Vol. 52 • No. 6

June 2009

Microwave Journal

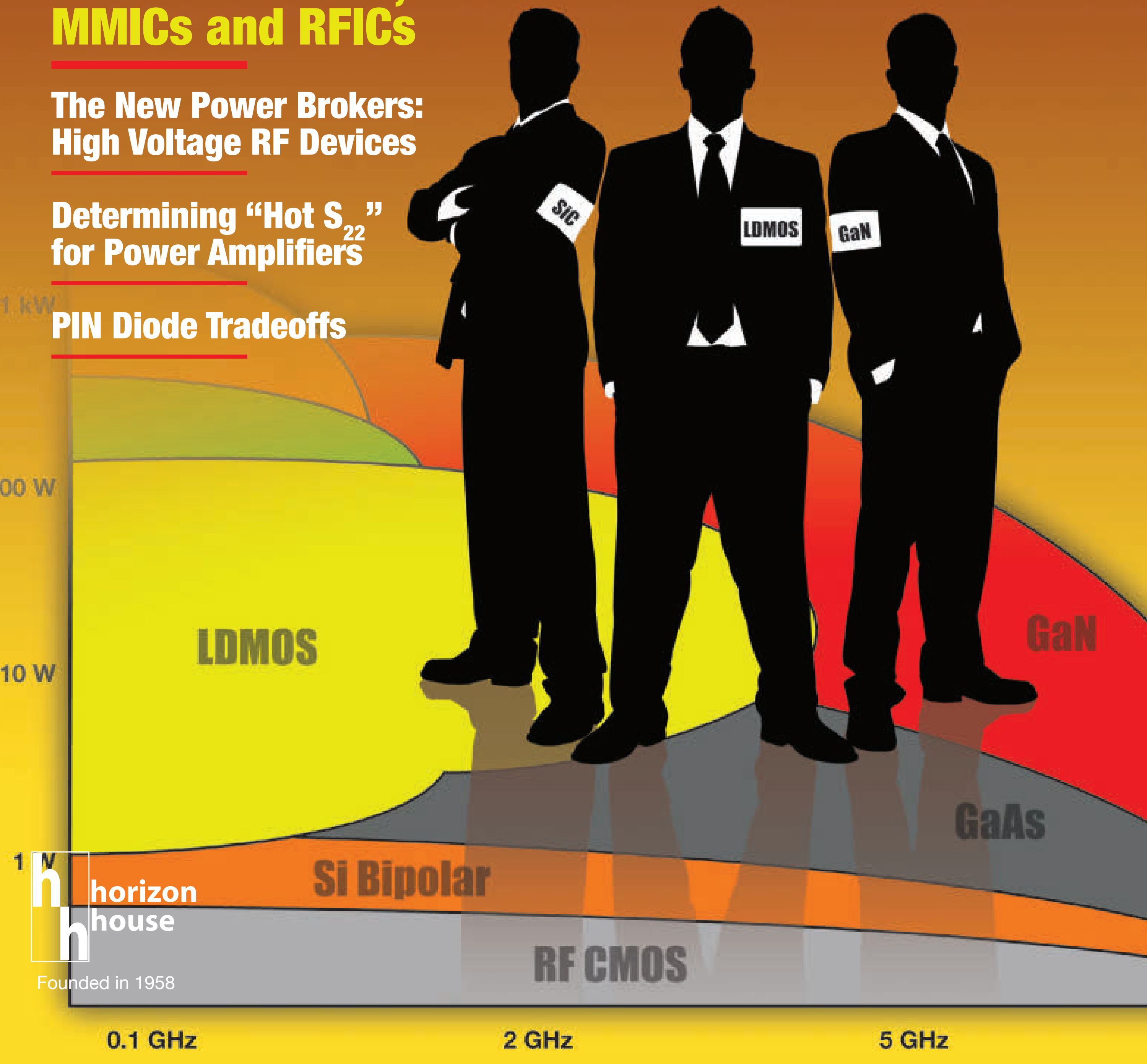
www.mwjournal.com

Semiconductors, MMICs and RFICs

The New Power Brokers: High Voltage RF Devices

Determining “Hot S_{22}” for Power Amplifiers

PIN Diode Tradeoffs



horizon house
Founded in 1958

MECA DELIVERS HIGH FREQUENCY COMPONENTS OFF THE SHELF!

Most models available from STOCK - 4 weeks ARO

- Microwave Radio
- Mobile Satellite
- Earth Station
- Instrumentation
- Telemetry
- Radar
- Aviation

- **Multi-Octave Power Divider/Combiners**
- **Octave Band Directional & Hybrid Couplers**
- **Attenuators, Terminations, Isolators/Circulators**
- **L, S, C, X and Ku Bands**

New Catalog Supplement
Focus on High Frequency

START YOUR CRITICAL PROJECTS ON TIME – EVERYTIME!

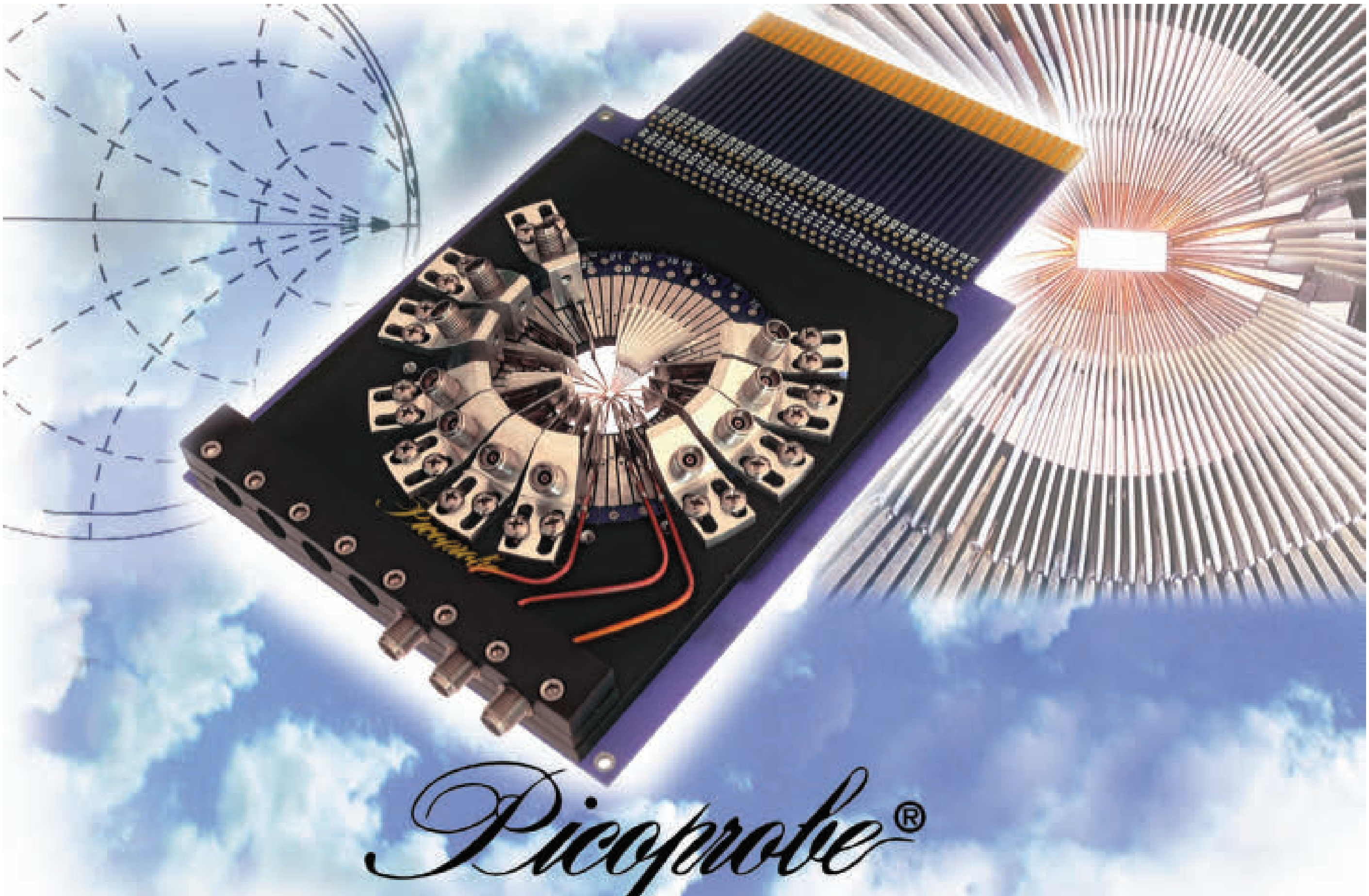
e-MECA.com

Microwave Electronic Components of America

866-444-6322 | sales@e-MECA.com | www.e-MECA.com
459 East Main Street, Denville, NJ 07834 T. 973-625-0661 F. 973-625-9277

Rugged and Reliable RF/Microwave Components
Since 1961 - Made in USA

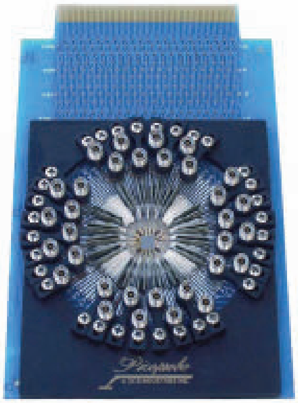
Visit http://mwj.hotims.com/23286-53 or use RS# 53 at www.mwjournal.com/info



Picoprobe elevates probe cards to a higher level…

(…110 GHz to be exact.)

Since 1981, GGB Industries, Inc., has blazed the on-chip measurement trail with innovative designs, quality craftsmanship, and highly reliable products. Our line of custom microwave probe cards continues our tradition of manufacturing exceptional testing instruments.



Through unique modular design techniques, hundreds of low frequency probe needles and a variety of microwave probes with operating frequencies from DC to 40, 67, or even 110 GHz can be custom configured to your layout.

Our patented probe structures provide the precision and ruggedness you require for both production and characterization testing. And only Picoprobe® offers the lowest loss, best match, low inductance power supplies, and current sources on a single probe card.

Our proven probe card design technology allows full visibility with inking capability and ensures reliable contacts, even when probing non-planar structures.

Not only do you get all the attractive features mentioned, but you get personal, professional service, rapid response, and continuous product support--all at an affordable price so your project can be completed on time and within budget.

Typical Specs	10GHz	20GHz	40GHz
Insertion Loss	0.6 dB	0.8 dB	1.3 dB
Return Loss	22 dB	18 dB	15 dB

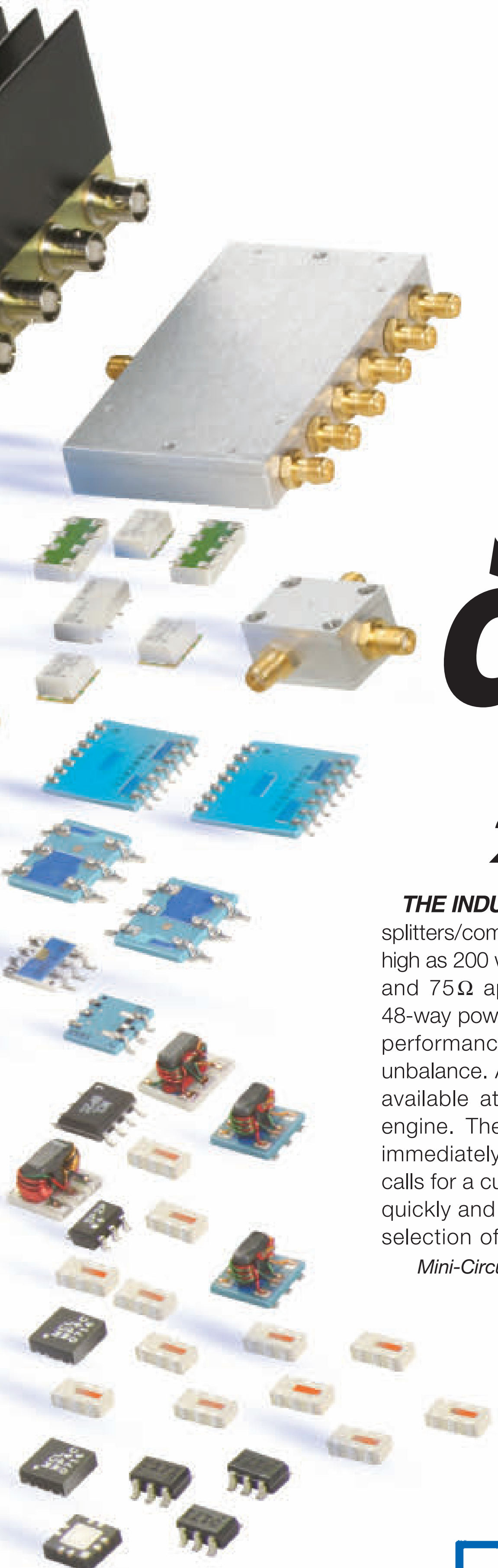
For technical assistance, custom product designs, or off-the-shelf delivery,call GGB Industries, Inc., at (239) 643-4400.

GGB INDUSTRIES, INC. • P.O. BOX 10958 • NAPLES, FL 34101

Telephone (239) 643-4400 • Fax (239) 643-4403 • E-mail email@ggb.com • www.picoprobe.com

Visit http://mwj.hotims.com/23286-35 or use RS# 35 at www.mwjournal.com/info


MCL B 744
ADP-2-10
MCL
QBA-12



POWER SPLITTERS/ COMBINERS

2 kHz to 12.6 GHz *as low as* 79¢

THE INDUSTRY'S LARGEST SELECTION Mini-Circuits offers thousands of power splitters/combiners for applications from 2 kHz to 12.6 GHz and with power handling as high as 200 watts. Choose from coaxial, flat-pack, and surface-mount housings, for 50Ω and 75Ω applications. The industry's largest selection includes 2-way through 48-way power splitters/combiners in 0°, 90°, and 180° configurations, with outstanding performance in terms of insertion loss, VSWR, amplitude unbalance, and phase unbalance. All models are characterized with detailed data and performance curves, available at the touch of a button using Mini-Circuits advanced Yoni2 search engine. These ***low-cost, off-the-shelf power splitters/combiners*** are available immediately, and backed by Mini-Circuits 1year guarantee. But if your application calls for a custom unit, our development team will meet or exceed your requirements quickly and cost-effectively. Contact Mini-Circuits today, for the industry's largest selection of power splitters/combiners.

Mini-Circuits...we're redefining what VALUE is all about!

RoHS Compliant
Product availability is listed on our website.

Mini-Circuits®
ISO 9001 ISO 14001 CERTIFIED

ALL NEW **minicircuits.com**

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending

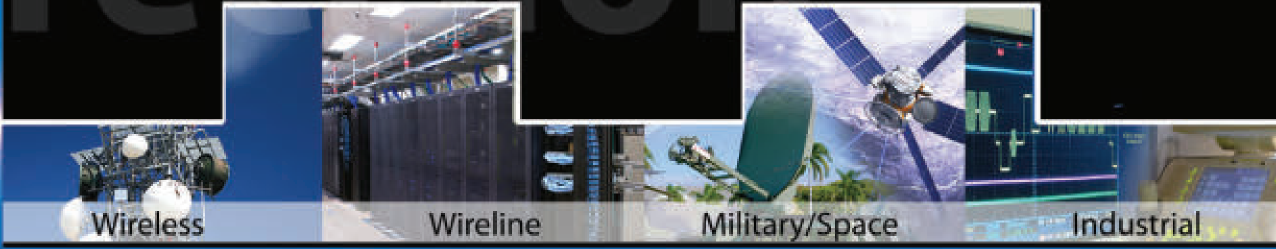
The Design Engineers Search Engine *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

IF/RF MICROWAVE COMPONENTS

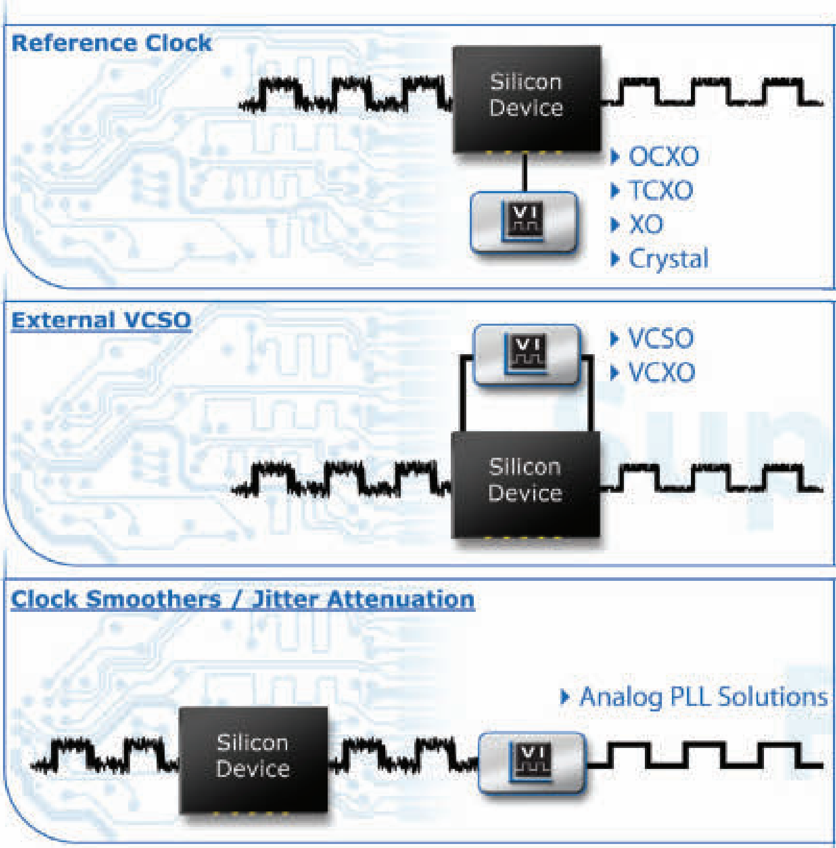
448 Rev Org

Visit http://mwj.hotims.com/23286-56 or use RS# 56 at www.mwjournal.com/info

Precision Frequency Control and Timing Solutions



Insure A Clean Clock Output From Your Silicon



Driving

Driven by Fundamental Precision Oscillators

Supporting

Supported by a Precision VCSO

Filtering

Filtered by Analog PLL Solutions

Select from **Our Precision Portfolio**
that supports Your Performance Requirements,
insuring **Stability, Synchronization and Timing**

For more information on Vectron products, please contact a customer service representative at 1-88-VECTRON-1 or visit www.vectron.com

OCXO/EMXO | TCXO | VCSO | VCXO | Jitter Attenuation | SAW Filter | Clocks/XO | Crystals | Timing Solutions | Hi-Temp Electronics

Precision Timing Solutions

With over 50 years of experience, we are the leader in providing frequency control and precision timing solutions to our customers around the world. Our innovative approach to design and manufacture has resulted in the most advanced product offering of any Frequency Control Supplier in the world.

