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You Should Know

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• ZHL-16W-43+	1800-4000	45	13	16	1595
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LZY-22+	0.1-200	43	16	32	1495
ZHL-30W-262+	2300-2550	50	20	32	1995
ZHL-30W-252+	700-2500	50	25	40	2995
LZY-2+	500-1000	47	32	38	2195
LZY-1+	20-512	42	40	50	1995
• ZHL-50W-52+	50-500	50	40	63	1395
• ZHL-100W-52+	50-500	50	63	79	1995
• ZHL-100W-GAN+	20-500	42	79	100	2395
ZHL-100W-13+	800-1000	50	79	100	2195
ZHL-100W-352+	3000-3500	50	100	100	3595
ZHL-100W-43+	3500-4000	50	100	100	3595
LZY-5+	0.4-5	52.5	100	100	1995

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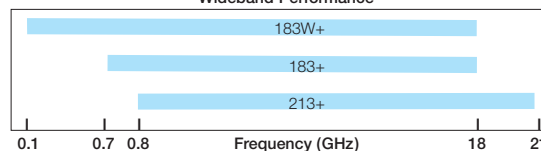
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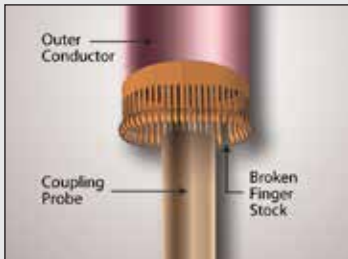
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By Ed Nakauchi

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By Lisa Clark

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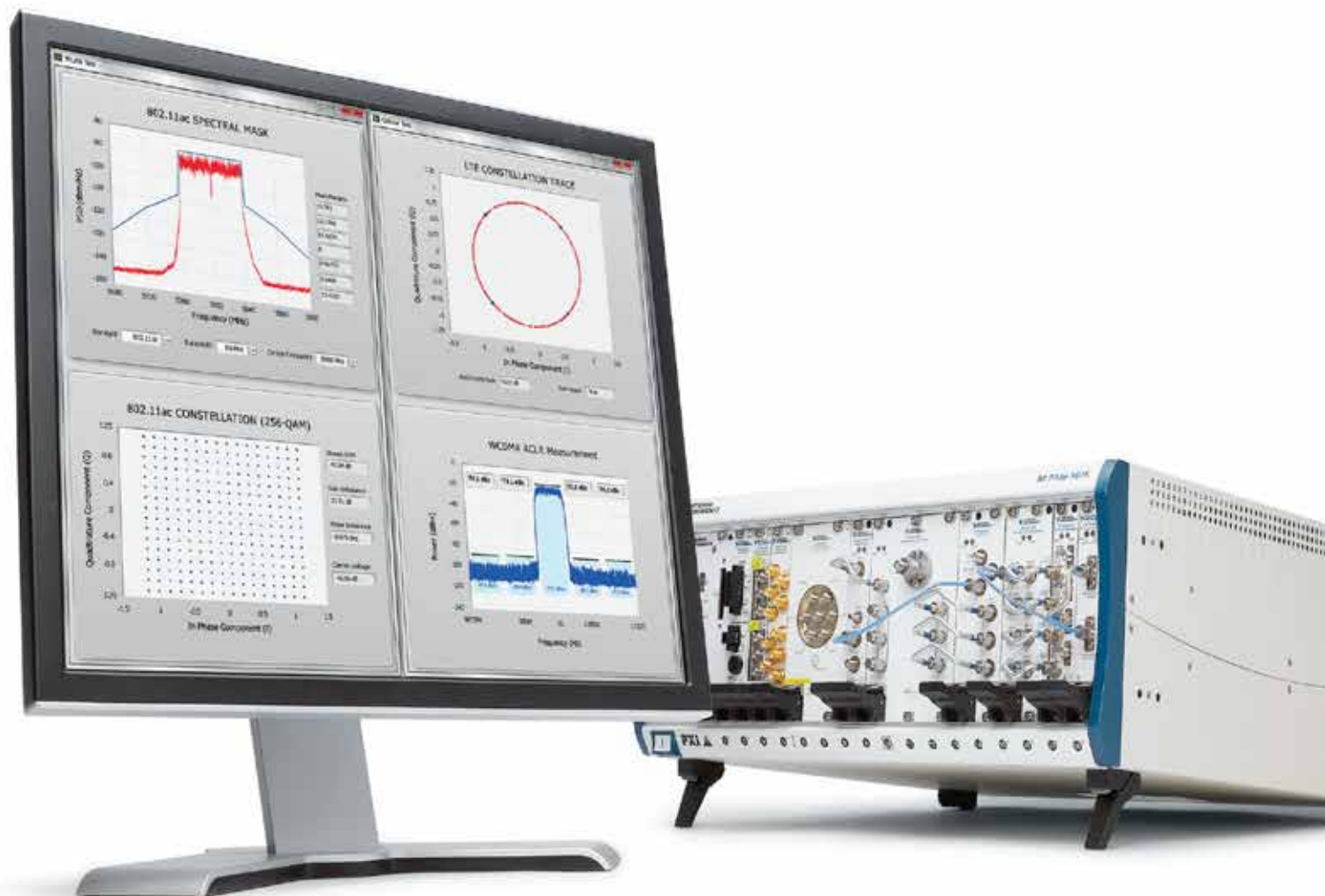
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► Editorial

PC: Phoenix Comfortable (Part 1 of 2)

Tom Perkins
Senior Technical Editor



Yes, a new definition for PC: Phoenix Comfortable. Unlike in June 2001 when Phoenix last hosted the IEEE International Microwave Symposium, the weather this year was very comfortable, with daytime temperatures in the 80s instead of over 100 degrees F.

Record IMS Exhibitors

The 2015 IMS is already history with near-record-setting technical attendance and more exhibitors than ever. As of the Awards Banquet on May 20, the number of technical attendees stood at 2,863 and exhibit booths numbered 939 with 620 companies represented. Although the Phoenix Convention Center (PCC) venue was there in 2001, it was hardly recognizable this time. The North Building was added in 2009 with addition of an underground connected West Building (built in 2006) between it and the Hyatt Hotel. The exhibit floor (312,500 square feet) and the technical meeting rooms were quite spacious. Excellent assistance, with knowledgeable people and signage, was available to guide attendees to all activities, particularly in the PCC.

One of my first meetings was with IMS 2015 General Chair Dr. Vijay Nair (Intel Corp.) and Vice Chair Dr. Steve Goodnick (Arizona State University). This very cordial meeting on Monday exceeded my expectations. Having served on past IMS committees, Boston (3) and Tampa, I was able to have a very useful dialogue. Symposium leadership explained the nature of the then-pending Plenary Session. Dr. John Rogers of the University of Illinois was chosen to speak on *Soft Assemblies of Radios, Sensors and Circuits for the Skin*. Dr. Rogers is Swanlund Chair, Professor of Materials Science and Engineering, Professor of Chemistry. This non-traditional topic was picked as a forward looking segue into other talks on wearable electronics which can include all sorts of sensors, particularly for monitoring medical conditions.

21st Century Challenges

In a similar manner the IMS Closing Session featured Dr. Darlene J. S. Solomon, Senior Vice President and Chief Technology Officer, Agilent Technologies. This talk titled, *The Century of Biology is Great for Engineering*, emphasized 21st century societal challenges – healthcare, energy, and the environment. The speech, like the Plenary, seemed designed to stimulate attendee thought on how our technology could be leveraged to enhance applications and convey information.

Topics of concern posed to IMS leadership included: why the Tuesday Ham Radio Social was cancelled; why all guest tours were cancelled; and why buses

didn't run to outlying hotels. Answers in order: No local ham to champion the cause; insufficient guest sign-ups to fill a bus; and use the very handy light rail in lieu of buses. While these explanations may not have satisfied all, at least leadership was very aware of the issues and prepared with answers. Incidentally, an informal ham radio event was quickly assembled with about 35 participants followed by a dinner at a local restaurant. One of the very uplifting topics discussed was the increasing emphasis on student involvement with STEM and university level Student Papers, Student Design Competitions, Student Challenge, scholarships, and RF Boot Camp. At closing, I profoundly thanked these men for their hard work and inspiration.

IMS a Non-Stop Event

On Tuesday and Wednesday I had the privilege of attending scheduled meetings with 24 companies. Just about non-stop from 9 to 5. As a result, I did not get to visit with everyone I would have liked. What an incredible week! The products discussed ranged from antennas, cables, circuit board material, connectors, filters, internet of things, market forecasting, passives, power amplifiers, semiconductors, test equipment, millimeter-wave hardware, and 5G technology.

One the highlights was *HFE's* second-year participation in the IMS Science Technology Engineering and Math (STEM) Program. The age range of this year's students was 8 to 14. This year *HFE* highlighted the life of Michael Faraday. On display in our booth was a pastel portrait of Faraday created by artist Debby Spencer, spouse of *HFE* Publisher Scott Spencer. My talk included a demonstration of a Faraday cage, employing a metal garbage can to enclose an operating portable FM radio receiver. Note that reception of

AM band signals was impossible in the exhibit hall, possibly because the Convention Center itself essentially amounted to an enormous Faraday cage.

Hot topics this year would include, but not be limited to: automobile electronics, carrier aggregation, digital techniques, GaN, IoT, linearization, millimeter-waves, 5G, consolidated

multi-functional test equipment, small cells, software-defined radio, new standards and streamlining workflow (enhanced speed to market-place).

Next month in this column I'll explore in greater depth specific topics and technology that received exposure in Phoenix. In the meantime, stay cool and comfortable!

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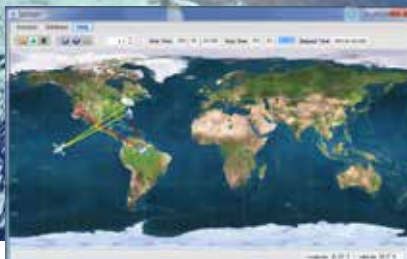
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► Meetings and Events

CONFERENCES & MEETINGS

2015 IEEE MTT-S International Conference on Numerical Electromagnetic Modeling and Optimization for RF, Microwave and Terahertz Applications (NEMO 2015)

11-14 August 2015
Ottawa, Canada
<http://nemo-ieee.org>
Paper Submission Deadline: 16 February 2015

2015 40th International Conference on Infrared, Millimeter, and Terahertz waves (IRMMW-THz)

23 – 28 August 2015
Hong Kong
www.irmmw-thz2015.org

2015 IEEE International Symposium on Radio-Frequency Integration Technology (RFIT)

26 – 28 August 2015
Sendai, Japan
www.ieee-jp.org/japancouncil/chapter/MTT-17/rfit2015/

2015 IEEE MTT-S 2015 International Microwave Workshop Series on RF and Wireless Technologies for Biomedical and Healthcare Applications (IMWS-BIO)

21 – 23 September 2015
Taiwan
www.ieee-jp.org/japancouncil/chapter/MTT-17/rfit2015/

2015 IEEE International Conference on Ubiquitous Wireless Broadband (ICUWB)

4 – 7 October 2015
Montreal
www.icuwb2015.org

2015 IEEE 24th Electrical Performance of Electronic Packaging and Systems (EPEPS 2015)

25 - 28 October 2015
San Jose, California
<http://epeps.ece.illinois.edu>
Paper Submission Deadline: 26 June 2015

2015 IEEE International Conference on Microwaves, Communications, Antennas and Electronic Systems (COMCAS)

2 - 4 November 2015
Tel Aviv, Israel

<http://www.comcas.org>

Paper Submission Deadline: 30 May 2015

2015 IEEE MTT-S International Microwave and RF Conference (IMaRC 2015)

10 - 12 December 2015
Hyderabad, India
<http://www.imarc-ieee.org>
Paper Submission Deadline: 7 August 2015

2016 IEEE MTT-S Radio Wireless Week (RWW 2016)

24 - 27 January 2016
Austin, Texas
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Paper Submission Deadline: 27 July 2015

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Growth Seen in Military Radio Spending

Moves towards bringing advanced capabilities will mean there will be continued spending on military radios. Strategy Analytics' military radio forecasts outline global defense expenditure trends segmented on a regional basis before breaking out the expected spend on military radios incorporating systems, hardware, support and related services across the land, air and naval domains.

- The Asia-Pacific region will drive spending on tactical radios particularly for land-based communications and account for the largest end market over the entire forecast period.

- Land-based radios will represent the largest market in terms of both dollar and total shipments.

- The total number of radio shipments is forecast to grow at a CAGR of 3.5% through 2024 to reach 172,867 units.

"While traditional HF, VHF and UHF radio frequencies will maintain use, there will be an increasing emphasis towards systems that can support multi-band and/or wideband operation," notes Strategy Analytics' Eric Higham. "The market for these radio systems will account for 47% of the total global military radio market in 2024."

"Handheld radios will drive the volume in the land-based military radio market, which will grow to \$6.5 billion. Smaller platforms such as fast attack craft and off-shore patrol vehicles, and the helicopter and light aircraft segment, will drive volumes in the shipborne and airborne segments," observed Asif Anwar of Strategy Analytics. "The associated market for radio component technologies will grow from \$710 million to almost \$1.1 billion with GaN (gallium nitride) becoming an established technology as it grows at a CAGR of 32.7%."

—Strategy Analytics
strategyanalytics.com

In-Building Wireless Market Heads Toward \$9 Billion

ABI Research's latest In-Building Wireless market data forecasts that North America will drive the overall market while Europe and Asia-Pacific will pick up the pace during 2016. **The market for in-building wireless equipment and deployments will more than double the current market by 2020.**

North America will continue to be the region with maximum DAS spend with sports venues, transportation, and healthcare remaining the verticals which attract the most DAS investment with shopping malls and hospital-ity coming in a close second place. Together, these verticals in North America account for just under half of DAS

spending. North America is followed by Asia-Pacific and then Europe, respectively, for market size.

"While the Asia-Pacific region accounts for just one-fifth of the total market, we forecast it to be the fastest growing region and to represent over 25% of the market by 2020," says Nick Marshall of ABI Research. "China dominates the activity in the Asia-Pacific region and we believe that while CAPEX today is targeted to TD-LTE and 4G macro deployments, in-building wireless deployments will turn the corner in 2016 when the market returns to growth and active DAS systems are deployed for better data coverage."

