Antenna
- Push-Pull Totem-Pole RF PA
- Dual-band Wi-Fi MIMO

Resource Library

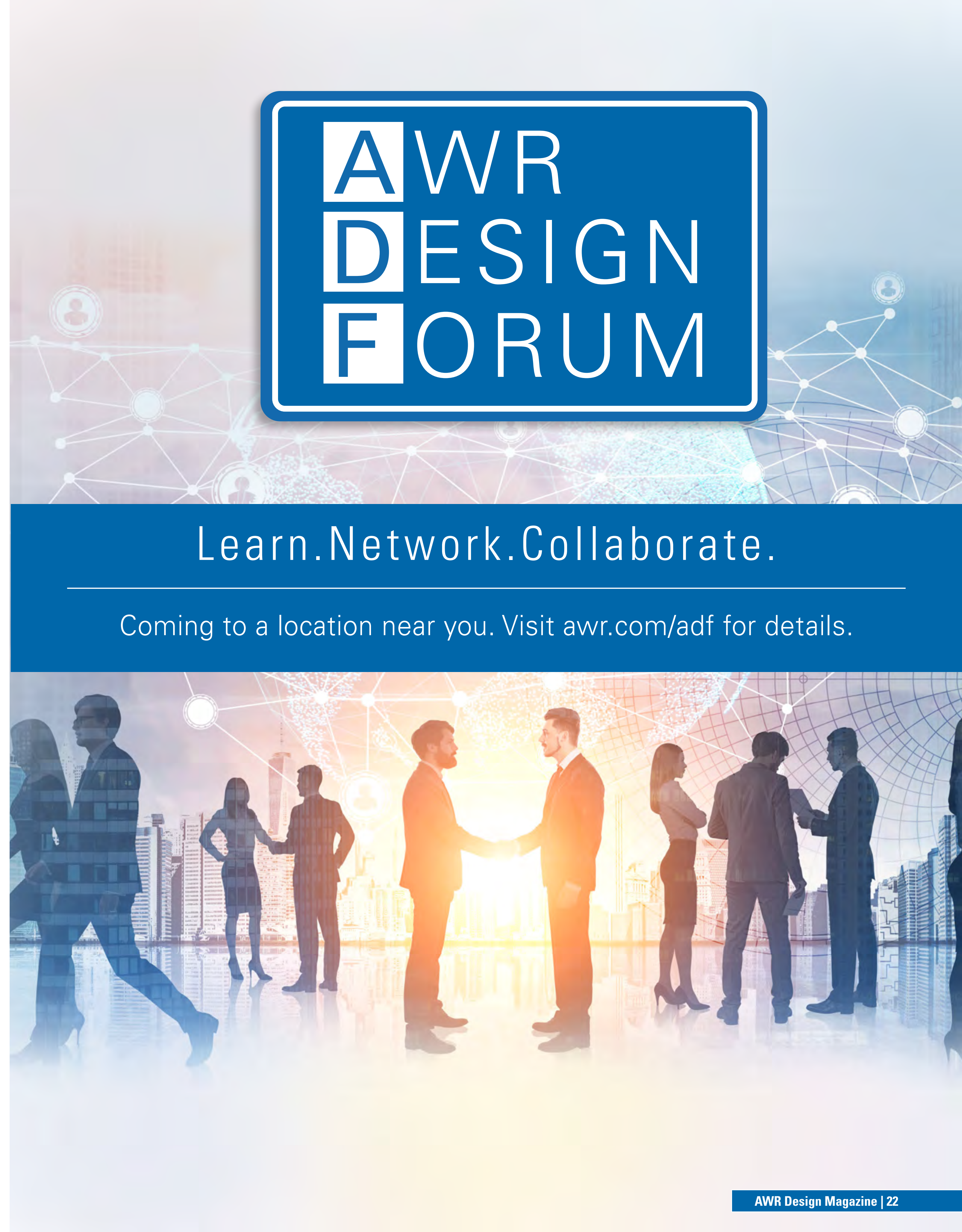
The Resource Library on ni.com/awr is a dedicated and searchable landing page for technical content on NI AWR software products, and solutions. Recent additions to the Resource Library include:

White Papers

- Software Solutions for RF Module Development
- Design and Physical Realization of Phased-Array Antennas for MIMO and Beam-Steering Applications
- RFIC PA Development for Communication and Radar Systems: Basic Operations and Metrics
- Primer: Load-Pull Primer for Optimizing PA Performance

Application Notes

- AXIEM EM Simulator Within Cadence Virtuoso RF for RFIC/SiP Design
- LTCC T/R X-Band Module With a Phased-Array Antenna
- Network Synthesis Wizard Automates Interactive Matching-Circuit Design
- EM Verification of Complex Board Structures Streamlined With PCB Import Wizard



NATIONAL INSTRUMENTS | AWR

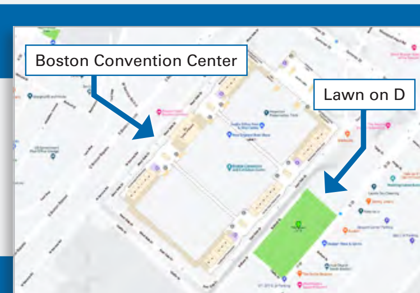
IMS2019 Activities

Tue, June 4

11:15 a.m. - 11:35 a.m.	**Advanced Synthesis, EM Simulation of IoT Antenna** This MicroApp presents a 3D-mesh antenna designed using AntSyn software. Derek Linden, AWR Group, NI | Booth #200
3:15 p.m. - 3:35 p.m.	**Designing a Narrowband Bandpass Filter for 5G** This MicroApp takes a look at the factors driving the physical, electrical, and cost restraints for 5G filters. David Vye, AWR Group, NI | Booth #200
3:15 p.m. - 5:15 p.m.	**EM Simulation in RFIC Silicon and Glass-Based Circuits** This Industry Workshop examines EM simulation to predict the behavior of critical components. John Dunn, AWR Group, NI | Room #152

Wed, June 5

6:00 p.m. - 10:00 p.m.	**Customer Appreciation Party** Join us for food, drinks, friendship, shoptalk, and fun outdoor activities. Lawn on D (Adjacent to the Convention Center)



Thu, June 6

10:30 a.m. - 10:50 a.m.	**New EM Port for Board Simulations** This MicroApp explains the new point ports feature, focusing on the physical principles underlying its use. John Dunn, AWR Group, NI | Booth #200
1:00 p.m. - 3:00 p.m.	**Design Phased-Array Antennas for MIMO** This Industry Workshop explores basic phased-array theory and design considerations. John Dunn, AWR Group, NI | Room #152
1:00 p.m. - 3:00 p.m.	**Design, Fab and Test Your Own Microwave Component** This Industry Workshop covers the basic theory of modern digital radios as well as design, fabrication and test of their components. Prof. Ricketts, NCSU, and Derek Linden, AWR Group, NI | Room #158

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