Helping Customers Innovate, Improve & Grow

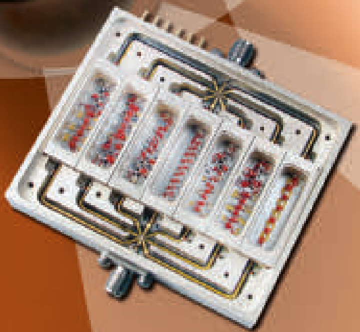
VECTRON INTERNATIONAL
A DOVER COMPANY

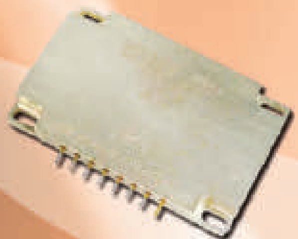
Visit http://mwj.hotims.com/23286-112 or use RS# 112 at www.mwjournal.com/info

K&L MICROWAVE
A DOVER COMPANY
CMP

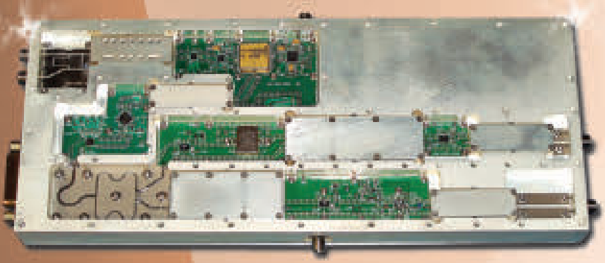
Filter Solutions

Integrated Microwave Assemblies
Frequency Agile Filters
Tunable Assemblies
Extremely Fast Switching
Low Profile Packaging





Product Spotlight



Up-Converter / Down-Converter Assemblies

K&L Microwave's Up-Converter/Down-Converter Assemblies employ state-of-the art RF, analog and digital technologies to maximize performance while minimizing size. These assemblies are configured from proven modular designs consisting of amplifiers, switches, multipliers, couplers and limiters. They also feature:

- Narrowband and Wideband Filtering
- Custom Compact Sizes
- Rugged Design for Military Applications
- Terminated IF Diplexer for Maximum IP3 Performance
- Integrated Low-Noise Amplifiers & Switches
- LO Pre-Amp & Multiplexers
- Available Frequency Ranges: 10.0 MHz to 18.0 GHz
- Operating Temperature Range: -40 to + 85°C

Filter Wizard SM

K&L Microwave's Filter Wizard SM software simplifies selection of the right filter product for your application from a vast number of designs. Provide desired specifications, and Filter Wizard SM returns response data and outline drawings for matching products. Visit www.klfilterwizard.com today!

CERAMIC & MICROWAVE PRODUCTS
Electronic Components & Microwave Solutions
A DOVER COMPANY
CMP

Certified System
AS 9100
ISO 14001

K&L Microwave, Inc. • 2250 Northwood Drive • Salisbury • MD • 21801 • P: 410-749-2424 • F: 443-260-2268
www.klmicrowave.com • www.klfilterwizard.com • sales@klmicrowave.com • sales@kleurope.com

Visit http://mwj.hotims.com/23286-45 or use RS# 45 at www.mwjournal.com/info

Enter Our "Strongest Link" Contest and Help Us Demonstrate What Has Always Been Known...Narda Components Last a Lifetime!

Entering Is Simple!

Go to Our "Strongest Link" Web Site:
www.nardamicrowave.com/strongestlink
Fill Out the Entry Form, Attach a Photograph of Your Oldest Narda Component Still In Service, and You'll Be Entered to Win a New **Sony Vaio Laptop** or Equivalent

Every Qualified Entry Will Receive a 4 GB USB "Link"

We're looking for photographs and application information on old Narda components that are still in service today...the older the better. The oldest example we receive will **Win the Grand Prize of a New Sony Vaio Laptop.** Every qualified submission will receive a 4 GB USB "link" as a thank you for entering. All photos and usage documentation will be posted on our new **Narda Strongest Link** community web site. ***For contest rules and to enter, visit our "Strongest Link" web site today!***

narda
microwave-east

The Most Trusted Link to RF & Microwave Solutions.

an L3 communications company

435 Moreland Road, Hauppauge, NY 11788
Tel: 631.231.1700 • Fax: 631.231.1711
e-mail: nardaeast@L-3com.com
www.nardamicrowave.com

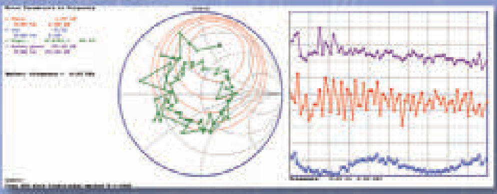
Visit http://mwj.hotims.com/23286-83 or use RS# 83 at www.mwjournal.com/info

Measure With Confidence!

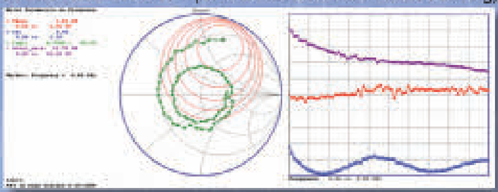
Maury & Agilent are Teamed Together for PNA-X Apps

100X+ Speed Improvement in Noise Parameter Measurement with Maury + PNA-X

Old Method

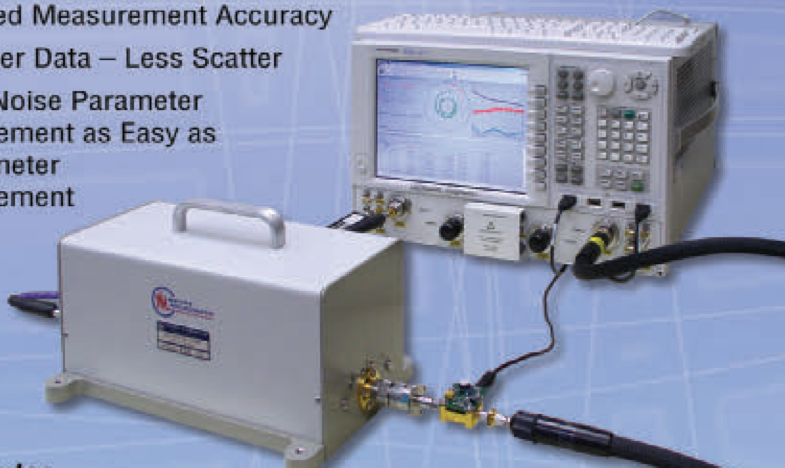


New Method* *(U.S. & International Patents Pending)*



- Simple Setup & Ultra-Fast Process (224X Faster fo the Example Shown)
- Enhanced Measurement Accuracy
- Smoother Data – Less Scatter
- Makes Noise Parameter Measurement as Easy as S-Parameter Measurement

Maury ATSv5.1 Software runs Inside Agilent's PNA-X

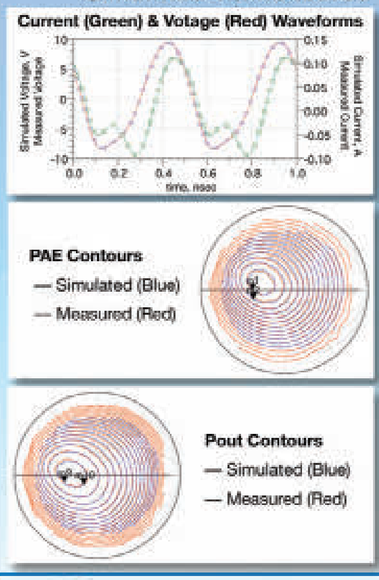


*Produces More Accurate Results in Just **8 Minutes** (Including Tuner Cal, Noise Receiver Cal, & DUT Measurements for 73 Frequencies!)*

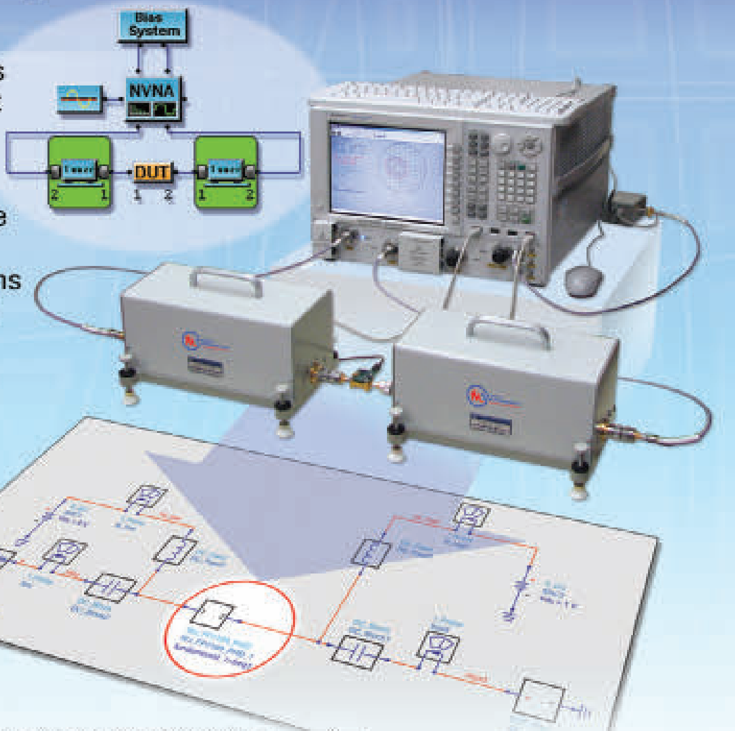
Maury Load Pull + NVNA Provides Instant Large Signal Models

Start Simulation Immediately with X-Parameter Large Signal Models Covering the Entire Smith Chart

Excellent Agreement – Simulated vs Measured



- Automated Process from Measurement to Simulation with Simple Setup
- Includes Magnitude & Phase Data as Non-linear Functions of Power, Bias and Load at Each Harmonic
- Includes Time Domain Data



MAURY MICROWAVE
WWW.MAURYMW.COM

Contact our Sales Department for more information
2900 Inland Empire Blvd.
Ontario, California 91764 USA
Tel: 909-987-4715 • Fax: 909-987-1112
Email: maury@maurymw.com

Agilent Technologies
Channel Partner

Visit http://mwj.hotims.com/23286-52 or use RS# 52 at www.mwjournal.com/info

JUNE 2009 VOL. 52 • NO. 6

COVER FEATURE

TECHNICAL FEATURES

Microwave Journal (USPS 396-250) (ISSN 0192-6225) is published monthly by Horizon House Publications Inc., 685 Canton St., Norwood, MA 02062. Periodicals postage paid at Norwood, MA 02062 and additional mailing offices.

Photocopy Rights: Permission to photocopy for internal or personal use, or the internal or personal use of specific clients, is granted by *Microwave Journal* for users through Copyright Clearance Center provided that the base fee of $5.00 per copy of the article, plus $1.00 per page, is paid directly to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923 USA (978) 750-8400. For government and/or educational classroom use, the Copyright Clearance Center should be contacted. The rate for this use is 0.03 cents per page. Please specify ISSN 0192-6225 *Microwave Journal* International. *Microwave Journal* can also be purchased on 35 mm film from University Microfilms, Periodic Entry Department, 300 N. Zeeb Rd., Ann Arbor, MI 48106 (313) 761-4700. Reprints: For requests of 100 or more reprints, contact Wendelyn Bailey at (781) 769-9750.

POSTMASTER: Send address corrections to *Microwave Journal*, PO Box 3256, Northbrook, IL 60065-3256 or e-mail mwj@omeda.com. Subscription information: (847) 291-5216. This journal is issued without charge upon written request to qualified persons working in that part of the electronics industry, including governmental and university installation, that deal with VHF through light frequencies. Other subscriptions are: domestic, $120.00 per year, two-year subscriptions, $185.00; foreign, $200.00 per year, two-year subscriptions, $370.00; back issues (if available) and single copies, $10.00 domestic and $20.00 foreign. Claims for missing issues must be filed within 90 days of date of issue for complimentary replacement.

©2009 by Horizon House Publications Inc.

Posted under Canadian international publicatioans mail agareement #0738654


CONTINENTAL & KEVLIN:
FOR COMPATIBILITY YOU CAN COUNT ON.
The power of Cobham integration is always working for you. Continental Microwave and Kevlin are proof of that. Continental Microwave and Kevlin are world-class manufacturers of waveguide and integrated waveguide subsystems, slotted arrays and microwave electro-mechanical rotating sub-systems. Whatever your requirements, you can count on Cobham to deliver
TAKING INTEGRATION TO NEW HEIGHTS.
For all your product needs -- Electronic Warfare, Homeland Security, Radar, Ground & Mobile Communications, Search and Surveillance, Smart Munitions, Force Protection, Missiles, Space, Satellite Communication, SIGINT, and Overhaul and Repair.
COBHAM
www.cobham.com
ATLANTIC POSITIONING SYSTEMS www.atlanticpositioners.com 727.299.0150 ATLANTIC MICROWAVE www.atlanticmicrowave.com 978.779.6963
CONTINENTAL MICROWAVE www.contmicro.com 603.775.5200 KEVLIN www.kevlin.com 978.557.2400 LANSDALE www.cobhamdes.com 215.996.2000
M/A-COM www.macom.com North America 800.366.2266 Europe +44 0 1908.574200 Asia / Pacific +81.44.844.8296 NURAD www.nurad.com 410.542.1700
REMEC DEFENSE & SPACE www.remecrds.com 858.560.1301 SIVERS LAB AB www.siverslab.se +46 8 477 6811
Visit http://mwj.hotims.com/23286-23 or use RS# 23 at www.mwjournal.com/info

Microwave Journal

PRODUCT FEATURES

DEPARTMENTS

I have just finished reading the RFID article on page 58 of the March issue. I would like to correct the author's description of the Cardullo/Parks device covered by US Patent # 3,713,148. I am the co-inventor and designer of the device and I am also a co-founder of the company that designed the device. The author states the device is a "passive" transponder. My understanding of passive devices is that they use "backscatter" as the retransmission technique. Our device had an RF transmitter stage. This was necessary as we needed much more range than is possible with passive backscatter devices. The device was also RF carrier powered and therefore needed no batteries. Finally, the device had a rewriteable memory. That was a lot of technology for 1970.

We thought we had a device that would revolutionize such chores as collecting tolls, keeping track of railroad cars, etc. Sadly, when we presented the device to the Port Authority of New York and New Jersey they turned us down. One of the reasons they gave was because it "violated driver's rights" to photograph them for failing to pay the toll and therefore they were not interested. The Southern Rail Road had a barcode scanner and they were not interested. San Francisco's BART also turned us down. And so it went. It's hell being first and a small business.

Yours,

William Parks

PS: I enjoyed the article.

