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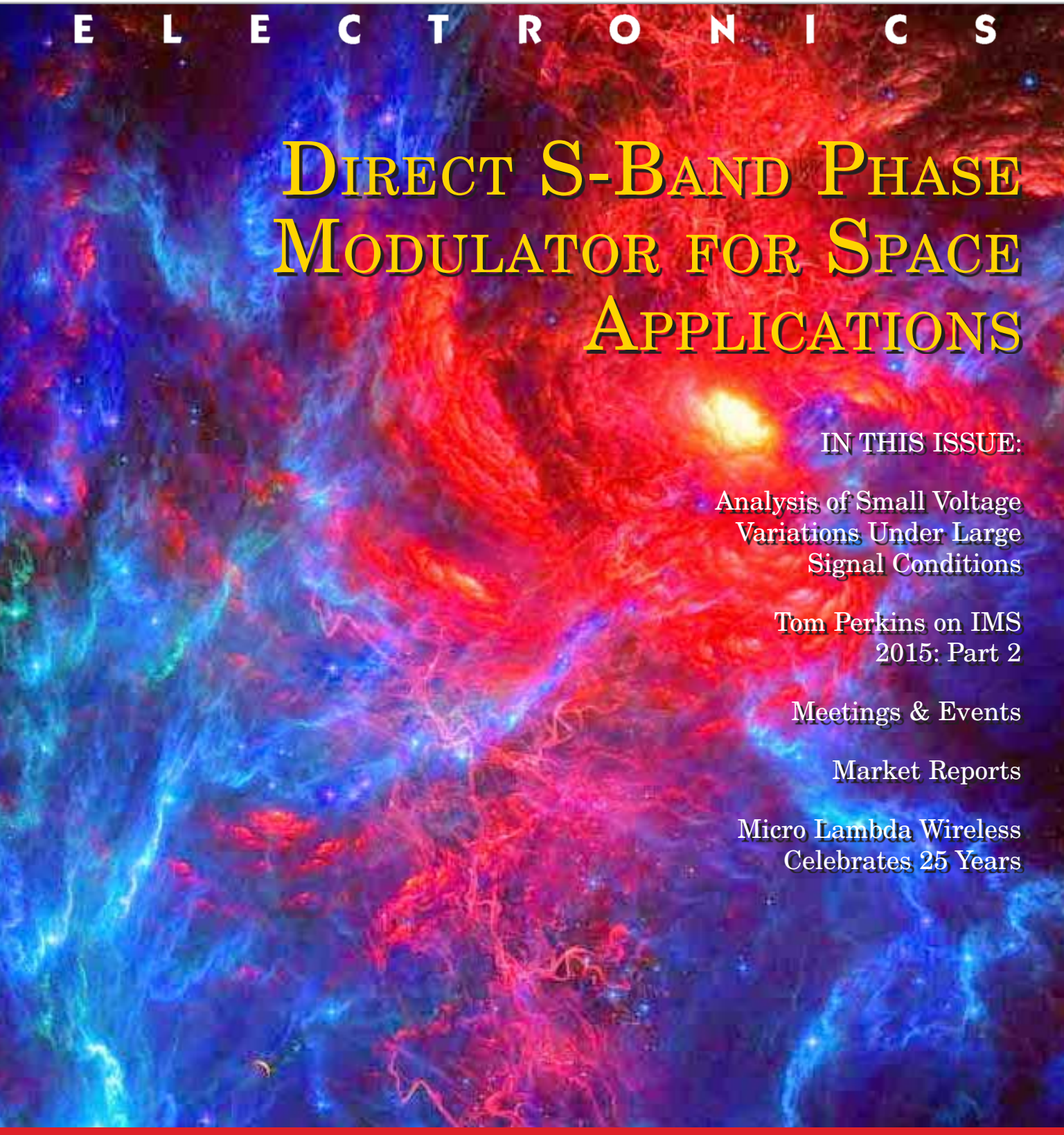

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SUMMIT Technical Media LLC

Editorial

Phoenix Comfortable (Part 2 of 2)

Tom Perkins
Senior Technical Editor

Last month I promised more on the May IEEE MTT-S Symposium. First, an update on attendance. According to a Weber Shandwick press release, the total attendance exceeded 8,600, from 56 countries. Twenty-three percent were first-time attendees. There was a record 904 exhibitor booths. Seventy-five technical sessions were held. Looking ahead to next year, fully 92 percent of the exhibit space for IMS 2016 in San Francisco is already sold.

Wearables

As mentioned last month, the intersection of health and RF and microwave technologies was a hot topic. An over-arching theme was "wearables." For example, flexible skin-like patches called Biostamps, described by John Rogers of the University of Illinois, will be able to keep track of *wellness.* These sensors, good for about a week of wear, will monitor body temperature, heartbeat rate, hydration, exposure to UV rays, blood oxygen, glucose levels, etc. A Biostamp may contain hundreds of transistors, as well as resistors, LEDs, and at least one antenna. Where high frequencies come into play is that the device powers itself from near-field communication radio signals—typically the wearer's cellphone, smartphone, or other wireless device. This energy harvesting along with data transfer may be via near-field communication (NFC) at 13.56 MHz. The Biostamp also may gather energy at longer distances using frequencies between 1 and 2.5 GHz.

Name Recognition and LoB

One general observation was that several companies, both old and new, have names which perhaps do not well describe their products or lines of business (LoB). With the recent proliferation of acquisitions and also certain obsolescence of older technology, some enterprises, that have traditional name recognition with one or two types of devices, now have a broad range of often newer products. It seems that they need to make a focused effort to adjust their identity, lest they be left out of some great opportunities. Some companies seem to be placing subtitles or captioning after their names to mitigate this issue. Others, while changing their name, have found clever ways to pull in their heritage, which can be important. Keysight's "Not Your Grandfather's HP" serves as a worthy example here.

Doherty Amplifiers

Peregrine Semiconductor announced the first product from the Monolithic Phase and Amplitude Controller (MPAC) product family consisting of a 90 degree hybrid splitter, two phase shifters, a digital step attenuator and a serial interface on a single die. This part is intended for phase-tuning flexibil-

ity for optimizing dual-path dynamically load-modulated architectures such as Doherty power amplifiers. Incidentally, there was a technical session led by Ed Niehenke and Jim Komiak that included Doherty Amplifiers that date back to 1936.

While on the subject of amplifiers: Northrop Grumman announced the highest power output GaN MMIC ever produced at Ka-band, with a peak power of 40W at 27 GHz.

Mergers and Acquisitions

Mergers and acquisition announcements are often reserved for, or around, the IMS. This year the acquisition of Freescale by Netherlands-based NXP in March was big news. Freescale had both a large display booth and also its 80-foot-long, 40-ton "Internet of Tomorrow" truck. The trailer displayed categories such as "Fitness Wearables and Medical," "Advanced Driving Systems," and "Smart Home, Buildings, Cities and Energy." Once parked, the trailer extends upwards with a second-floor meeting room and third-floor balcony. The segment of NXP displaying at IMS is apparently not part of the merger.

It was announced during IMS week that Cree would spin off its GaN products. Earlier this year Rogers Corporation, maker of microwave laminates, acquired Arlon. Due to IMS exhibition sign-up deadlines, Rogers therefore had two booths in Phoenix, one of which they cleverly used for one-on-one conferences.

Avago Technologies debuted a Miniature RFIC for Satellite Digital Audio Radio Service (SDARS) Car Radio Systems. They claim this industry-first highly integrated LNA-Filter module enables SDARS coexistence with cellular, WiFi, Bluetooth and GPS. Shortly after the symposium, Avago announced the acquisition of Broadcom for approximately $37 billion. Since 1999 Broadcom has itself acquired dozens of companies.

Faster Time to Market

A great deal of emphasis was placed on streamlining design and test processes to get reliable products to market faster. New multifunction instruments with incredibly powerful data storage are speeding up the test process. Low-cost USB-connected alternative test solutions continue to evolve for low-budget hardware developers. One defense-centric company appeared confident that "open system hardware" would enable faster time to market and enable seamless solutions.

IMS 2016

IMS 2016 is set for the week of May 22 to 27, 2016, in San Francisco.

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
http://www.radiowirelessweek.org/
Paper Submission Deadline: 27 July 2015

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Market Reports

RF Component Revenue in Wireless Backhaul Applications to Decline

While wireless backhaul radio quantities will grow slowly, price erosion will create a decline in RF component revenues in the segment. The Strategy Analytics Advanced Semiconductor Applications (ASA) spreadsheet model and Forecast and Outlook report, "Wireless Backhaul RF Component Demand: 2014 – 2019," forecasts **RF component revenues will experience a compound average growth rate of minus 2 percent over the forecast period.**

The report concludes:

Even though the quantity of wireless backhaul radios will grow and wireless will remain the backhaul method for more than 50 percent of the market, **fiber-based backhaul networks will capture market share.**

The need to accommodate rapidly increasing amounts of data consumption will push equipment manufacturers and operators to higher frequency bands. **The frequency bands at 60 GHz and above will see an annual growth rate of 33 percent, as enormous available bandwidth outweighs the design challenges of these higher frequencies.**

While this market is served primarily by GaAs devices, GaN revenue for power amplifiers will grow to $6 million in 2019.

Strategy Analytics' Eric Higham commented: "There is no question that backhaul has become a critical part of wireless network deployment and the rapid increase in wireless data consumption is forcing system designers to develop networks that provide options for future growth. This "future-proofing" is leading to fast growth in the higher frequency bands, but it is also creating much more interest in fiber-based front haul and the added capabilities which that architecture provides."

—Strategy Analytics
strategyanalytics.com

China Drives RF Power Amplifier Sales to Nearly US$5 Billion in 2014

The year 2014 was strong for wireless infrastructure hardware—especially RF power amplifiers—and **prospects look good for growth through 2020.** The Asia-Pacific region, including Japan, continues to account for the majority of RF power amplifiers that are sold into the mobile wireless infrastructure segment. According to ABI Research's Research Director Lance Wilson, **"For the foreseeable future the Asia-Pacific region, particularly China, will remain the most important region and focus for RF power amplifiers for wireless infrastructure."**

LTE and TD-LTE have become increasingly important factors in this business and will continue as the engines of growth for the future. "Although up until 2014, LTE had not significantly impacted RF power amplifier sales to the degree some would have wished," says Wilson, "that has changed now and as 2014 demonstrated, it is going to drive RF power sales in the wireless infrastructure space from 2015 onward." The continuing overall need for wireless data remains an important driver for the overall market for RF power amplifiers for wireless infrastructure.

ABI Research's report RF Power Amplifier Equipment for Cellular and Wireless Infrastructure examines quantitatively how RF power amplifiers are evolving to the changing topologies of modern basestations, remote radio heads, and active antennas. Quantitative forecasts are presented through 2020.

—ABI Research
abiresearch.com

Consolidation Gathers Pace in EMC Test Equipment and Services Market

The need for regulatory compliance across industries is imparting new momentum to the electromagnetic compatibility (EMC) testing equipment and services market in North America. Monitoring of radio frequency devices such as transmitters, receivers and industrial scientific medical equipment, as well as radiation and immunity testing requirements, stimulate adoption.

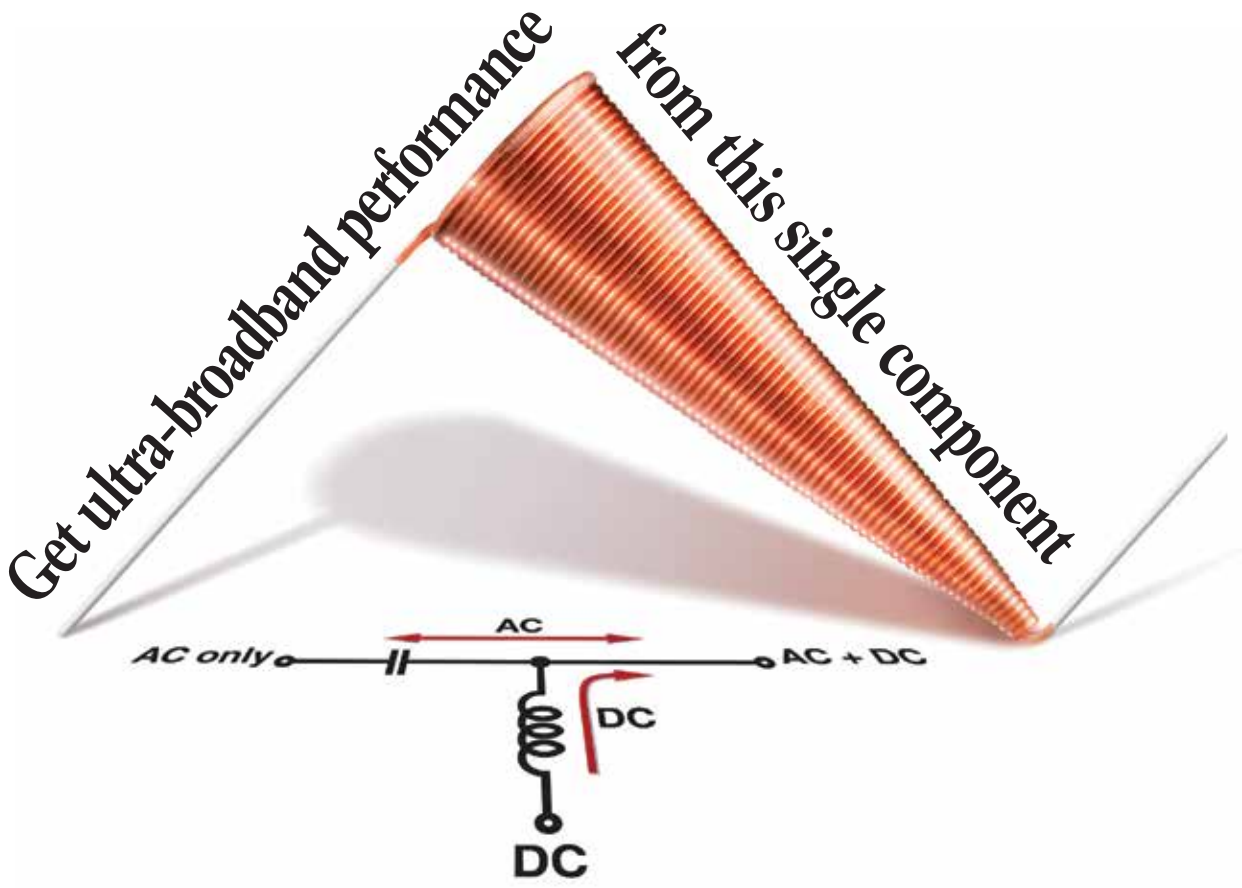
New analysis from Frost & Sullivan, EMC Test Equipment and Services Market in North America finds that the market earned **revenues of $453.4 million in 2014 and estimates this to reach $607.6 million in 2021.**

"The rising popularity of electric vehicles and smart grid systems will unlock substantial opportunities for EMC test equipment and service vendors in North America," said Frost & Sullivan Measurement and Instrumentation Research Analyst Janani Balasundar. **"The highest demand for EMC testing will stem from the dynamic wireless communication industry in the region."**

However, manufacturers are being forced to reduce the cost of testing in the price-sensitive market. The ensuing commoditization of EMC test services limits service providers from expanding their portfolio. On the other hand, expensive EMC test equipment restricts service providers from serving a broad range of industries.

Creating awareness among customers on the costs involved in performing a reliable EMC test that will help improve product performance and eradicate interference is vital to market success.