The leading companies in this market are CommScope, TE Connectivity, Axell Wireless, Corning, JMA Wireless, Dali Wireless, Zinwave, Goodman Networks, Wireless Telecom Group, and SOLiD, and will all benefit from DAS spending.

—ABI Research
abiresearch.com

Threats Driving IR Countermeasures System Growth

Market participants have been developing airborne infrared countermeasures (IRCM) systems to help fend off growing threats to low-flying aircraft. Due to advancements in man portable surface-to-air missiles, market participants are investing in R&D to find IRCM that autonomously defends against these threats.

Frost & Sullivan reports that the market earned revenues of \$503.8 million in 2014 and estimates this to reach \$563.1 million in 2019. The study covers warning systems; rotor, tilt and small fixed wing aircraft; and large aircraft.

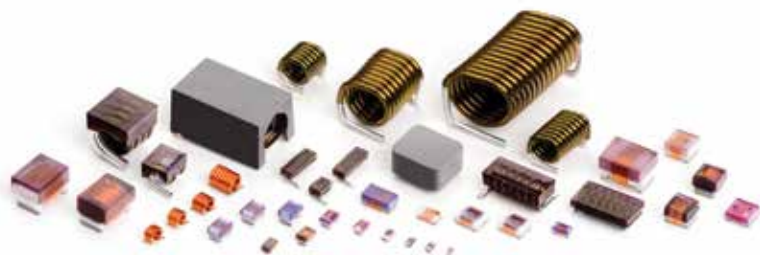
"Global IRCM spending on large aircraft will remain stable as the United States continues to upgrade its Air Force planes," said Frost & Sullivan's John Hernandez. "Steady opportunities will emerge for market participants as the **U.S. Air Force plans to acquire 179 KC-46A tankers between 2015 and 2028.**"

Tight defense budgets led to the delay of IRCM equipment purchases in some countries. Most third-world countries are going to adopt airborne IRCM systems several years down the road. They are still building defense structures, which require time and development through proper priority purchases.

Most R&D related to airborne IRCM is being done by the U.S. because it has the largest air force and helicopter fleets. Other countries have been capitalizing on U.S. efforts by procuring IRCM systems that have been field-tested.

—Frost & Sullivan
frost.com

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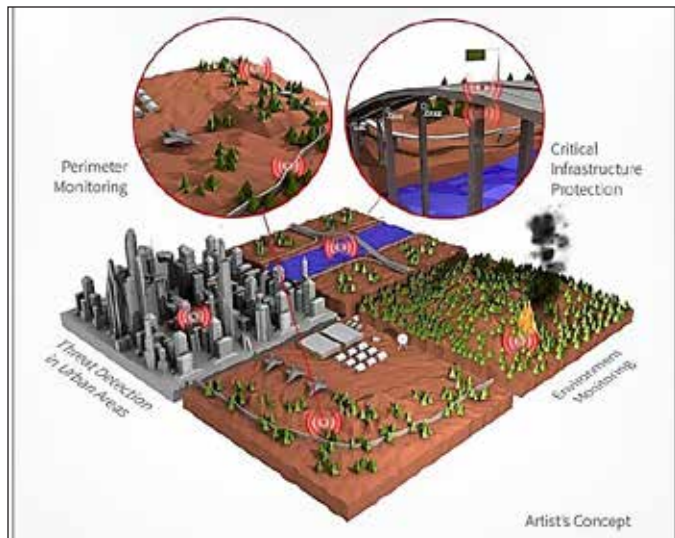
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► In the News

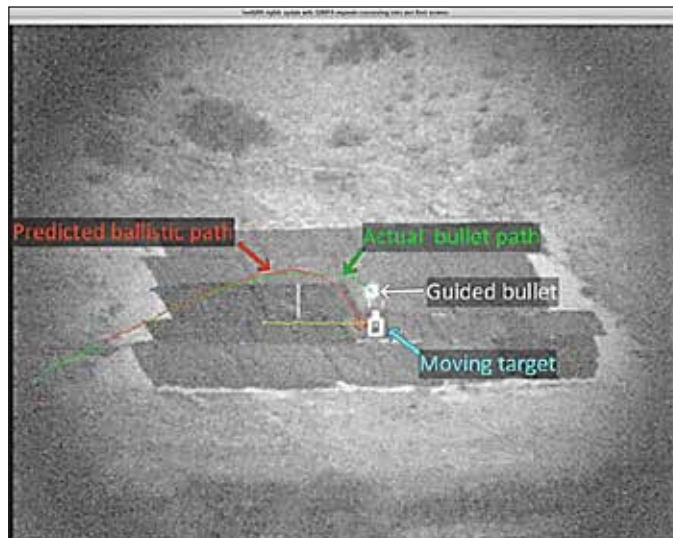


Work Begun on Wireless, Event-Driven Sensors

State-of-the-art military sensors today rely on “active electronics” to detect vibration, light, sound or other signals. That means they constantly consume power, with much of that power and time spent processing what often turns out to be irrelevant data. **This power consumption limits sensors’ useful lifetimes to a few weeks or months when operating from state-of-the-art batteries**, and has slowed the development of new sensor technologies and capabilities. Moreover, the chronic need to redeploy power-depleted sensors is not only costly and time-consuming but also increases warfighter exposure to danger.

DARPA’s new Near Zero Power RF and Sensor Operations (N-ZERO) program seeks to overcome the power limitations of persistent sensing by **developing wireless, event-driven sensing capabilities that would allow physical, electromagnetic and other sensors to remain dormant—effectively asleep yet aware—**until an event of interest awakens them. To achieve these goals, the program intends to develop underlying technologies to continuously and passively monitor the environment and activate an electronic circuit only upon detection of a specific signature, such as the presence of a particular vehicle type or radio communications protocol. N-ZERO seeks to exploit the energy in signal signatures to detect and recognize attention-worthy events while rejecting noise and interference.

“It is the waiting for a specific event or activity that constrains mission life and drains the battery energy of these essential electronics,” said **Troy Olsson**, DARPA program manager. “By cutting reliance on active power and enhancing battery life, N-ZERO aims to enable wireless, ubiquitous sensing that is energy efficient and safer for the warfighter. Our goal is to use the right signal itself



to wake up the sensor, which would improve sensors’ effectiveness and warfighters’ situational awareness by drastically reducing false alarms.”

* * *

Tests Continue on Self-Steering Bullet

DARPA’s **Extreme Accuracy Tasked Ordnance** (EXACTO) program, which developed a **self-steering bullet to increase hit rates for difficult, long-distance shots**, completed in February its most successful round of live-fire tests to date. An experienced shooter using the technology demonstration system repeatedly hit moving and evading targets. Additionally, a novice shooter using the system for the first time hit a moving target.

A video shows EXACTO rounds maneuvering in flight to hit targets that are moving and accelerating. EXACTO’s **specially designed ammunition and real-time optical guidance system** help track and direct projectiles to their targets by compensating for weather, wind, target movement and other factors that can impede successful hits.

“True to DARPA’s mission, EXACTO has demonstrated what was once thought impossible: the continuous guidance of a small-caliber bullet to target,” said **Jerome Dunn**, DARPA program manager. “This live-fire demonstration from a standard rifle showed that EXACTO is able to hit moving and evading targets with extreme accuracy at sniper ranges unachievable with traditional rounds. Fitting EXACTO’s guidance capabilities into a small .50-caliber size is a major breakthrough and opens the door to what could be possible in future **guided projectiles across all calibers.**”

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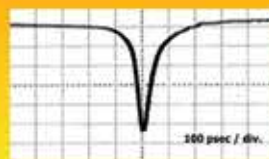
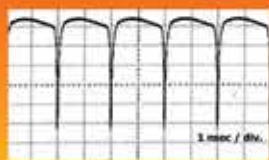
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GIM250A	250	-18	80
GIM500A	500	-15	60
GIM1000A	1000	-10	50
GIM1500A	1500	-8	45
GIM2000A	2000	-7	35

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In the News



Pasternack Enterprises appointed **Bruce Yolken** as the company's Quality Assurance Manager. Mr. Yolken joins

Pasternack with more than 30 years of Quality Assurance experience in the aerospace and defense sector.

* * *

Mini-Circuits Launches Microwave Calculator Mobile App

Mini-Circuits launched a new Microwave Calculator app for Android mobile devices that performs three calculations commonly needed by RF and microwave system designers. The app provides a simple interface for users to quickly compute:

- The effect of VSWR or return loss on transmitted power
- Cascaded noise figure and gain for up to five amplifier stages
- Power to voltage conversion (W, mW, dBm, Volts RMS, and Volts Peak)

It also provides the formulas for each of these computations as a convenient reference. It's a tool to simplify and expedite problem-solving whether working in the lab or in the field. The Microwave Calculator is now available for free download from the company's website and on Google Play™.

Separately, Mini-Circuits also announced that it has entered into a licensing agreement with The **National Radio Astronomy Observatory** (NRAO) to permit the use of NRAO-developed technology in a new suite of commercial electronics products. This newly signed agreement, which covers a part of the NRAO portfolio of radio frequency filters known as **cascadable absorptive filters**, will foster the development of new radio-frequency-based

technologies in a wide range of commercial applications.

* * *

Anokiwave, supplier of semiconductors enabling mmW and AESA markets, announced the completion of a Series B round of funding. The round was led by Mr. JP Carney, CEO and co-founder of Revolabs; Dr. Lamberto Raffaelli; and COM DEV International Ltd. Anokiwave will use the funds to continue to expand its engineering team, launch development laboratory facilities, and expand rapidly innovative products for mmW 5G and complementary markets.

* * *

Crane Aerospace & Electronics announced the appointment of **Mike Clark** as Vice President of Microwave



Components & Integrated Assemblies. Clark will be responsible for driving customer satisfaction, continued growth and strategic direction of

the Microwave business along with overseeing operations at the Beverly, Mass., design center and Chandler, Ariz., and West Caldwell, N.J., manufacturing facilities. He will be located in Chandler, Ariz.

* * *

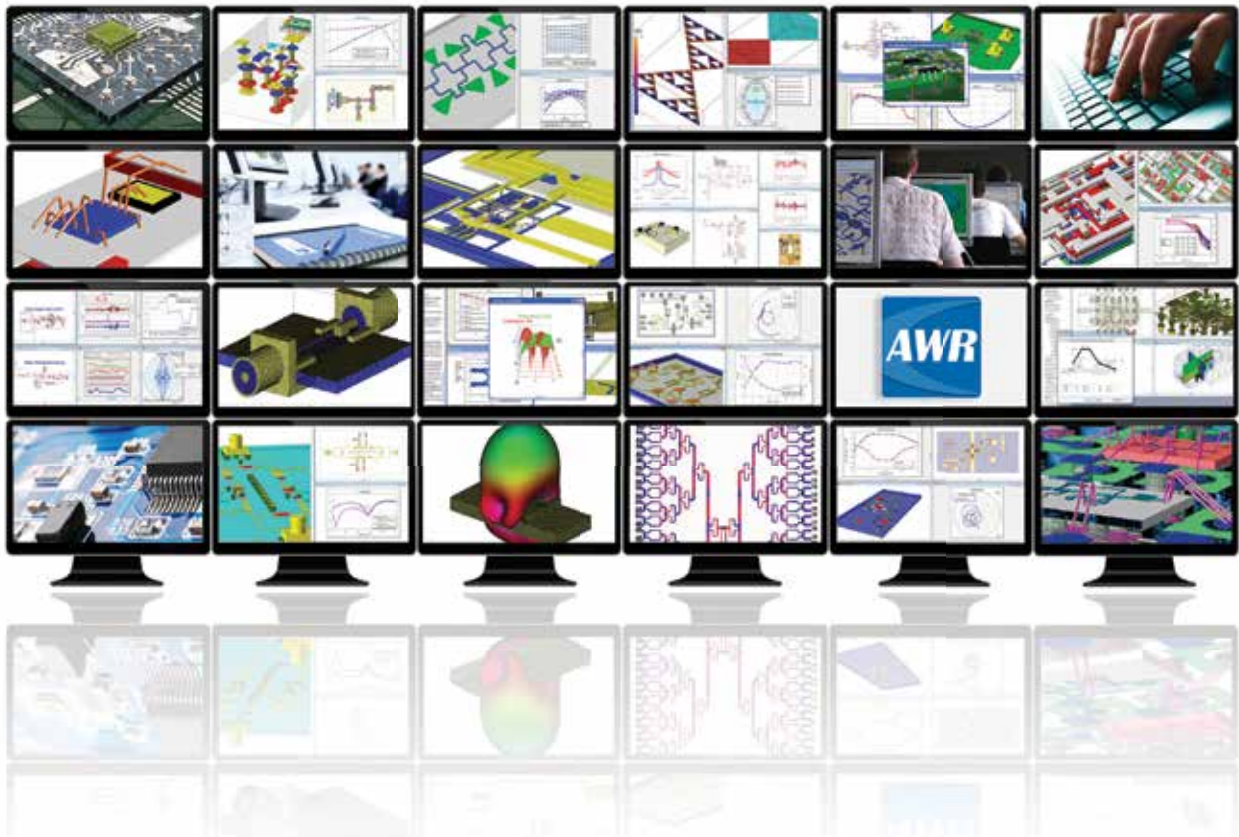
Azimuth Systems, provider of automated, real-world mobile performance test solutions, announced that **Parrot**, supplier of advanced technology wireless products for consumers and professionals in the automotive, civilian drones and connected objects markets, has selected **Azimuth's ACE MX channel emulator** for testing the performance of its drones in real-world conditions.



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speed and ease-of-use enhancements, it's never been easier to streamline your design process, improve your end-product performance, and accelerate your time to market. Display NI AWR Design Environment on your desktop today. Get started at awrcorp.com/tryawr.

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Power Sensor

Anritsu introduced the MA24208A/MA24218A Universal USB Power Sensors that leverage Anritsu's patented triple path architecture to provide highly accurate, true RMS measurements of CW, multi-tone, and digitally modulated signals up to 18 GHz. They are designed to increase throughput and reduce cost-of-test in any lab, high-volume manufacturing and field environment.

Anritsu
anritsu.com



Filter

Model SCF-08308320-SFSF-B1 is a bandpass filter with broad pass-band, a sharp-rejection and low insertion-loss characteristics. It shows 1.8 dB maximum insertion loss in the frequency range of 4 to 12 GHz and greater than 20 dB rejection at 3.5 GHz and 12.5 GHz, which are only 500 MHz away from the passband.