STAFF

Publisher: Carl Sheffres
Editor: David Vye
Managing Editor: Keith W. Moore
Technical Editor: Patrick Hindle
Associate Technical Editor: Dan Massé
Staff Editor: Jennifer DiMarco
Editorial Assistant: Barbara Walsh
Consulting Editor: Harlan Howe, Jr.
Consulting Editor: Frank Bashore
Consulting Editor: Peter Staecker
Consulting Editor: Dan Swanson
Web Editor: Samantha Bookman
Circulation Manager: Michelle Frazier
Traffic Manager: Edward Kiessling
Director of Production & Distribution: Robert Bass
Multimedia Designer: Greg Lamb
DTP Coordinator: Janice Levenson
Graphic Designer: Sachiko Stiglitz

EUROPE

International Editor: Richard Mumford
Office Manager: Eugenie Hardy

CORPORATE STAFF

Chairman: William Bazzy
CEO: William M. Bazzy
President: Ivar Bazzy
Vice President: Jared Bazzy

Editorial Review Board

Dr. I.J. Bahl
D.K. Barton
F.M. Bashore
Dr. E.F. Belohoubek
Dr. C.R. Boyd
N.R. Dietrich
Dr. Z. Galani
Dr. F.E. Gardiol
G. Goldberg
M. Goldfarb
Dr. P. Goldsmith
Dr. M.A.K. Hamid
J.L. Heaton
Dr. G. Heiter
N. Herscovici
Dr. W.E. Hord
H. Howe, Jr.
Dr. T. Itoh
Dr. J. Lasker
Dr. L. Lewin
Dr. J.C. Lin
Dr. S. Maas
Dr. R.J. Mailloux
S. March
Dr. G.L. Matthaei
Dr. D.N. McQuiddy
Dr. J.M. Osepchuk
Dr. J. Rautio
Dr. U. Rohde
Dr. G.F. Ross
M. Schindler
Dr. P. Staecker
F. Sullivan
D. Swanson
Dr. R.J. Trew
G.D. Vendelin
C. Wheatley
Dr. J. Wiltse
Prof. K. Wu

Executive Editorial Office:
685 Canton Street, Norwood, MA 02062
Tel: (781) 769-9750
FAX: (781) 769-5037
e-mail: mwj@mwjournal.com

European Editorial Office:
16 Sussex Street, London SW1V 4RW, England
Tel: Editorial: +44 207 596 8730 Sales: +44 207 596 8740
FAX: +44 207 596 8749

www.mwjournal.com

Printed in the USA


AWR®
Shatter your EM speed record
AXIEM™ is a quantum shift in momentum for 3D planar EM simulators. More than lightning quick, AXIEM is the most accurate solver in its class. And it's capable of solving big problems as well — typically 10x faster than current alternatives. Let us prove it on one of your toughest designs. If it doesn't shatter your EM speed record, lunch is on us! Go to axiem3d.com/lunch and take the challenge. Think Fast. Think AXIEM.
AXIEM
3D PLANAR EM
Advancing the wireless revolution™
Visit http://mwj.hotims.com/23286-19 or use RS# 19 at www.mwjournal.com/info
© 2009 AWR Corporation. All rights reserved.

Microwave Journal Online

Go to www.mwjournal.com

The latest industry news, product updates, resources and web exclusives from the editors of *Microwave Journal*

Free Webinar

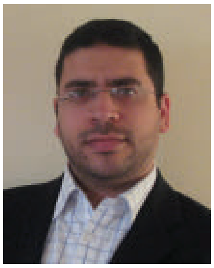
MWJ/Besser Associates Webinar Series

High-speed Design
EMC Basics

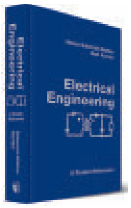
In this Webinar, the presenter will discuss EM radiation, shield theory and faraday cages, return current path management, transmission line basics, and common and differential modes.

Live webcast:
6/23/2009, 11:00 am (ET)

Expert Advice



Dr. Ali Muhammad Abuelma'atti, Device Modeling Engineer at **RFMD (UK)**, talks about the design and optimization of low power, low noise and power amplifiers.



Read the advice from this industry expert, respond with your comments and win a complimentary copy of *Electrical Engineering: A Pocket Reference* from Artech House (see www.mwjournal.com for details).

Featured White Papers

Rohde & Schwarz Develops a New Technique for Group Delay Measurements without LO Access
Thilo Bednorz, Product Management & Applications Engineering, Spectrum and Network Analysis, Rohde & Schwarz

EM Analysis within the Design Flow
Dr. Mike Heimlich, AWR

A-GPS Over the Air Test Method: Business and Technology Implications
Spirent Communications

Correcting Imperfections in IQ Modulators Improves RF Signal Fidelity
Eamon Nash, Analog Devices

More on the New Power Brokers

Read the full responses to our questionnaire on the state of LDMOS, GaN, SiC and HV-FETs from contributors RFMD, Freescale, NXP, Cree, Nitronex and HVVi. Go to www.mwjournal.com/powerbrokers.

Executive Interview

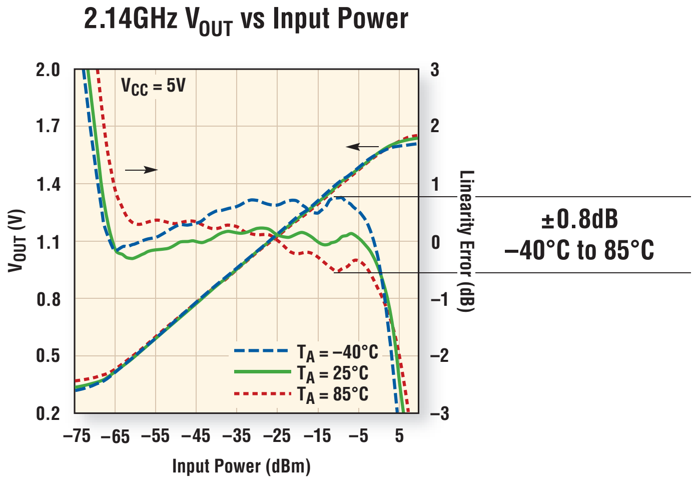
Dr. Bernd Niedermann, Head of Corporate Communications at **HUBER+SUHNER**, explains the company's evolution since its formation following the merger of two independent companies 40 years ago, its commitment to providing connectivity solutions and its strategies for developing new technologies.

MWJ Blog

Our Blog section now includes guest bloggers from the industry, discussing the state of business and technology. Follow (RF) Leonard Pelletier of Freescale Semiconductor and Sherry Hess of AWR along with the various musings of *Microwave Journal* editors. Go to www.mwjournal.com for details.

75dB Dynamic Range 3.8GHz Log Detector

Actual Size
3mm x 3mm DFN



Best-in-Class Performance at Half the Power

Whether you are designing next generation LTE (Long-Term Evolution) cellular or WiMAX broadband wireless, the LT®5538 extends system performance. Its unparalleled accuracy and dynamic range minimizes equipment calibration requirements, resulting in stable system performance and reduced operating costs.

Outstanding RF Detector Family

Product Category	Part Number	Dynamic Range	Frequency Range	Power	Package
Log Detector	LT5534	60dB	50MHz to 3GHz	7mA @ 3V	2mm x 2mm SC-70
	LT5537	83dB	LF to 1GHz	13.5mA @ 3V	3mm x 2mm DFN
	LT5538	75dB	40MHz to 3.8GHz	29mA @ 3V	3mm x 3mm DFN
RMS Detector	LT5570	60dB	40MHz to 2.7GHz	26.5mA @ 5V	3mm x 3mm DFN
	LT5581	40dB	10MHz to 6GHz	1.4mA @ 3.3V	3mm x 2mm DFN
Schottky Peak	LTC®5505	34dB	0.3GHz to 3GHz	0.5mA @ 3.3V	SOT-23
	LTC5532	35dB	0.3GHz to 12GHz	0.5mA @ 3.3V	TSOT-23, 2mm x 2mm DFN

Info & Free Samples

www.linear.com/5538

1-800-4-LINEAR

www.linear.com/wireless

LT, LTC, LT, LTM and Burst Mode are registered trademarks of Linear Technology Corporation. All other trademarks are the property of their respective owners.

LINEAR TECHNOLOGY

Visit http://mwj.hotims.com/23286-47 or use RS# 47 at www.mwjournal.com/info

WORLD'S WIDEST SELECTION

VCOs

RoHS COMPLIANT
RoHS models available, consult factory.

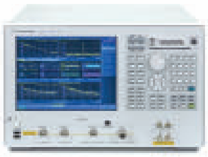
10 to 6740 MHz from $11.95 ea. (qty. 5)

Want a miniature surface mount, shielded plug-in, or rugged coaxial voltage controlled oscillator with the right stuff for your project? Contact Mini-Circuits! From custom designs to standard catalog models ***always in stock***, we'll supply extra robust, 100% tested VCO solutions you need at a price you can afford. Choose from narrow to broad to octave band widths. Select linear tuning, low phase noise, and 5V models optimized for PLLs and synthesizers. And pick from an innovative array of miniature SM packages as small as 0.370" square for a variety of designs and applications. You can quickly find the model you need using "The YONI2 Search Engine" at the Mini-Circuits web site.

Just enter your specifications into YONI2...click...and immediately start evaluating suggested VCO solutions using the *actual measured performance data* displayed. But perhaps you need a custom design. Not a problem! Contact us for our lightning fast response, low prices, and quick turnaround. Give the competition *real competition*... specify Mini-Circuits VCOs!

Agilent Technologies

For high reliability, all Mini-Circuits VCOs are tested with the Agilent E5052B Signal Source Analyzer.
www.agilent.com/find/ssa



Mini-Circuits®
ISO 9001 ISO 14001 CERTIFIED

ALL NEW **minicircuits.com**

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending ***The Design Engineers Search Engine*** *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

IF/RF & MICROWAVE COMPONENTS

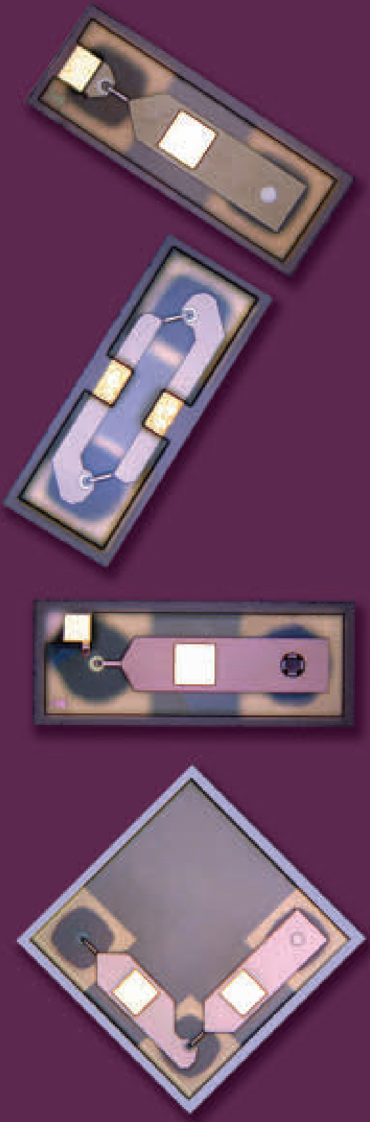
359 Rev J

Visit http://mwj.hotims.com/23286-57 or use RS# 57 at www.mwjournal.com/info

JULY 2009

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
28	29	30	1	2	3	4
5	6	7	8 ◄	9 **43rd Annual Microwave Power Symposium** Washington, DC	10	11 ◄ **UK Microwave Group** Yorkshire Roundtable, Finningley
12 **UK Microwave Group** Yorkshire Roundtable, Finningley ►	13	14 **43rd Annual Microwave Power Symposium** · **CST 2009 Innovation Workshop** Chicago, IL	15 ◄ **ASQED 2009** **The 1st Asia Symposium on Quality Electronic Design** Kuala Lumpur, Malaysia	16 **Ansoft Product Training** San Jose, CA	17 ►	18
19 ►	20	21 **MWJ/Besser Webinar: OFDM and OFDMA** Besser Associates / AWR	22	23	24 ◄	25 **UK Microwave Group** Amsat-UK Colloquium, Manchester University
26 **UK Microwave Group** ►	27	28 	29 ◄► **Birthday Henry Albert Howard "Harry" Boot** English physicist who developed the cavity magnetron with Sir John Randall. Born 29 July 1917	30 	31	1

Go to: www.mwjournal.com/events


M/A-COM Technology Solutions
surface mount diodes

Delivering High frequency performance with the lowest parasitic capacitance and inductance

www.macomtech.com

M/A-COM Technology Solutions

Visit http://mwj.hotims.com/23286-50

Coming Events

CALL FOR PAPERS

The International IEEE Conference on Microwaves, Communications, Antennas and Electronic Systems
Deadline: June 15, 2009

APMC 2009
Asia Pacific Microwave Conference
Deadline: June 19, 2009

IEEE Applied Electromagnetics Conference
Deadline: August 15, 2009

For complete coverage of the IMS 2009 conference, event news, exhibitor product information and special reports from the editors of *Microwave Journal*, visit our online show daily at www.mwjournal.com/ims2009.

www.mwjournal.com/events

JUNE

EMC 2009/China
International Exhibition on Electromagnetic Compatibility
June 16–18, 2009 • Beijing, China
http://expo.ces.org.cn

China MW 2009
China Microwave 2009 Exhibition
June 16–18, 2009 • Beijing, China
http://chinamw2009.ces.org.cn

JULY

ASQED 2009
The 1st Asia Symposium on Quality Electronic Design
July 15–16, 2009 • Kuala Lumpur, Malaysia
www.isqed-asia.org

AUGUST

NIWeek 2009
August 4–6, 2009 • Austin, TX
www.ni.com/niweek

EMC 2009
IEEE International Symposium on Electromagnetic Compatibility
August 17–21, 2009 • Austin, TX
www.emc2009.org

SEPTEMBER

4G World 2009
September 15–18, 2009 • Chicago, IL
http://4gworld.com

Antenna Applications Symposium
September 22–24, 2009 • Monticello, IL
www.ecs.umass.edu

EuMW 2009
European Microwave Week
September 28–October 2, 2009
Rome, Italy
www.eumweek.com

OCTOBER

RF & Hyper 2009
October 6–8, 2009 • Paris, France
www.rfhyper.com

International Radar Conference
October 12–16, 2009 • Bordeaux, France
www.radar09.org

AOC 2009
46th Annual AOC International Symposium and Convention
October 18–22, 2009 • Washington, DC
www.crows.org

ISAP 2009
International Symposium on Antennas and Propagation
October 20–23, 2009 • Bangkok, Thailand
www.isap09.org

NOVEMBER

AMTA 2009
Antenna Measurement Techniques Association
November 1–6, 2009 • Salt Lake City, UT
www.amta.org

COMCAS 2009
The International IEEE Conference on Microwaves, Communications, Antennas and Electronic Systems
November 9–11, 2009 • Tel Aviv, Israel
www.comcas.org

DECEMBER

APMC 2009
Asia-Pacific Microwave Conference
December 7–10, 2009 • Singapore
www.apmc2009.org

AEMC 2009
IEEE Applied Electromagnetics Conference
December 14–16, 2009 • Kolkata, India
www.ieee-aemc.org

JANUARY

Radio Wireless Week 2010
January 10–14, 2010 • New Orleans, LA
www.radiowirelessweek.org

FEBRUARY

Nate 2010
National Association of Tower Erectors
February 15–18, 2010 • Orlando, FL
www.natehome.com

Delivering High Power...in the field and beyond

M/A-COM Technology Solutions' high power MELF PIN diodes are well suited for the demanding needs of military, consumer and industrial applications.