—Frost & Sullivan
frost.com



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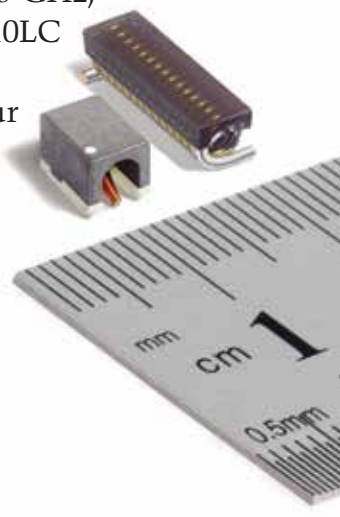

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In the News

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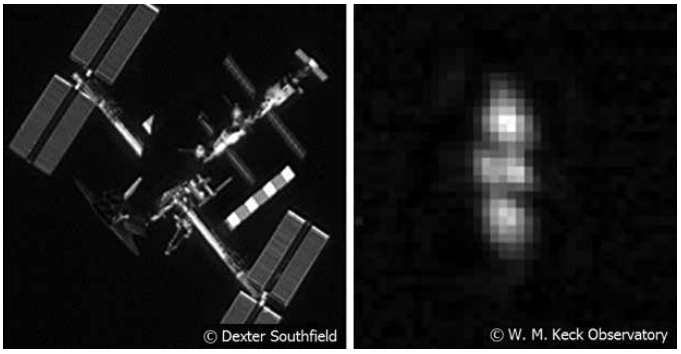

DARPA is seeking paths to high-res imaging of GEO objects.

DARPA's **High-Energy Liquid Laser Area Defense System (HELLADS)** has demonstrated sufficient laser power and beam quality to advance to a series of field tests. The achievement of government acceptance for field trials marks the end of the program's laboratory development phase and the beginning of a new and challenging set of tests against rockets, mortars, vehicles and surrogate surface-to-air missiles at **White Sands Missile Range, New Mexico**.

"The technical hurdles were daunting, but it is extremely gratifying to have produced a new type of solid-state laser with unprecedented power and beam quality for its size," said **Rich Bagnell**, DARPA program manager. "The HELLADS laser is now ready to be put to the test on the range against some of the toughest tactical threats our warfighters face."

Ground-based field testing of the HELLADS laser is expected to begin this summer as an effort jointly funded by DARPA and the Air Force Research Laboratory. Following the field-testing phase, the goal is to make the system available to the military Services for further refinement, testing or transition to operational use.

The HELLADS program has been developing an electrically driven solid state laser at greatly reduced size and weight over lasers of similar power for tactical use. The laser was developed by DARPA performer General Atomics.

* * *

Imaging of Earth from satellites in space has vastly improved in recent years. But the opposite challenge—**using Earth-based systems to find, track and provide detailed characterization of satellites** and other objects in high orbits—has frustrated engineers even as the need for space domain awareness has grown. State-of-the-art imagery of objects in low Earth orbit (LEO), up to 2,000 km (1,200 miles) high, can achieve **resolution of 1 pixel for every 10 cm** today, providing relatively crisp details. But image resolution for objects in geosynchronous Earth orbit (GEO), a favorite parking place for space assets roughly 36,000 km (22,000 miles) high, drops to just 1 pixel for every 2 meters, meaning many GEO satellites appear as little more than fuzzy blobs when viewed from Earth. Enabling LEO-quality images of objects in GEO would greatly enhance the nation's ability to keep an eye on the military, civilian and commercial satellites on which society has come to depend, and to coordinate ground-based efforts to make repairs or correct malfunctions when they occur.

Achieving that goal will require radical technological advances because traditional or "monolithic" telescopes designed to provide high-resolution images of objects in GEO would be too physically and financially impractical to construct. For instance, achieving image resolution of 1 pixel to 10 cm for objects at GEO would require the equivalent of a primary imaging mirror 200 meters in diameter—longer than two football fields. To overcome these limitations and expedite the possible development of revolutionary benefits, DARPA has issued a **Request for Information (RFI) seeking specific technological information and innovative ideas demonstrating the potential for high-resolution imaging of GEO objects.**

The RFI envisions a ground-based system that would be a sparse-aperture interferometer, which instead of relying upon one primary imaging mirror would measure the interference patterns of light detected by multiple smaller telescopes, from which a composite image could be derived. The GEO-imaging interferometer would **rely on only passive (solar) illumination or thermal self-emission from imaged objects and could require the use of many telescopes, quite likely in a reconfigurable array**. Responses to the RFI may inform a potential future program.

* * *

NI (formerly AWR Corp.) announced that undergraduate students at the **University of Peradeniya (PDN)** in Sri Lanka **designed a unique multistage coupler using NI AWR Design Environment™ circuit design software**, specifically Microwave Office. The students designed and simulated a unique wideband coupler that

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improves directivity by increasing the number of stages of the coupled line coupler, resulting in improved bandwidth performance, directivity and phase compensation.

"I use NI AWR software extensively in the undergraduate projects I supervise," said **Dr. Aruna Gunawardena,** senior lecturer at PDN. "In particular, the wideband asymmetric coupler project was submitted as a paper at the IEEE International Conference on Industrial and Information Systems in December 2014 and won the second best paper award."

* * *

Cobham AvComm, formerly a division of Aeroflex and manufacturer of advanced test solutions for P25, DMR, dPMR™, NXDN™, TETRA and analog land mobile radio test solutions, is proud to announce the selection of **Nextec Global** as a Global Channel Partner for the USA, Latin America and other selected areas worldwide. "We are excited to be able to offer the Cobham 8800S Digital Radio Test Set, the 3920B Analog and Digital Radio Test Platform, the 3550R Portable Radio Test System, and other products to Nextec's existing customers. Their legacy of reliable service and support now can be provided to new Cobham AvComm customers worldwide," said **Bill Martin**, Vice President of Worldwide Sales and Customer Support for Cobham AvComm.

* * *

Crane Aerospace & Electronics was selected by Gulfstream Aerospace Corp. to supply its **ELDEC® Transformer Rectifier Units (TRU)** on the Gulfstream G500 and G600. Each aircraft will have five 250 Amp TRUs, which will provide DC bus power throughout the aircraft. Gulfstream previously selected the same TRU for use on the G650 aircraft providing commonality across all three aircraft models.

Ed Fuhr, Vice President, Power Solutions for Crane Aerospace & Electronics said, "We have a long-standing relationship with Gulfstream and are pleased to be working with them on the G500 and G600. We are excited to provide our lightweight and reliable TRUs on these new, advanced business jets."

Crane Aerospace & Electronics has been the world's leading supplier of Transformer Rectifier Units (TRUs) for commercial and business aircraft since the 1960s. The high-efficiency 250 A TRU offers 115V AC 3-phase current at 400Hz input, with 28V DC output power.

* * *

Raytheon Integrated Defense Systems presented **Mini-Circuits** its 4-Star Supplier Award for the fifth consecutive year, recognizing outstanding quality and service. The award was presented at Raytheon's Operational Excellence Supplier Conference, held at Gillette Stadium, Foxborough, Mass. Separately, Mini-Circuits announced the industry's widest selection of products specially designed and specified for **DOCSIS 3.1 compliant systems and equipment.** Its **catalog** for these applications features over 60 off-the-shelf models from passive devices to active components.

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FS725 Benchtop Rubidium Frequency Standard

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- **Built-in distribution amplifier (up to 22 outputs)**
- **1 pps input and output**
- **RS-232 computer interface**

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SRS rubidium frequency standards have excellent aging characteristics, extremely low phase noise and outstanding reliability.

The PRS10 component rubidium oscillator is designed for easy system integration. It has a 1 pps input for phase-locking to an external reference (like GPS) and provides 72 hour Stratum 1 level holdover.

The FS725 benchtop instrument is ideal for the metrology laboratory as well as the R&D facility – anywhere precision frequency is required. It generates 5 MHz and 10 MHz signals and has a built-in distribution amplifier with up to 22 outputs.

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Featured Products

GaN Amp

Comtech PST introduced a Gallium Nitride (GaN) amplifier for applications in the X-Band weather radar market. The AB linear design operates over the 9.3 - 9.5 GHz frequency range intended for use in radar applications. Features include options for control of phase and amplitude to allow for integration into high power systems utilizing conventional binary or phased array combining approaches for power levels of up to 10 kW.

Comtech PST
comtechpst.com

Power Divider

Marki Microwave introduced the first family of Wilkinson power dividers specifically designed for digital data. The PD-0426, PD-0440, PD-0450, and PD-0465 offer very low excess insertion loss (only 3 dB up to 65 GHz) combined with flat group delay and high isolation. These properties allow the power dividers to split data with less loss than resistive power dividers, especially into poorly matched loads.

Marki Microwave
markimicrowave.com

Multiplier

Model SFA-713863410-12KF-S1 is a 71GHz to 86GHz X4 active multiplier designed for E-Band communications and automotive radar applications. It converts 17.75 to 21.5 GHz/+5 dBm input signal to deliver 71 to 86 GHz frequency band with a typical +10 dBm output power. The spurious and harmonic suppressions are 60 dBc 20 dBc or better, respectively. It draws 250 mA current from a +8Vdc DC power supplier.

SAGE Millimeter
sagemillimeter.com

VCO Selection Guide

Z-Communications announced the release of a new Product Selection Guide. This short form catalog includes a wide variety of surface mount VCO (Voltage Controlled Oscillator) and (PLL) Phase Locked Loop Synthesizer modules ranging from 40 MHz to 15 GHz. Users can download an electronic version of the product guide in PDF format or contact the company for a hard copy version.

Z-Communications
zcomm.com

FEM

The SKY65709-81 is a Front-End Module (FEM) with an integrated Low Noise Amplifier (LNA) and prefilter designed for the BeiDou Satellite Navigation System/Global Positioning System/Global Navigation Satellite System (BDS/GPS/GNSS) receiver applications. The device provides high linearity, excellent gain, a high 1 dB Input Compression Point (IP1dB), and a superior Noise Figure (NF).

Skyworks Solutions
skyworksinc.com

Gain Blocks

Guerrilla RF announced a line of gain blocks that feature industry-leading linearity and outstanding saturated output power along with low noise. These internally matched devices enable a number of general-market designs including small cells, cellular repeaters, LTE/WCDMA linear driver amplifiers, high power saturated power amplifier (PA) drivers and other wireless infrastructure applications.

Guerrilla RF
guerrilla-rf.com

Power Amp

Model SBP-8138632520-1212-E1 is an E-band high power amplifier with a small signal gain of 25 dB and a P-1 dB of +20 dBm minimum in the frequency range of 81 GHz to 86 GHz. The DC power requirement for the amplifier is +6.0 to +12.0 Vdc/1,000 mA. The input and output port are inline configuration as shown in the photo with both WR-12 waveguides and UG387/U Flanges.

SAGE Millimeter
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The QM2010-10-20 RF Synthesizer Module is a low-cost, wideband 10 GHz to 20 GHz frequency syn-

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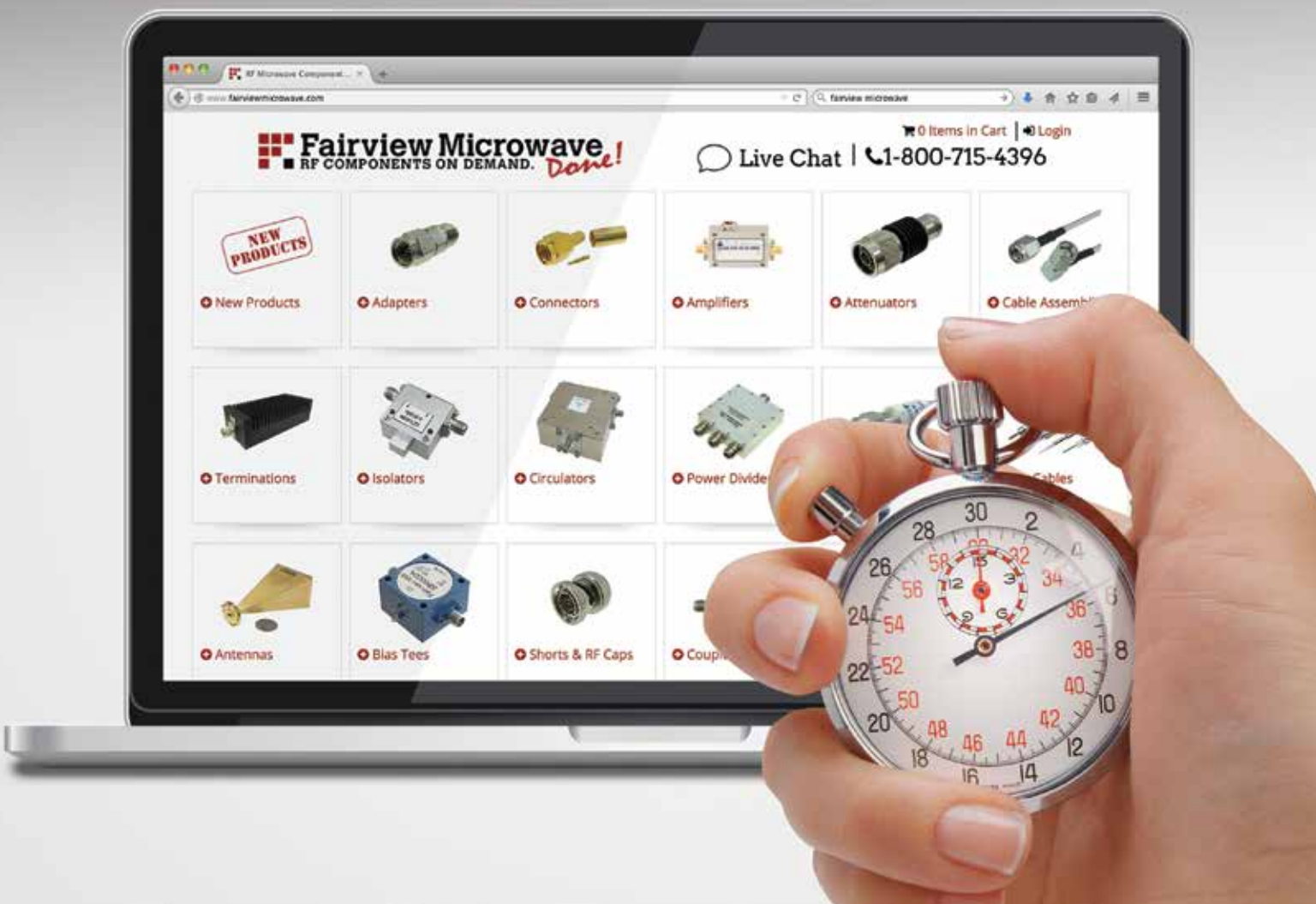

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Mini-Circuits
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NI AWR Design Environment

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NI (formerly AWR Corporation) announces the availability of the first major release in 2015 of NI AWR Design Environment™ for designers of monolithic microwave integrated circuits (MMICs), radio-frequency printed circuit boards (RF PCBs), modules and more. V12 was previewed for the first time at International Microwave Symposium 2015, creating significant interest, and feedback from early-access customers has been very positive.

NI
awrcorp.com

Power Divider

PMI MODEL APD-8-30M6G-SFF is a 30 MHz to 6.0 GHz amplified 8 way power divider module. It provides a nominal insertion loss of 6 dB with a typical flatness of ±1 dB over the operating frequency range. Over 36 dB of reverse isolation is provided with a typical noise figure of 6.5 dB and an input 1 dB compression of -2.5 dBm. Input and Output VSWR is less than 2.0:1 into 50 OHM impedance.

Planar Monolithics Industries
pmi-rf.com

Amplifier

Comtech PST announced a new Gallium Nitride (GaN) amplifier for X-Band applications. This class AB linear design operates over the full 9.0 - 10 GHz frequency range and is ideal for use in Phase Array Radar applications, as a TWT replacement or for a microwave communication link. It features phase and amplitude control, internal DC to DC converters and DC filtering, PA self-test and LED fault indications, unique waveguide coupling circuits, an internal isolator and digital control via a magic tee.