SAGE Millimeter
sagemillimeter.com

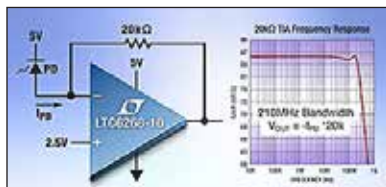


Bias Tees

The BTHF (high frequency), BTHC (high current) and BTS (standard) bias tee series enhance the breadth and depth of RF and microwave solutions from TTE Filters. These series are designed for use in biasing active antennas, amplifiers and laser diodes, and for DC blocking or return in broadband microwave, RF,

data communication and ADC/DAC applications, including laboratory test systems.

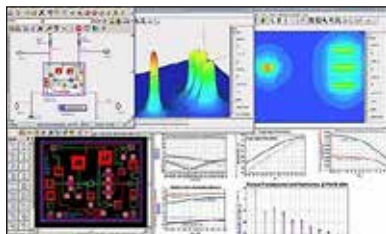
TTE Filters
tte.com



Op Amp

The LTC6268-10 single and dual LTC6269-10 4GHz FET-input op amps are designed for high dynamic range and high speed transimpedance amplifier (TIA) applications. These decompensated amplifiers extend the speed and dynamic range capabilities of this ultralow bias current op amp family for applications with a gain of 10 or higher.

Linear Technology
linear.com



Simulator

The ADS Electro-Thermal Simulator provides accurate, temperature aware IC simulation results by using device temperatures that take into account thermal coupling and thermal characteristics of the RFIC/MMIC component packaging. It supports steady-state (harmonic balance, DC, AC, S-parameter) analysis, and transient and envelope analyses.

Keysight Technologies
keysight.com

Splitter

RFMW announced support for the MRFSP6725, 2-way splitter from MiniRF. It extends the frequency range of this series of splitters to 1600 MHz. Two other devices, the MRFSP0014 with coverage from 5 to 1002MHz and the MRFSP5725



with coverage from 5 to 1200MHz, have already seen acceptance in the broadband CATV market.

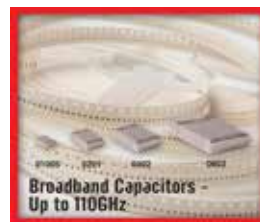
RFMW
rfmw.com



Antenna

The new SFA04-W800 E-Band antenna is one of the most discreet E-band (80 GHz) microwave antennas ever developed. Its light weight, compact design, multi-band capabilities, and low-profile aesthetics make the SFA04-W800 ideal for small cell, front haul and traditional backhaul systems.

RFS
rfsworld.com

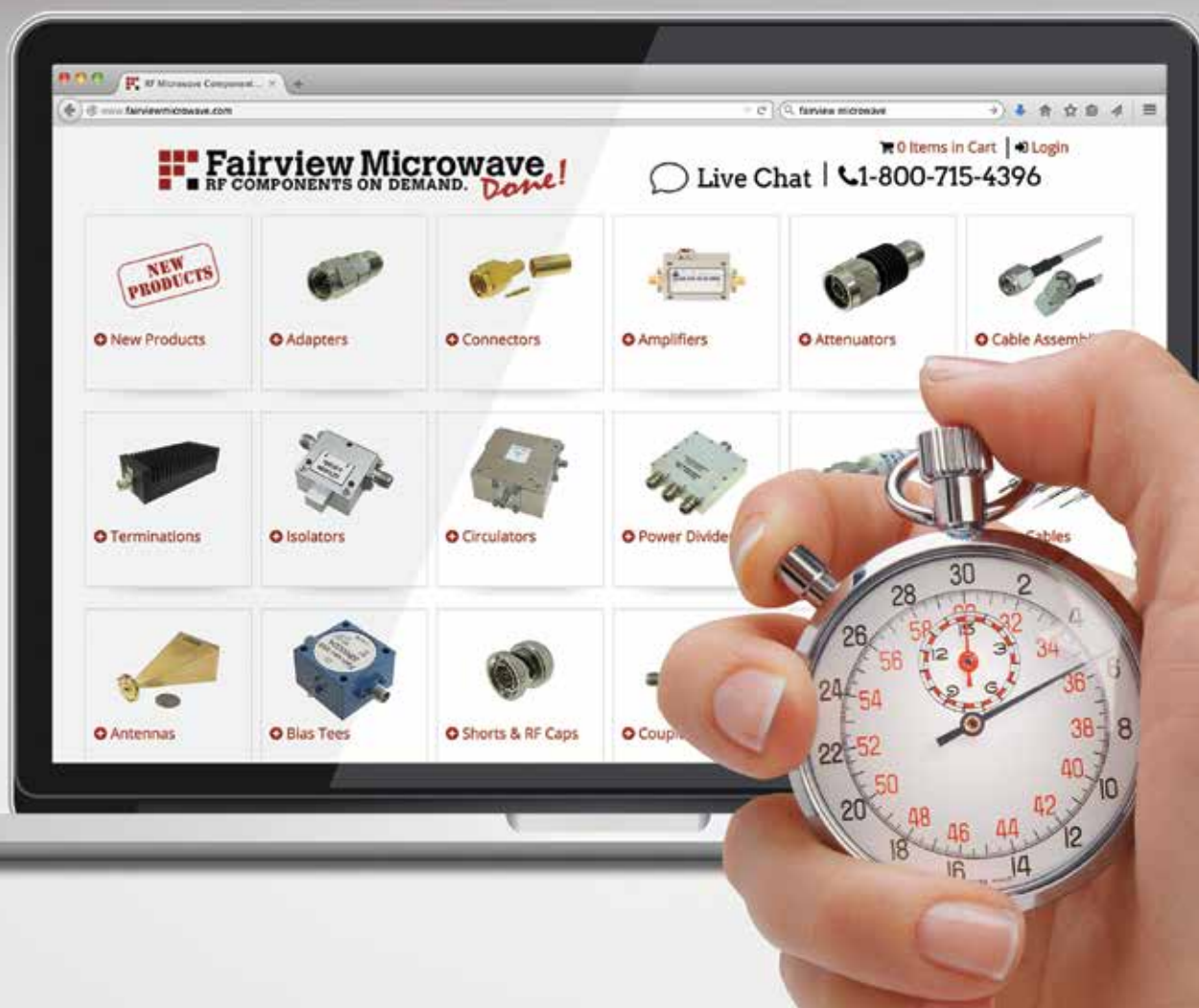


Capacitors

Passive Plus has developed a series of broadband and ultra-broadband capacitors: 01005BB104, 0201BB104, 0402BB104, and 0402BB103. These are intended primarily for coupling RF signals or, occasionally, for bypassing them to ground, while blocking DC. The applications for which they are intended require small, surface-mountable devices that provide low RF impedances.

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Featured Products



Filter

The BPF-C59+ is a 50Ω, 30 to 88 MHz broadband filter in a small shielded package (size of 0.87" x 0.80" x 0.25") fabricated using SMT technology. This filter offers outstanding close in rejection, low insertion loss for use in telecommunication and broadband wireless application. The stopband extends up to 4.5 GHz.

Mini-Circuits
minicircuits.com



VNA

Anritsu introduced Intermodulation Distortion (IMD) options for its VectorStar® platform that expand the measurement capability of the line to meet the needs of design and production engineers. New IMDView software creates an advanced, easy to use graphical user interface (GUI) that simplifies complex IMD measurements.

Anritsu
anritsu.com



Downconverter

Model MFC146 is a Dual Band Block Downconverter (BDC) and covers the Ku band segments of 10.7-11.7 GHz and 11.7-12.75 GHz with low noise figure and low phase noise, housed in a compact, rugged low-profile enclosure. It supports Ku band VSAT applications and is built to withstand

challenging airborne environments.

TRAK Microwave
trak.com



LNA

PMI Model No. PE2-28-15G18G-4R0-13-12-SFF is a 15.0 to 18.0 GHz, low noise amplifier with a typical gain of 26 dB at the 10.0 to 18.0 GHz frequency range. This unit has a noise figure of 4.0 dB max and a typical VSWR of 1.5:1. It is supplied with removable SMA(M) connectors in PMI's standard PE2 housing.

Planar Monolithics Industries
pmi-rf.com



Power Amp

Comtech PST introduced a high power density solid state RF module. It is the latest in GaN-based 6-18 GHz RF amplifiers. This highly integrated design is ideal for use in communication, electronic warfare, and radar transmitter systems where space, cooling, and power are limited.

Comtech PST
comtechpst.com



Rack Enclosure

Equipto Electronics' new Ka Shield™ rack enclosure is so named because it offers certified EMI/RFI shielding from the RF



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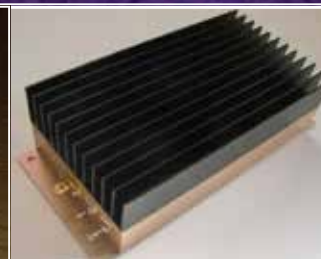
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Diagram illustrating the application of Amplifiers across various domains:

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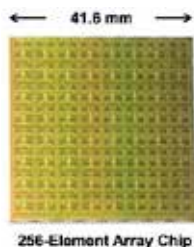
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range, through the microwave Ka Band.

Equipto Electronics
equiptoelec.com



256-Element Array Chip

Transmitter

TowerJazz and UC San Diego collaborated to demonstrate the first 256-element (16 x 16) wafer-scale phased array transmitter with integrated high-efficiency antennas operating at 56 - 65 GHz frequency range.

TowerJazz
towerjazz.com

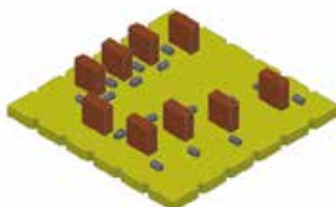
YIG Filters

Teledyne Microwave Solutions announced a line of YIG Tuned



Band-Reject Filters that cover the frequency range of 125 MHz to 18 GHz.

Teledyne Microwave Solutions
teledynemicrowave.com



Diplexer

DPB85102-75+ is a 75Ω high performance diplexer with the lowpass port at DC - 85 MHz and highpass port at 102-1220 MHz. Excellent return loss combined with high out of

channel rejection makes it an ideal part in cable TV and multiband radio systems.

Mini-Circuits
minicircuits.com



Switch

Model SK4-7238130830-1212-R1 is an E band Single-Pole Four-Throw (SP4T) Pin diode switch covering the frequency range of 72.0 to 81.0 GHz. It offers better than 30 dB isolation and 8.0 dB typical insertion loss over the entire frequency range.

SAGE Millimeter
sagemillimeter.com

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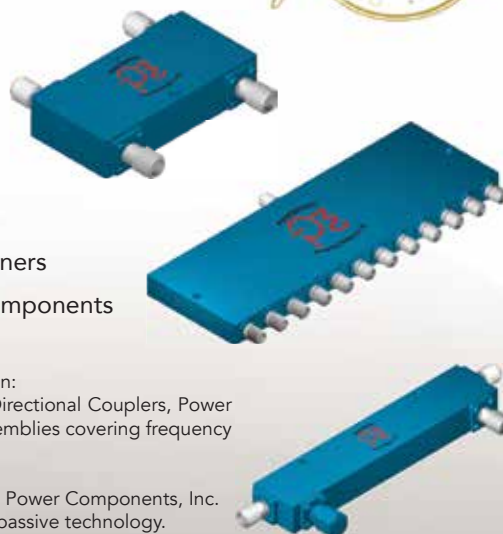


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The new division is headed up by Paul Davidsson, former founder and president of RF Power Components, Inc. Paul's experience encompasses over 30 years of experience in high power active and passive technology.

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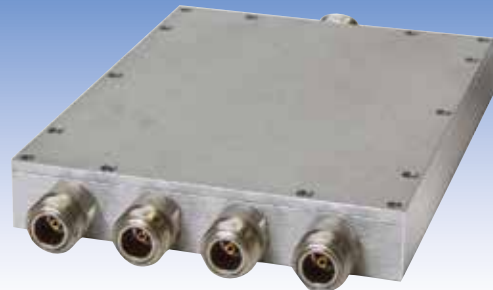
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- ✓ Excellent VSWR, 1.2:1

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500 to 3300 MHz



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- ✓ Amplitude unbalance, 0.2 dB
- ✓ Excellent VSWR, 1.15:1
- ✓ Good isolation, 22 dB

ZN8PD-362HP+

600 to 3600 MHz



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from **\$369⁹⁵** ea. (qty. 1-9)

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- ✓ Amplitude unbalance, 0.4 dB
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- ✓ Good VSWR, 1.2:1

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- ✓ Excellent VSWR, 1.1:1

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Controlling EMI in the Microwave/RF Industry

By Ed Nakauchi

EMI can disrupt the performance of the circuit it originates from as well as other circuits and systems nearby.

Electromagnetic interference (EMI) can plague even the best microwave/RF designs and requires careful planning to control. Designers working with electromagnetic (EM) energy are constantly faced with the threat of leaks that could lead to stray EM energy making its way into other parts of a circuit or system. EMI can disrupt the performance of the circuit or system it originates from as well as other circuits and systems nearby.

There are two basic approaches for reducing or shielding EM emissions from a device or system as well as improving its immunity performance. One approach is shielding at the printed circuit board (PCB) level utilizing proper design techniques. The other approach is to place the device or system in a shielded enclosure.

Circuit and System Levels

At the circuit level, any long signal trace on a PCB or an active device component can double as an antenna radiating EM energy. Signal interconnections can also produce unwanted EM radiation. At the system level, controlling EMI can be even harder since multiple EMI sources may exist (i.e., local oscillators within a receiver), and they may be within close proximity to components that can be impacted by the radiated emissions (i.e., frequency mixers or analog-to-digital converters). When all of these components are packed within a metal enclosure, the enclosure can provide a means of achieving an effective ground to reduce EMI.

Any design can be susceptible to EMI. Because of the need to control EMI, an industry has grown up around the development of shielding materials such as gaskets and board level shielding (BLS), which are added to the enclosure of an electronic product to achieve electromagnetic compatibility (EMC). Just how well an EMI shield works is measured by its shielding effectiveness (SE).