- Ideal for applications from DC to 1 GHz
- Surface mount hermetic package with low RF resistance (R_S) and thermal resistance (θ) — the ultimate choice for power switch applications
- High voltage (V_R) — ideal for high peak voltage applications such as MRI systems
- Low distortion vs. forward current — optimal for stringent attenuator applications
- Available in tape and reel for high volume manufacturing

For details, contact your local M/A-COM Technology Solutions sales office or visit www.macomtech.com

Part Number	V_R (V)	R_S (Ω)	C_T (pF)	θ (°C/W)
MA4PH235-1072T	35	0.5	1.2	15
MA4P1450-1091T	50	0.75	2.5	5
* MA4P1250-1072T	50	0.75	1.5	15
* MA4P4001F-1091T	100	0.5	2.2	5
* MA4P7101F-1072T	100	0.5	1	15
MA4P7001F-1072T	100	0.8	0.7	15.5
MA4P4301F-1091T	100	1	2	8
MA4P4002F-1091T	200	0.5	2.2	6.5
MA4P7102F-1079T	200	0.5	1	21
MA4PH237-1079T	200	0.6	1.5	25
MA4P7002F-1072T	200	0.8	0.7	15
MA4PH236-1072T	200	3	0.5	25
MA4P7104F-1072T	400	0.5	1	20
MA4P506-1072T	500	0.3	1	10
MA4P505-1072T	500	0.45	0.65	15
MA4P504-1072T	500	0.6	0.5	20
* MA4P4006F-1091T	600	0.5	2.2	6
* MA4P7006F-1072T	600	0.8	0.7	13

* Non-magnetic equivalents available

M/A-COM Technology Solutions, Inc.
Lowell, Massachusetts 01851
North America 800.366.2266 • Europe +353.21.244.6400
India +91.80.4155721 • China +86.21.2407.1588
www.macomtech.com

M/A-COM Technology Solutions

Visit http://mwj.hotims.com/23286-51 or use RS# 51 at www.mwjournal.com/info

The whole is far greater than the sum of its parts

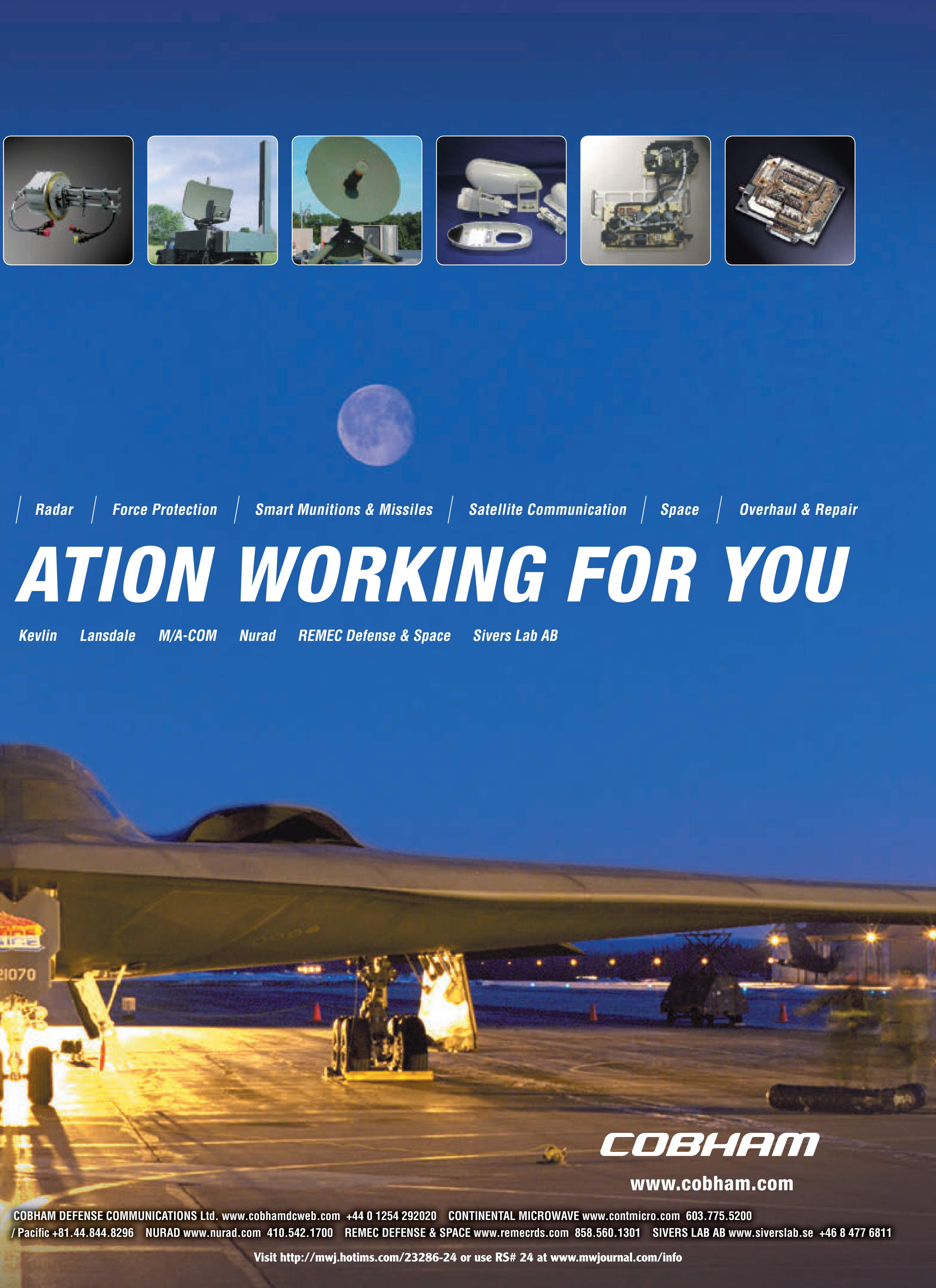

Cobham Sensor Systems consists of these groups: Sensor Electronics, Microwave Electronics, and Microwave Components. For added assurance, all our products, from the smallest MMIC components to the largest antenna subsystems, are designed, manufactured, tested and inspected to meet the most stringent customer specifications.


Electronic Warfare | *Ground & Mobile Communications* | *Homeland Security* | *Search & Surveillance*

THE POWER OF INTEGR

Atlantic Positioning Systems *Atlantic Microwave* *Continental Microwave*

ATLANTIC POSITIONING SYSTEMS www.atlanticpositioners.com 727.299.0150 ATLANTIC MICROWAVE www.atlanticmicrowave.com 978.779.6963
KEVLIN www.kevlin.com 978.557.2400 LANSDALE www.cobhamdes.com 215.996.2000 M/A-COM www.macom.com North America 800.366.2266 Europe +44 0 1908.574200 Asia


Radar
Force Protection
Smart Munitions & Missiles
Satellite Communication
Space
Overhaul & Repair
ATION WORKING FOR YOU
Kevlin
Lansdale
M/A-COM
Nurad
REMEC Defense & Space
Sivers Lab AB
COBHAM
www.cobham.com
COBHAM DEFENSE COMMUNICATIONS Ltd. www.cobhamdcweb.com +44 0 1254 292020 CONTINENTAL MICROWAVE www.contmicro.com 603.775.5200
/ Pacific +81.44.844.8296 NURAD www.nurad.com 410.542.1700 REMEC DEFENSE & SPACE www.remecrds.com 858.560.1301 SIVERS LAB AB www.siverslab.se +46 8 477 6811
Visit http://mwj.hotims.com/23286-24 or use RS# 24 at www.mwjournal.com/info

THE NEW POWER BROKERS: HIGH VOLTAGE RF DEVICES

Ever since Bell Lab physicists Shockley, Bardeen and Brattain invented the transistor, this little solid state device has been constantly evolving; leveraging the advantages of different semiconductor and process technologies and addressing an increasing number of applications once reserved for tubes. Sixty-plus years later—driven by a number of promising commercial and defense-related markets—transistors (and MMICs) specifically targeting high power applications in the RF and microwave frequency range continue to be the focus of sizable research and development.

Among the changing landscape of RF/microwave semiconductor developments, devices with material properties that can sustain high electric breakdown are of particular interest. To understand the state of the high power transistor market, we spoke to a number of leading vendors. Our discussion was mostly concerned with devices that could produce in excess of 30 W at UHF/VHF frequencies and above (up to X-band). These are the high-power transistors required for avionics, radar, EW and wireless infrastructure applications. Although these devices are also found in medical equipment, those applications will not be part of our focus in this article. The following is a summary of our correspondence.

HIGH POWER TRANSISTOR TECHNOLOGIES AND APPLICATIONS

Within the last six months alone, the *Journal* has published over a dozen papers on Laterally Diffused MOS (LDMOS), Gallium Nitride (GaN), Silicon Carbide (SiC) and High-Voltage Vertical FETs (HVVFET). The principle market segments for high-power, high-frequency transistors are wireless infrastructure (3G, 3G+, WiMAX/LTE base stations and backhaul), defense and military applications (radar, jamming, counter-measures, guided weapons, etc.) and broadcast and communication satellites (SatCom). The factors that will decide whether a technology dominates a given application include performance (linearity, efficiency), reliability (ruggedness and thermal considerations), size, cost and legacy.

DAVID VYE *Microwave Journal*
LEONARD PELLETIER *Freescale Semiconductor*
STEVEN THEEUWEN *NXP Semiconductors*
DAVE AICHELE *RFMD*
RAY CRAMPTON *Nitronex*
RAY PENGELLY *Cree Inc.*
BRIAN BATTAGLIA *HVVi Semiconductors*

RF & MICROWAVE FILTERS

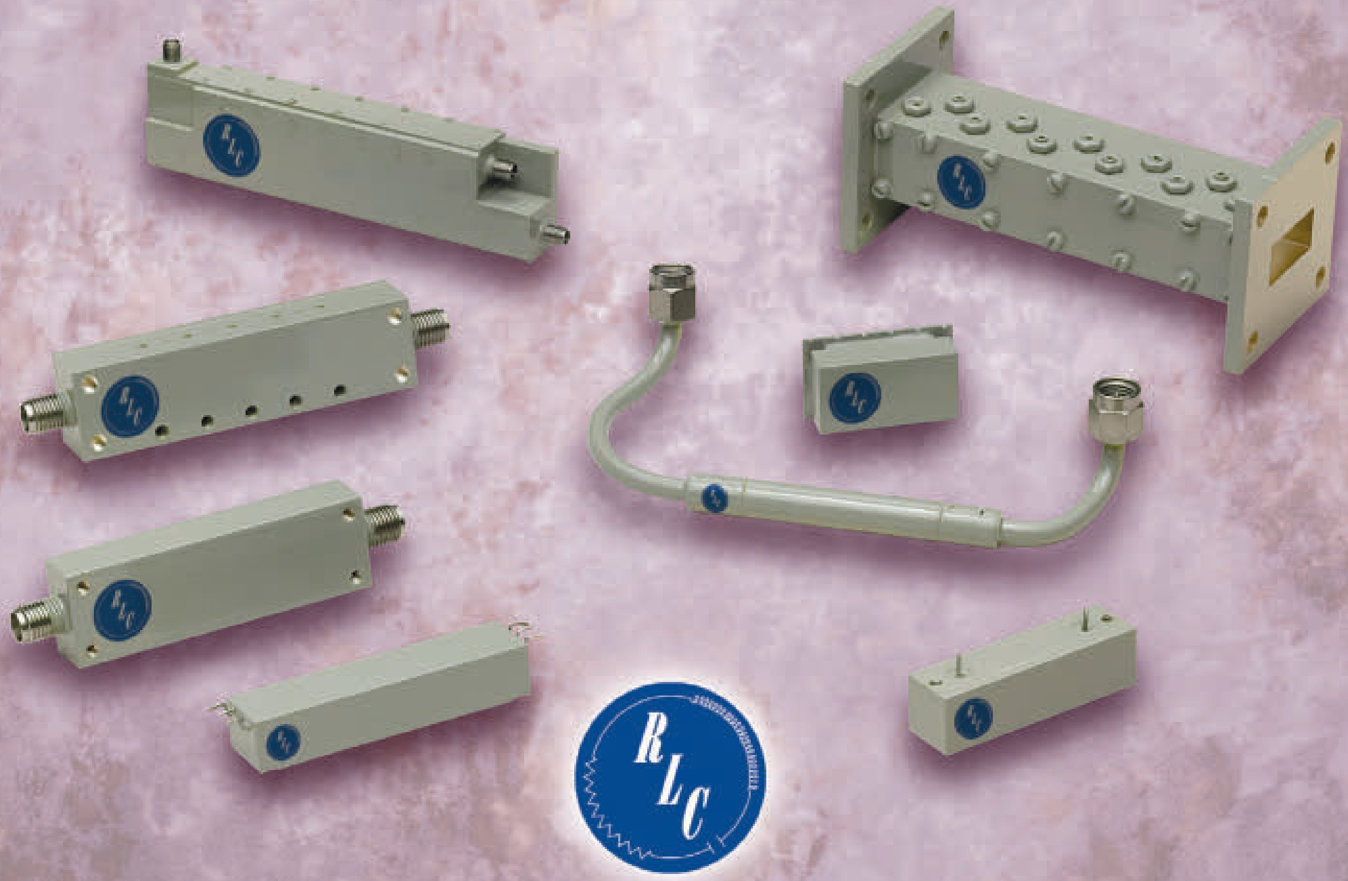
RLC has the customized filter solutions you need.

RLC manufactures a complete line of RF and Microwave filters covering nearly every application in the DC to 50 GHz frequency range. We offer different filter types, each covering a specific engineering need.

In addition, our large engineering staff and high volume production facility give RLC the ability to develop and deliver both standard and custom designed filters at competitive costs, within days or a few weeks of order placement.

- Band Pass, Low Pass, High Pass & Band Reject
- Connectorized, Surface Mount, PCB Mount or Cable Filters
- Wave Guide Bandpass and Band Reject
- 4th Order Bessel Filters
- Spurious Free, DC to 50 GHz, Low Loss, High Rejection
- Custom Designs

For more detailed information, or to access ***RLC's exclusive Filter Selection Software****, visit our web site.*



RLC ELECTRONICS, INC.

83 Radio Circle, Mount Kisco, New York 10549 • Tel: 914.241.1334 • Fax: 914.241.1753

E-mail: sales@rlcelectronics.com • www.rlcelectronics.com

ISO 9001:2000 CERTIFIED

VISA MasterCard

RLC is your complete microwave component source...
Switches, Filters, Power Dividers, Terminations, Attenuators, DC Blocks, Bias Tees & Detectors.

Visit http://mwj.hotims.com/23286-98 or use RS# 98 at www.mwjournal.com/info

Figure 1 maps the various high-power semiconductor technologies relative to their operating frequencies and available output power. With an understanding of the power and frequency requirements for a given application, this graph provides a rough guide to the leading technologies today. Implicit in this representation are regions where one technology overlaps another due to its cost advantage. This cost can be related to higher production costs (complexity, less mature processes or lower volume production all drive up costs) as well as replacement costs (a technology missed the critical time-to-market). As process technology advances and new standards (i.e. 4G) provide new opportunities to enter a market, technology dominance in any particular region is subject to change. These factors will be discussed later in this article.

RADAR AND AVIONICS

According to ABI Research, the demand for the pulsed RF power devices (greater than 5 W of peak output power and frequencies up to 3.8 GHz) is expected to show solid growth over the next five years, in part due to a worldwide upgrade of air traffic control systems including new avionics transponders and air navigation systems.[1] In response, many semiconductor manufacturers are attempting to enter the avionics, L-band, S-band and sub-1 GHz radar markets. Competitive technologies such as GaN and SiC devices will be vying for market share along with the more established silicon-based technologies. With the entry of many would-be players, competition will be fierce. Companies that have an established track record working with government agencies and defense contractors will naturally have an advantage over new entrants.

Long-range radar systems operating from VHF thru S-band are demanding increased performance from the RF power amplifier in order to support the required improvements in system ranging and sensitivity. A key lesson learned from the crisis on 9/11 was the need to extend the pulse width to at least 300 µs for long-range radar as well as the ability to increase the operating dynamic range of the power amplifier.[2]

UHF/VHF RADAR

Historically, silicon Class C amplifiers were limited by heat dissipation due to the potential for thermal runaway during long pulses (> 300 µs) and high peak powers. Military applications were among the first to use wide band gap (WBG) devices, especially with the SiC MESFETs being developed through broadly financed DARPA and DoD programs in the US.[3] Recently, Microsemi's Microwave RF Power Division developed its WBG SiC technology in support of the new longer pulse radar systems and avionics being developed from VHF thru S-band.

The state of material technology has progressed to the point where Microsemi can build high power devices with reasonable yields and consistent performance. In 2008, the company introduced its first two RF power transistors utilizing silicon carbide technology for high power VHF and UHF band pulsed radar applications. The two Common Gate N-Channel, Class AB, SiC Static Induction Transistors (SIT) are capable of providing 1000 W, pulsed (300 µsec pulse width, 10 percent duty cycle) from 406 to 450 MHz and 1250 W pulsed at 150 to 160 MHz.

In January, the company made good on its promise to extend SiC technology to higher frequencies by introducing a new family of power transistors and modules designed for S-band (3.1 to 3.4 GHz) pulsed radar. The new products include a 65 and 100 W power transistor and two Power Solution Modules TM rated at 180 and 200 W (100 µsec pulse width and 10 percent duty cycle). The modules demonstrate 40 percent collector efficiency and power flatness of less than 0.5 dB, utilizing the company's advanced chip design and processing enhancements for high power and high gain.

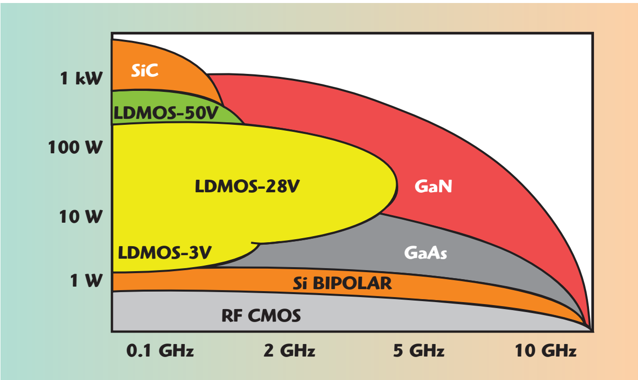
Around the same timeframe (December 2008), HVVi Semiconductors announced its first product to target the UHF-band weather and long-range radar markets using its High Voltage Vertical Field Effect Transistor (HVVFET™) architecture. The company's 50 V device offered 175 W pulsed, 55 percent drain efficiency, 25 dB of gain for a pulse width of 300 µsec and pulse duty cycle of 10 percent at VDD = 50 V and IDQ = 50 mA. The UHF part also provided a boost to system reliability by withstanding an output load mismatch corresponding to a 20:1 VSWR across all phase angles at rated output power and operating voltage across the entire frequency band.