Comtech PST
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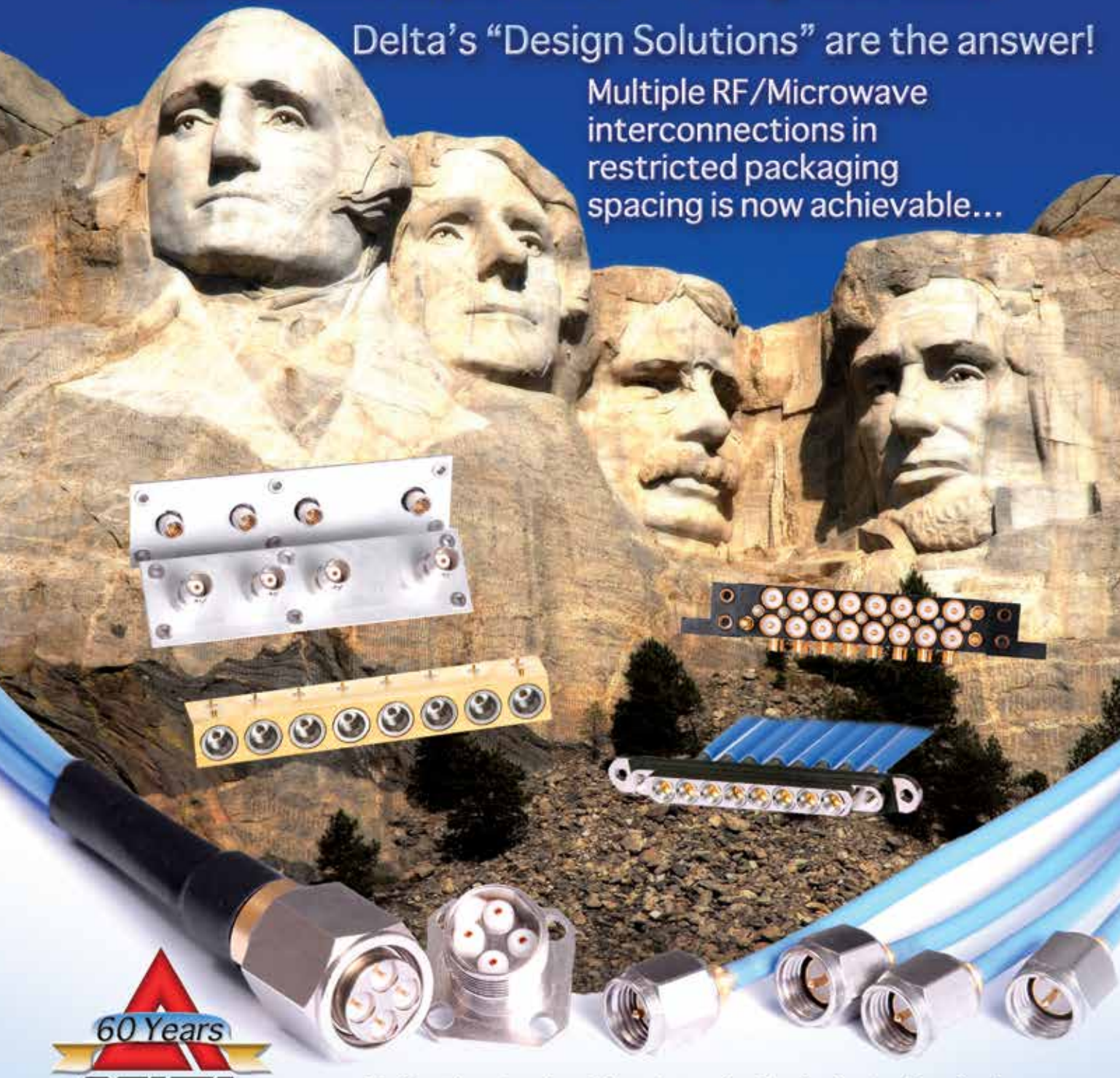

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VidaRF
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Skyworks through its subsidiary Trans-Tech announced webCRaFT, a new Web-based ceramic bandpass filter selection program. Customers can search for bandpass filter solutions by defining target performance criteria. Frequencies range from 300 to 5000 MHz and bandwidths from 2 to 25 percent. Filters outside of those boundaries are available upon request.

Skyworks Solutions
skyworksinc.com

App Note

This new app note provides solution examples for dealing with the challenges of DDR4/LPDDR4 device design, including increasing data rates and new systems not behaving as designed.

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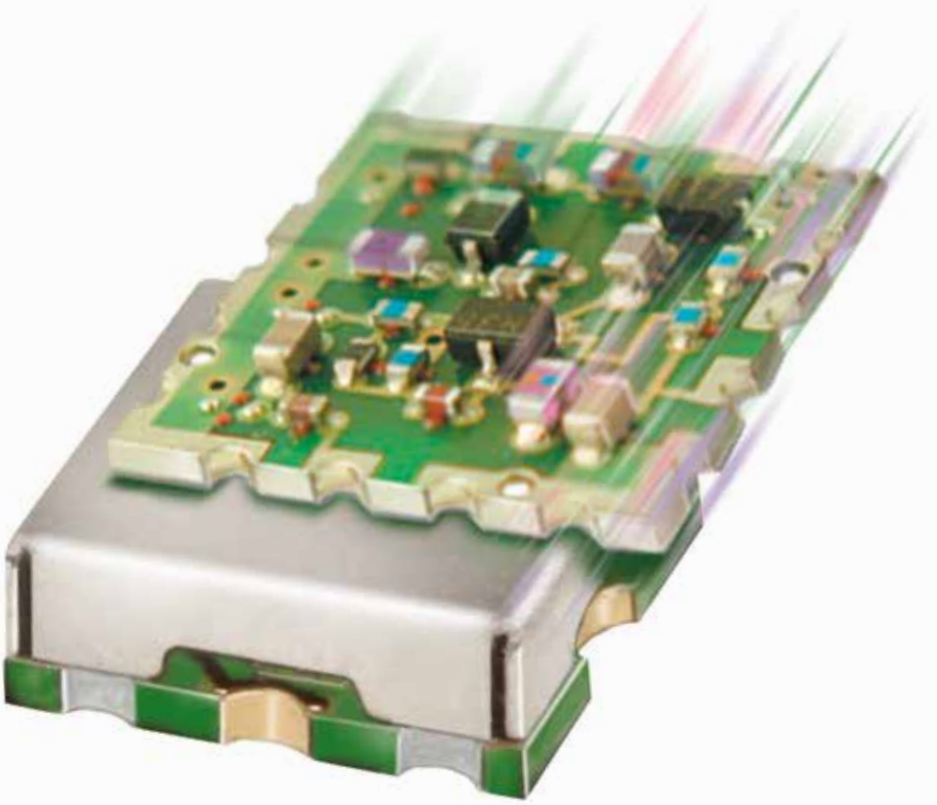

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Direct S-Band Phase Modulator for Space Applications

By D.V. Ramana, Sourabh Basu and Jolie. R

This paper describes the design, simulation and measured results of an S-band direct phase modulator. The phase modulator is realized based on the principle of a reflection modulator using 90° branch line hybrid couplers and varactor diodes. The diode is used in its linear region of operation based on simulations using ADS software. A tone processing circuit is also designed to generate appropriate bias to the modulator. The amplitude of the tone can be varied to tune the modulator for the desired modulation index. The circuits are fabricated, tested and qualified for space applications.

The design, simulation and measured results of an S-band direct phase modulator.

Introduction

A modulated microwave signal is required in almost every type of wireless application including space applications where the main concerns are the size and weight of the circuit. In order to meet these requirements, a direct phase modulator can be an appropriate solution.

There are two types of phase modulators – transmission type and reflection type. The requirements of a microwave phase modulator are to maintain a linear relationship between the phase and the modulating signal voltage and to have no change in the carrier amplitude with a wide band modulating signal and large modulation index. It is difficult to satisfy both amplitude and phase requirements in a transmission type modulator.

In a reflection type modulator, if devices and circuits including circulators are considered to be lossless, then the above constant amplitude requirement can be met. Thus, ideally, only the phase requirements need to be considered in a reflection type modulator [1].

If the carrier signal is phase modulated [2], the resultant signal is

$$E(t)=J_0(m)\cos(\omega_c)t - J_1(m)\{\cos(\omega_c-\omega_m)t-\cos(\omega_c+\omega_m)t\} + J_2(m)\{(\cos(\omega_c-2\omega_m)t + \cos(\omega_c+2\omega_m)t\} - \ldots\ldots,$$ where

$J_n(m)$ is the Bessel function of the first kind, order n

ω_c = carrier frequency

ω_m = modulating signal frequency

m = modulation index

In phase modulation, the modulation index is proportional to the amplitude of the modulating signal, independent of its frequency,

$m \alpha Vm$, where

m = Modulation index and peak phase deviation

V_m = Peak modulating signal amplitude (volts)

A reflective type phase shifter is used. For low power analog applications, a varactor diode phase shifter offers considerable potential. Variable reactance of varactor diodes under reverse bias condition is utilized in the phase shifter. Varactor diode phase shifters commonly make use of reflection type circuits, of which, the hybrid coupled type is very popular.

This paper details the development of two circuits, a direct S-band phase modulator and a tone processing circuit which provides the desired modulating input (tone) to the modulator.

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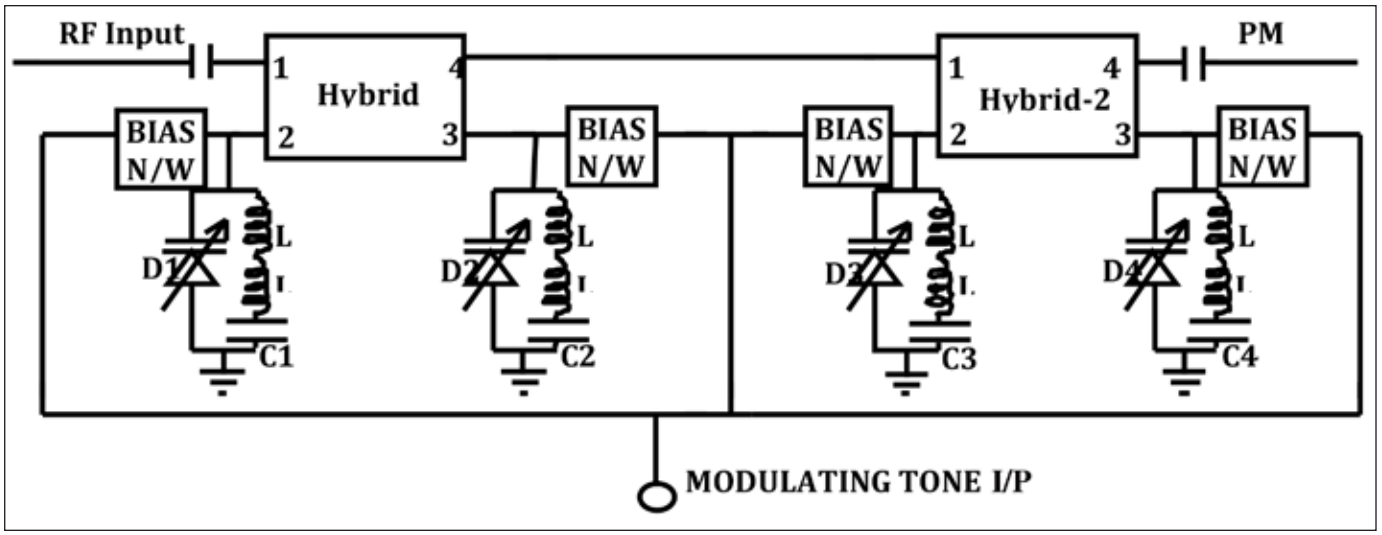

Figure 1 • Schematic of Reflection type Phase Modulator.

Both circuits are integrated and tested under appropriate environmental conditions. Simulation and hardware results are also presented.

S-Band Phase Modulator

A phase modulator at S-band is realized as a reflection type of modulator using 90° branch line hybrid couplers and varactor diodes (DH76022, M/S TEKELEC TEMEX). The schematic of the reflection type phase modulator is shown in Fig.1. The RF input i.e. the S-band carrier is modulated by the applied modulating tone input signal to get a phase modulated (PM) output. The layout of the phase modulator is shown in Fig.2.

The phase modulator is realized using two stages to get desired phase shift. Each stage has a hybrid coupler with varactor diodes as shown in Fig.1. The carrier fed to the input port of the first stage hybrid coupler encounters variable reactance offered by the reverse biased varactor diodes. This causes the incident wave to get reflected with a phase shift proportional to the reactance offered by the varactor diodes, which in-turn, is proportional to the modulating signal. The reflected signals combine at the isolated port and the combined output is fed as input to the second hybrid coupler. The second coupler stage is identical to the first stage. The final phase modulated

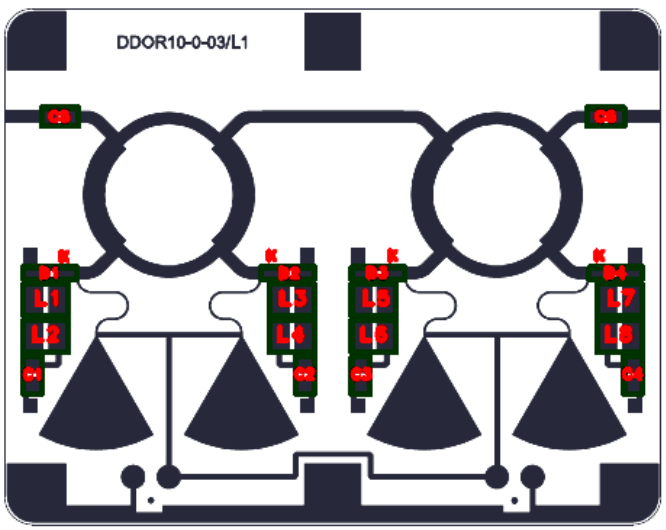

Figure 2 • Layout of Phase Modulator.

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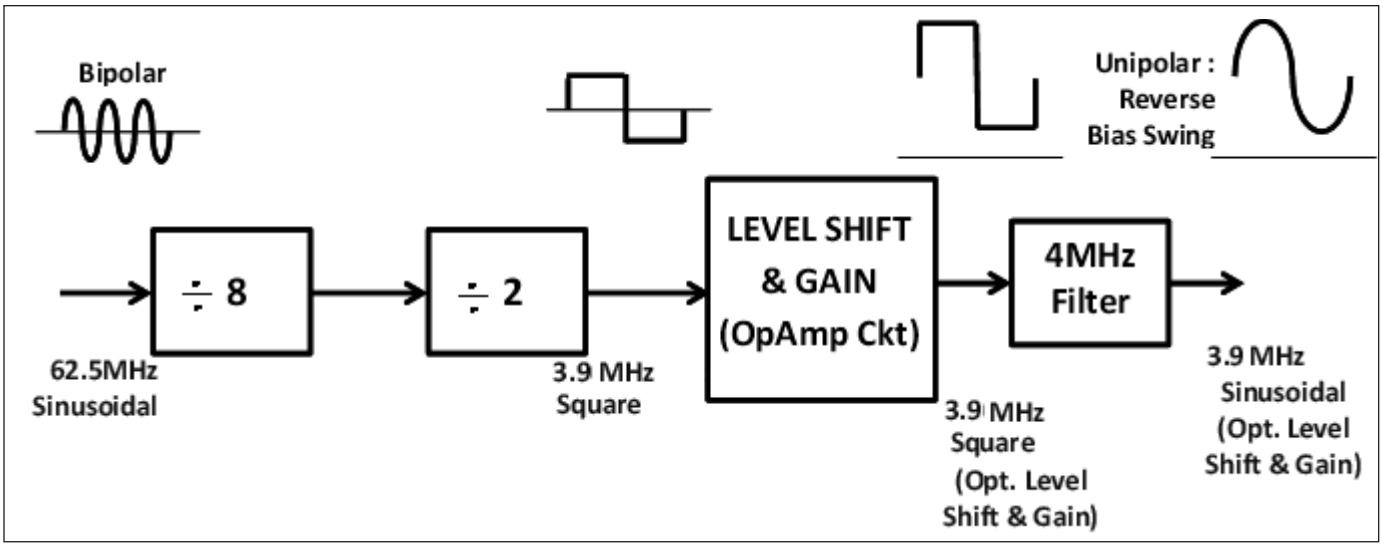

Figure 3 • Block Diagram of Tone Processing Circuit.

signal is obtained at the isolated port of the second stage coupler.