EMI shielding is essentially any barrier placed between an EM

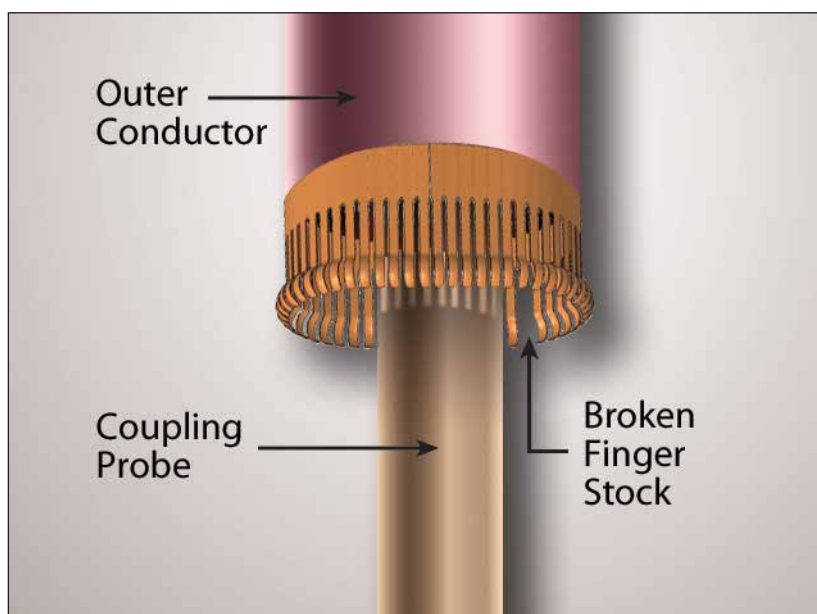


Figure 1 • Soldered finger-stock ring at the end of an outer conductor with a broken finger.

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Figure 2 • Board level shielding (BLS) can be manufactured in one-piece, two-piece, multi-cavity, and custom configurations.

emitter and a susceptible device, designed to reduce the field strength of the emitter. The losses in EM emitter field strength are a function of the barrier's electrical and physical characteristics including permeability, conductivity, and thickness; EMI frequency; and the distance from the EMI source to the barrier/shield.

In addition to EMI shielding, it is of considerable importance for a microwave/RF system to have good uniform electrical contacts between separate parts (i.e., a microwave component and a cavity wall) to realize an EM field with little reflection, leak-free connections, and leak-free sealing at any water-cooled parts. Flange connections of waveguides are another connection needing good uniform electrical contact. Figure 1 illustrates a soldered finger-stock ring at the end of an outer conductor that has a broken finger. You can see that the rest of the finger-stock ring shows no damage.

EMI Shielding Solutions

This article will discuss some of the available shielding products for use at both the printed circuit board

level (board level shielding) and the system level (gasketing). In most cases, device manufacturers rely on shielding suppliers for the technical capabilities and knowledge needed to suppress EMI. EMI shielding remains a challenging task.

Board Level Shielding (BLS)

A board level shield can be viewed as a five-sided can. Available in unlimited sizes, shapes, and heights, board level shielding (BLS) is placed around the component or circuit on the printed circuit board that needs to be shielded. BLS is used to restrict the amount of electromagnetic energy propagating between the source and a receptor to acceptable levels. When designing and manufacturing BLS, the following elements need to be considered in relation to shielding effectiveness:

Near-field effects: When the shield is in the near-field of the source, shielding performance will be impacted by the frequency of the source, the field configuration, position of the source, and distributed inductances and capacitances. In other words, the approach now becomes a “coupling” problem and should no longer be considered a radiated problem. Even when accounting for the apertures in a shield, calculating or estimating shielding effectiveness could still fall short of approximation. The coupling of the source to the shield, the effect of mutual coupling between elements, effect of the shield termination, and grounding technique all need to be accounted for. Currents diffusing through the shield, shield bends and corners, and the resultant generated external voltages also need to be considered.

Layout and hole considerations: The effectiveness of BLS is highly dependent on the proper design of the printed circuit board mounting area. Normally, the sixth side of this “box” will be a ground plane on the board. The number and spacing of traces, vias, and holes running from this shielded area to other board components can affect the effectiveness of BLS. With higher frequencies and shorter wavelengths, the size and number of holes can become issues along with thermal effects. However, this concern is tempered by the near-field effect. Capacitive and inductive coupling are more significant than aperture size for shielding.

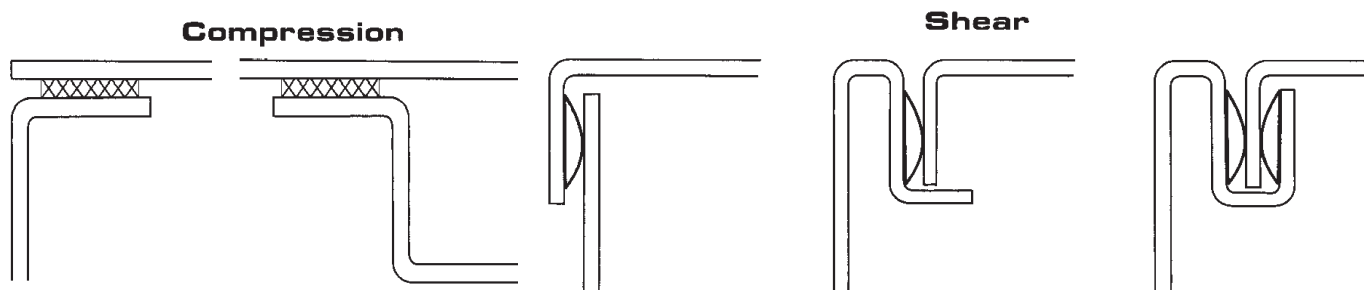


Figure 3 • Gasket application: compression configuration vs. shear application.



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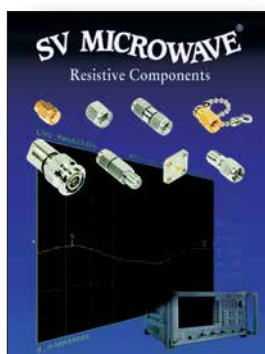
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- Environmental Standards per MIL-STD-202

Terminations

- SMA, TNC, N, 2.4 mm, 2.9 mm, ZMA
- Nominal Impedance: 50 ohms
- Frequency Range: DC-50 GHz
- Interfaces IAW MIL-PRF-39012
- Meet requirements of MIL-DTL-39030
- Environmental Standards per MIL-STD-202



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▶ Controlling EMI

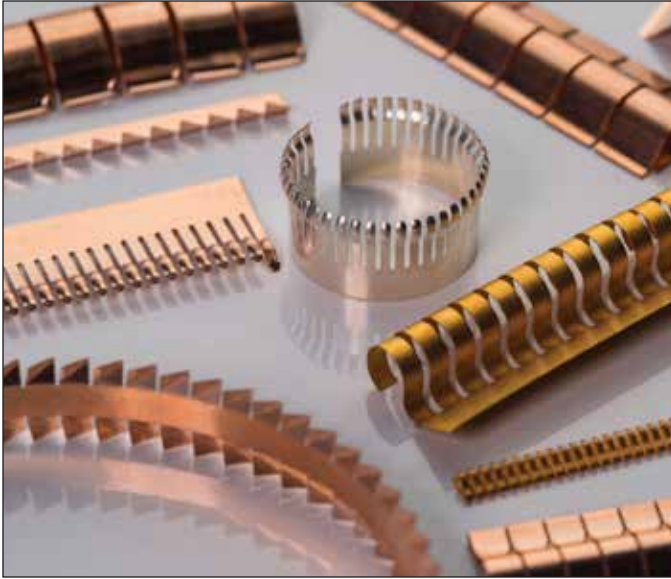


Figure 4 • BeCu gaskets deliver the industry's highest EMI shielding effectiveness and are available in a variety of finishes.

Resonances: Another issue with higher frequencies is resonance effect (its coupling is a consequence of self-resonance of various structures). A 2-inch by ½-inch



Figure 5 • Metalized fabric gaskets from are manufactured with a polyurethane foam core and nickel-plated copper-conductive fabric.

enclosure resonates at a first order mode of around 12 GHz. Even weak coupling at these high frequencies can induce strong oscillations that can then couple to any other point in the enclosure.

Thermal management: As devices become faster in frequency, they generate more heat. Hence, thermal management is also a design factor. Thermal management can be achieved through the use of thermal pads and heat sink—companies like Orbel can assist with various design options that may be available.

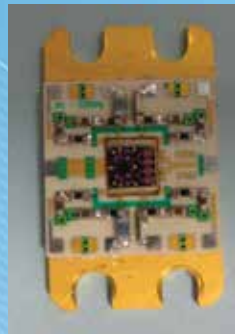
Gasketing

Gasketing is used to maintain shielding effectiveness through proper seam treatment. It is the effect of seams, in general, that accounts for most of the leakages in an enclosure design. The shielding effectiveness of a seam is dependent on materials, contact pressure, and surface area. Gaskets maintain conductive contact across mating surfaces. A solution to radiated problems is found by making all seams of adjoining metal pieces continuous. If there is no continuity between metal pieces, a radiating aperture for RF currents is created. This is where gasketing can be used.

These conductive surfaces must be cleaned of any insulating finish. Although close-spaced fasteners (approximately 25mm or 1") can be used alone, gaskets are preferred in order to reduce the number of fasteners and compensate for mechanical variations or joint unevenness.

Most gasket applications involve two types of forces, compression and shear. When gaskets are installed under a flat cover panel in a compression configuration,

AMCOM is pioneering the technology of controlling the device impedance to achieve ultra wide-band, high-power MMIC amplifiers. **AMCOM** is releasing 4 GaN MMIC ultra wide-band, high-power amplifiers. The Table below shows the performance. **AMCOM** products include discrete power devices, MMIC power amplifiers and connectorized power amplifier modules from 30MHz to 16 GHz with output power from 1W to 50W. For more product details, please visit www.amcomuse.com for data sheet with detailed performance.



AMCOM GaN HEMT MMIC Summary

Model	Frequency (GHz)	G _{ss} (dB)	P _{sat} (dBm)	Eff _{sat} (%)	V _d (V)	I _{eq} (A)	ECCN
AM004047SF-2H*	0.05-4.0	33	47	44	25, 90	0.5, 0.9	EAR99
AM006044SF-2H*	0.05-6.0	22	44	42	30, 60	0.4, 1.0	EAR99
AM206542TM-00!	2.0-6.5	25	42	20	28	0.96	3A001.b.2.a
AM010130TM-00!	0.05-13.0	13	33	15	28	0.24	3A001.b.2.b

* 100uS pulse width, 10% duty cycle. They also work in CW mode at lower bias voltage with slightly reduced output power.
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WG-Big&SmallE5

▶ Controlling EMI

pressure is used to preserve the shielding effectiveness of the seam. The alternative is a shear application where a flange or channel arrangement is maintained to preserve the shielding effectiveness and no sliding action occurs.

Chosen based on specific shielding effectiveness requirements, application atmosphere, and spatial specifications, both beryllium copper (BeCu) gaskets and

metalized fabric gaskets can be used to ensure maximum EMI compliance:

Beryllium copper gaskets: BeCu gaskets offer the highest level of attenuation over the widest frequency range and are useable in both compression and shear applications. Solid fingers have greater cross-sectional area, hence higher conductivity. In addition, the finger shape has the characteristics of an interconnecting ground plane with a large contact area. The inductance will therefore be low as well. The movement of the finger shape also provides a “wiping” action that aids in penetrating or removing any oxide buildup in the contact area. They are very forgiving to compression, meaning that it is very difficult to over-compress them causing compression set or breakage. Potential problem areas, depending on frequency range, are the slots between the fingers. At sufficiently high frequencies, these slots begin to permit RF energy transmission through the bounded slot configuration.

Metalized fabric gaskets: These gaskets are made of conductive fabric material over foam. Conductivity can be very low and hence offer very high attenuation—the amount of attenuation is determined by the level and matrix of the conductive particles used, and the compression force. These gaskets come in various styles and shapes (rectangular, square, D-shaped, bell-shaped, knife-shaped, etc.) that allow various compression ranges down to low values.

Gasket Design Guidelines

Generally, either of these gasket types will provide effective shielding (mechanical characteristics and cost generally determine choice of gasket). The effectiveness of the gasket is dependent on the use of proper design guidelines. Regardless of gasket type, important factors that must be considered during the selection process are RF impedance, material compatibility, corrosion control, gasket height, compression force, compressibility, compression range, compression set, and environment. For RF impedance control, high conduc-

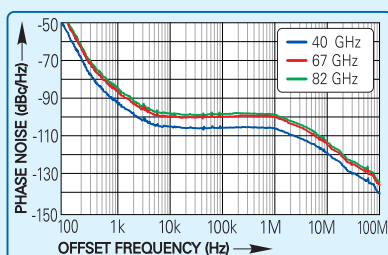
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We've extended our popular QuickSyn Lite frequency synthesizers to three commonly used mmW bands—27 to 40 GHz, 50 to 67 GHz, and 76 to 82 GHz for high-speed short-range data links, WirelessHD, IEEE 802.11ad, digital radios, automotive radars, etc. QuickSyn mmW frequency synthesizer modules are ideal for demanding application environments like field trials and embedded systems where bulky benchtop solutions were the only choice.

Feature	FSL-2740	FSL-5067	FSL-7682
Frequency GHz	27 to 40	50 to 67	76 to 82
Switching Speed μ s	100	100	100
Phase Noise at 100 kHz	-108 dBc/Hz at 40 GHz	-105 dBc/Hz at 67 GHz	-103 dBc/Hz at 82 GHz
Power (min) dBm	+17	+17	+10
Output Connector	2.92 mm	1.85 mm	WR-12



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ANODIC (Most susceptible to corrosion)

Magnesium	+2.37 v
Beryllium	+1.85 v
Aluminum	+1.66 v
Zinc	+0.76 v
Chromium	+0.74 v
Iron/Steel	+0.44 v
Cadmium	+0.40 v
Nickel	+0.25 v
Tin/Tin lead	+0.14 v
Lead	+0.13 v
Copper	-0.34 v
Silver	-0.80 v

CATHODIC (Least susceptible to corrosion)

Figure 6 • Typical galvanic activity.

tivity and low inductance is desired. It should not be a surprise that BeCu has the highest conductivity.