L-BAND RADAR

This new device, based on the company's HVVFET, followed the earlier releases (October 2008 at European Microwave Week) of three devices with pulsed output powers of 60, 100 and 250 W operating in the 1025 to 1150 MHz frequency band. These devices targeted airborne Distance Measuring Equipment (DME) applications, a transponder-based radio navigation technology that measures distance by timing the propagation delay of radio signals. The company also targeted ground-based DME (960 to 1215 MHz) with a 50 V device that provides 150 W, 20 dB gain and 43 percent drain efficiency.

These products expanded the company's portfolio across three L-band, pulsed radar applications: 1025 to 1150 MHz, 1030 to 1090 MHz and 1.2 to 1.4 GHz. The 1030 to 1090 MHz frequency band is used for IFF, TCAS and mode-S applications. For this market, HVVi introduced a pulsed (50 µs pulse width, 5 percent duty cyle) 35 W device (20 dB gain, 52 percent drain efficiency) and 300 W device (18 dB gain , 48 percent drain efficiency).

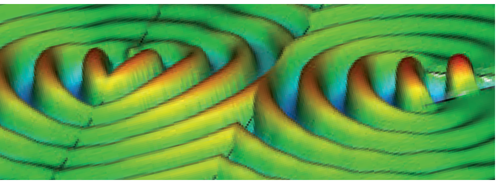
Meanwhile, Silicon Bipolar devices



▲ *Fig. 1 An overview of preferred transistor technologies for 2008 design-ins as a function of power and frequency (courtesy of NXP Semiconductors).*

Reach the next level

Pull ahead with CST MICROWAVE STUDIO. Explore your world with the No.1 technology for 3D EM simulation.



Visit http://mwj.hotims.com/23286-27 or use RS# 27 at www.mwjournal.com/info

→Get equipped for the job. CST's tools enable you to characterize, design and optimize electromagnetic devices all before going into the lab or measurement chamber. This can help save substantial costs especially for new or cutting edge products, and also reduce design risk and improve overall performance and profitability.

CST's flagship product, CST MICROWAVE STUDIO® [CST MWS], is the market leading time domain tool for 3D EM simulation, but its achievements don't stop there. CST MWS is the first commercial HF 3D EM code to offer the advantages of time and frequency domain, hexahedral, tetrahedral, and surface meshing, united in one interface. This gives you the flexibility to choose the technology best suited to solving your application. Embedded in an advanced design environment, CST MWS can be coupled with all CST STUDIO SUITE™ solver technology including circuit and thermal simulation.

Want to learn more? Take a look at why our customers have chosen CST technology: http://www.cst.com/Testimonials

→Go further; draw your advantage from CST technology.

CST

CHANGING THE STANDARDS

CST of America®, Inc. | To request literature (508) 665 4400 | info@cst.com

continue to be introduced into the market. Companies such as ST Microelectronics, NEC, Motorola and NXP have large Si-BJT product portfolios (to name a few). Last summer, M/A-COM announced a line-up of new high-power bipolar transistors designed for pulsed avionics applications such as ATC, DME and IFF systems, ranging from 960 to 1215 MHz. The Class C, Si-BJT pulse power transistors provide peak powers of 50, 350 and 500 W with gains of approximately 9 dB and 40 to 45 percent collector efficiencies. Integra Technologies also has an extensive portfolio of Si-BJT high power transistors targeting VHF through S-band pulsed radar applications, but they are also offering LDMOS devices as this technology continues to challenge the supremacy of the Si-BJT in the avionics and radar markets.

At last year's IMS in Atlanta, Freescale Semiconductor introduced the world's first 50 V LDMOS device for L-band radar with a demonstration of a class AB, long-pulse (300 µsec, 12 percent duty cycle) amplifier with peak power of 330 W, 17 dB gain and 60 percent drain efficiency operating between 1200 to 1400 MHz, a band used for ground-based, long-range surveillance radar applications. Freescale pointed to advantages, such as a standard voltage supply, low cooling costs and high reliability of pallet design and expected to demonstrate gain, efficiency and thermal resistance characteristics that would outperform other similar products in the market.

A year later at IMS in Boston, HVVi introduced its 500 W (19 dB gain, 50 percent drain efficiency) device operating with a 50 µsec pulse width, and 5 percent duty cycle adding to its portfolio of products with pulsed output powers of 25, 75 and 120 W (200 µsec pulse width, 10 percent duty cycle). The 500 W power level was also achieved by NXP Semiconductors this past November with an LDMOS device demonstrating greater than 50 percent drain efficiency and 17 dB of gain operating at 100 µsec pulse width and a 25 percent duty cycle at 1.4 GHz.

Japanese manufacturer Eudyna hit the 500 W mark and then some with an AlGaN/GaN HEMT 1.5 GHz power amplifier reported back in 2006 at the MTT-S IMS that year and an 800 W S-band transistor with linear gain of 14.0 dB, 56.4 percent drain efficiency covering a wide frequency range of 2.9 to 3.3 GHz (operating at 65 V, pulse width of 200 µsec and 10 percent duty cycle) reported just one year later at CS MANTECH. While Eudyna holds a strong position in the market, the company is at a disadvantage to domestic suppliers when it comes to US military opportunities due to (offshore) sourcing concerns. Not surprisingly, Eudyna markets its GaN HEMTs primarily to the WiMAX and LTE infrastructure markets where the majority of GaN manufacturers also have made considerable in-roads.

S-BAND RADAR

Integra Technologies addresses the S-band radar market with a comprehensive family of Si-bipolar devices (drivers, medium and high power amplifiers) operating from 2.2 up to 3.5 GHz (in bandwidths ranging from 200 to 400 MHz). The high power amplifiers have peak output powers up to 125 W (3.1 to 3.4 GHz) at 300 µs pulse width (PW), 10 percent DC and 140 W (3.1 to 3.5 GHz) at the shorter 100 µsec PW, 10 percent duty cycle. The company offers a LDMOS device operating at the same frequency and pulse conditions, which yields an output power of 154 W (29 W more) and an extra dB of gain (10.4 dB) at a lower drain voltage (32 vs. 36 V). This improvement in performance underlines the competition between technologies, even within the same company.

One domestic manufacturer going after the S-band radar market with GaN technology is RFMD. At last year's MTT-S IMS in Atlanta, the company debuted a 400 W pulsed output power GaN HEMT amplifier operating over the 2.9 to 3.5 GHz band (17 percent bandwidth). Under pulsed RF drive, with 10 percent duty cycle and 100 µsec pulse width, the amplifier delivers an output power in the range of 401 to 446 W over the band, with a drain efficiency of 48 to 55 percent when biased at a drain voltage of 65 V.

The wideband nature of GaN-based amplifiers, with the ability to easily cover 500 MHz to 3 GHz, make them well-suited for use in frequency agile pulsed applications such as military radar, air traffic control radar and communications jamming.

GaN Wideband Amplifiers

2-520MHz products

Part Number	Gain (dB)	Psat (W)
RWP02005-10	20	5
RWP02020-10	35	20
RWP02040-10	35	40
RWP02080-10	35	80
RWP02160-10	35	160

20-1000MHz products

Part Number	Gain (dB)	Psat (W)
RWP05020-10	37	20
RWP05040-10	37	40
RWP05080-10	35	80
RWP05200-10	35	200

450-870MHz products

Part Number	Gain (dB)	Psat (W)
RWP06005-10	20	5
RWP06020-10	37	20
RWP06040-10	37	40
RWP06080-10	35	80
RWP06200-10	35	200

500-2500MHz products

Part Number	Gain (dB)	Psat (W)	Size (MM)
RUP15010-10	14	10	55x30
RUP15010-11	57	10	120x80
RUP15020-10	15	20	60.4x30.2
RUP15020-11	57	20	120x80
RUP15030-10	14	30	90x50
RUP15050-10	11	50	100x50
RUP15100-10	55	100	130x60

2500-6000MHz products

Part Number	Gain (dB)	Psat (W)	Size (MM)
RUP43010-10	8	10	70x35
RUP43020-10	7	20	75x35

NEW VALUE STANDARD IN TOWN.

Are you looking for wideband amplifiers with great performance & value? Wideband amplifiers doesn't have to be always expensive.
Contact RFHIC for Broadcasting, Wireless communications & Military application wideband amplifiers, and feel the difference!

RFHIC

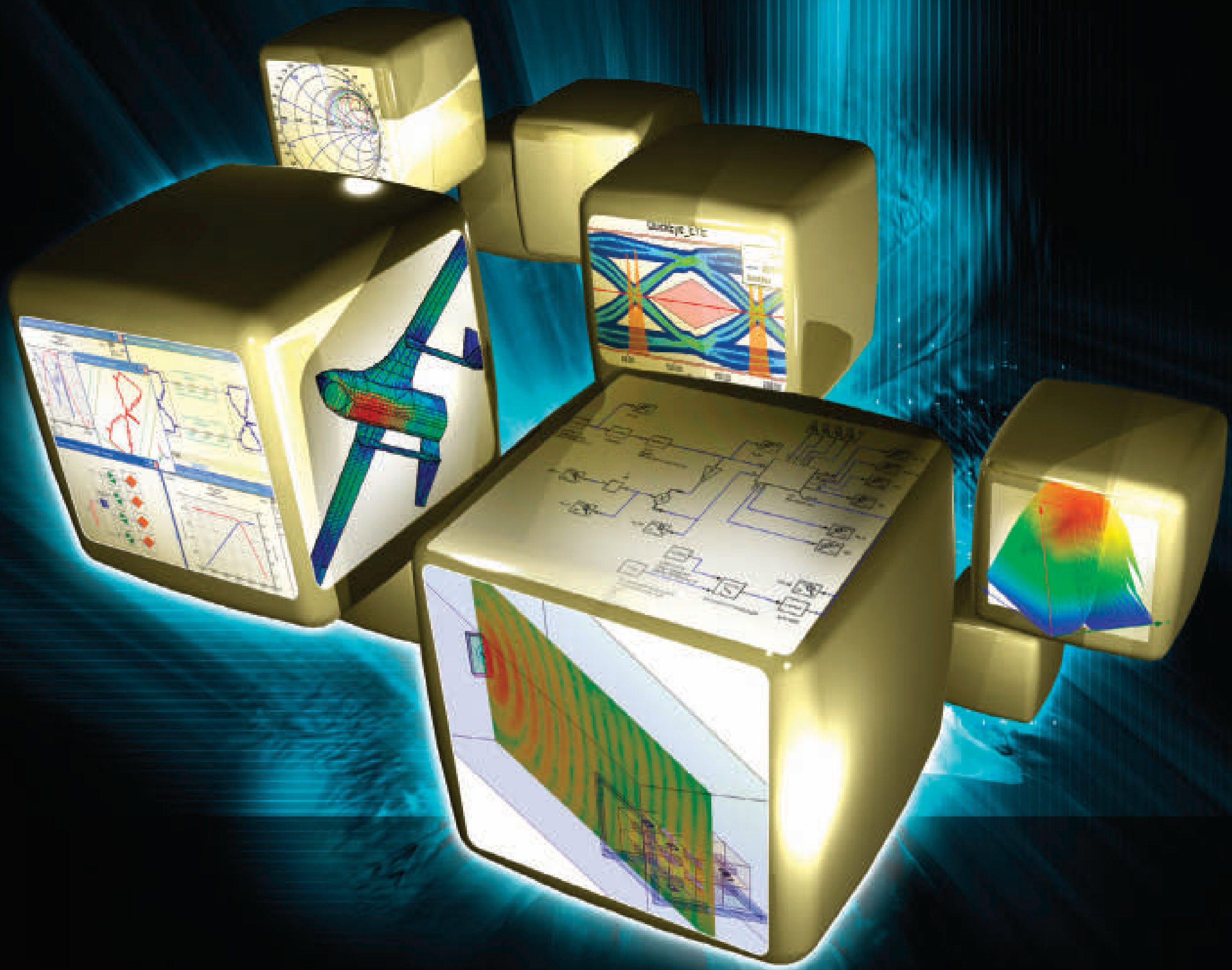
MTT-S Booth# 738

www.rfhic.com

Tel) 82-31-250-5011 / Fax) 82-31-250-5088
E-mail) rfsales@rfhic.com

Manufacturer of active RF components and modules primarily for the wired and wireless telecommunication and broadcasting markets, serving to over 45 international countries, and over 1000 customers.

Visit http://mwj.hotims.com/23286-95



FIRST-PASS SYSTEM SUCCESS

FOR RF & MICROWAVE DESIGN

Let Ansoft show you how to achieve first-pass system success when designing high-performance RF and microwave systems. Our unique two-way dynamic link between HFSS and Ansoft Designer allows you to combine high-fidelity component modeling with accurate system and circuit simulation to precisely predict performance, tune and optimize your designs before committing to hardware.

With Ansoft first-pass system success is possible.
Ask us. We will show you how.

ANSOFT.COM

ANSOFT

A subsidiary of ANSYS, Inc.

Visit http://mwj.hotims.com/23286-12 or use RS# 12 at www.mwjournal.com/info

In speaking with the *Journal*, RFMD remarked on GaN's higher efficiency for pulsed, CW saturated and linear applications, which improves thermal requirements and energy usage; showing 5 to 10 percent improvement over LDMOS and Si-Bipolar.

Ray Crampton of Nitronex further added that, "Radar applications require pulsed power in the hundreds of watts up to very high frequencies. This fits well because GaN devices offer improved robustness, higher efficiency, higher power density, higher gain and faster switching speed than competing technologies for today's broadband radar systems. GaN also offers the ability to replace TWTs with more reliable and robust devices." An example of Nitronex recent product offerings is the NPT1007, released last February. This is a 200 W device (based on two 100 W transistors) that targets military communication applications below 1.5 GHz and has notable "design-ins" in the 30 to 512 MHz band as well as bands up to 1 GHz, according to Crampton.

Meanwhile, TriQuint Semiconductor began investigating GaN technology back in 1999, and through subsequent years developed a baseline process that led to a DARPA contract focusing on technology maturity and wideband performance in 2005. This research and development effort resulted in a production-released 0.25 micron gate process supporting products from DC to 18 GHz and achieving power levels in excess of 100 W.

COMMERCIAL MARKETS – WIRELESS INFRASTRUCTURE

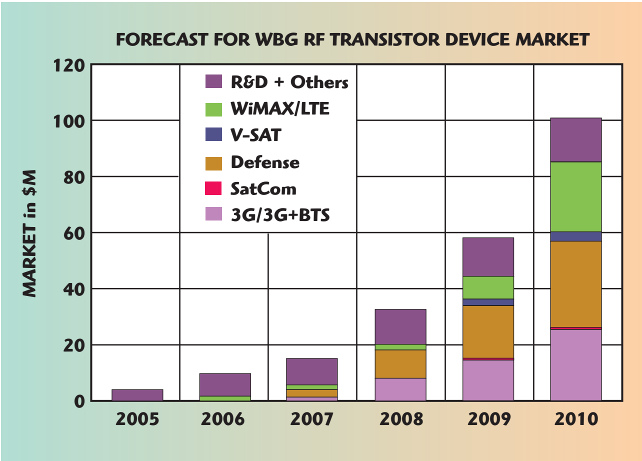
Until four years ago, LDMOS covered about 90 percent of the high power PA applications above 2 GHz; the remaining market share belonged mostly to GaAs PHEMT technology.

WBG devices made a significant commercial breakthrough in 2006 when Eudyna and NTT jointly announced the first 3G network "test" deployment using GaN HEMT in Tokyo. New commercial offerings from Cree, RFMD and Nitronex soon followed, targeting both base station (3G, WiMAX) and general purpose applications. According to a 2008 GaN RF market report by Yole Développement, "GaN is currently positioned to challenge silicon dominance in the high power RF amplifier market estimated to be about $900 M in 2008."[3] ABI Research has the RF power market somewhat below this figure at a predicted $800 M in 2011.[1] But this challenge is not across the board, as LDMOS maintains an upper hand with pricing and legacy in certain sectors.