The four bias networks are implemented using quarter wavelength radial stubs, spaced by high impedance quarter wavelength lines, which offer an RF open circuit at the operating frequency, but ensure a DC path for the diodes.

A sinusoidal modulating tone of 3.9 MHz is fed to the varactor diodes through the bias networks. Tuning elements C1-C4 & L1–L8 are provided in the circuit to improve linearity, if required. However, in the existing configuration, acceptable linearity is achieved without the use of these elements.

Tone Processing Circuit

A TCXO at 62.5 MHz is selected to derive the tone frequency. Two stages of frequency dividers with division factors of 8 and 2 respectively are used to get a tone at 3.9 MHz. The ÷ 8 (PE9313) and ÷ 2 (PE9311) pre-scalars from M/S Peregrine are used. An LDO (3301A2) from M/S IR is used to provide +3V supply to the pre-scalars. The output of the pre-scalars is a bipolar square wave. This is fed to an operational amplifier (LM7171) from M/S National Semiconductor. The op-amp circuit is tuned to provide appropriate bias voltage swing and DC level shift to bias the varactor diodes in phase modulator. The output is filtered using a low pass filter to remove the unwanted frequency components and produce a sinusoidal tone at 3.9 MHz, which is fed as modulating signal to the phase modulator. The block diagram along with waveforms and the schematic of the tone processing circuit are shown in Figs. 3 and 4, respectively.

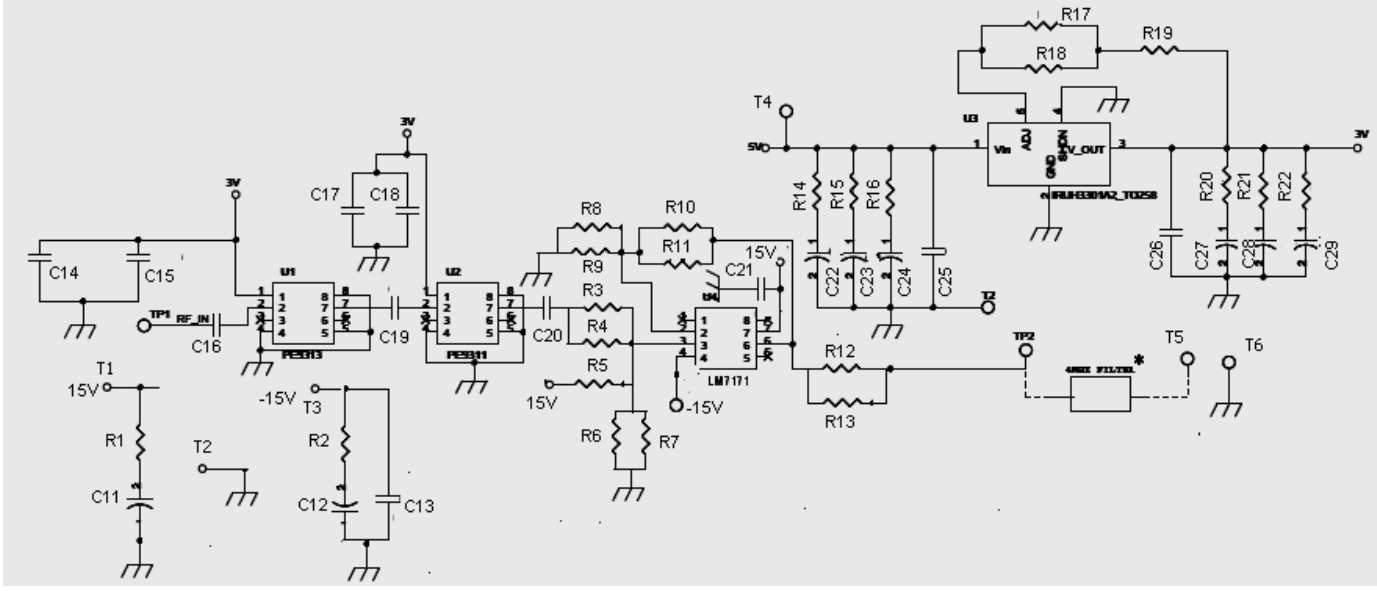

Figure 4 • Schematic of Tone Processing Circuit.

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Phase Modulator

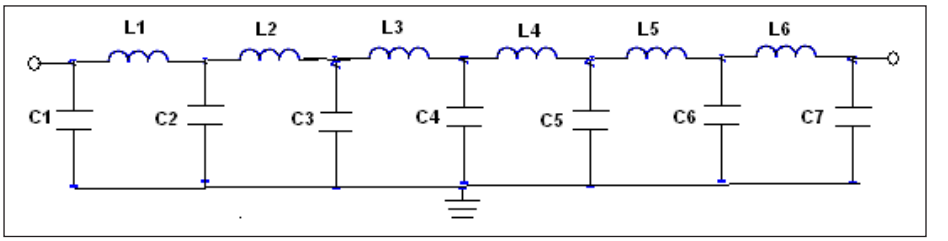

Figure 5 • Schematic of Tone LPF.

The low pass filter is designed for a cut-off frequency of slightly higher than 3.9 MHz, i.e., 4MHz, to accommodate frequency shift due to temperature. It is a lumped element filter. The schematic of the filter is shown in Fig. 5 and its simulated and measured responses compared in Fig.6.

Phase Modulator Specifications

Input Carrier Frequency	:	2296.875MHz
Modulating Tone Frequency	:	3.9 MHz
Modulation Index	:	0.7 rad. ± 0.1 rad. (typ.)
Insertion loss	:	5 dB (typ.)
Return loss	:	14 dB (typ.)
Temp Range	:	- 20°C to + 60°C

Simulation Results

The varactor diode (DH76022) is simulated using Agilent ADS software to obtain a phase shift vs bias voltage curve, as shown in Fig. 7. The linear region of operation of the diode is identified in the figure and proposed for the phase modulator application. The proposed region is expanded in Fig.8 and it is seen that the linear region is centered at 3.75V with a voltage swing of 2.5V p-p.

The phase modulator is also simulated using ADS software and optimized at the desired center frequency of 2296.875 MHz. The simulated S-parameters are shown in Fig. 9.

Hardware Test Results

The phase modulator is characterized by applying bias voltage to the diodes. Based on the above simulation results, the bias voltage for the modula-

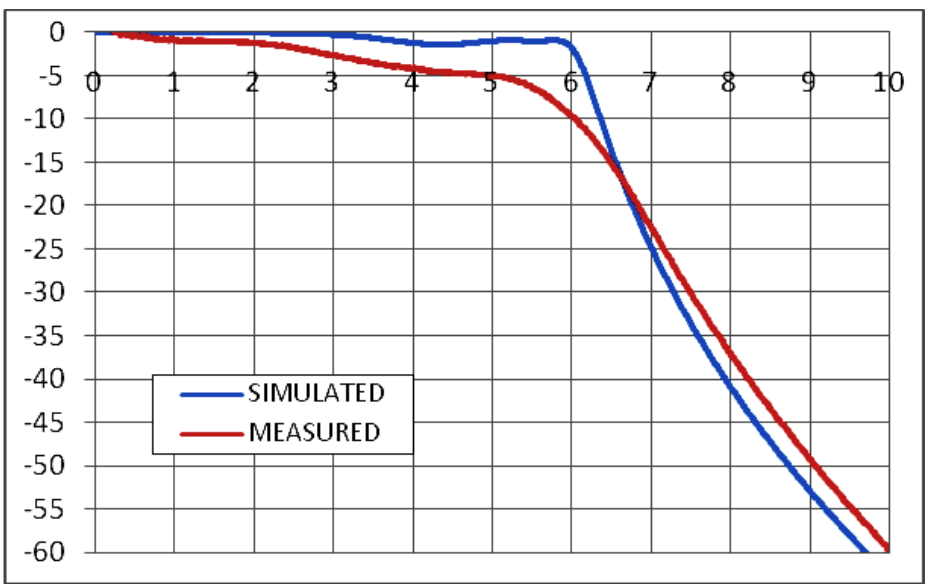

Figure 6 • Comparison of Simulated & Measured Responses for LPF.

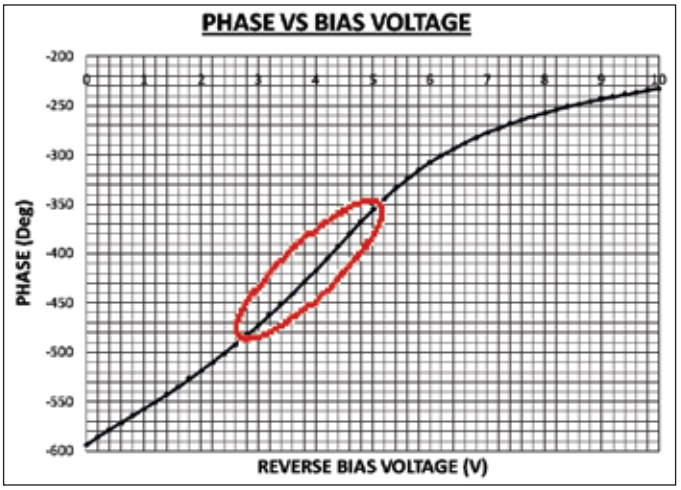

Figure 7 • Phase Variation over Various Bias Points.

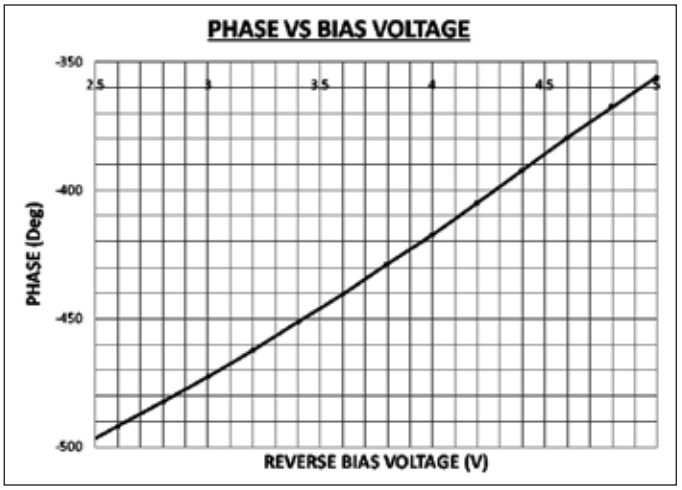

Figure 8. Phase Variation over Proposed Operating Swing (expanded from Fig.7).

tor is chosen from 2.5V to 5V. The modulator performance is studied for various bias voltages in the specified voltage range. The operating point is selected as 3.65V in the linear region. The sideband level and in turn the modulation index is varied by adjusting the voltage swing of the generated tone. The modulation index is adjusted to 0.7 rad., as per specification. The corresponding voltage swing is 1.3 V, which is within the linear limits of operation of diode, as obtained by simulation. The performance of the circuit is evaluated over temperature: - 20^0C (cold), + 25^0C (ambient) and + 60^0C (hot). The S-parameters for 3.65V bias at different temperatures is shown in Fig.10. The insertion loss is 4.5 to 5 dB and the return loss is 11 to 14 dB at the operating carrier frequency of 2296.875MHz.

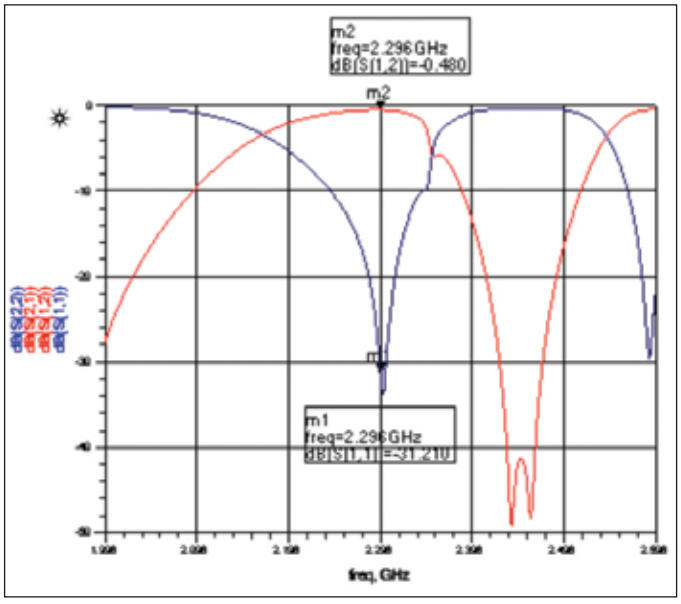

Figure 9 • S-parameter Simulation for Phase Modulator.

The modulator is tested at different RF input power levels (0 dBm to +12 dBm) with the selected tone and the output spectrum is observed as shown in Fig.11. The modulator loss is 4.8 dB.

The voltage, current, output power and modulation index for the modulator at different temperature conditions are given in Table 1. It is observed that the variation of output power and modulation index over temperature is 0.83 dB and ± 0.09 rad respectively.

Conclusion

This paper describes the design, simulation and hardware realization of an S-band direct phase modulator suitable for space applications. The modulator is tested for its performance over environmental conditions and the performance is satisfactory.

References

[1] C.S. Kim, Varactor S-band Direct Phase Modulator, IEEE Journal of Solid State Circuits, Vol. Sc-1, No.1, September 1966.

[2] Mahrukh Khan, Novel S-band Direct Phase Modulator using Hybrid Coupler, IEEE-2009.

About the Authors

Dr. D.Venkata Ramana holds an M.Tech degree from NIT, Surathkal and a Ph.D from IISc, Bangalore, India. He joined ISRO Satellite Centre, Bangalore in 1983 and currently he is Deputy Project Director for Resourcesat-2A. His areas of interest are Microwave Systems and Space Communications. He has published papers in National and International Journals of repute. He is Life Member of ASI & IMAPS, Senior Member-IEEE and Fellow IETE & IE (I). dvramana@isac.gov.in.

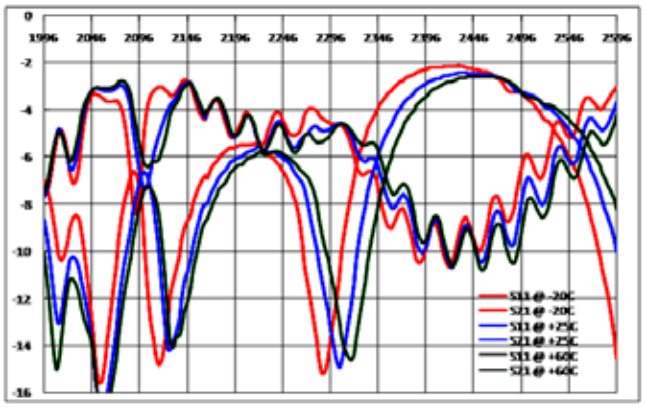

Figure 10 • S-parameters at 3.65V Bias over Different Temperatures.