Corrosion: Corrosion is a concern as it can lead to reduced shielding effectiveness due to causing the gasket material to become insulative or creating new problem frequencies through nonlinear mixing. There are two types of corrosion. The most common is galvanic corrosion and is due to contact between two dissimilar metals in the presence of moisture. The second type is electrolytic and is due to current flow between two metals in the presence of an electrolyte. For commercial applications within controlled environments, galvanic-compatible materials are those within 0.5 to 0.6 volts. Typical galvanic activity is shown in Figure 6.

Compressibility: The height or diameter of the gasket must be large enough to compensate for the joint unevenness of the mating surfaces for the force applied (compressibility). The difference between the minimum

and maximum compressed gasket height should equal the joint unevenness.

Compression force: Compression force is the force required to achieve maximum shielding effectiveness. The higher the pressure or compression force, the lower the impedance. A minimum closure force is recommended to obtain low surface contact resistivity and effective shielding. Minimum closure force is the pressure required to break through corrosive and oxide films to make a low resistance contact. Therefore, if insufficient pressure is applied to the seam, a high contact resistivity will exist and reduced shielding effectiveness will result. For a good joint seal, there needs to be low surface contact resistivity as well as low gasket resistivity (i.e., high gasket conductivity).

About the Author

An EMI/EMC/EMP/ESD consultant with close to 50 years of experience, Ed Nakauchi has worked on projects for the Space Shuttle; the Global Positioning Satellite; Disneyland's Splash Mountain and Rocket Rod rides; the U.S. Navy, Army, and Air Force; and Tesla Motors. Nakauchi received his AA and Technician Certificate from Orange Coast College, his BSEE from Northrop University, and his MSEE from Columbia Pacific University. He is a NARTE Certified EMC/ESD Engineer and Master Design Engineer with senior life membership in the IEEE.

About Orbel Corp.

Since 1961, Orbel's custom design and manufacturing process has enabled unique engineered solutions for a variety of applications and industries. From conception through delivery, Orbel offers today's most effective EMI/RFI shielding, photo-etched precision metal parts, precision metal stampings, and electroplated metal foils. Areas of specialization include microwave/RF, aerospace, telecommunications, electronics, medical, automotive, and manufacturing. For more information, visit Orbel.com or call 610-829-5000.

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Things You Should Know About EMC Test Equipment

By Lisa Clark

Locating the sources of electromagnetic signals to decrease their potential interference with other devices nearby.

There has been an increase in electromagnetic and radio frequency interference created partly by high-end electronics and their components; and also by interconnecting cables. Many electronic instruments these days transmit and receive signals. This tends to create electromagnetic pollution that can interfere with the functionality of some devices. The interference can also create serious malfunction in electronic devices such as radio, television, computers and medical equipment.

EMC (Electromagnetic Compatibility) testing is performed to locate these sources of electromagnetic signals to decrease their potential interference with other devices nearby. EMC testing also measures the susceptibility of equipment to the electromagnetic signals emitted from its neighboring devices.



The Test Equipment

The function of EMC Test Equipment can be explained as devices used “in the analysis of interference, noise, mitigation and hence electromagnetic susceptibility of electronic equipment. EMC testing is achieved by addressing both emissions and susceptibility issues. This is best achieved by quieting the sources of interference, making the coupling path between source and





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EMC Test



victim less efficient, and/or making the potential victim systems less vulnerable.”

Do I Need to Do It?

Many types of equipment are regulated for EMC testing. Further, if you are running a business, it is always beneficial in the long run to regularly perform EMC testing not only to conform to regulations but to reduce the potential service cost by maintaining the electronic health of your devices. Successfully testing your devices gives you confidence in the product's reliability.

What Equipment Would You Need?

You can either set up your own EMC test lab by purchasing or renting EMC test equipment, renting a lab or hiring professionals to do the test. There is a wide range of EMC testing equipment and it is important to understand which equipment will best suit the device to be tested. For example, a phone would need a different kind of test equipment than a computer.

These tests are usually performed inside a screen room and normally the bulk of test equipment consists of sensitive measurement receivers and spectrum analyzers apart from generators if there are susceptibility tests to be performed.

The cost of EMC testing equipment is usually high and many people prefer hiring a lab. However, for organizations, it would be cost-efficient to rent or buy the equipment

during the designing and initial testing phase of their electronic products.

What Does EMC Test Equipment Do?

The core function of your equipment is to determine the Electromagnetic Compatibility (EMC). The EMC value decides the extent of susceptibility towards the electromagnetic interference from other electronics, thus establishing if they are compatible or not. For instance, using certain wireless devices at a hospital might cause disturbance in the working of critical health care instruments showing their incompatibility to the wireless device.

Types of Equipment

As discussed, there is a variety of EMC Testing Equipment available for different products in different contexts. These devices differ in their voltage sources, simulators, generator capacities, resistors and plugs. Depending on what range of power is required by the device being put to text and in what environment, the most appropriate type is selected.

The Important Parts:

Absorbers:

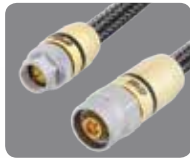
This is the most crucial module in the EMC testing equipment. No matter what device is being tested and in what kind of environment, these are absolutely critical for the health of the experiment and its users. Absorbers convert the incoming elec-

RF Solutions From RF Engineers

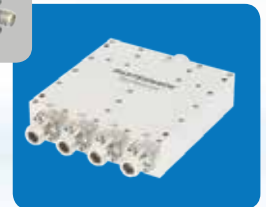
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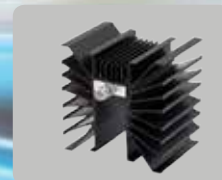
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tromagnetic energy into thermal energy and dissipate that into the air. Without this essential conversion there could be harmful electromagnetic radiation where these tests are conducted.

Antennas:

They help in coping with the levels of radiation. There are many types of antennas available alongside your EMC test equipment, and which one you choose depends on the size of the device being tested and the possible amount of radiation you expect it to generate. This is very critical to safety of the process, and care needs to be taken to make these calculations as precisely as possible to maintain low levels of radiation in the testing place.

These are the important things that you need to know before choosing the right EMC test equipment for your device or product. It is advisable to not choose equipment merely because it's cheaper but does not deliver the right power or absorption. Users are rather advised to rent EMC test equipment from electronic test & measurement suppliers like TRS RenTelco, Tektronix, Rohde & Schwarz, JDSU and others and get the most accurate electromagnetic compatibility rating from high-quality equipment.

Best Practices:

Finally, here are a few best practices that we recommend you follow before and after the EMC Testing, for the best results:

Write a test plan. You'll definitely want to define the process beforehand to avoid any "black swans." You could either hire a consultant, or do this yourself. Ideally, your test plan should consist of configurations, operation and monitoring modes, and a worst-case scenario.

You also want to list the external power and data ports involved in the test, a to-do list on monitoring and documenting failures, description of all the hardware undergoing test, and cooling fans.

Secondly, form a detailed pricing estimate and schedule for your test. Further, list the supplies you would need from the lab, and the list of supplies you'd provide in-house.

Once the supplies are arranged, preliminary testing is always helpful. Each test method can be performed in a preliminary way so that the modifications in design can be made before the final test. Usually, a radiated emissions pre-test is the commonly performed one, and it gives an overview of possible failures.

And to conclude, it is very important to have a basic troubleshooting guide that describes solutions for simple issues that arise during testing or pre-testing. This might include cable usage, immunity tests and managing leakages. Needless to say, for more complicated issues it is essential to consult a professional lab.

About the Author

Lisa Clark is a product and test engineer based in Madison, Wis., and has been working as a freelance product and test engineer. She keeps up-to-date with the advancements and challenges in the test & measurement equipment industry. She also has a keen interest in writing and reading articles related to electronic test, measurement, and monitoring equipment.

Best Practices for EMC Testing

- ✓ Write a test plan. Define the process beforehand to avoid "black swans."
- ✓ List the external power and data ports involved in the test.
- ✓ Form a detailed price estimate and schedule for your test.
- ✓ Perform each test method in a preliminary way before the final test.
- ✓ Develop a basic troubleshooting guide for simple issues that are bound to arise.
- ✓ In over your head or don't need the hassle? Consult a professional test lab.

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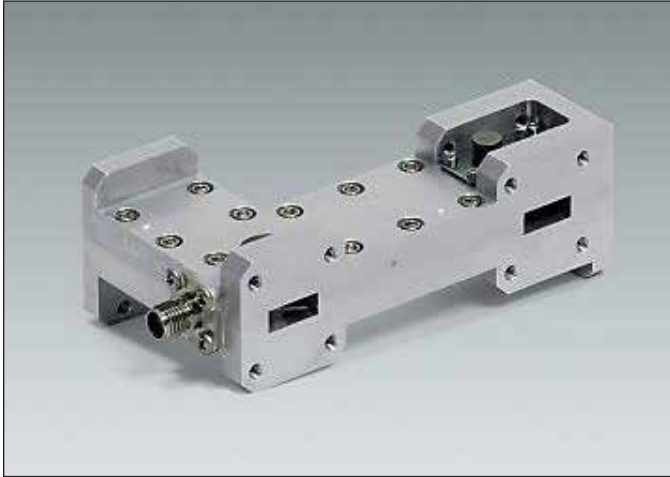
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► Product Highlights



Circulator

TRAK Microwave announced a Ka-Band Dual-Junction Latching Circulator-Isolator for high performance SATCOM links, commercial aviation systems, missile systems, and other high-rel aerospace applications. It can be designed to cover a variety of bandwidths across the 16 - 35 GHz range and offers 1 μ s switching speed and low insertion loss of 0.2 dB in transmit mode and 0.4 dB in receive mode.

TRAK Microwave
trak.com



Polarizer

Model SAS-773-12512-F1 is a 75 to 79 GHz Linear to Circular Polarizer. It exhibits 0.7 dB maximum insertion loss, better than 1.2:1 VSWR and 1.2 dB axial ratio. The RF interface is 0.125" diameter circular waveguide with UG387/U-M flange. A mode transition will be required for standard WR-12 waveguide interface.

SAGE Millimeter
sagemillimeter.com



Coax Switches

Ducommun offers six different options of Multi-Throw Manual Coaxial Switches for all applications. Current options range from DC to 3 GHz; DC to 12.4 GHz; and DC to 18 GHz up with 50 WCW of power handling capability.

Multi-Throw options include SP3T; SP5T; and SP6T positions.

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► Product Highlights



Coupler

Mini-Circuits' ZADC-40-27HP+ is a 50Ω, Up to 40W, 1400 to 2700 MHz directional coupler that features: low mainline loss, 0.2 dB typ.; excellent VSWR, 1.15:1 typ.; coupling variation with temperature, from -55°C to 100°C is very small, ±0.1 dB typ.; usable over 1400-2700 MHz; DC current through input to output 2A Max. at 40 watt RF output power.

Mini-Circuits
minicircuits.com



RF SSPA Modules

Exodus Advanced Communications announced two new state of the art SSPA modules: AMP1089 covering 2 to 6 GHz, 250 W high power broadband featuring state of the art GaN devices with <5uS switching time; and AMP1081 covering 1 to 18 GHz, 1 W ultra-broadband using the latest in chip and wire technology.

Exodus Advanced Communications
exoduscomm.com



High-Frequency Filters

Skyworks announced a family of ceramic-based filters targeting high frequency applications. They are compact, offer improved power handling, support frequencies up to 7 GHz, and are completely customizable. "Skyworks is pleased to be expanding our portfolio of ceramic-based

filters to address customer demands," said Mark A. Wolf, VP and GM of Skyworks' Trans-Tech division.

Skyworks
skyworksinc.com

► Product Highlights



Design Software

NI (formerly AWR Corp.) announced that NI AWR Design Environment™ V12—the first major software release in 2015—is now available as a pre-release to select customers, partners and evaluators. This latest release boasts new load-pull and antenna- and radar-specific features, as well as ease-of-use improvements, speed enhancements, and third-party integration flows.

NI AWR
awrcorp.com



Amplifier

Amplifier model AF0118273A operates from 0.1 to 18 GHz and has a noise figure of 2.8 dB and VSWR of 2:1. It has gain of 27dB with max gain variation of +/- 1.2 dB, P1dB output of +10 dBm, and current draw of 100mA at +5V bias with option for different bias voltages. It comes in a hermetically sealed package with removable connectors for drop-in assembly. Designed for both military and commercial applications.

Herotek
herotek.com

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► Product Highlights



Phase Noise Tester

With the R&S FSWP phase noise tester, users can measure the spectral purity of signal sources such as generators, synthesizers and voltage-controlled oscillators more quickly. It covers a frequency range up to 50 GHz and offers a top dynamic range. The low phase noise of its LO coupled with cross-correlation even makes it possible to easily measure signal sources that once required complex test setups.

Rohde & Schwarz
rohde-schwarz.com



LNA

Ducommun RF Product Group released a Low Noise Amplifier covering 26.5 to 40 GHz. Specifications: Fo: 26.5 to 40 GHz; Gain: 30 dB (min); P-1: 10 dBm (min); Noise Figure: 4.0 dB (typ); VSWR: 2:1 (typ); V/I: +8 Vdc/200 mA (typ); Connectors: K (F). Features: Broadband Low Noise; Wide Operational Temperature Range; Reliable, Proven Technology; Integrated Voltage Regulator.

Ducommun
ducommun.com



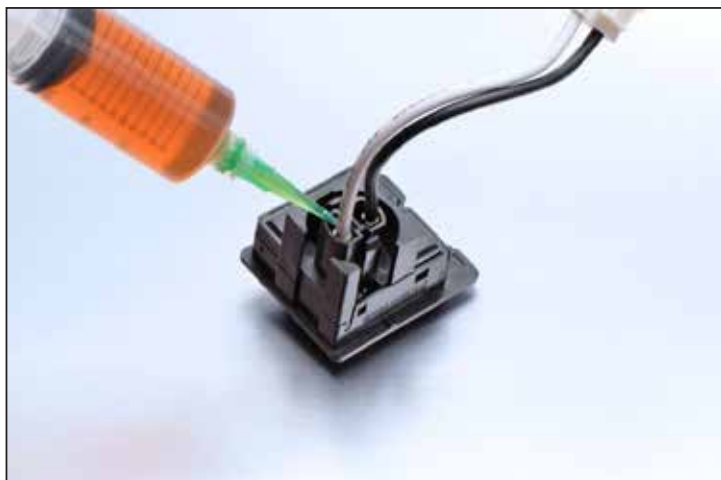
Power Amp

The QBS-620 is a dual channel, rack mount GaN power amplifier module designed for shipboard communications; other applications include battlefield and mobile communication platforms. Weighing 65 lbs., it consists of two identical channels, each containing a 200W amp, VHF

& UHF switched harmonic filter banks, SP3T high powered switches, a controller, and an AC/DC power supply.