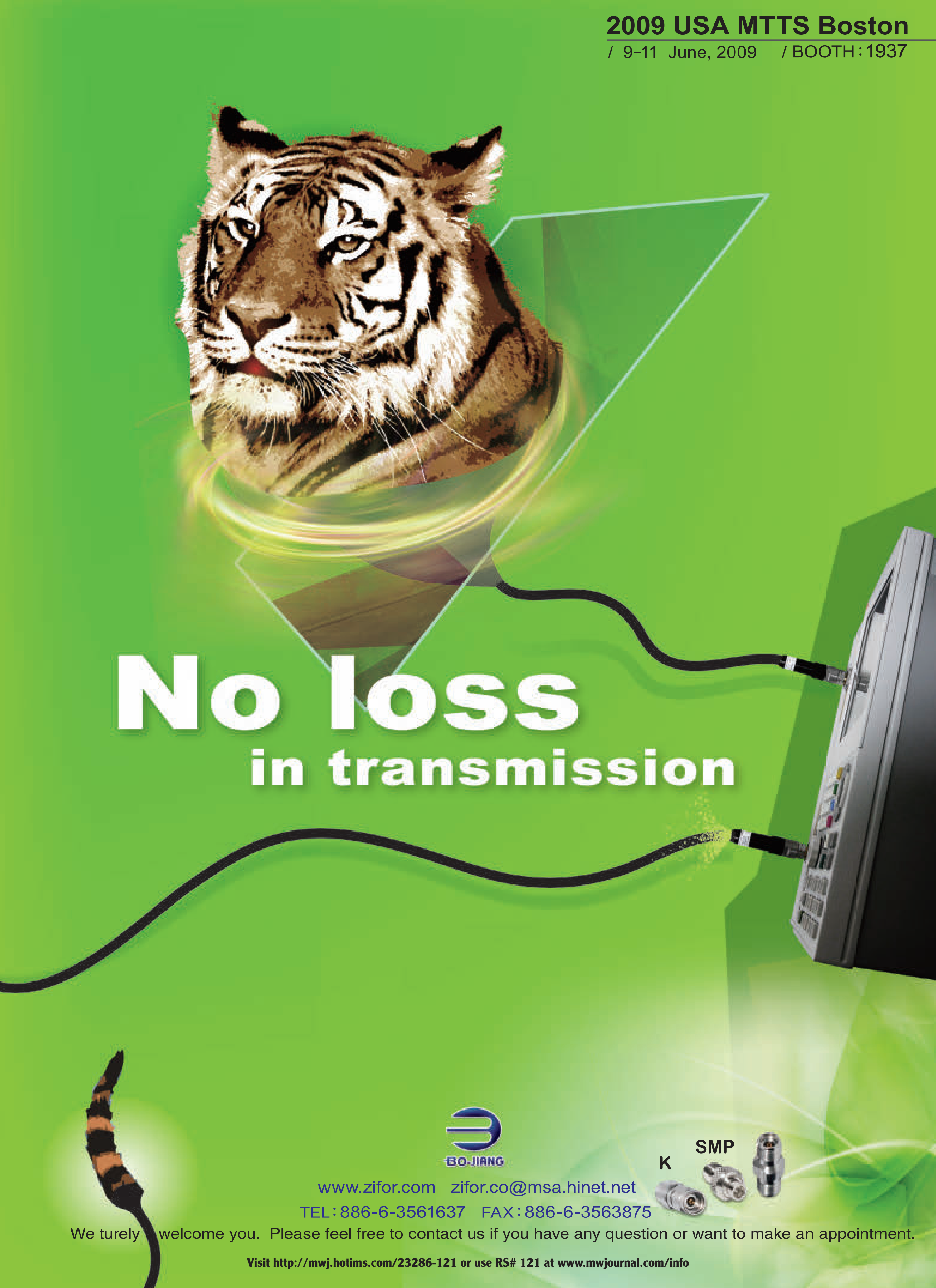
In the power market below 4 GHz, RF LDMOS transistors captured almost 70 percent of the total market in 2006. However, that number is predicted to go to 50 percent share of the RF power market in 2011, the ABI report forecasts. GaN may dominate most of the high-power markets at frequencies above 4 GHz, beyond the performance range of Si LDMOS. Eudyna Devices and Toshiba have wisely targeted the microwave (> 4 GHz) markets for much of their participation with GaN.

4G OPPORTUNITIES

Market analysts point to product announcements by GaN manufacturers as indicators of their increased focus on WiMAX/LTE markets and a shift away from existing 3G/3G+ infrastructure, where LDMOS is the entrenched technology. Unfortunately, the WiMAX market in 2009 has been hit rather hard by the economic downturn. Building-out brand new networks from scratch, as is the



▲ *Fig. 2 Projected RF markets for WBG transistors indicates most significant growth coming from 4G (courtesy of Yole Développement).*


2009 USA MTTS Boston
/ 9–11 June, 2009 / BOOTH：1937
No loss
in transmission
BO-JIANG
SMP
K
www.zifor.com zifor.co@msa.hinet.net
TEL：886-6-3561637 FAX：886-6-3563875
We turely welcome you. Please feel free to contact us if you have any question or want to make an appointment.
Visit http://mwj.hotims.com/23286-121 or use RS# 121 at www.mwjournal.com/info

case with WiMAX, requires hundreds of millions of dollars of capital. The current credit crunch along with a decrease in demand for broadband due to weakened consumer spending has led to many network build-outs being put on hold or delayed into next year.

Total sales of fixed and mobile WiMAX equipment fell 21 percent to US$245 M in the third quarter of 2008, from the second quarter's figure, and are expected to slide further in 2009 (a report in early May 2009 shows component makers revenue down 20 to 30 percent versus the year-ago quarter). Prior to the current slowdown, the GaN RF Market 2008 from Yole Développement had forecasted that the market size for GaN RF transistors could reach a level of about \$100 M by 2010, largely due to strong penetration of WiMAX/LTE systems, as shown in ***Figure 2.***

Still LTE rollouts are expected to be coming in the 2010 to 2011 timeframe and any WiMAX delays will shorten its current time to market advantage over LTE. Therefore, WiMAX deployment cannot afford to be postponed for too long. According to ABI Research, the LTE standard is being driven by operators, which is the key differentiator between it and preceding wireless technologies. CDMA and Asian operators who are early adopters will be the first to launch LTE. Existing UMTS operators will probably delay launch to extend the life of their existing HSPA networks and simplify the upgrade to LTE by slowly evolving their current architectures.

When network operators introduced HSPA, packet data traffic quickly exceeded voice traffic. In some cases, a four fold increase in data traffic occurred in just three months. Future WiMAX and LTE build-outs will be needed in order to serve 1.8 billion broadband subscriptions by 2012, according to a five year projection made by Ericsson in 2007.[4] To get there, high power transistors will need to deliver on performance, size, reliability and price.

TECHNOLOGY

WiMAX faces strong competition from existing wireless services, making it essential that WiMAX infrastructure equipment be as cost-effective as possible. A rough rule of thumb is that for high volume cellular base station applications, LDMOS prices are on the order of \$0.30 per W, GaAs is about \$0.9/W and GaN is about \$1/W. Performance-wise, linearity and efficiency for both WiMAX and LTE are also critical.

THE IMPORTANCE OF LINEARITY AND EFFICIENCY

Both WiMAX and LTE use OFDM as the core modulation technology in the downlink direction and thus have roughly similar performance for any given RF bandwidth and set of conditions. However, the uplink modulation techniques are somewhat different. While WiMAX uses OFDMA for the uplink, LTE uses single carrier frequency division multiple access (SC-FDMA), which has a significantly reduced Peak to Average Power Ratio (PAPR). WiMAX's OFDMA has a peak-average ratio of about 10 dB, while LTE's SC-FDMA's peak-average ratio is about 5 dB.

The higher PAPR associated with

Visit http://mwj.hotims.com/23286-26

Frequency Synthesizers

Features:

- Band Coverage from VHF through Ka-Band
- Low Phase Noise and Spurious Performance
- Serial or Parallel Interface
- Small Modular Assemblies from 2.25" x 2.25" x 0.6"
- New Models to satisfy the most demanding specifications
- Extended Temperature Range available

ISO 9001 Registered · ANAB · 3 Year Warranty

Model	Bands	Step Size	BW (GHz)	Typical Phase Noise 10	100	1K	10K	100K	1M	Output Frequency	Output Power (dBm, Min.)
BTE	L - Ku	1 kHz	2.2	-73	-80	-96	-96	-97	-123	12.72 GHz	13
MFS	L - K	1 kHz	2	-60	-75	-90	-95	-95	-120	5.3 GHz	13
CFS	L - K	1 Hz	2	-62	-75	-85	-89	-97	-110	14.84 GHz	13
Ku3LS	X - Ku	1 kHz	2.2	-62	-70	-75	-85	-97	-115	12.50 GHz	13
C3LS	C	1 kHz	1.1	-63	-88	-90	-100	-100	-115	5.50 GHz	13
UWB	S - K	1 kHz	Multioctave	-60	-71	-80	-90	-96	-105	12 GHz	13
MOS	VHF - K	1 kHz	Multioctave	-55	-65	-75	-85	-90	-100	20 GHz	13
SLS	L - Ku	125 kHz	1	-70	-80	-86	-88	-105	-115	3.3 GHz	13
SLFS	VHF - Ku	100 kHz	2	-70	-75	-80	-90	-115	-125	5 GHz	13
LFTS	VHF - Ku	100 Hz	1	-78	-88	-98	-98	-110	-130	350 MHz	13
VFS	L - Ku	>25 MHz	1.5	-60	-80	-110	-115	-115	-130	12.5 GHz	13

For additional information or technical support, please contact our Sales Department at (631) 439-9220 or e-mail components@miteq.com

MITEQ

100 Davids Drive, Hauppauge, NY 11788
(631) 436-7400 FAX: (631) 436-7430

www.miteq.com

Visit http://mwj.hotims.com/23286-77 or use RS# 77 at www.mwjournal.com/info

WiMAX and OFDMA requires that the amplifier handle the occasional high power levels that can greatly exceed the average signal strength without introducing unacceptable levels of distortion. One way to do this is to use a larger transistor operating far below its compression point, otherwise known as backing-off the amplifier. Unfortunately, amplifier efficiency takes a hit when the device is backed-off. At 2 GHz, the latest LDMOS has about 18 dB gain and is 65 percent efficient at the P1dB compression point. At a 6 dB back off point, the devices are typically -45 dBc WCDMA ACPR and 30 percent efficient. GaN offers slightly higher efficiency at 6 dB OBO.

SAVING SOME GREEN

According to Steven Theeuwen of NXP Semiconductors, "All the developments particularly for base stations and broadcast applications are driven by an ever increasing demand for higher efficiency, generally speaking. In turn this means less lost power, which means "greener" amplifiers. Higher efficiency does not only mean better use of RF power, but also reduces the energy necessary to remove the dissipated energy (cooling systems). Hence, improved efficiency helps twice, on amplifier and system level, to reduce overall power consumption. NXP claims leadership in delivering high efficient transistors and high efficiency concepts: developing the world's first fully integrated Doherty amplifier and the highest efficiency, discrete Doherty setup to date." (Ed. note: Based on LDMOS technology.)

At Mobile World Congress (Barcelona, Spain) in February, Freescale introduced its next generation (HV8) of LDMOS high power transistors, specifically targeting the stringent demands of high-data rates called for by WCDMA, WiMAX, LTE and Multicarrier GSM. The company claims that a primary benefit of the HV8 technology is the increase in operating efficiency, reducing the total power consumption of a base station system. This growing concern in "green" technology is driven by a global desire to cut energy costs and reduce the industry's carbon footprint along with the telecom provider's interest in lowering operating expenses.

The new devices introduced in February operate over the 860 to 960 MHz range, providing a power output range of 100 to 300 W and can be used in Class AB or C configurations. A symmetrical Doherty reference design using two transistors designed for multicarrier GSM applications was shown to deliver 58.0 dBm (630 W) peak power, 16.3 dB gain and a drain efficiency of 42.5 percent at an average output power level of 49.4 dBm (87 W) with good broadband linearity. Digital pre-distortion (DPD) evaluations showed the reference design to correct very well with six GSM carriers in signal bandwidths of up to 20 MHz.

According to Leonard Pelletier of Freescale, one of the most substantial system-related issues to consider when working with LDMOS is creating higher linearity through digital pre-distortion or feed forward error correction systems. With improve-

Visit http://mwj.hotims.com/23286-49

Boonton's Peak Power Meters...
The Future of Amplifier Testing.

In the past, your options were using one- or two-tone test signals to measure amplifier linearity. Today, Boonton allows you to use your signal to characterize your DUT. No more extrapolating graphs or guessing likely compression points. Our family of peak power meters offers powerful statistical analysis tools, and is joined by the fastest and widest dynamic range sensors in the industry.

If you measure extreme signals with:

- High peak to average ratio
- Ultra-low duty cycle
- Noise-like communication signals

Boonton delivers the fastest and most comprehensive results in the industry.

For more information visit us at boonton.com or call
+1 973-386-9696

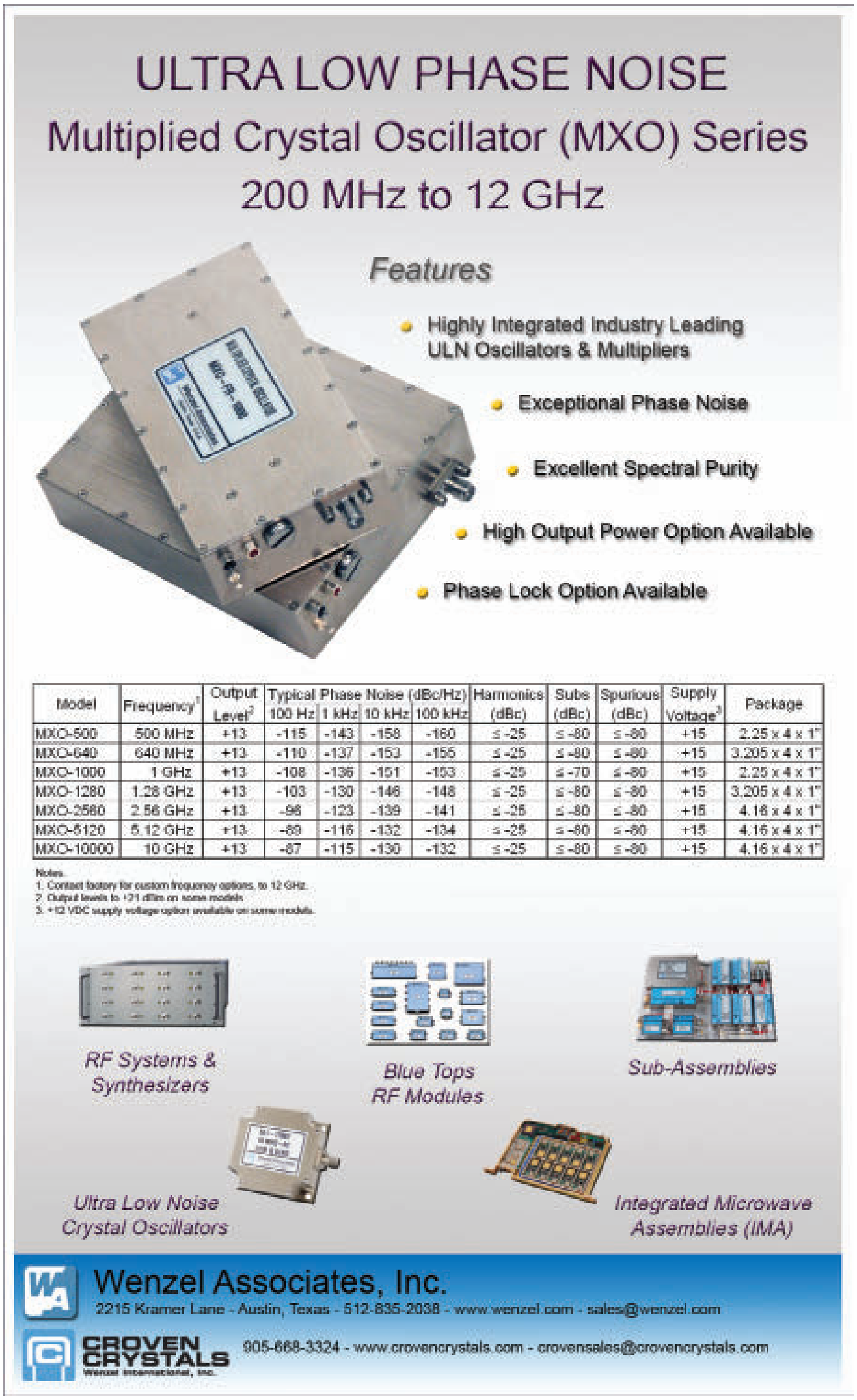
Wireless Telecom Group
Boonton Microlab Noisecom Willtek

Boonton

Visit http://mwj.hotims.com/23286-21 or use RS# 21 at www.mwjournal.com/info

ments in the correction capability of the architectures, the RF devices can be operated closer to their P1dB compression point, where the DC to RF conversion efficiencies are at their highest level. Improved linearity translates to improved efficiency and lower overall system costs.

Linearity and efficiency are also addressed with similar circuit architectures designed using GaN devices. According to Dave Aichele of RFMD, "The high terminal impedances of high voltage GaN devices make the amplifiers suitable for higher bandwidth Class AB amplifiers as well as applications that attempt to improve efficiency such as Doherty, linearity such as push-pull, and extreme bandwidth such as distributed techniques. Thanks to the high impedances (and low parasitics) of GaN HEMTs, these higher bandwidth amplifiers can utilize most any standard circuit architecture with enhanced simultaneous bandwidth/efficiency/power performance."