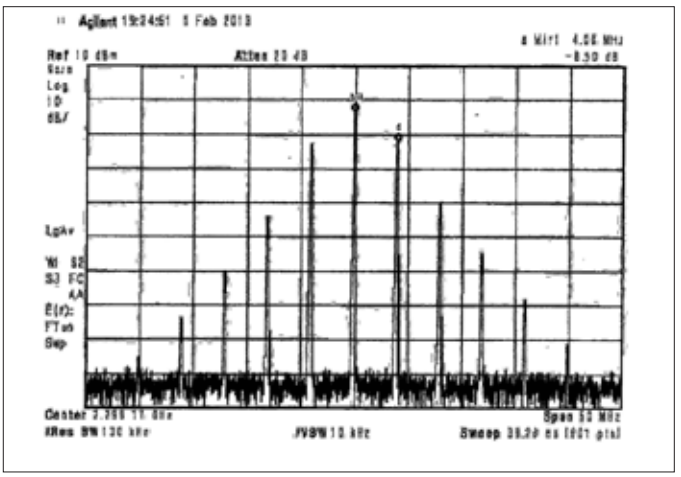

Figure 11 • Spectrum of the Phase Modulated Signal.

TEMP. CONDITION	VOLTAGE (VOLTS)	CURRENT (mA)	OUTPUT POWER (dBm)	MODULATION INDEX (rad)
AMBIENT	+15	11.6	3.8	0.83
	-15	6.5		
	+5	12.6		
COLD	+15	11.9	3.3	0.91
	-15	6.9		
	+5	13.3		
HOT	+15	11.8	4.13	0.73
	-15	6.9		
	+5	13.5		

Table 1 • Voltage, current, output power and modulation index.

Mr. Sourabh Basu holds an M.Tech from University of Delhi, South Delhi. He worked with Communication Systems Group, ISRO Satellite Centre, Bangalore. Currently, he is under deputation at NTRO, New Delhi. His area of interest is Microwave & Communication. sourabhbasu@yahoo.com.

Ms. Jolie.R received her B.Tech from the University of Kerala and M. Tech from Cochin University. She joined ISRO Satellite Centre, Bangalore in 2000. Currently, she is Deputy Project Director for Cartosat-3 series. Her research includes development of high bit rate modulators and Ka-band data transmitters. jolier@isac.gov.in.

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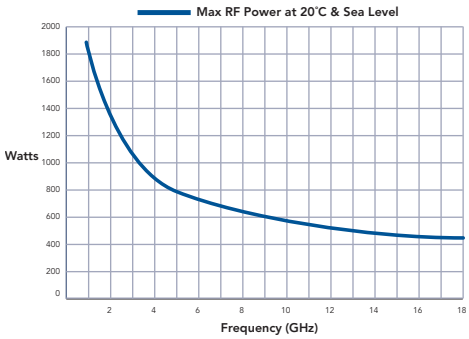
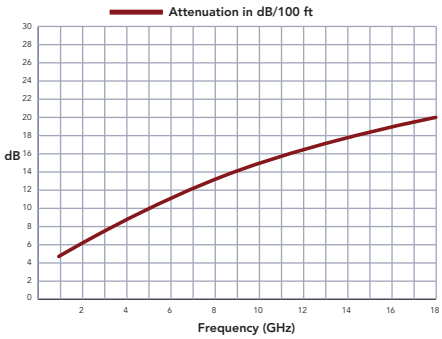


Attenuation in dB/100 ft



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Analysis of Small Voltage Variations Under Large Signal Conditions

By Matthias Beer, Renate Mittermair, Dr. Markus Herdin

Measuring small voltage variations when high voltage components are present is a common challenge.

Measuring small voltage variations when high voltage components are present is a common challenge in electronic design and testing. Typical applications are switched-mode power supplies (SMPS) where the voltage across the switching transistor has to be measured during the switching period. In this case, the voltage difference between ON and OFF state of the transistor can easily reach a hundred volts or more. To measure small voltage variations under such conditions with the required accuracy, more than 8 bit of vertical resolution would be required on an oscilloscope. The same requirements would apply, for example, when analyzing an AM modulated signal with low modulation index.

Switched Mode Power Supply

Switched-mode power supplies, commonly abbreviated as SMPS, are electronic power supplies which transfer power from a source to a load while converting the voltage and current characteristics. SMPS incorporate a switching regulator, typically a MOSFET (metal oxide semiconductor field-effect transistor) or IBGT (insulated-gate bipolar transistor). The pass-transistor translates power efficiently as it switches continuously and spends very little time in the high dissipation transitions; ideally, the power supply dissipation is zero. The output voltage regulation of the SMPS is realized by varying the duty-cycle of the switching transistor. The switches are realized using semiconductor devices such as FET's, IBGT's or diodes.

In general, the SMPS can be classified in isolated and non-isolated topologies. For the latter topology type, buck or boost converters are typical candidates [1], whereas for the first one,

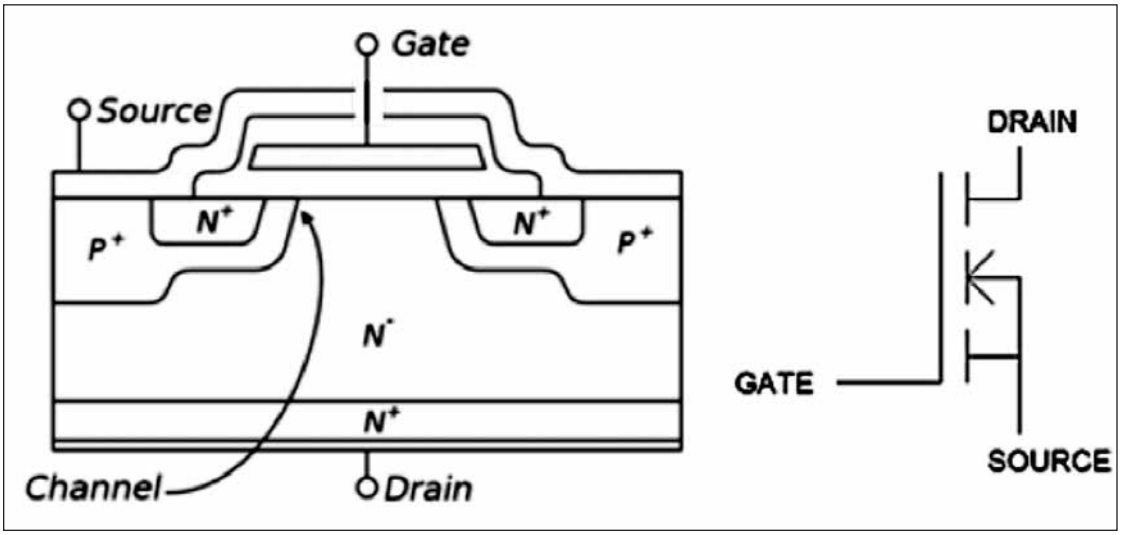

Figure 1 • Cross section of MOSFET (single VDMOS transistor).

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We're adding more models and more functionality to our line of RF switch matrices. All models now feature switch cycle counting with automatic calibration interval alerts based on actual usage, an industry first! This function improves test reliability and saves you money. Our new RC-series models feature both USB and Ethernet control, so you can run your test setup from anywhere in the world! Rugged aluminum cases on all models house our patented mechanical switches with extra-long life of 10 years/100 million cycles of guaranteed performance!*

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USB Control Switch Matrices

Model	# Switches (SPDT)	IL (dB)	VSWR (:1)	Isolation (dB)	RF P_{MAX} (W)	Price $ (Qty. 1-9)
NEW USB-1SP4T-A18	1 (SP4T)	0.25	1.2	85	2	795.00
USB-1SPDT-A18	1	0.25	1.2	85	10	385.00
USB-2SPDT-A18	2	0.25	1.2	85	10	685.00
USB-3SPDT-A18	3	0.25	1.2	85	10	980.00
USB-4SPDT-A18	4	0.25	1.2	85	10	1180.00
USB-8SPDT-A18	8	0.25	1.2	85	10	2495.00

NEW USB and Ethernet Control Switch Matrices

Model	# Switches (SPDT)	IL (dB)	VSWR (:1)	Isolation (dB)	RF P_{MAX} (W)	Price $ (Qty. 1-9)
RC-1SP4T-A18	1 (SP4T)	0.25	1.2	85	2	895.00
RC-2SP4T-A18	2 (SP4T)	0.25	1.2	85	2	2195.00
RC-1SPDT-A18	1	0.25	1.2	85	10	485.00
RC-2SPDT-A18	2	0.25	1.2	85	10	785.00
RC-3SPDT-A18	3	0.25	1.2	85	10	1080.00
RC-4SPDT-A18	4	0.25	1.2	85	10	1280.00
RC-8SPDT-A18	8	0.25	1.2	85	10	2595.00

*The mechanical switches within each model are offered with an optional 10 year extended warranty. Agreement required. See data sheets on our website for terms and conditions. Switches protected by US patents 5,272,458; 6,650,210; 6,414,577; 7,633,361; 7,843,289; and additional patents pending.

†See data sheet for a full list of compatible software.

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Voltage Variations

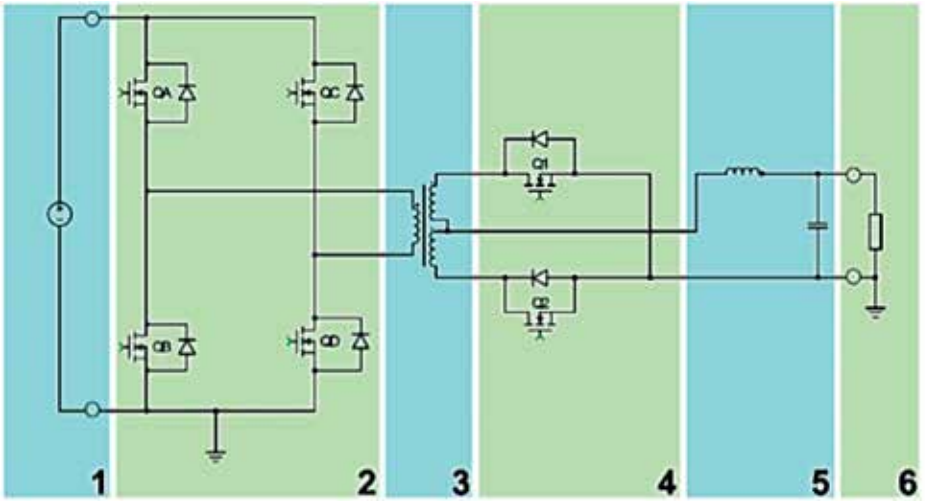

Figure 2 • Block diagram of an active full-bridge converter (1: DC input supply; 2: DC/AC converter; 3: transformer; 4: active rectifier; 5: filter; 6: load).

flyback (isolated buck-boost converter) or full-bridge converters are known [2]. A very efficient converter for high-power ranges of up to several kW would be an active full-bridge converter (Fig. 2). Here, power MOSFETs are often used to realize the rectifier as they are designed to handle significant power levels while having a high switching speed and a good efficiency at low voltages at the same time.

In switched-mode power supply applications, one key parameter to determine the conducting loss of the commonly used power MOSFET is $R_{DS(ON)}$. In ON state, the transistor shows a resistive behavior between the drain and source terminal which is the sum of resistive elements between them (Fig. 3).

To measure $R_{DS(ON)}$, special requirements appear, as small drain-to-source voltages have to be measured in ON state, typically a few hundreds of mV, while having high drain-to-source voltages in OFF state. In addition to the large dynamic range, fast rise- and fall-times in the order of ns have to be considered. This requirement leads to special demands on the measurement tool, typically an oscilloscope.

Accurate Measurement of $R_{DS(ON)}$

To calculate $R_{DS(ON)}$ of a SMPS MOSFET, the drain current and the drain-to-source voltage of the rectifier need to be measured (Fig. 2, section 4). As the

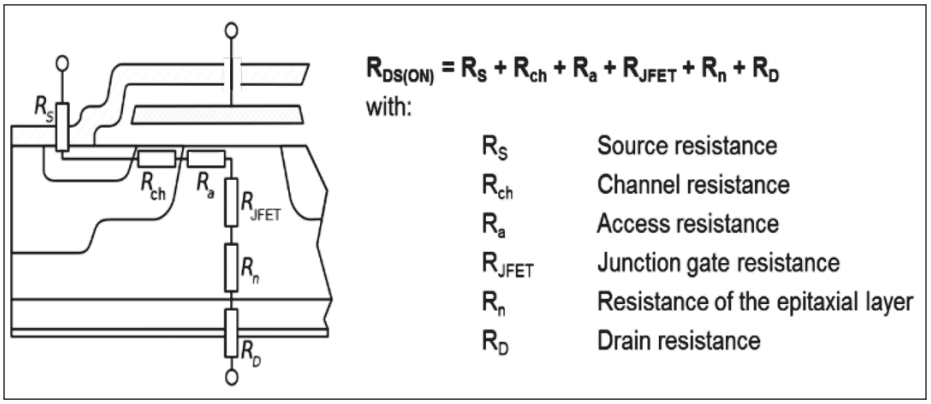

Figure 3 • $R_{DS(ON)}$ as sum of resistive elements between source and drain terminal of MOSFET in ON state.

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Figure 4 • R&S RTE/RTO K17 High Definition Mode.

rectifier is typically operated in the 100 kHz range, no special requirements appear in this regard. However, measuring small drain-to-source voltages in ON state is challenging, typically a few hundreds of mV, due to high drain-to-source voltage levels in OFF state and peaks during state switching. Viewing such signals with both large and small voltage details, referred to as high dynamic range requirement, is challenging to meet for a standard oscilloscope with 8 bit resolution of the A/D converter. For example, referring to Equation 1, the resolution of an 8 bit ADC would be around 39 mV when measuring a 100V signal.

$$Vertical\ resolution\ of\ ADC = \frac{V_{cc}}{2^n - 1}$$

Equation 1 • Calculation of vertical resolution of a n-bit ADC with reference voltage Vcc.

Additionally, poor probe compensation and incorrect probing techniques can lead to significant signal distortions, leading to incorrect measurement results even if the oscilloscope offers the necessary dynamic range.

Analyzing Small Signal Details under High Dynamic Range Conditions

With the R&S digital oscilloscope RTE or RTO and the high-definition (HD) mode, referred to as option K17, it is possible to measure the drain-to-source voltage for $R_{DS(ON)}$ under high dynamic range conditions. The high-definition mode applies a digital low-pass filtering on the measured signal which reduces noise and increases the signal-to-noise ratio inside the filter bandwidth. With this method, depending on the selected filter bandwidth, a resolution improvement of 256 times compared to a typical 8 bit resolution can be achieved. This enhancement corresponds to a vertical resolution of 16 bit (Fig. 4).

With this approach it is possible to see small signal details like the drain-to-source voltage in switched mode power supply applications, which would otherwise vanish in noise. Fig. 5 and Fig. 6 show such a measurement. Because the HD mode is not utilized in Fig. 5, the displayed noise is significantly higher compared to Fig. 6 were it is enabled. The improvement of the higher resolution can be seen on the measurement curve and in particular at the "zoomed" part of the signal (Fig. 6). Both are

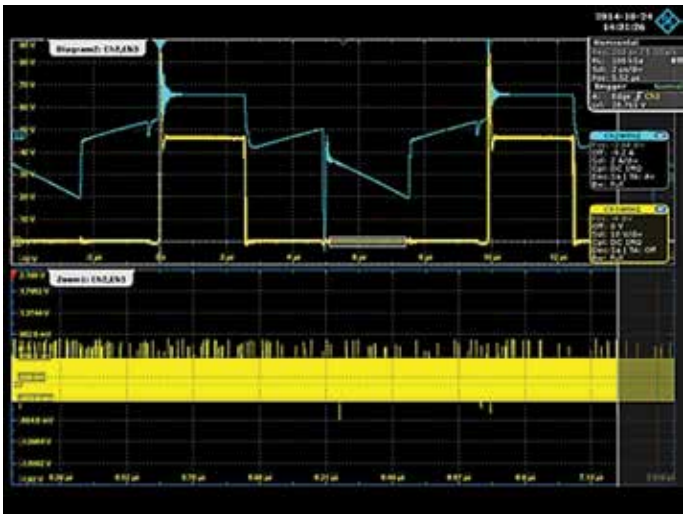

Figure 5 •Drain-to-Source voltage measurement of SMPS without utilizing HD mode.

showing less noise and more signal details compared to the displayed result in Fig. 5 where the HD mode is not enabled.