API Technologies
apitech.com

► Product Highlights



Clear Epoxy

Master Bond EP62-1LPSP delivers an array of strength, electrical and handling properties that are well suited for bonding, sealing, coating and encapsulation applications. With a tensile lap shear strength exceeding 2,000 psi, it bonds well to a variety of substrates including metals, composites, glass, and many plastics.

Master Bond
masterbond.com



Downconverter

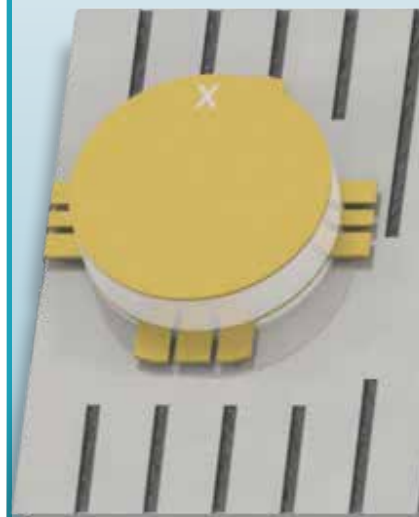
Model SSR-7530630580-12-M1 is an integrated E-Band block quadrature downconverter covering the frequency range of 72 to 78 GHz. It is designed and fabricated for automotive and broadband FMCW radar applications. Due to the built-in X6 active multiplier, the required LO frequency and power are 12 to 13 GHz and +11 dBm.

SAGE Millimeter
sagemillimeter.com



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- Θ_n <-145dBc@1 MHz Offset
- Harmonics <-20 dBc
- Spurious <-70 dBc

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Phone: 707-541-7000
info@vidaproducts.com

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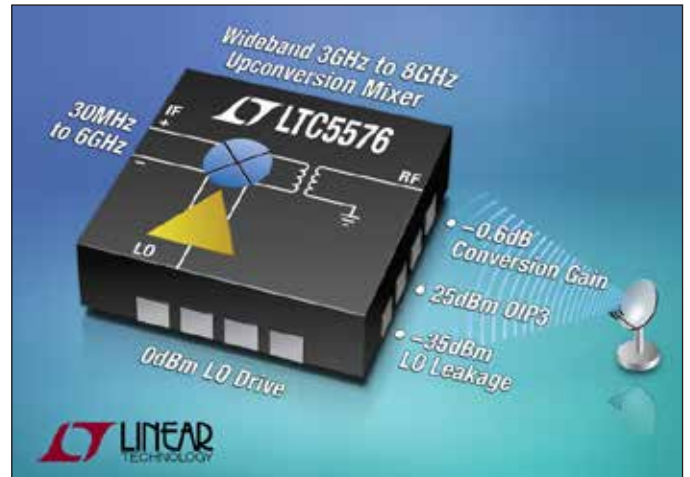
► Product Highlights



Broadband RF Amplifiers

Exodus Advanced Communications introduced two compact, high power SSPA modules covering the 2.0 to 18.0 GHz frequency range. AMP1016 covers 2.0 to 6.0 GHz with 35 W min CW, 50 W typ, output power at 28 VDC and 7 A max consumption. AMP1068 covers 6.0 to 18 GHz with 10 W min CW output power at 12 VDC and 11 A max consumption.

Exodus Advanced Communications
exoduscomm.com



Mixer

Linear Technology's LTC5576 is an active double balanced upconversion mixer with very wide RF frequency range, extending from 3 GHz to 8 GHz. It enhances microwave transmitter and upconversion performance with its exceptional linearity of 25 dBm OIP3 and outstanding conversion loss of only 2 dB at 8GHz, providing superior output signal quality compared to alternative passive mixers.

Linear Technology
linear.com

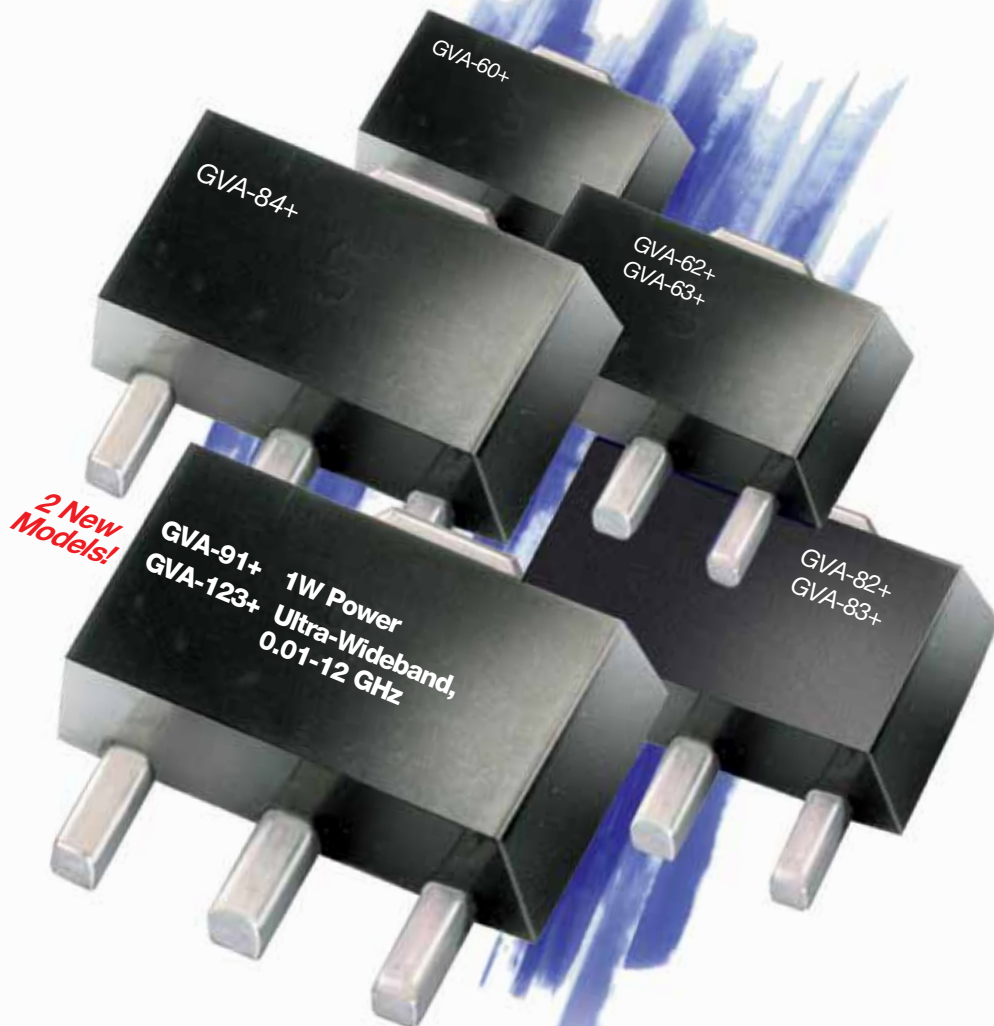


Cable Customizer

Pasternack Enterprises released the Cable Assembly Designer, which allows the user to design and customize RF cable assemblies with an easy-to-use online web application. It enables engineers and buyers to create assemblies from any combination of compatible connec-

tors and cables offered by the company, with over 250,000 possible combinations.

Pasternack
pasternack.com



GVA AMPLIFIERS

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various combinations of gain, P1dB, IP3, and noise figure to fit your application. Based on high-performance InGaP HBT technology, these amplifiers are unconditionally stable and designed for a single 5V supply in tiny SOT-89 packages. All models are in stock for immediate delivery! Visit minicircuits.com for detailed specs, performance data, export info, **free X-parameters**, and everything you need to choose your GVA today!

US patent 6,943,629

*Low frequency cut-off determined by coupling cap.
For GVA-60+, GVA-62+, GVA-63+, and GVA-123+ low cut off at 10 MHz.
For GVA-91+, low cut off at 869 MHz.

NOTE: GVA-62+ may be used as a replacement for RFMD SBB-4089Z
GVA-63+ may be used as a replacement for RFMD SBB-5089Z
See model datasheets for details

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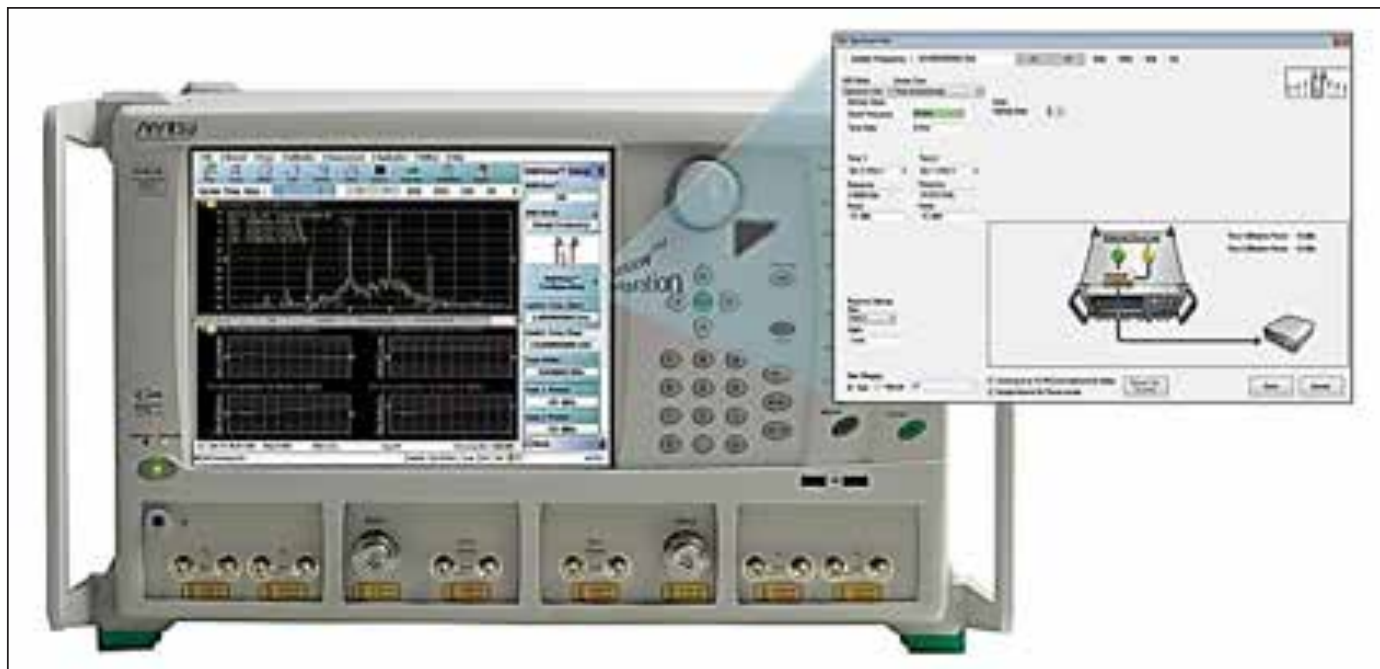


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458 rev P



VNA Family Features IMD Options

Anritsu Company introduced Intermodulation Distortion (IMD) options for its VectorStar® platform that expand the measurement capability of the VNA family to meet the needs of design and production engineers who must conduct highly accurate and efficient IMD measurements on their amplifier designs. Included in the enhancements is the new IMDView software that creates an advanced, easy to use graphical user interface (GUI) that simplifies complex IMD measurements and allows for more thorough IMD evaluation.

An Internal RF Combiner/Switch option for VectorStar has also been introduced that provides single connection IMD measurements without the need to re-cable the measurement setup. This is an extremely useful capability, as it reduces setup and measurement time and improves overall accuracy by reducing concatenation errors of multiple calibrations and system setups.

IMDView provides a wide range of tools so engineers have greater confidence in their amplifier designs. Multiple channels and traces allow for the simultaneous display of IMD swept frequency and IMD CW performance under different operating conditions. IMDView also has a unique ability to modify key parameters while monitoring the effects, so engineers can

quickly determine optimum performance capabilities without switching between configuration panels to view results. The software also tracks the frequency bands of interest, as well as the power levels required of the two tones. During power calibration, the software automatically switches the paths to provide calibrated tones at the DUT input.

IMDView can be used with the VectorStar ME7838x broadband system to establish an easy to configure accurate mmWave IMD measurement solution that dramatically reduces setup and calibration time. With the enhancements, VectorStar is the only

VNA platform that can offer engineers three different IMD setups and the ability to upgrade to any of the configurations.

Anritsu Company
anritsu.com

“IMDView provides a wide range of tools so engineers have greater confidence in their amplifier designs.”

► Product Highlights



SATCOM Subassemblies

TRAK Microwave announced several new aerospace and SATCOM communication system subassemblies and precision network timing products. These new products demonstrate the latest size, weight, and performance (SWaP) requirements for integrated multi-function assemblies and synchronization in both civilian and military communications.

TRAK Microwave
trak.com



Synthesizer, Oscillator Website

Micro Lambda Wireless launched a revamped, comprehensive, and user-friendly website featuring detailed product sections for its lines of oscillators, filters, synthesizers, multipliers, and test instruments. All company model numbers are showcased and include relevant specifications such as frequency range, output power, phase noise, harmonic rejection, package size, and much more.

Micro Lambda Wireless
microlambdawireless.com



Online Service Center

MECA Electronics announced an expedited online service center, RF Components on Demand (RFPOD). RFPOD offers an expedited online service that processes your order and has it available for pickup at will call or shipment within 2 hours from order placement. Will call

pick up hours are 9 a.m. to 5 p.m. (ET), with earlier hours available by calling customer service in advance @ (973) 625-0661.

MECA Electronics
e-meca.com

PRODUCTS TO SOLUTIONS

MMW Amplifiers

Ducommun has more than 45 years of experience with the design, testing and manufacturing of standard and custom millimeter wave amplifiers.