Model	Frequency[1]	Output Level[2]	Typical Phase Noise (dBc/Hz) 100 Hz	1 kHz	10 kHz	100 kHz	Harmonics (dBc)	Subs (dBc)	Spurious (dBc)	Supply Voltage[3]	Package
MXO-500	500 MHz	+13	-115	-143	-158	-160	≤ -25	≤ -80	≤ -80	+15	2.25 x 4 x 1"
MXO-640	640 MHz	+13	-110	-137	-153	-155	≤ -25	≤ -80	≤ -80	+15	3.205 x 4 x 1"
MXO-1000	1 GHz	+13	-108	-136	-151	-153	≤ -25	≤ -70	≤ -80	+15	2.25 x 4 x 1"
MXO-1280	1.28 GHz	+13	-103	-130	-146	-148	≤ -25	≤ -80	≤ -80	+15	3.205 x 4 x 1"
MXO-2560	2.56 GHz	+13	-96	-123	-139	-141	≤ -25	≤ -80	≤ -80	+15	4.16 x 4 x 1"
MXO-5120	5.12 GHz	+13	-89	-116	-132	-134	≤ -25	≤ -80	≤ -80	+15	4.16 x 4 x 1"
MXO-10000	10 GHz	+13	-87	-115	-130	-132	≤ -25	≤ -80	≤ -80	+15	4.16 x 4 x 1"

Notes:
1. Contact factory for custom frequency options, to 12 GHz.
2. Output levels to +21 dBm on some models.
3. +12 VDC supply voltage option available on some models.

Visit http://mwj.hotims.com/23286-114

Ray Pengelly from Cree noted that, "There has also been much success designing very high efficiency Class E, F, inverse F, J, etc. PAs (with GaN). Doherty (Class A/B/C) with DPD have addressed a range of telecommunications applications. We today achieve efficiencies > 50 percent at peak power levels as high as 500 W. PAs associated with Envelope Tracking (ET), where the high breakdown aspects of GaN, allow drain voltage operation anywhere from 20 to 65 V again with efficiencies exceeding 50 percent. ET is particularly promising for multi-band telecom applications."

TriQuint recently introduced its PowerBand™ family of wideband, high power discrete transistors employing a "revolutionary" (and somewhat secretive) circuit architecture and process technology. The product portfolio is based on different semiconductor technologies, including TriQuint's GaAs PHEMT, LDMOS and GaN materials and processes. The first released LDMOS device operates from 500 MHz to 2 GHz and produces 30 W, P1dB (instantaneous bandwidth), while a GaN-based product that will produce 100 W P1dB CW is expected this year.

Changes to infrastructure architecture will have an impact on how devices will compete. There is a desire by network operators to move the power amplifier from the base of the radio tower closer to the antenna, so that the losses attributed to long cable runs can be eliminated. This will reduce the power required out of the amplifier. The Remote Radio Head (RRH) architecture can increase overall efficiency of the network from 13 to 15 percent up to 30 percent, but requires smaller and lighter amplifiers than those found in the cabinet of a base station. In addition, since the amplifier is on top of a tower, reliability takes on a new importance. The higher operating temperature, higher power density (and therefore smaller device periphery) and better efficiency are strong drivers for using GaN or SiC in the growing RRH market.

SCORECARD

LDMOS

Summary: LDMOS was developed between the late 1980s and early 1990s and became the technology of

Aeroflex's SMART^E is your only Synthetic Test Solution

SMART ENVIRONMENT 5000 SERIES

Are you looking for high ROI for your test investment? Do you need low life-cycle cost for your test applications? Aeroflex's SMART^E 5000 (Synthetic Multifunction Adaptable Reconfigurable Test Environment) offers configurable high throughput testing at the lowest possible cost. By combining the best-in-class throughput and measurement components available on the market today (i.e. PXI, cPCI, LXI, object-oriented open software architecture), SMART`E gives you obsolescence resistance and highly competitive cost-of-test for all your needs. When combined with Aeroflex's worldwide fast response global support, SMART^E is the only fully supported and customizable system-level synthetic test solution!

Let the Synthetic Test experts at Aeroflex show you how to solve your RF/microwave and mixed-signal test needs. For a demonstration, data sheets or more information, call us today at +1 614 888 2700 or e-mail us at: SMARTE-Synthetic-Test@aeroflex.com

www.aeroflex.com/smartemj0609

AEROFLEX
A passion for performance.

www.aeroflex.com

Visit http://mwj.hotims.com/23286-3 or use RS# 3 at www.mwjournal.com/info

choice for cellular and 3G base station applications, completely replacing the BJT with its higher gain and efficiency, and superior linearity. A typical 28 V LDMOS FET has a power density in the range of 0.7 to 1 W/mm with improvements occurring for each new generation.

Cree has reported GaN-on-SiC power densities of approximately 4 W/mm, meaning that less die size is required for GaN for the same amount of output power compared to LDMOS. Higher power density helps offset GaN's higher cost by increasing the number of die per wafer, yet not enough to surpass the price advantage held by LDMOS. Despite more chips per wafer, GaN is processed on smaller (SiC) wafer substrates whereas LDMOS is processed on much larger and cheaper Si wafers.

Benefits: Costs—LDMOS has the lowest cost per watt ($/W) ratio of any of the high power RF amplifier technologies. LDMOS also has some of the best Class AB linearity, gain, reliability and thermal resistance of any popular RF power technologies.

Where to use: LDMOS excels in high volume, medium to high power, linear systems with very stringent cost goals and very high reliability requirements.

Working with the technology: After years in the field, LDMOS has a solid track record. There are very highly developed and extensively used MMICs in the market place as multi-stage RF drivers and gain blocks. Freescale, for example, has a very extensive internal library of on-chip silicon passive components to design a wide variety of internally matched, temperature compensated, multi-stage RF MMIC devices with power levels ranging from 10 to 100 W. Large signal model (MET) includes thermal behavior.

Downside: LDMOS performance is excellent up to 3.8 GHz, but degrades rapidly beyond 4 GHz.

The Power Brokers: Freescale Semiconductor, RFMD, TriQuint, NXP Semiconductors, Integra Technologies, Infineon Technologies and ST Microelectronics.

GaN

Summary: GaNs early development dates back to the late 1990s, with funding largely from defense agencies such as DARPA. By the second half of this decade, GaN began to enter commercial markets with performance that challenged the prevailing technologies. Adoption of GaN has hinged on performance, cost and reliability, all of which has been favorable enough for the technology to make impressive penetration into several key high power markets.

Thermal management is key to achieving acceptable reliability. Because of this, GaN manufacturers use varying techniques to manage thermal rise. Most GaN suppliers use silicon carbide (SiC) as the substrate of choice due to its inherent high thermal conductivity. GaN-on-Si manufacturers use the ability to process very thin wafers with large die areas to achieve the same result. Along with SiC and Si, GaN is also processed on diamond, sapphire and silicon substrates. The diversity of substrates by individual vendors further segments the GaN family of devices.

Visit http://mwj.hotims.com/23286-84

SKYWORKS®

High Performance Amplifiers

General Purpose Gain Block Amplifiers

- Broadband
- Typical gain up to 20 dB
- Typical bandwidths from 3 GHz up to 12 GHz
- OIP3 up to 36 dBm
- Input and output impedances are 50 Ohms
- Available in SC-88 or SOT-89 packages

Frequency (MHz)	Gain Typ. (dB)	NF (dB)	OIP3 Typ. (dBm)	$OP_{1\ dB}$	Vdc (V)	Quiescent Current Typ. (mA)	Package (mm)	Part Number
LF–7	12.5	5.5	29	12.5	3.5	40	SOT-89	**SKY65013-70LF**
LF–12	12.5	5.8	29	12.5	3.5	40	SC-88	**SKY65013-92LF**
LF–6	16	4.8	36	18	4.7	70	SOT-89	**SKY65014-70LF**
LF–9	15	5.4	36	18	4.7	70	SC-88	**SKY65014-92LF**
LF–6	18	4.2	35	17	4.7	70	SOT-89	**SKY65015-70LF**
LF–6	18	4.8	35	18	4.7	70	SC-88	**SKY65015-92LF**
LF–3	20	4.8	27	14	3.5	40	SOT-89	**SKY65016-70LF**
LF–3	20	5.4	27	14	3.5	40	SC-88	**SKY65016-92LF**
LF– 6	20	4.5	35	20	5	100	SOT-89	**SKY65017-70LF**

Ultra Linear Power Amplifier Drivers

- OIP3 up to 42 dBm
- Typical gain up to 20 dB
- Noise figure down to 1.8 dB

Frequency (MHz)	Gain Typ. (dB)	NF (dB)	OIP3 Typ. (dBm)	$OP_{1\ dB}$	Vdc (V)	Quiescent Current Typ. (mA)	Package (mm)	Part Number
0.25–2.7	16	5.5	42	25	3.3 or 5	125	3-pin MCM 4 x 4	**SKY65004**
0.25–2.7	20	3	33	21	3.3	76	3-pin MCM 4 x 4	**SKY65008**
0.25–2.5	12	4.3	42	27	3.3 or 5	100	4-pin SOT-89	**SKY65009-70LF**
0.25–2.7	16	5.5	42	25	3.3 or 5	125	4-pin SOT-89	**SKY65028-70LF**
0.25–6	15	2	40	21.5	3 to 5	140	4-pin SOT-89	**SKY65038-70LF**
0.39–1.5	14	1.8	37.5	25	5	46	4-pin SOT-89	**SKY65045-70LF**
1.5–2.5	14	2.1	38	21	5	47	4-pin SOT-89	**SKY65080**
0.4–2.3	18		39	27	5	260	SOIC-8 Exposed Paddle	**SKY65112-84LF**
0.4–2.3	20		40	30	5	450	SOIC-8 Exposed Paddle	**SKY65113-84LF**

Application-Specific Amplifiers

- Advanced Metering Infrastructure (AMI)
- IEEE 802.15.4
- ISM
- TETRA
- WLAN

SKY65111, SKY65116, SKY65131, SKY65132, SKY65137, SKY65152

- High gain
- Internally matched 50 Ohm input and output ports
- Voltage controlled PA enable pin






USA: 781-376-3000 • Asia: 886-2-2735 0399 Ext. 990 • Europe: 33 (0)1 4144366 • Email: sales@skyworksinc.com

www.skyworksinc.com

Visit http://mwj.hotims.com/23286-102 or use RS# 102 at www.mwjournal.com/info

SiC Pros:

- Greater than 3x better thermal conductivity of SiC vs Si (4.9 W/cm°K vs. 1.5 W/cm°K), supporting higher junction temperatures, reducing system complexity and weight
- Lower parasitic capacitance
- Epitaxial growth of GaN is better on SiC due to smaller lattice mismatch (3.4 percent on SiC vs. 17 percent on Si)
- Lower TEC mismatch on SiC (+25 percent for SiC vs. +100 percent on Si)

Si Pros:

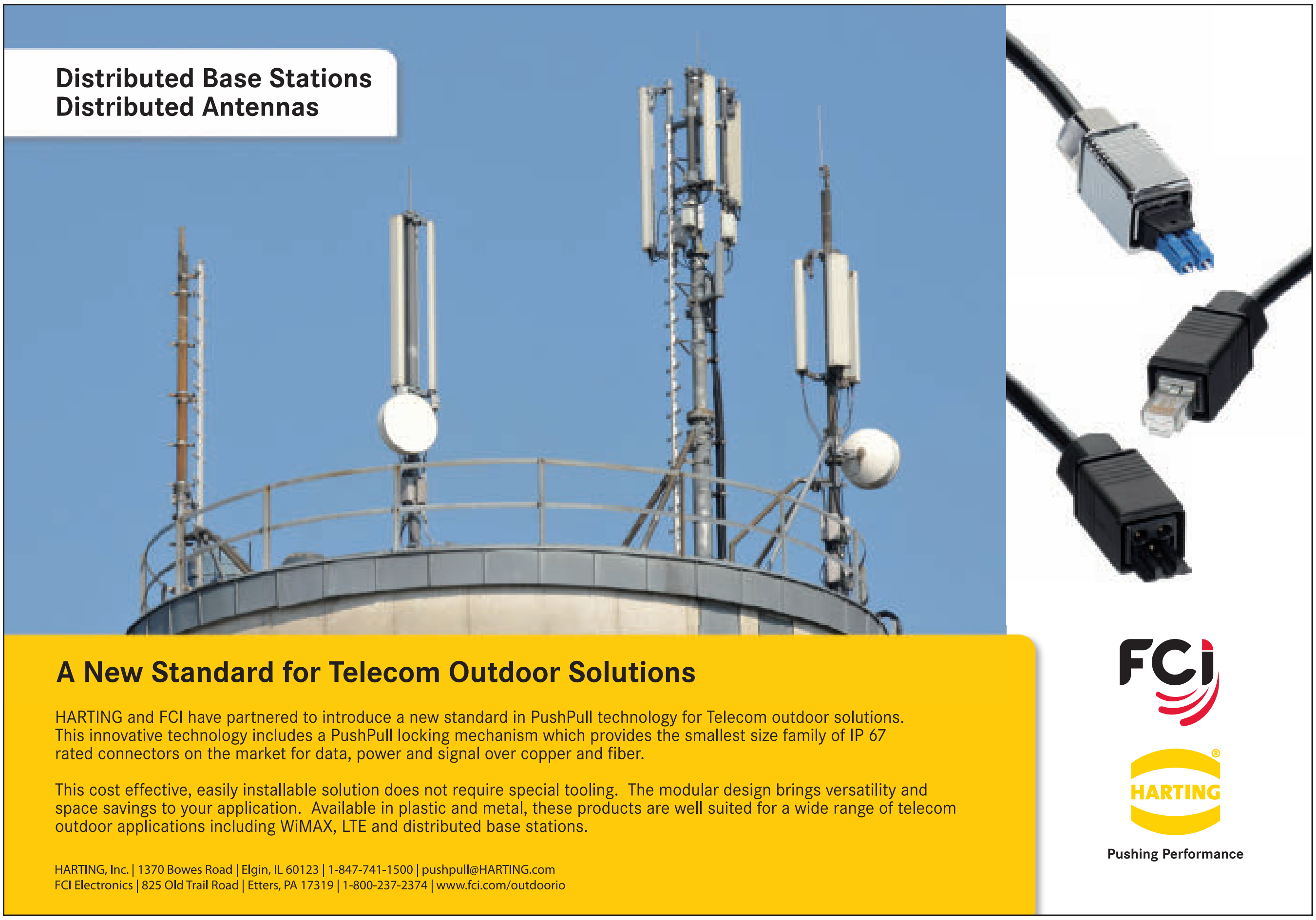
- Silicon can be readily processed in very thin finished form, compensating for the higher thermal conductivity of the substrate relative to SiC
- The low cost and high yield of silicon allows larger die to be used, letting die designers spread heat over a larger area than SiC
- Lower cost than SiC, although this factor is expected to decrease with increasing volume of SiC substrates manufactured over time
- Supply chain advantage from wafer procurement, wafer processing, die attach and packaging can be second sourced by several existing well respected companies to avoid single thread manufacturing steps as well as the ability to scale production to support high volume requirements.

Benefits: GaN has high breakdown voltages (typically 100 to 200 V), higher power densities than LDMOS and higher ft depending on gate length (anywhere from 20 to > 150 GHz). The transistors have low capacitance per watt resulting in higher output impedances, which leads to easier matching networks and relatively wide band performance.

Where to use: GaN is the high power transistor of choice above 4 GHz and is making in roads at lower frequencies with applications that can afford the higher price compared to LDMOS.

Working with the technology: GaN HEMTs in hybrid, discrete designs are most suited to Class A/B, Doherty, push-pull, feedback and lossy match, etc. For MMICs, a range of amplifier techniques ranging from distributed, through multi-stage and cascode implementations have been proven and many are now in production or pre-production. Today's commercially available GaN-on-SiC HEMTs usually use either copper-moly-copper or copper-tungsten flanged packages. In some special cases more elaborate heat-sinking is required using advanced materials, such as those containing diamond, but they are less mature and tend to be expensive. In some critical applications where liquid cooling may not be available, that option may be acceptable. The transistors can also be "spread out" to reduce heat density, but this can have an impact on the frequency of operation of the devices as well as the number of parts that can be produced on each wafer. Models are available for popular RF/microwave design software depending on the device manufacturer.

Downside: Currently more expensive than LDMOS, relative lack of field data and minimal reliability data based on life history of the technology.



Visit http://mwj.hotims.com/23286-36

"We Started With A Dream, And It's Grown Into A Reality."

Donald "Shep" Shepherd
Chairman

We've come a long way from that first amplifier built in my basement almost 40 years ago. Today we're recognized as the ultimate source for testing and communications solutions in the worlds of EMC, military, wireless, and beyond. And our products are everywhere. They're boosting the power of military radios for our troops in battle; driving the most sophisticated industrial/medical/scientific equipment; testing the emissions and susceptibility of electronic equipment; and helping new electronic products get to market faster.