A prerequisite to achieve accurate measurement results is the right probing technique. When measuring signals with high-frequency components, one has to make sure that the "loop" formed by the probing connections (signal pin and ground connection) is as short as possible. The spring-loaded tip of the R&S RT-ZP10 passive probe together with spring-type ground contacts allows a safe contact with minimal noise and interference coupling on the measured signal (Fig. 7). This allows a direct probing of the MOSFET pins and body.

In addition, accurate probe compensation is very important for high-resolution measurements. A poorly compensated probe introduces measurement errors resulting in inaccurate readings, which can also influence differential measurements. For measurements where

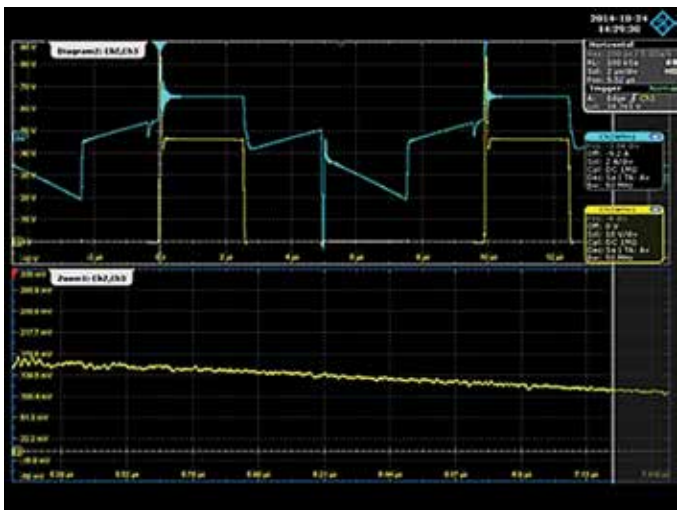

Figure 6 • Drain-to-Source voltage measurement of SMPS with HD mode enabled.

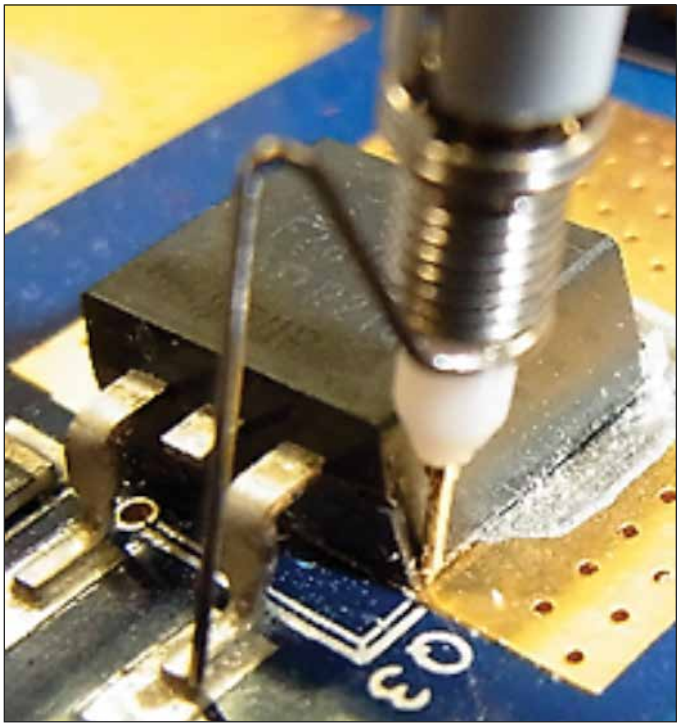

Figure 7 • R&S RT-ZP10 passive probe with spring-type ground connection to reduce noise and interference coupling.

none of the MOSFET pins have ground potential, an active differential probe like the R&S RT-ZD10 can be used.

Avoiding Offset Problems When Calculating $R_{DS(on)}$

Measuring different voltage levels under high dynamic range conditions requires additional steps to get an accurate result. To calculate $R_{DS(ON)}$ of a MOSFET, the offset accuracy of oscilloscopes is no longer sufficient to simply divide the measured drain-to-source voltage

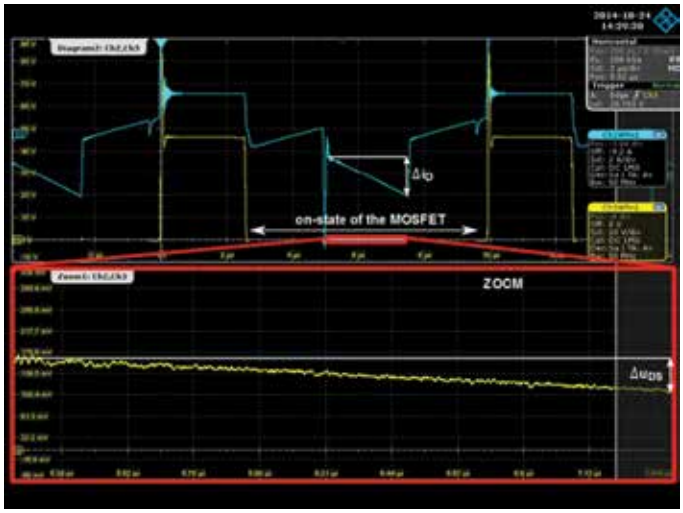

Figure 8 • Differential method to calculate $R_{DS(ON)}$ under high dynamic range conditions.

across the MOSFET by the drain current. Furthermore, when Rogowski probes are used to measure the current through the drain pin of the MOSFET, only the AC components are considered. Therefore, the resulting current measurement on the oscilloscope will have a DC offset. This problem can be addressed by taking advantage of the fact that the drain current shows a constant or nearly constant slope for a certain time interval while the MOSFET is in on-state. Concerning this matter, a differential method as shown in Fig. 8 can be applied to calculate $R_{DS(ON)}$.

The procedure is to measure the slope of the drain-to-source voltage and derive Δu_{DS} first. Next, in order to get Δi_D, the slope of the drain current of the MOSFET has to be measured in the same time interval used for measuring Δu_{DS}. $R_{DS(ON)}$ can now be calculated based on Δu_{DS} and Δi_D.

Summary

To analyze signals with both large and small voltage details, special considerations need to be included. The discussed example of measuring $R_{DS(ON)}$ of a SMPS is a typical example for such an application and shows that special measurement capabilities are required to address these challenges. Today's oscilloscopes like the R&S RTE and R&S RTO are featuring such measurement capabili-

ties and allow the user to solve the measurement task in a fast and accurate way. With special features like the high-definition mode, option K17 on the R&S RTE and R&S RTO oscilloscopes, the signal analysis gets even more accurate and simplified as the noise of the displayed waveforms gets reduced and signal details are displayed with greater clarity.

About the Authors

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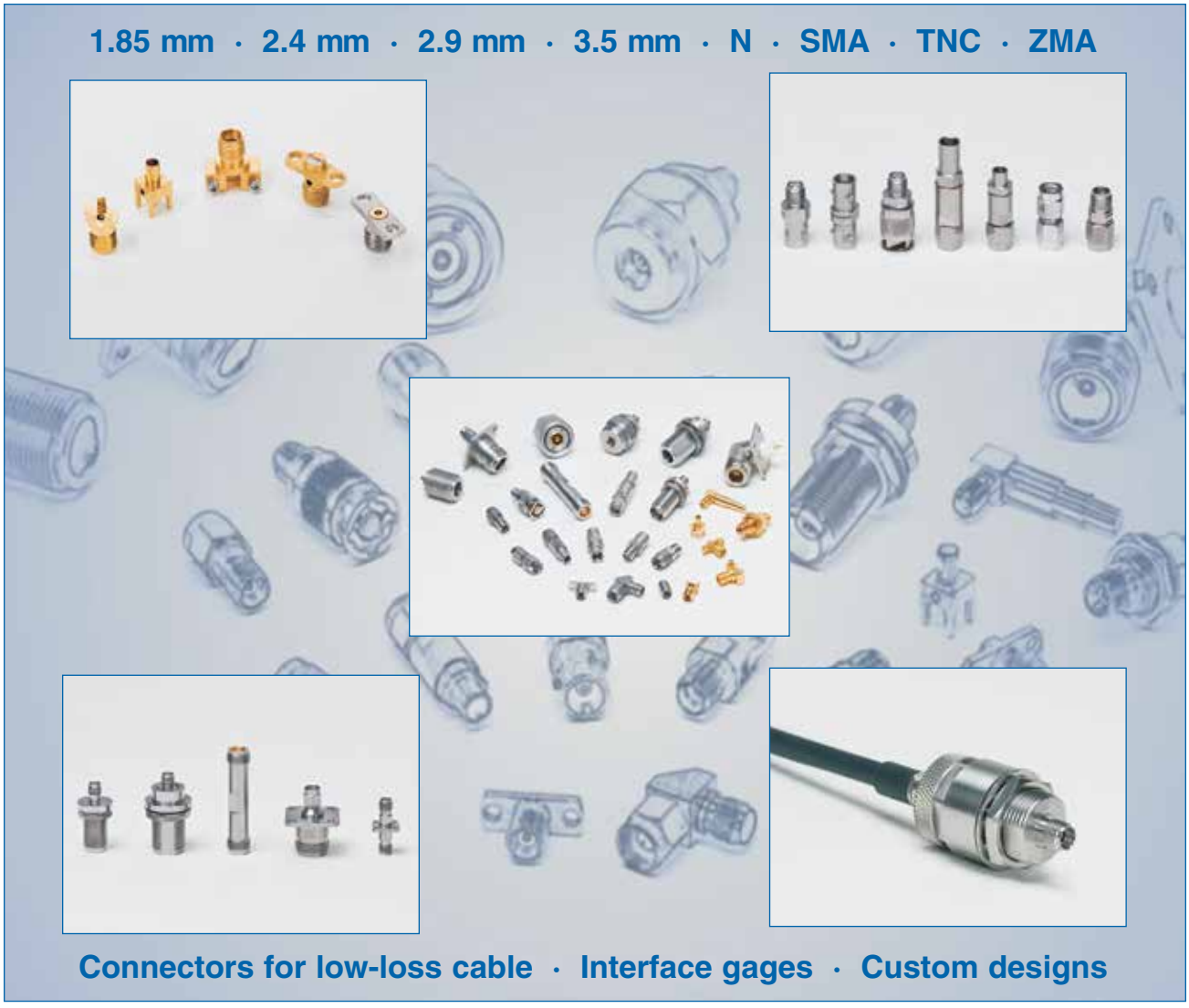

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Product Highlights

Isolator

Model STF-12-S1 is a full band Faraday isolator that covers the frequency range from 60 GHz to 90 GHz. The Faraday isolator exhibits 28 dB isolation and 1.5 dB insertion loss typically over entire E band. The Faraday isolator is equipped with standard WR-12 waveguide and UG387/U flange. The isolator measures 2.5" long and weighs 1.8 oz typically.

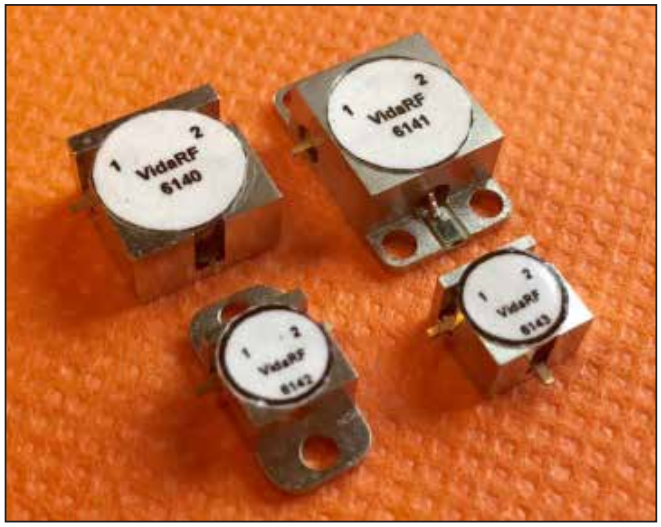
SAGE Millimeter
sagemillimeter.com

1.0mm Connectors

SGMC Microwave's 1.0mm connectors feature: frequency: DC to 110 GHz; ruggedized construction for repeatability and reliability; phase-matched adapters, captivated center contact; low VSWR and insertion loss; cable connectors for various semi-rigid and flexible cables; receptacle configurations including threaded and flanged.

SGMC Microwave
sgmcmicrowave.com

Product Highlights



Isolators

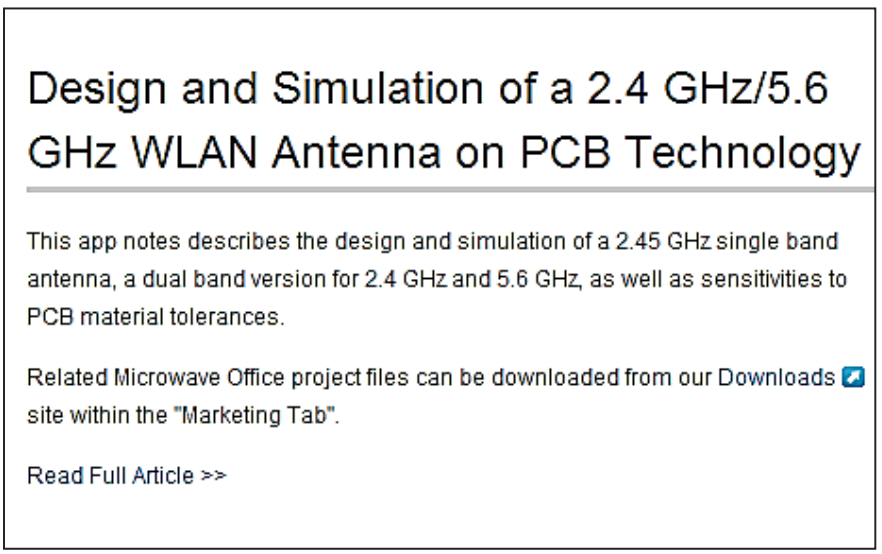
VidaRF is offering drop in surface and flange mount Isolators and Circulators covering from 3.6GHz to 32GHz. VidaRF also offers wide range of narrow and broad band coaxial and waveguide Isolators and Circulators.

VidaRF
vidarf.com

Signal Analyzer

The SR785 Two-Channel Dynamic Signal Analyzer is a precision, full-featured signal analyzer that offers state-of-the-art performance at a price that's less than half that of copetitive analyzers. Building on its predecessor, the SR780, the SR785 incorporates new firmware and hardware that make it the ideal instrument for analyzing both mechanical and electrical systems.

Stanford Research Systems
thinksrs.com



File Downloads

NI (formerly AWR Corp.) announced that the accompanying example project files for two recently released application examples, Design and Simulation of a 2.4 GHz/5.6 GHz WLAN Antenna on PCB Technology and Design and Simulation of an ISM Band Antenna on PCB Technology, are now available for customers and evaluators to download. The project files can be downloaded from the NI AWR Downloads site within the "Marketing" tab.