- High Power, Single DC power supply/ internal sequential biasing



32 to 36 GHz Power Amplifier

- AHP-34043530-01
- Gain: 30 dB (Min)
- Gain Flatness: +/-2.0 dB (Max)
- P-1dB: 34 dBm (Typ), 33 dBm (Min)

- Broadband, Low noise with high gain



26.5 to 40.0 GHz Low Noise Amplifier

- ALN-33144030-01
- Gain: 30 dB (Min)
- Gain Flatness: +/-1.0 dB across the band
- Noise Figure: 4.0 dB (Typ)

For additional information, contact our sales team at 310.513.7256 or rfsales@ducommun.com

CONTACT US

► Product Highlights



LDMOS Transistor

Freescale Semiconductor introduced the MRF8VP13350N 50 V RF power LDMOS transistor, designed to deliver high RF output power in ISM applications. These range from industrial heating and material welding at 915 MHz to particle accelerators at 1300 MHz. Particle accelerators are used for nuclear physics experiments and chemicals crystallography, or for proton therapy in cancer treatments.

Freescale Semiconductor
freescale.com



Power Splitter

Mini-Circuits' SYPS-3-142W+ is a 3 Way-0°, 50Ω, 5 to 1450 MHz power splitter/combiner. Features: low insertion loss 1.5, dB typ. at midband; wide frequency band, 5 to 1450 MHz; low amplitude unbalance, 0.3 dB typ. Applications: VHF/UHF CATV; cellular; GPS; satellite distribution.

Mini-Circuits
minicircuits.com

► Product Highlights



Receive Modules

Skyworks introduced eight low noise, variable gain receive modules for LTE and WCDMA infrastructure applications requiring low noise and high linearity. The SKY65369-11, SKY65370-11, SKY65371-11, SKY65372-11, SKY65373-11, SKY65374-11, SKY65375-11, and SKY65376-11, are low noise, highly linear VGA modules that operate in the 700 to 2600 MHz range and feature very low return loss.

Skyworks
skyworksinc.com



LNA

The APT3-00500600-1010-D4 is ultra-wideband LNA with super-low noise figure (<1.0 dB, 0.8 dB typical), low VSWR, and low flatness across the entire 0.1 to 6 GHz band for use in many applications where lowest NF, VSWR and linearity are required. The high performance is an example of AmpliTech's industry-leading low-noise design and technology.

AmpliTech
amplitechinc.com

PRODUCTS TO SOLUTIONS

RF Products

Ducommun has more than 45 years of experience with the design, testing and manufacturing of coaxial switches and integrated systems.



Coaxial Switch

- 400 MHz to 8 GHz
- Low Insertion Loss
- High isolation
- For use in all Thermal Vacuum Chambers



Manually Controlled

- DC to 18 GHz
- Available in SPDT, DPDT, Multi-throw
- Great for lab testing



Ultra Broadband

- SPDT to SP8T
- Isolation:
 - i. Reflective: 25dB min
 - ii. Absorptive: 40dB min
- Complete solid state solution
- 0.05 MHz to 67 GHz



For additional information, contact our sales team at 310.513.7256 or rfsales@ducommun.com

CONTACT US

Get info at www.HFeLink.com

► Product Highlights



True RMS Average Power Sensor

The new LB5918A is a state of the art high accuracy, high sensitivity True RMS Average power sensor that offers full functionality while not connected to a computer or power meter. The sensor is capable of logging up to 1,000 measurements per second and can store over 50 million measurements in nonvolatile memory with its easy to use Unattended Operation feature.

LadyBug Technologies
ladybug-tech.com



BERT

Anritsu introduced the MP1861A 56/64 Gbit/s MUX and MP1862A 56/64 Gbit/s DEMUX for its MP1800A BERT Signal Quality Analyzer to support 56/64 Gbit/s BER measurements required by signal integrity engineers to accurately evaluate high-speed serial transmission devices. The solution supports generation of NRZ data and BER measurements up to 64.2 Gbit/s, as well as jitter tolerance and bathtub jitter measurements.

Anritsu
anritsu.com



Amplifier

Amplifier model A2640205010A operates from 26 to 40 GHz and is matched for low VSWR. It has gain of 20 dB with max gain variation of ± 2.5 dB, noise figure of 5 dB, P1dB output of +10 dBm, and current draw of 180 mA at +12V bias. It comes in a hermetically sealed package

with removable connectors for drop-in assembly. Designed for both military and commercial applications.

Herotek
herotek.com

► Product Highlights



SDSI Instrument

RADX® Technologies highlighted the technology insertion capabilities of the LibertyGT® family of Modular, COTS, Multifunction Software Defined Synthetic Instruments (SDSI®) at IEEE IMS2015 by demonstrating the insertion of a National Instruments® PXIe-5668R 26.5 GHz Vector Signal Analyzer into a RADX LibertyGT 1211B (LGT1211B), effectively extending the system's upper measurement frequency range from 6 GHz to 26.5 GHz, with no impact on user developed Test Program Sets (TPS) or other user applications.

RADX Technologies
radxtech.com



Transceiver Module

Saelig Company introduced the STD-503, a 2.4 GHz radio transceiver module, designed to facilitate the simple embedding of wireless capabilities in industrial remote control equipment. This compact radio transceiver module was specifically developed for industrial applications that must have stable and reliable communication for up to 300 yards with battery operation.

Saelig Company
saelig.com



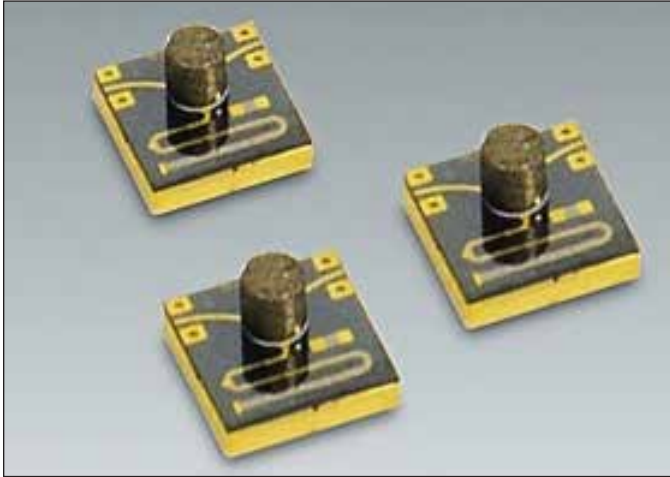
Downconverter

Model SSR-7530630580-12-M1 is an integrated E-Band block quadrature downconverter covering the frequency range of 72 to 78 GHz. It is designed and fabricated for automotive and broadband FMCW radar applications. Due to the built-in X6 active multiplier, the

required LO frequency and power are 12 to 13 GHz and +11 dBm.

SAGE Millimeter
sagemillimeter.com

► Product Highlights



Isolators

TRAK Microwave announced two microstrip isolators covering popular mm-wave frequency bands. Models T001110 (29.6-30.6 GHz) and T001111 (34.5-35.5GHz) integrate ferrite circulator/isolator substrates on to printed circuit board (PCB) material providing for a high performance, economical solution. Typical insertion loss is 0.8 dB, return loss 20 dB, and isolation of 20dB.

TRAK Microwave
trak.com



Waveguide Circulator

Model F3800-2225-38 is a full band WR42 waveguide circulator covering 18.0 GHz to 26.5 GHz frequency range with 0.5 dB maximum insertion loss, 19.0 dB minimum reverse isolation, 1.25:1 VSWR at input and output, and can handle 25 Watts of CW power. The RF ports are designed to match to UG-595/U waveguide flanges.

Wenteq Microwave
wenteq.com



Linear Amplifier

Comtech PST announced the release of a solid state Class "AB" linear amplifier which operates over the full 2 to 18 GHz frequency in two (2) bands. Two inputs and two outputs allows for simultaneous operation. The amplifier uses the latest Gallium Nitride (GaN) technology and is

packaged in a standard rack mountable enclosure measuring 19" x 22" x 3.5".

Comtech PST
comtechpst.com

Product Highlights



Power Meter

The 4530 series RF Peak Power Meter can make Peak, CW Power and RF Voltage measurements at high speed from 10 Hz to 40 GHz. Features: Frequency Range: 10 Hz to 40 GHz; Dynamic Range: Peak Power >60 dB CW Power -90 dB; Synchronous/Asynchronous Triggering; Dual-channel statistical measurements (CDF/PDF); Modulation bandwidth to 20 MHz; GPIB - SCPI / RS232 commands.

Boonton
boonton.com



Power Divider

For high power S-band space qualified applications, REC has designed a 50 W 2-channel power divider that has low loss and high isolation. The design uses NASA compliant low outgassing materials with a housing/cover that can be laser welded for a truly hermetic seal.

Renaissance Electronics
rec-usa.com

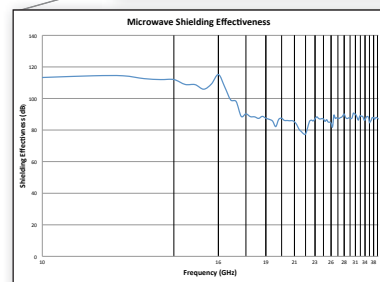
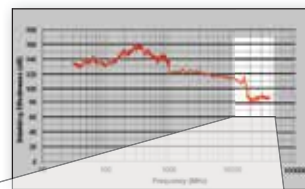
PROTECT Ka BAND COMMUNICATIONS AND DATA WITH THE Ka SHIELD™

Provides certified protection up to 40GHz!

The Ka Band is hot! New **Ka Shield rack enclosures** provide serious protection for EMI/RFI signal intrusions or leakage with sensitive equipment from RF to the microwave Ka Band. With shielding effectiveness of over 75 dB at 40 GHz, the enclosure provides an essential defense against EMP weapons and geomagnetic storms that can "take out" communication centers, power plants, μ P-controlled infrastructure, surveillance systems and more.

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Get info at www.HFeLink.com

► Product Highlights



DLVA

PMI Model No. GMDA-D1007 is an Extended Dynamic Range DLVA designed to operate over the 0.5 to 2.0 GHz frequency range. It employs planar diode detectors and integrated video circuitry for high speed performance and outstanding reliability. It is of superior construction using state of the art MIC/MMIC technology.

Planar Monolithics Industries
pmi-rf.com



Catalog

MECA released its latest publications, Catalog (Issue 10) & mmWave Supplement (Issue 1). Includes the company's latest Low PIM & DAS equipment and components from 20 MHz to 40 GHz. Since 1961 MECA Electronics has served the RF/Microwave industry with equipment and passive components covering Hz to 40 GHz. MECA is a privately-held ISO9001:2008 Certified, global designer and manufacturer for the communications industry with products manufactured in the USA.

MECA Electronics
e-meca.com



Directional Coupler

KRYTAR continued the expansion of its growing line of directional couplers with a new model offering 6 dB of coupling over the frequency range of 2.0 to 20.0 GHz, in a single, compact and lightweight package. KRYTAR's latest addition enhances the selection of multi-purpose,

stripline designs that exhibit excellent coupling over a broadband frequency range of 2.0 to 20.0 GHz.

KRYTAR
krytar.com

► Product Highlights



TWTA

The Model 187Ka TWT Amplifier has been specifically designed to operate pulsed traveling wave tubes up to 200 watts peak power at frequencies in the 34 - 36 GHz range. Grid pulse performance provides flat topped RF pulses from 50 ns to 100 μ s, up to 50% duty cycle, with rise and fall times of less than 15 ns, and PRF up to 100 kHz. Computer control interfaces available are IEEE-488, RS-232/422 and Ethernet.

Applied Systems Engineering
aplsys.com



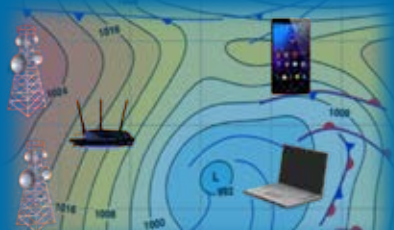
Bi-Directional Amp

NuWaves Engineering announced a new linear bidirectional amplifier (BDA) for OFDM radios. The NuPower Xtender™ 12E06A model is a broadband, small, lightweight and cost-effective solution for high-performance S-band Orthogonal Frequency Division Multiplexing (OFDM) transceivers with Mobile Ad hoc Networking (MANET) and/or Multiple-Input and Multiple-Output (MIMO) technology.

NuWaves Engineering
nuwaves.com

Wideband Wireless MIMO Connectivity

Testing wideband MIMO applications requires controllable, wideband connectivity with the right phase-amplitude characteristics



Azimuth's solution provides:

- Wideband channel over a wide frequency range
- RF path with controllable attenuation
- 4x4 connection with Butler phase-amplitude



LTE-U/LAA COTS Applications

- Fully controllable RF path loss
- 700 MHz - 6 GHz
- 400 MHz plus bandwidth
- Full rank MIMO support (up to 4x4)
- Exceptional isolation

**Comprehensively Test
802.11ac, LTE-U/LAA
and other wideband
MIMO applications**

Azimuth.
www.azimuthsystems.com

Get info at www.HFeLink.com



FPGA Processing Card Speeds Envelope Tracking

Keysight Technologies announced the M9451A PXIe Measurement Accelerator, a high performance FPGA processing card, which speeds envelope tracking (ET), and digital pre-distortion (DPD) characterization for power amplifier test. With the M9451A, engineers can make closed/open loop DPD and envelope tracking measurements in tens of milliseconds for up to a 100 times speed improvement.

The M9451A is now integrated with the RF PA/FEM Characterization and Test, Reference Solution, to provide even higher throughput while maintaining highly accurate S-parameter, harmonic distortion, power and demodulation measurements. The Reference Solution enables full characterization of next-generation power amplifier modules, such as a power amplifier-duplexer (PAD).

The robust DPD algorithms in the Reference Solution came from years of close cooperation with wireless manufacturing customers and insights gained from Keysight's SystemVue simulation and N7614B Signal Studio for Power Amplifier Test software applications. This makes it the only solution capable of providing consistent measurements, from simulation to manufacturing, for next-generation power amplifier modules.

"We continue to make enhancements to our power amplifier Reference Solution to provide our customers unrivaled technology and test performance," said Mario Narduzzi, marketing manager of Keysight's Software and Modular Solutions Division. "The M9451A shows what is possible when you combine the measurement expertise of Keysight, with the high speed data handling of PXIe, and state of the art commercially available FPGAs."