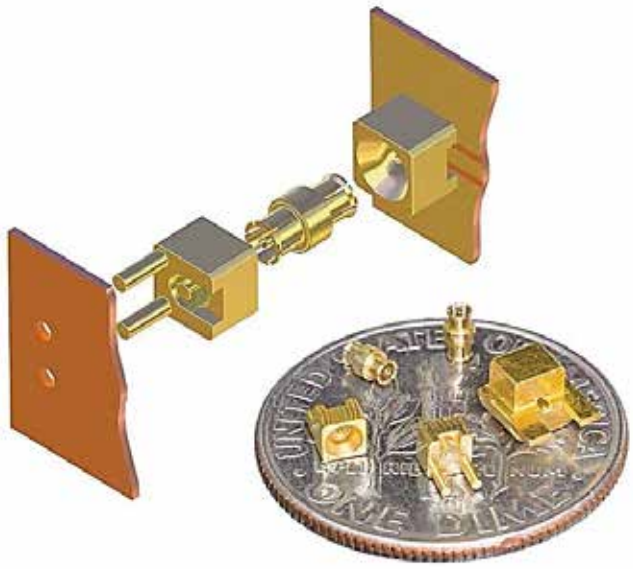
National Instruments
awrcorp.com

Product Highlights

Power Sensor with Extended Frequency Range

The new LB5918L is a state of the art high accuracy, high sensitivity True RMS Average power sensor well suited to source calibration and EMC testing applications. The high accuracy sensor covers frequencies from 9 kHz to 26.5 GHz and offers excellent dynamic range. The innovative multipath processing scheme processes the entire dynamic range in each sample providing exceptionally fast True RMS measurements.

LadyBug Technologies
ladybug-tech.com



Board-to-Board Connectors

Southwest Microwave announced a new line of SuperMini Board-to-Board DC to 67 GHz Connectors. These RF / millimeter wave blind-mate connectors optimize interconnect performance for board-to-board stacking applications. They maximize electrical performance of the transmission path between connector and circuit while accommodating axial misalignment of up to .010" and radial misalignment of +/- 5°.

Southwest Microwave
southwestmicrowave.com

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	PWR-4GHS	CW	0.009 to 4000	USB	795.00
	PWR-6GHS	CW	1 to 6000	USB	695.00
	PWR-8GHS	CW	1 to 8000	USB	869.00
NEW!	PWR-8GHS-RC	CW	1 to 8000	USB & Ethernet	969.00
	PWR-8FS	CW	1 to 8000	USB	969.00
	PWR-4RMS	True RMS	50 to 4000	USB	1169.00

*Measurement speed as fast as 10 ms for model PWR-8-FS. All other models as fast as 30 ms.

† Dynamic range as wide as -35 to +20 dBm for model PWR-4RMS. All other models as wide as -30 to +20 dBm.

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Product Highlights

Switch Matrix

Renaissance Electronics is offering a 48 x 4 switch matrix with a frequency range of 700 MHz (LTE) to 6 GHz (Wi-Fi). Using high reliability solid state switches (>1 billion cycles) and capability of switching at speeds of 100 nS or better, the 18A6BAC is designed for the most demanding applications. The 18A6BAC is the perfect way to extend your expensive ATE equipment to test multiple products at the same time.

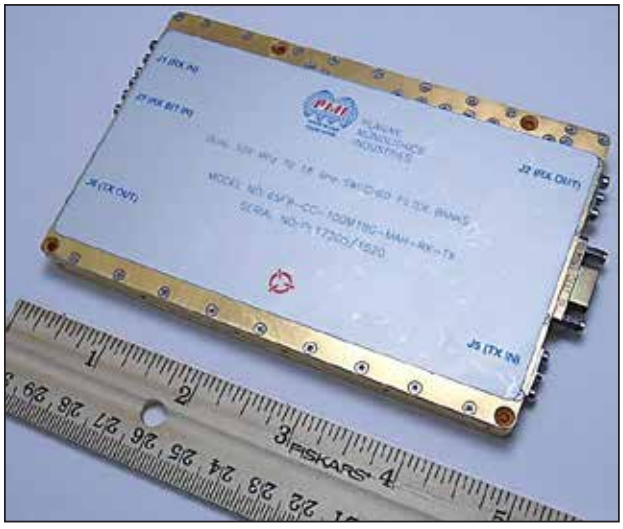
Renaissance Electronics
rec-usa.com

High-Performance Silicone

Passing ASTM E595 testing for NASA low outgassing, MasterSil 920-LO is a high-performance, room temperature vulcanizing silicone for sealing, coating and small encapsulations. It has a moderate, flowable viscosity and a solid electrical profile, making it well suited for conformal coating applications. Featuring a soft durometer of 25-35 Shore A, this low stress silicone can protect sensitive electronic components.

Master Bond
masterbond.com

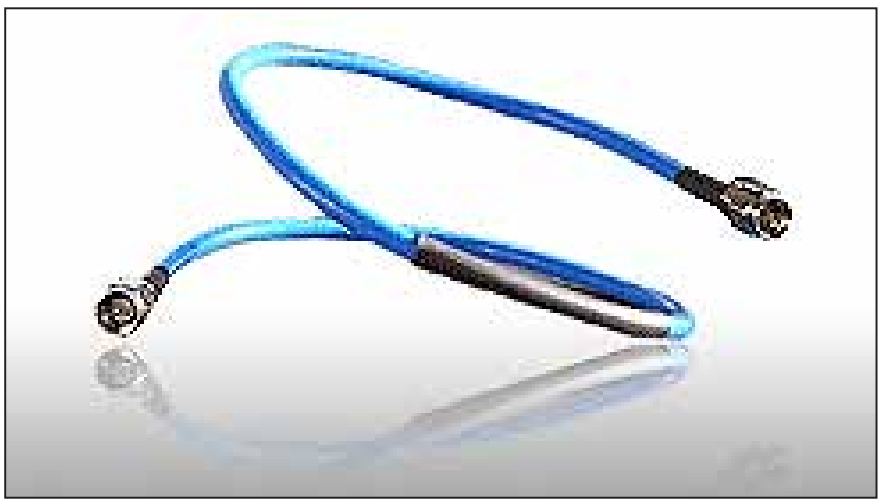
Product Highlights



Integrated Module

PMI Model No. 6SFB-CC-100M18G-MAH-RX-TX is an integrated module containing two 6-channel switched filter banks covering 100 MHz to 18.0 GHz. A receive switched filter bank has 2 inputs, one with 18 dB gain and one with 10 dB insertion loss. The absorptive input switch has 100 dB isolation between the 2 inputs. A transmit switched filter bank has 32 dB typical gain while allowing 1 of 6 filter paths to be chosen.

Planar Monolithics Industries
pmi-rf.com



Cable Assemblies

The eP-Formable series offers users ability to hand form cable assemblies to final shape, so bending to fit your connection is a breeze. They are easy to install while maintaining excellent performance up to 18 GHz. If low cost, high-performance and shorter than average delivery is your goal, empower evissaP to select the best suited cable end connectors for your application.

evissaP
evissap.com

Product Highlights

VCO

Z-Communications, Inc. announced a RoHS compliant VCO model TRO1800A-LF, the first in a new line of Ceramic Resonator VCOs which saves precious board space while delivering exceptional phase noise performance. This innovative VCO covers the frequency of 1800 MHz within a tuning voltage range of 0.5 to 4.5 Vdc while featuring a spectrally clean signal of -117 dBc/Hz @ 10 kHz offset.

Z-Communications
zcomm.com

Power Dividers

MECA announced the latest addition to its extensive line of Power Dividers with (80X-X-3.250WWP); broadband models covering UHF through ISM bands. Available in 2, 4, 8 & 16-Way, 30W Wilkinson Power Dividers, optimized for excellent performance from 500 MHz – 6.00 GHz. Also available in a variety of connector styles such as Type N or SMA.

MECA Electronics
e-meca.com

Product Highlights

Test Set

Model STG-12-S1 is an E-Band noise figure and gain test set, which including a high performance solid-state E-Band noise source (STZ-12-I1) and a full waveguide band down converter (STC-20-12-S1). It extends the noise and gain measurement capacity from 10.0 to 15.0 GHz to the frequency range of 60 to 90 GHz. The full waveguide band down converter requires a +10 dBm LO signal in the frequency range of 10.0 to 15.0 GHz.

SAGE Millimeter
sagemillimeter.com

VCO

Crystek's CVCO55CC-3650-3650 VCO operates at 3650 MHz with a control voltage range of 0.5 V~4.5 V. This VCO features a typical phase noise of -108 dBc/Hz @ 10 KHz offset and has excellent linearity. Output power is typically +7 dBm. Engineered and manufactured in the USA, the model CVCO55CC-3650-3650 is packaged in the industry-standard 0.5-in. x 0.5-in. SMD package.

Crystek
crystek.com

Product Highlights

Switch

Model No. P2T-6G18G-40-R-570-TFF-1D6KW is a 6.0 GHz to 18.0 GHz single-pole, double throw solid-state switch capable of handling input power levels up to 1.6kW peak having a duty cycle of 8% and a pulse width of 250 us. It offers low loss of 2.2 dB maximum and 40 dB of isolation with a switching speed of 200 ns maximum. DC operating voltages are +5VDC & -70VDC. The housing is hermetically sealed, measures 2.0" x 2.0" x 0.75" and is supplied with TNC female connectors.

Planar Monolithics Industries
pmi-rf.com

Signal Analyzer

Keysight Technologies announced the release of four new M9290A CXA-m PXIe signal analyzer tracking generator options. The CXA-m signal analyzer, with a built-in tracking generator, now has 3, 7.5, 13.6 and 26.5 GHz options, making it the industry's first modular stimulus response measurement solution and providing the industry's highest tracking generator frequency coverage.

Keysight Technologies
keysight.com

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Product Highlights

Video

Skyworks announced the launch of "How Wireless Works" – a short, animated video explaining what happens each time we use our smartphones, tablets or other wireless device. Wireless connectivity is everywhere and an integral part of our daily lives. Yet very few understand how it all works. This non-technical video is fun, informative and created for those who want to simply understand what enables all those seamless connections. Watch it directly at http://www.skyworksinc.com/HowWirelessWorks .aspx

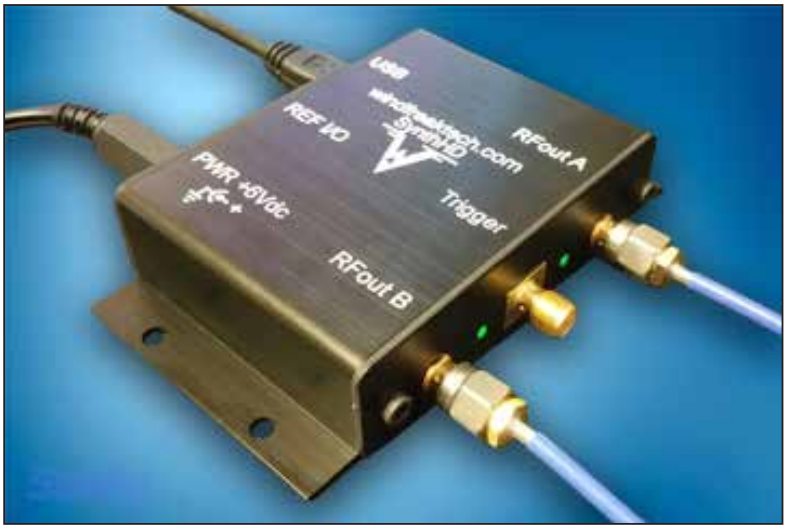
Skyworks Solutions
skyworks.com

Power Splitter

The ZAPD-232-75+ is a 2 Way-0° 75Ω 700 to 2300 MHz Power Splitter/Combiner that features: wideband, 700-2300 MHz; low insertion loss, 0.5 dB typ.; good isolation, 25 dB typ.; excellent output VSWR, 1.15:1 typ.; excellent input VSWR, 1.25:1 typ. Applications: cable TV; cellular; GPS; PCS; WCDMA, communication systems.

Mini-Circuits
minicircuits.com

Product Highlights



Signal Generator

Saelig's SynthHD Dual-channel RF Signal Generator is a highly portable device that brings low cost to precision microwave signal generation. It is a compact software-tunable, dual channel RF signal generator which can be controlled by a Windows or Linux PC via its USB port, or run as a standalone generator. It allows frequency stepping to better than 0.1Hz on each channel, and control of the relative phase between channels to less than a millidegree.

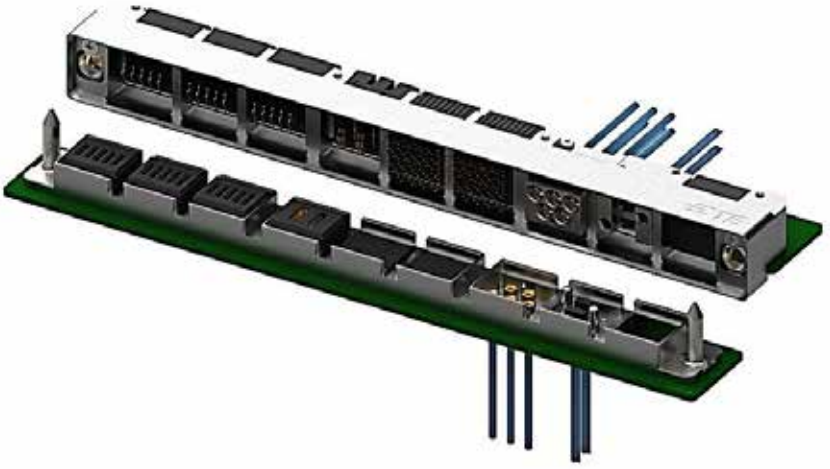
Saelig
saelig.com

Lab Kit

Coilcraft developed a Power Magnetics Lab Kit to help educators provide hands-on experience in their classrooms and instructional labs. It has a broad selection of through-hole power inductors for easy soldering, and is offered free-of-charge to accredited Electrical Engineering programs. Coilcraft also added a Student Resource Center to its website, which offers free access to powerful design tools.

Coilcraft
coilcraft.com

Product Highlights



Connector System

TE Connectivity announced its new Fortis Zd LRM connector system, an innovative modular connector system for rugged, next-generation packaging from avionics boxes to military ground vehicles. It features a rugged, lightweight multi-bay shell that accepts high-speed digital signal, power, radio-frequency (RF) and optical modules.

TE Connectivity
te.com

Test Accessories Catalog

The new RF & Microwave catalog offers over 200 pages of in-depth information on the most reliable and repeatable RF & microwave switches, attenuators, amplifiers and other test accessories. This includes mixers, detectors, directional couplers, power dividers, splitters and PXI modular test accessories. New product highlights and easy-to-read product selection and comparison tables help users find just the right Keysight accessory to complement their test and measurement environment.

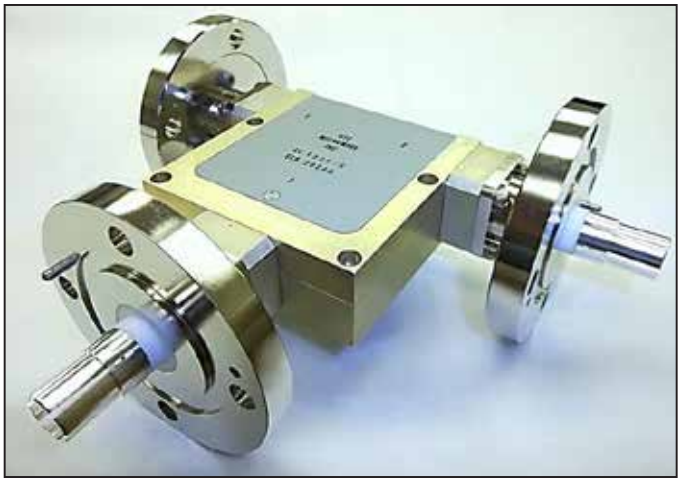
Keysight Technologies
keysight.com

Product Highlights

RF Amplifiers

Herotek's 0.5 to 40 GHz miniature ultra-wideband RF amplifiers feature low power consumption, flat gain response, low noise figure, and more. Applications: Microwave Radio & VSAT; Military & Space; Test Instrumentation; Fiber Optics; Telecom Infrastructure. Max Input Power: 100mW; Operating Temperature Range: -55°C to +85°C; Storage Temperature Range: -65°C to +125°C; Shock: 50G, 11 msec; Vibration: 20G, 100 to 2000 Hz.