The Reference Solution's open source test scripting example code facilitates rapid evaluation of power amplifier test configurations and reduces time to first measurement. With this new capability, engineers can improve device performance with DPD and ET while also reducing test time.

Keysight's PXI and AXIe modular products and Reference Solutions benefit from the company's trusted measurement science and calibration expertise. This allows customers to count on consistent measurement results, from R&D through production, and realize accelerated design cycle time.

Keysight Technologies
keysight.com

Product Highlights



Triple-Band Antenna

Radio Frequency Systems introduced APXVBLL20X-C and APXVBLL20X-C-I20 models of its popular RF X-TREME™ Triple-Band Antenna. The newest additions to RFS's family of ultra-broadband antennas facilitate triple-band site upgrades for reduced cell interference in high traffic areas. BLL RF X-TREME antennas can be used for multiple bands such as LTE 700, LTE 800, Digital Dividend 2, CDMA, GSM, DCS, UMTS and LTE 2.6.

Radio Frequency Systems
rfsworld.com



Spectrum Analysis Software

Signal Hound updated its free Spike™ Spectrum Analysis software by creating a variety of digital modulation analysis tools for its BB60C and BB60A USB-powered real-time spectrum analyzers. Spike software version 3.0.8 now provides constellation diagrams, symbol tables, error-vector magnitude (EVM) measurements, and bit pattern matching analysis tools for a wide range of modulation types.

Signal Hound
signalhound.com



RF & Microwave Transistors For Commercial and Military Applications

- ✓ PHEMT for high power efficiency
- ✓ MESFET for low-phase noise
- ✓ LNA PHEMT for very low noise figure

All parts below are available as bare-die. * Marks devices also available in a SMT package.

DRIVER PHEMT	P _{1dB} (dBm)	GAIN (dB)	I _{dss} (mA)	NF (dB)	FREQ. (GHz)	V _{ds} (V)
BCP018B*	23.0	14.5	65	0.9	DC - 26	8
BCP020B	22.5	14.0	60	0.8	DC - 26	8
BCP025B*	23.5	14.0	90	1.10	DC - 26	8
BCP030B	25.0	13.0	90	1.0	DC - 26	8
BCP040B	25.5	13.0	120	1.03	DC - 26	8
BCP060B	27.5	12.0	180	1.05	DC - 26	8

POWER PHEMT	P _{1dB} (dBm)	GAIN (dB)	I _{dss} (mA)	PAE (%)	FREQ. (GHz)	V _{ds} (V)
BCP075B	28.0	12.5	270	60	DC - 26	8
BCP080B	29.0	11.0	240	60	DC - 26	8
BCP105B	30.3	10.0	380	55	DC - 26	8
BCP120B	31.0	11.0	320	54	DC - 26	8
BCP150B	31.5	10.5	540	60	DC - 26	8
BCP160B	31.5	10.5	440	55	DC - 26	8
BCP240B	33.0	10.0	700	47	DC - 26	8

DRIVER MESFET	P _{1dB} (dBm)	GAIN (dB)	I _{dss} (mA)	NF (dB)	FREQ. (GHz)	V _{ds} (V)
BCF020T	20.0	13.5	60	1.1	DC - 26	8
BCF030T	21.5	13.5	90	1.45	DC - 26	8
BCF040T	23.0	13.0	120	1.65	DC - 26	8
BCF060T	25.0	12.5	170	1.85	DC - 26	8

POWER MESFET	P _{1dB} (dBm)	GAIN (dB)	I _{dss} (mA)	PAE (%)	FREQ. (GHz)	V _{ds} (V)
BCF080T	26.0	11.2	240	27	DC - 26	8
BCF120T	28.0	11.2	340	31	DC - 26	8
BCF240T	30.4	9.8	720	26.7	DC - 26	8

LNA PHEMT	NF (dB)	G _a (dB)	FREQ. (GHz)	P _{1dB} (dBm)	GATE (μm)	V _{ds} (V)
BCP016B	0.40	13.5	DC - 40	14.5	0.15x160	2

Specifications are typical at 12 GHz

Get info at www.HfeLink.com

► Product Highlights



Signal Generators

Vaunix Technology's LSG and LMS series of Lab Brick Signal Generators provide all the signal-generating capability of a full-sized test signal source without the need for cumbersome rack equipment. Together they cover frequency ranges from 20 MHz – 20 GHz, with high output levels and excellent spectral purity. The LDA series of Lab Brick Digital Attenuators boast 120 dB of programmable attenuation through 6 GHz.

Vaunix Technology
vaunix.com



VNAs

Copper Mountain Technologies (CMT) introduced a new series of high-performance vector network analyzers (VNAs) designed to efficiently handle advanced test applications. The Cobalt series, which presently features the C1220 and C1209 models, offers an unmatched price-performance combination for S parameter measurement between 100 kHz and 20 GHz.

Copper Mountain Technologies
coppermountaintech.com



Test System


Eastern OptX introduced the Series 8000, a test system that addresses the need to test multiple RF radios or wireless systems over different propagation paths, simultaneously. Radio signals are affected by many things—by impairments in their path and items they must pass through. The Series 8000 is a multi-channel, bi-directional radio path replicator that allows full duplex operation for two or more radios over varying propagation paths and RF frequencies.

Eastern OptX
eastern-optx.com

RF Amplifiers, Isolators and Circulators from 20MHz to 50GHz

- Super low noise RF amplifiers
- Broadband low noise amplifiers
- Input PIN diode protected low noise amplifiers
- General purpose gain block amplifiers
- High power RF amplifiers and broadband power amplifiers





- RF isolators and circulators
- High power coaxial and waveguide terminations
- High power coaxial attenuators
- PIN diode power limiters
- Active up and down converters

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 Email: sales@wentek.com, Website: www.wentek.com

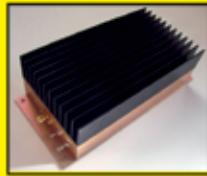
Product Showcase

RF Bay, Inc.



10GHz Divide-by 13 Prescaler

- Low Noise Amplifier
- Power Amplifier
- Frequency Divider
- Frequency Doubler
- Frequency Mixer



850-950MHz 10W Power Amplifier

- Voltage Control Oscillator
- Phase Locked Oscillator
- Up/Down Converter
- RF Power Detector
- RF Switches



100kHz - 10GHz RF Amplifier

RF Bay, Inc.

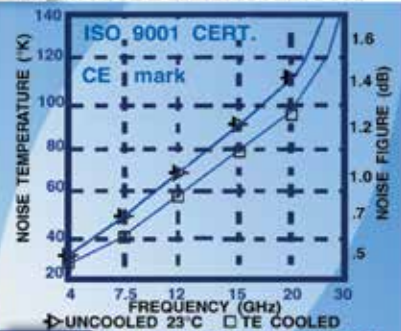
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www.astswitch.com

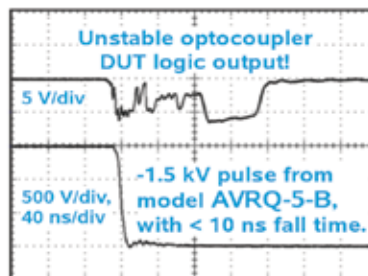


When only the best will do

Transient Immunity Testers from AVTECH

The Avtech AVRQ series of high-voltage, high-speed pulse generators is ideal for testing the common-mode transient immunity (CMTI) of next-generation optocouplers, isolated gate drivers, and other semiconductors.

- Kilovolt amplitudes (± 1 , ± 1.5 , -2 kV)
- Transition times down to 10 ns, dV/dt rates up to 120 kV/us
- Switchable daughterboards to handle a variety of DUT package styles
- GPIB, RS-232 ports standard
- Ethernet / VXI optional



Prices, manuals, datasheets & test results:

<http://www.avtechpulse.com/semiconductor>
Info@avtechpulse.com



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► Product Highlights



Circulators

RFMW announced support for RF Circulator Isolator, Inc.'s family of broadband, octave and Octave Plus drop-in circulators. Spanning 800 MHz to 18 GHz in multiple broadband models, the portfolio offers solutions to broadband applications that previously required a coaxial connected product. The RFCR8934 protects active components from distortion or potentially damaging reflected power from 8 to 18 GHz with 250 W peak/25W average forward power handling.

RFMW
rfmw.com



RF Tester

The MT8821C Radio Communication Analyzer is an all-in-one RF tester with the widest capability for supporting LTE-Advanced (LTE-A), as well as all other adopted technologies. Combining simplicity, efficiency, and accuracy in a single instrument, it can lower the cost of test and speed time to market. A single system will perform LTE-Advanced Carrier Aggregation (CA) with up to four Component Carriers (CCs) using 2 x 2 MIMO, as well as two Component Carrier aggregation (2CCs) in the uplink.

Anritsu
anritsu.com



Switches

Ampical announced a new family of competitively priced, high-performance broadband coaxial PIN diode switches featuring low insertion loss, low VSWR, high isolation, and fast switching speed. Standard configurations range from single-pole, single-throw (SPST) through single-pole, six-throw (SP6T), single-pole eight-throw

(SP8T) and single-pole, twelve-throw (SP12T). All are available with either absorptive or reflective inputs in many broadband frequency ranges.

Ampical
ampical.com

► Product Highlights



Frequency Synthesizers

Micro Lambda Wireless's MLSP-Series of low-noise frequency synthesizers cover up to 33 GHz. Standard models include MLSP-1829 covering 18 to 29 GHz and MLSP-2333 covering 23 to 33 GHz. Step sizes are programmable from 1 kHz and up using 5 wire SPI or standard USB control. Units are available with internal crystal reference, external crystal reference or both. Output power levels of +13 dBm are provided.

Micro Lambda Wireless
microlambdawireless.com



Connectors

SGMC Microwave's 1.0 mm series are precision grade connectors designed for microwave applications requiring excellent performance up to 110 GHz. Optimum results are achieved with the use of a 1.0 mm outer conductor diameter and air dielectric. SGMC offers precision adapters, receptacles, and cable connectors for various semi-rigid and flexible coaxial cables. Special designs are available upon request.

SGMC Microwave
sgmcmicrowave.com



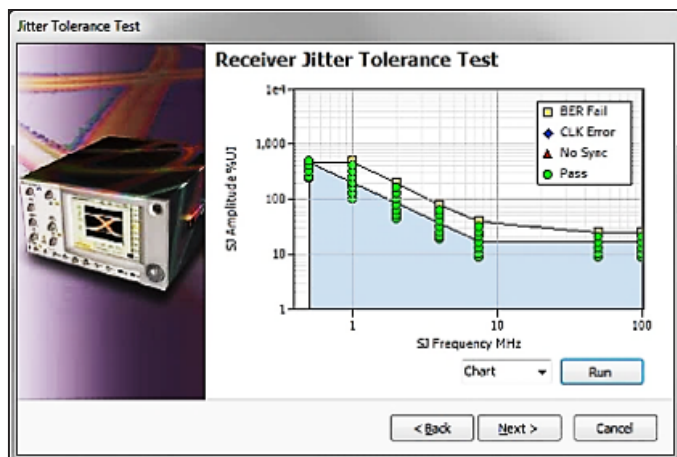
Test Set

Cobham AvComm, formerly Aeroflex AvComm business unit, announced new automated test and alignment support for Motorola APX Series and Motorola MOTOTRBO Series radios to its latest product; the 8800 Series Digital Radio Test Set. The application fully auto-

mates radio testing and alignment, and ensures optimum radio performance in significantly less time; minimizing service and support costs for the end users and dealers.

Cobham AvComm
aeroflex.com

► Product Highlights



Test Software

A new set of USB 3.1 compliance test solutions allows designers to quickly verify designs against the latest USB specs and achieve fast time to market while minimizing costs. The new release expands Tektronix's USB 3.1 and USB 2.0 test capabilities to include a new USB 3.1 receiver test solution supporting the 10 Gb/s data rate, a new USB Power Delivery test solution and a new USB Type-C cable test solution.

Tektronix
tektronix.com

► BOOK REVIEW

Analog Circuit Design

Volume 3 Design Note Collection

Edited by Bob Dobkin and John Hamburger

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Analog Circuit Design, Volume 3, Design Note Collection brings Linear Technology's *Design Notes* into one volume. The first *Design Notes* were published over 25 years ago, with now over 500 available. The information in this collection helps new designers grasp a basic understanding and gives experienced designers a fundamental knowledge base for developing more complex designs. The publisher states that this book has two purposes: to speed designs by presenting finished examples, and to provide a teaching resource for designers.

Although full of useful design information, this is not a textbook. Also implied is that the designer will be using Linear Technology devices. However, the included information could be used to discern functional means to accomplish end designs and performance goals with other manufacturers' parts.

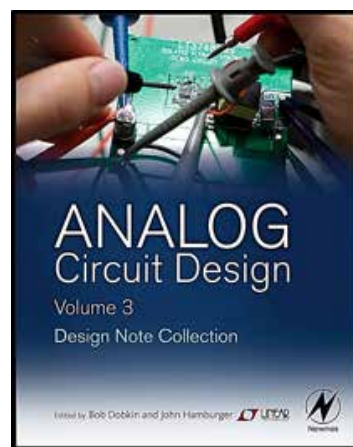
Of specific interest to many of our *HFE* readers are sections that cover a range of analog design topics, including data conversion, data acquisition, communications interface design, operational amplifier design techniques, active filter design, wireless/RF communications, and network design. The book also includes extensive power management sections, covering switching regulator design, linear regulator design, microprocessor power

design, battery management, powering LED lighting, automotive and industrial power design. LT is quite noted for their abilities in these technologies, also. These latter topics, some of which might be considered power supply/conditioning support circuitry for RF circuits, are often somewhat overlooked in other venues, particularly in the areas of circuit protection, overload margins and other fail proof techniques. Available free computer aided design (CAD) resources are also explained.

The book is well organized by topics, into Parts and Sections, and not chronologically according to the timeframe in which a given part was developed. Part 1 covers Power Management; Part 2 - Mixed Signal; Part 3 - Signal Conditioning; and finally Part 4 - Wireless, RF & Communications Design. Thus the designer can easily locate information on specific subjects. The Index is well done and very comprehensive.

The consistency of note formatting is commendable. Pertinent information including schematics, physical layout, photos, graphic data curves, circuit descriptions, performance specifications, tips and conclusions are remarkably well ordered and readable from note-to-note.

—Tom Perkins
Senior Technical Editor



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