Herotek
herotek.com

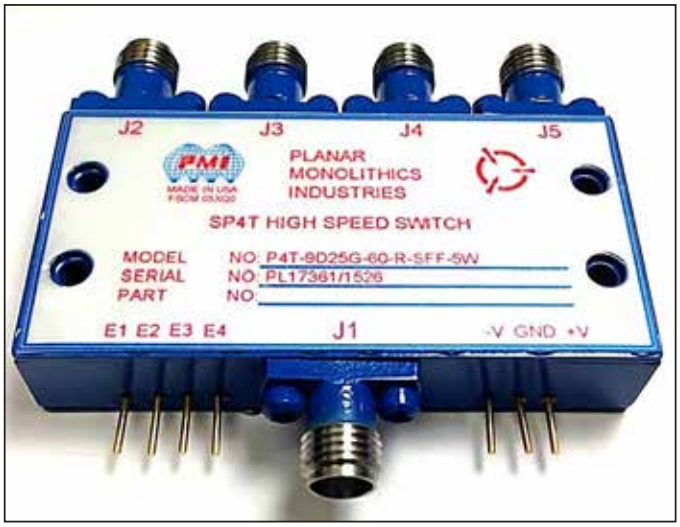


High Power Circulator

Model CT-1872-S is rated at 60 kW peak and 600W average power at 325 MHz. It provides 20 dB minimum isolation, 0.2 dB insertion loss, and 1.20 max. VSWR. Its extremely compact design has flange-to-flange insertion length of only 6 ¾ in. and height of 5 ¼ in. For use in radar applications, it has 1 5/8 in. EIA connectors.

UTE Microwave
utemicrowave.com

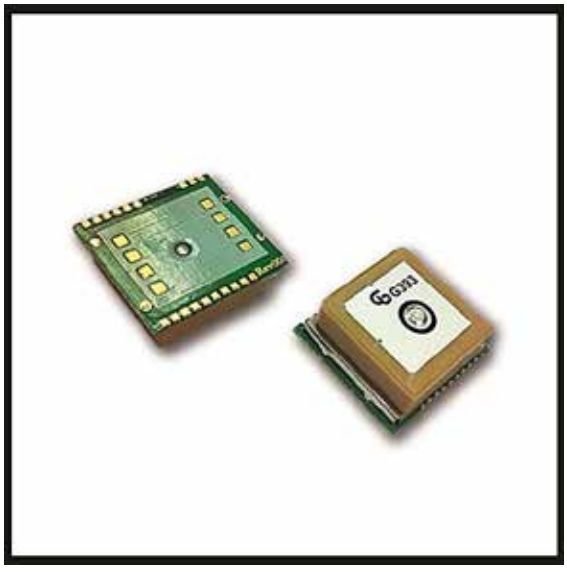
Product Highlights



Switch

Model No. P4T-9D25G-60-R-SFF-5W is a 9.25 GHz ± 30 MHz, single-pole, four throw solid-state switch capable of handling input power levels up to +37dBm peak with a maximum PRF of 8 kHz and a maximum pulse width of 1.5 us. It can handle an average input power of +33 dBm CW while offering low insertion loss of 2.0 dB maximum and over 40 dB of isolation. Switching speed is 50 ns and DC operating voltages are +5VDC & -12VDC.

Planar Monolithics Industries
pmi-rf.com



Antenna Module

Richardson RFPD announced availability and design support capabilities for a new GPS antenna module subsystem from Maestro Wireless Solutions. The A2135-H combines an enhanced, fully-functional SiRFStar IV GPS engine and a custom-designed high directional patch antenna on-board. It presents a solution to the most critical challenges in the GPS market: simplified integration, leading performance, and efficient time-to-market.

Richardson RFPD
richardsonrfpd.com

Product Highlights

Attenuators

Model series 372-182-XXX* are 75 Ohm fixed attenuators available in 1-20 and 30 dB attenuation values featuring an operating frequency range of DC - 3 GHz. Attenuation accuracy is ±0.5 dB maximum DC - 1 GHz, ±0.75 dB maximum 1 - 2 GHz and ±1.0 dB maximum 2 - 3 GHz. Maximum VSWR is 1.50:1, input power is 2 watts average, RF connectors are N male / N female and the operating temperature range is -55˚C to +125˚C.

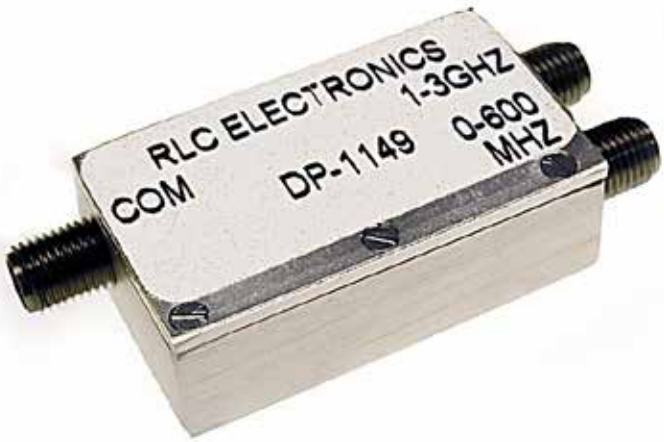
BroadWave Technologies
broadwavetechnologies.com

Benchtop Amps

Pasternack announced its lines of portable benchtop amplifiers that cover extremely wide frequency bands up to 40 GHz. These rugged RF amplifier modules are designed to meet MIL-STD-202F environmental test conditions for humidity, shock, vibration, altitude and temperature cycle which makes them ideal for use inside high traffic test labs in industries such as aerospace, defense, optical, industrial, telecom and R&D.

Pasternack
pasternack.com

Product Highlights



Multiplexers

RLC Electronics' multiplexers are available in two, three or four channel versions. Adjacent passbands may be designed for a contiguous response, impedance matched through the crossover region with theoretical 3 dB power split at the crossover frequency. Alternatively, non-contiguous passbands may be selected with an out-of-band region between adjacent passbands. For passband frequencies below 2 GHz, lumped element designs will often achieve the desired response in the smallest package.

RLC Electronics
rlcelectronics.com

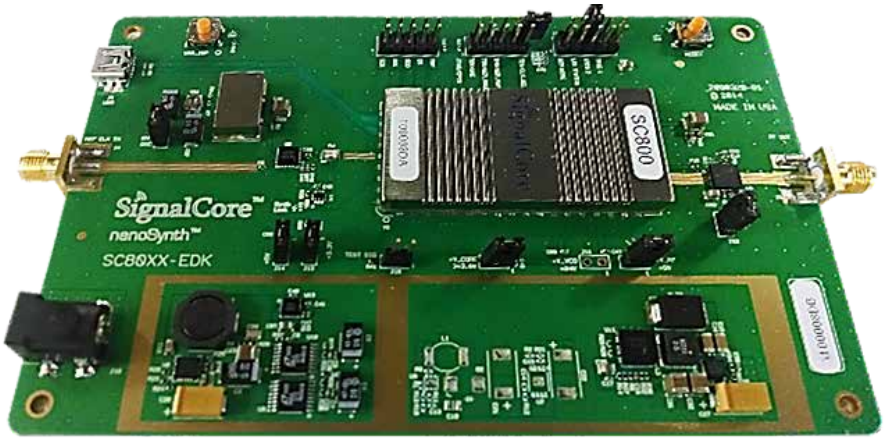
Power Supply

Versatile Power's line of BENCH 600W Programmable Power Supplies are compact, programmable, DC power supplies and are nearly half the cost compared to the industry's leading producer of power supplies. The power supply measures just 1.73 in. (44 mm) High x 8.82 in. (224 mm) Wide x 10.30 in. (262 mm) Deep and Weighs only 5.8 lbs. (2.6 Kg).

Versatile Power
versatilepower.com

Product Showcase

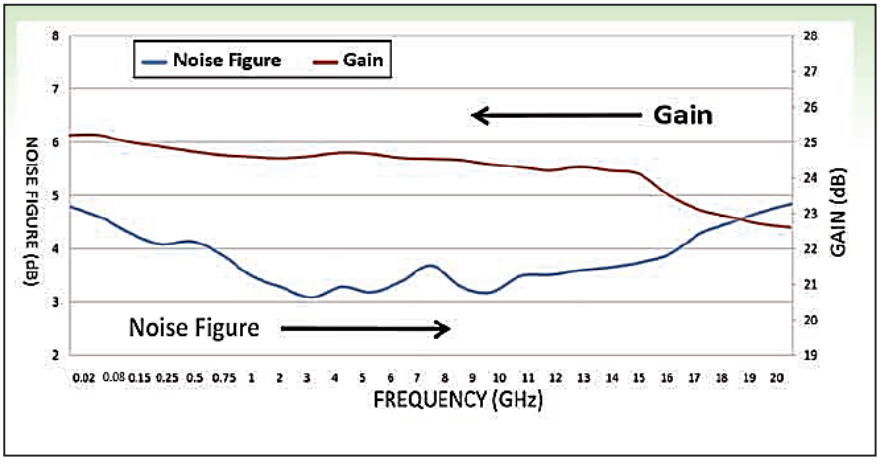
Product Highlights



Synthesizer

The SC800 nanoSynth™ is a fully integrated broadband CW signal synthesizer designed with a proprietary architecture in a rugged and miniature 2"x1" surface mountable package. Output frequency range is 25 MHz to 6 GHz with average output power of +10 dBm. Tuning at 1 Hz resolution, the multiple PLL design eliminates close-in phase spurs associated with fractional-N PLLs.

SignalCore
signalcore.com



Broadband Amps

The Ultra-Broadband Amplifier Series includes designs that cover frequency ranges as wide as 20 MHz to 20 GHz of instantaneous bandwidth. They feature flat gain response over ultra-broadband widths with typical gain flatness of better than +/- 2.0 dB over the full frequency bands. Featuring noise figures of 3.2 dB TYPICAL over much of their bands with very good input and output matches of better than 2.0:1.

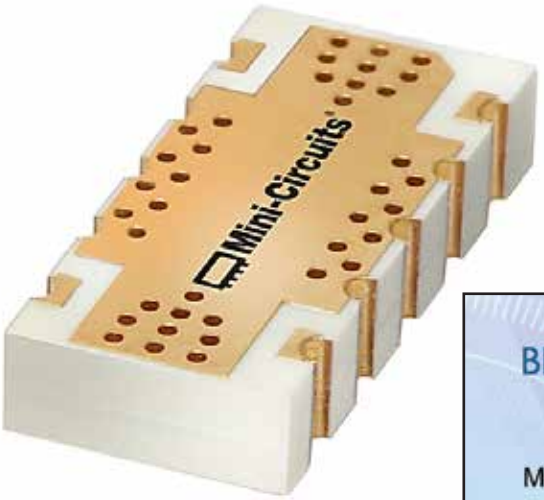
Ciao Wireless
ciaowireless.com

Product Highlights

Power Meter

Boonton's versatile 4541 (1 Ch) and 4542 (2 Ch) combined Peak/Average Power and Voltage meters are leading-edge instruments for most accurate RF measurements. Features like high dynamic range, rise time of less than 7ns and an effective time resolution of 200 ps provide the greatest detail in signal waveform analysis. These are the instruments of choice for capturing, displaying, and analyzing RF power in both the time and statistical domains.

Boonton
boonton.com



Coupler

The SCBD-16-63HP+ is a 50Ω, Up to 100W 50 to 6000 MHz Bi-Directional Coupler that features: wide frequency range, 50 to 6000 MHz; usable from 10-8000 MHz; high directivity, 23 dB typ.; good return loss; high power, up to 100W; DC current pass through input to output. Applications: cellular; lab use; WiMax; PCN; GSM; ISM.

Mini-Circuits
minicircuits.com

70 GHz Oscilloscope Offers Speed, Precision, Scalability

The new DPO70000SX 70 GHz oscilloscope from Tektronix combines high-performance with low noise and scalability to address such applications as high-speed coherent optical system development and advanced scientific research. The real-time oscilloscope's accurate characterization of high-speed signals is enabled by its use of a patented asynchronous time interleaving technique for extending bandwidth. Key features include:

- Low noise, 70 GHz real time signal capture
- Compact 5.25-inch (3U) instrument package for space and energy efficiency in laboratories or test stations
- Precise, scalable performance for multi-channel systems using the UltraSync time synchronization bus
- Leading trigger performance with >25 GHz Edge trigger bandwidth and RF envelope trigger

A major contributing factor to the DPO70000SX oscilloscope's performance is ATI technology. Current approaches for digitizing ultra-high bandwidth signals distribute signal energy to two digitizing paths then use a DSP to reconstruct the input signal. Unlike these schemes, the ATI architecture provides a symmetric technique that delivers all signal energy to both digitizing paths resulting in an inherent noise advantage.

> "UltraSync is used to tightly synchronize sample clock, trigger and run-stop control across multiple units."

The DPO70000SX uses a 5.25-inch (3U) package that optimizes space usage and shortens the signal path to the device under test. Two DPO70000SX instruments stack in less height than a single similar-class bench instrument yet achieves higher measurement performance. Each compact, SX-series unit provide full oscilloscope functionality and performance. All SX-series models run the full suite of Tektronix's Advanced Analysis applications for tasks such as jitter, noise, optical modulation and spectral analysis.

DPO70000SX-series instruments include the new Tektronix UltraSync multi-unit time synchronization bus. UltraSync is used to tightly synchronize sample clock, trigger and run-stop control across multiple units with performance better than what can be found in many of today's monolithic oscilloscopes. This scalable approach to performance allows users to purchase performance suitable for today's requirements and add more units over time, or to deploy units individually or in pairs to meet other test demands.

Tektronix
http://info.tek.com/www-dpo70000sx-ati-performance-oscilloscope-wc.html

Micro Lambda Wireless Celebrates 25 Years at IMS 2015

Micro Lambda Wireless, designer and manufacturer of YIG oscillators, synthesizers, filters, multipliers, and benchtop instruments, marked its 25th year in business at IMS 2015, with a celebration at Phoenix's Heard Museum. The anniversary featured museum tours, cocktails, dinner, remarks from top management, and performances by American Indian musicians and dancers. Founded in 1929, the Heard Museum is recognized internationally for the quality of its Native American art collections, its educational programming, and its festivals.

Micro Lambda Wireless President and CEO John Nguyen (right), and VP of Sales and Marketing Rich Leier kick off the festivities at Micro Lambda Wireless's 25th Anniversary celebration at IMS 2015.

President and CEO John Nguyen addresses invitees.

The Heard Museum's outdoor courtyard provided an appealing setting.

Phoenix's Heard Museum served as the venue for Micro Lambda Wireless's 25th anniversary celebration at IMS 2015.

Native American music was a highlight of the event.

Native American performers entertain the crowd.

A Native American dancer entertains attendees.

Celebrants queue up for cocktails in the Heard Museum outdoor courtyard.

Vice-President of Sales and Marketing Rich Leier welcomes attendees.

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