We've become the industry leader by continually setting the bar a little higher. By raising quality. And increasing cost-efficiency. With innovations like "subampability" – the ability to add power to existing amps; and test systems that can be upgraded from the Internet to adapt to changing specs.

With the combined resources of all the AR companies, AR is your source for everything from RF power amplifiers, antennas, complete test systems, probes, monitors, software and receivers to military booster amps, and RF amplifier modules that can be customized to meet the toughest specs. We take great pride in the support & service we deliver to our customers anywhere in the world, whenever they need it.

"AR is truly the source for infinite solutions, combining the innovations of all AR companies worldwide with the products & services to manage today's needs, meet tomorrow's challenges, and turn their dream into realities."

To learn more, visit us at ar-worldwide.com or call 215-723-8181.

40 years ar
And Still Going Strong

rf/microwave instrumentation • modular rf • receiver systems • ar europe

USA 215-723-8181. For an applications engineer, call 800-933-8181.

In Europe, call ar emv United Kingdom 441-908-282766 • ar emv France 33 -1-47-91-75-30 • emv Germany 89-614-1710 • emv Netherlands 31-172-423-000

Visit http://mwj.hotims.com/23286-15 or use RS# 15 at www.mwjournal.com/info

Copyright© 2008 AR. The orange stripe on AR products is Reg. U.S. Pat. & TM. Off.

The Power Brokers: RFMD, Nitronex, TriQuint, Eudyna, Cree, Toshiba, NEC, Fujitsu and Matsushita MEI/Panasonic.

SiC

Summary: The larger thermal conductivity of SiC and GaN enables lower temperature rise due to self heating. The five to six times' higher breakdown field of SiC and GaN is what gives those materials the advantage over Si and GaAs for RF power devices.[5] SiC is a wide bandgap material (3.26 eV), but suffers from poor electron transport properties, which hinders its use in very high frequency amplifiers. SiC has also been limited by expensive, small and low-quality substrate wafers.

In addition, the new SiC devices from Microsemi are fabricated with 100 percent gold metallization and gold wires in hermetically sealed packages (measuring a compact 0.9 × 0.4 in, which is 50 percent smaller than the highest power devices in BJT or LDMOS). This gives the technology the highest reliability in weather radar and long-range tracking radar applications (i.e. providing military-grade long-term reliability), according to the company. The product capability at 10:1 load mismatch tolerance performance also improves system yields. Cree boosts using the same epoxy sealed (gross leak proof) ceramic/metal packages used for GaN HEMTs. The semiconductors are fully passivated providing MTTFs greater than 1 million hours at transistor junction temperatures of 225°C.

Benefits: Microsemi says that typical silicon-based RF power transistor solutions offered throughout the industry, such as BJT (bipolar junction transistor) or LDMOS (laterally diffused metal oxide semiconductor) devices must use complex push-pull circuit designs to achieve similar power levels. In contrast, the SiC RF power transistors have a single-ended design with simplified impedance matching.

Where to use: Radar and avionics where higher power levels (up to the kilowatt range) at UHF and VHF frequencies are required. Development is pushing the frequency range higher.

Downside: Smaller number of suppliers and limited frequency.

The Power Brokers: Microsemi and Cree Inc.

References

1. "High Power RF Semiconductors for Pulsed Applications for the Avionics, L-band, S-band and Sub-1 GHz Radar Markets," ABI Research. Available at http://www.abiresearch.com/research/1003599.
2. "SiC High Power Transistors for Next Generation VHF/UHF Radar," Microsemi, Vol. 52, No. 1, January 2009, p. 108.
3 . "GaN RF Market 2008," Yole Développement. Available at http://www.yole.fr/pagesAn/products/ganrf.asp.
4. "Long Term Evolution (LTE): An Introduction," Ericsson White Paper, 2007. Available at http://www.ericsson.com/technology/whitepapers/lte_overview.pdf.
5. C.E. Weitzel, "RF Power Devices for Wireless Communications," *IEEE MTT-S Digest*, Vol. 1, 2-7 June 2002, pp. 285-288.

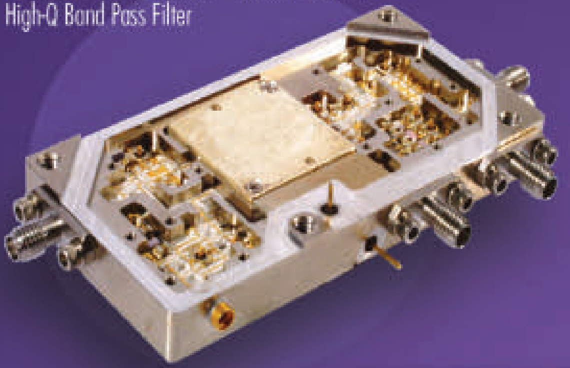
Contributor's full responses are posted online at www.mwjournal.com/powerbrokers

Visit http://mwj.hotims.com/23286-28

AML's Low Phase Noise Integrated Microwave Assemblies

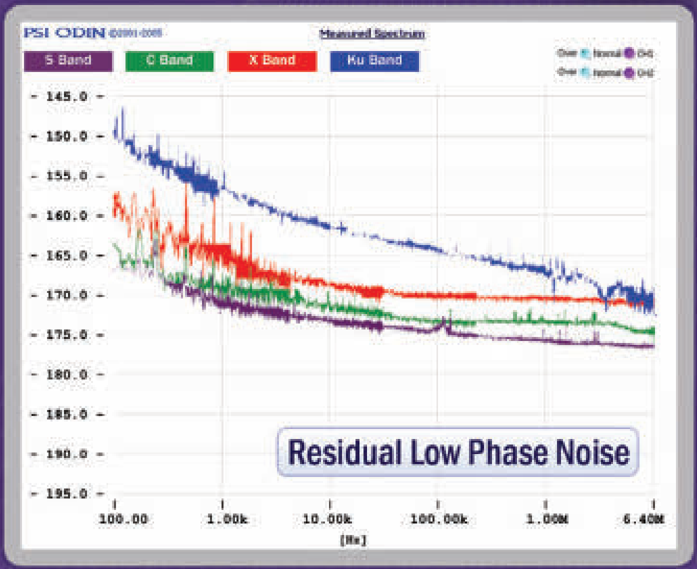
IMA for Low Phase Noise Oscillator

Amplifiers • Phase Shifter • Power Detectors • High-Q Band Pass Filter



Broadband Microwave Repeater

Low Noise & Medium Power Amplifiers • Attenuators • Limiter • Switches • VCO • Detector • Equalizer • Filter

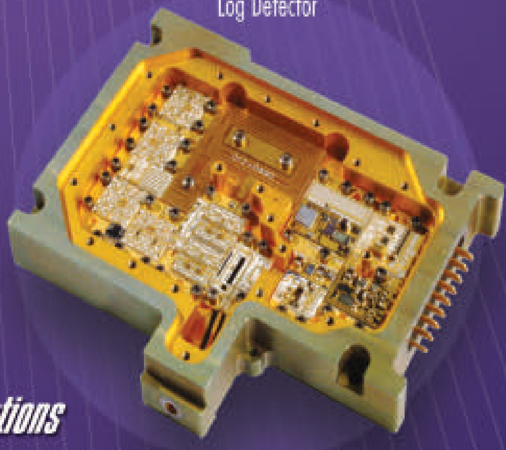


EW Switched Amplifier Assembly

Broadband Amplifiers • Switches • Logic & Control • Temperature Compensation Circuit

High Power Low Phase Noise Assembly

Power Amplifiers • Digital Attenuators • Pulse Gate • Temperature Compensation Circuit • Log Detector



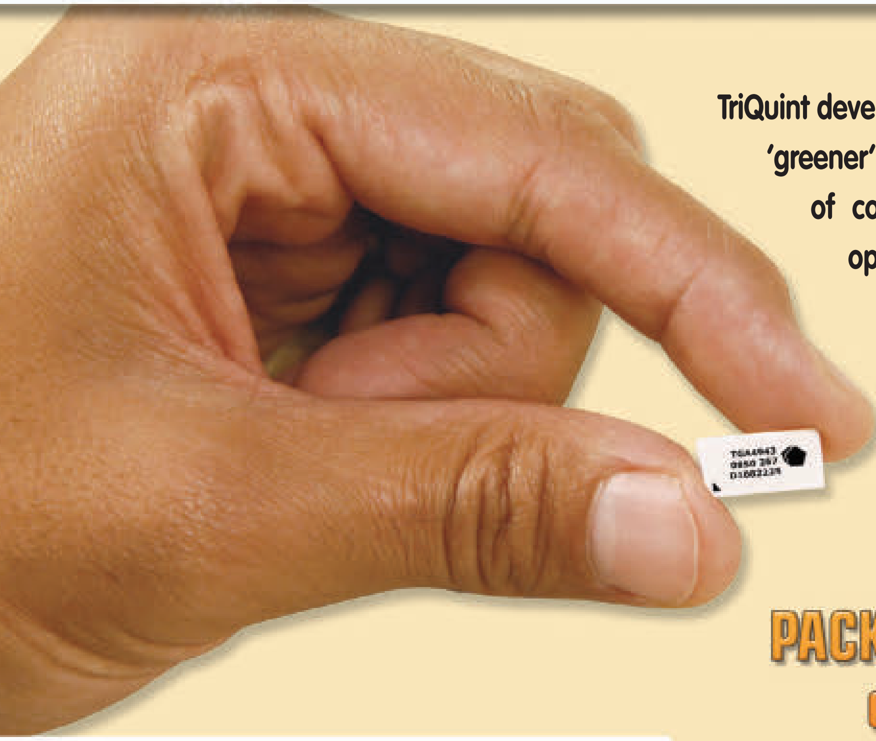
Visit http://mwj.hotims.com/23286-9 or use RS# 9 at www.mwjournal.com/info

AML Communications

1000 Avenida Acaso • Camarillo • California 93012

Phone: 805.388.1345 • Fax: 805.484.2191 • www.amlj.com • email: sales@amlj.com

Need a Greener 40Gb/s SMT Driver?



TriQuint develops leading optical driver amplifiers like our 'greener' TGA4943-SL that uses just half the power of conventional approaches to lower network operational costs. The TGA4943-SL is also the market's first 40Gb/s SMT PA. Our SMT drivers simplify assembly while setting efficiency and edge rate benchmarks, a heritage continued by our newest 10Gb/s amplifier, the 8x8mm TGA4956-SM.

PACKAGED PERFORMANCE...

One Way TriQuint Simplifies RF Connectivity

Your Technical Connection

"Expanding 'social media' and web video traffic are pushing network operators to increase bandwidth. TriQuint driver PAs are optimized for optical modulators and transceivers; they're perfect for your next design."

— Mike, Product Marketing Manager

Find out how TriQuint optical innovations can improve your designs:

www.triquint.com/tech-connect/optical

Connecting the Digital World to the Global Network®

www.triquint.com

© 6-09 TriQuint Semiconductor, Inc.

TriQuint Optical Drivers

Description	Frequency (GHz)	Power (Vpp or dBm)	Gain (dB)	Noise Figure (dB)	Voltage / Current (V / mA)	Package Style	Part Number
10.7 Gb/s Diff. TIA	DC - 10	–	8K dB Ω SE	6pA √ Hz	3.3 / 80	Die	TGA4815
10.7 Gb/s Diff. TIA	DC - 10	–	1.6K dB Ω SE	6pA √ Hz	3.3 / 60	Die	TGA4816
10.7 Gb/s Diff. TIA	DC - 10	–	3.2K dB Ω SE	11pA √ Hz	3.3 / 70	Die	TGA4817
9.9 - 12.5 Gb/s 3V - 7V Driver	DC - 13	3 - 7 Vpp	20	–	3.3 - 5 / 100	SM-A5-28	TGA4955-SM**
9.9 - 12.5 Gb/s 3V - 7V Driver	DC - 13	3 - 7 Vpp	32	–	3.3 - 5 / 115	SM-A8-28	TGA4956-SM*
40 Gb/s LN / MZ Mod. Driver	DC - 35	5 - 8 Vpp	30	–	8 / 300	SL-A7-21	TGA4942-SL**
28 Gb/s 8Vpp SE Driver	DC - 30	3 - 9Vpp	32	–	6 - 7 / 270	SL-A7-21	TGA4943-SL*
9.9 - 12.5 Gb/s Mod. Driver	DC - 16	3V - 10V	35	2.5	5.5 - 8 / 210	SL-A2-18	TGA4953-SL
9.9 - 12.5 Gb/s Mod. Driver	DC - 16	3V - 10V	35	2.5	5.5 - 8 / 210	SL-A4-18	TGA4954-SL
12.5 Gb/s NRZ Driver	DC - 18	11V	16	–	8 / 285	Die	TGA4807
12.5 Gb/s NRZ Driver	DC - 18	24 dBm	16	3.5	5 - 8 / 70 - 175	Die	TGA1328-SCC
12.5 Gb/s NRZ Driver	DC - 18	8V	16	3.5	8 / 175	SL-A1-12	TGA8652-SL
12.5 Gb/s RZ Driver	DC - 25	7V	15	–	9 / 100	Die	TGA4802
43 Gb/s NRZ Driver	DC - 35	7V	15	–	6.5 / 170	Die	TGA4801
Wideband Driver (40 Gb/s)	DC - 35	4V	12	–	5 / 135	Die	TGA4832
40 Gb/s TIA, SE	DC - 40	–	250 dB Ω	15pA √ Hz	5 / 30	Die	TGA4812
LNA / Gain Block	DC - 40	11.5 dBm	13	3.2	5 / 50	Die	TGA4830
LNA / Gain Block	DC - 60	13 dBm	15	3	6 / 50	Die	TGA4811
43 Gb/s Driver	DC - 78	3V	8	5	6 / 82	Die	TGA4803
10.7 - 12.5 Gb/s Linear Mod. Driver	0.03 - 8	25 dBm	20	–	8 / 310	SM-A8-28	TGA4823-2-SM
CATV TIA / Gain Block, SB	0.04 - 1	27 dBm	20	1.5	8 / 350	SM-O8-20	TGA2803-SM

NOTES: * = New, ** = Coming Soon, SB = Self Biased, SE = Single-Ended

This table contains a subset of the total selection of products available from TriQuint. If you are unable to locate the product you need, please contact your local sales representative or the factory for more information.

TriQuint SEMICONDUCTOR

Visit http://mwj.hotims.com/23286-110 or use RS# 110 at www.mwjournal.com/info

RF Amplifiers and Sub-Assemblies for Every Application

Delivery from Stock to 2 Weeks ARO from the catalog or built to your specifications!

- Competitive Pricing & Fast Delivery
- Military Reliability & Qualification
- Various Options: Temperature Compensation, Input Limiter Protection, Detectors/TTL & More
- Unconditionally Stable (100% tested)

ISO 9001:2000 and AS9100B CERTIFIED

OCTAVE BAND LOW NOISE AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA01-2110	0.5-1.0	28	1.0 MAX, 0.7 TYP	+10 MIN	+20 dBm	2.0:1
CA12-2110	1.0-2.0	30	1.0 MAX, 0.7 TYP	+10 MIN	+20 dBm	2.0:1
CA24-2111	2.0-4.0	29	1.1 MAX, 0.95 TYP	+10 MIN	+20 dBm	2.0:1
CA48-2111	4.0-8.0	29	1.3 MAX, 1.0 TYP	+10 MIN	+20 dBm	2.0:1
CA812-3111	8.0-12.0	27	1.6 MAX, 1.4 TYP	+10 MIN	+20 dBm	2.0:1
CA1218-4111	12.0-18.0	25	1.9 MAX, 1.7 TYP	+10 MIN	+20 dBm	2.0:1
CA1826-2110	18.0-26.5	32	3.0 MAX, 2.5 TYP	+10 MIN	+20 dBm	2.0:1

NARROW BAND LOW NOISE AND MEDIUM POWER AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA01-2111	0.4 - 0.5	28	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA01-2113	0.8 - 1.0	28	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA12-3117	1.2 - 1.6	25	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA23-3111	2.2 - 2.4	30	0.6 MAX, 0.45 TYP	+10 MIN	+20 dBm	2.0:1
CA23-3116	2.7 - 2.9	29	0.7 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA34-2110	3.7 - 4.2	28	1.0 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA56-3110	5.4 - 5.9	40	1.0 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA78-4110	7.25 - 7.75	32	1.2 MAX, 1.0 TYP	+10 MIN	+20 dBm	2.0:1
CA910-3110	9.0 - 10.6	25	1.4 MAX, 1.2 TYP	+10 MIN	+20 dBm	2.0:1
CA1315-3110	13.75 - 15.4	25	1.6 MAX, 1.4 TYP	+10 MIN	+20 dBm	2.0:1
CA12-3114	1.35 - 1.85	30	4.0 MAX, 3.0 TYP	+33 MIN	+41 dBm	2.0:1
CA34-6116	3.1 - 3.5	40	4.5 MAX, 3.5 TYP	+35 MIN	+43 dBm	2.0:1
CA56-5114	5.9 - 6.4	30	5.0 MAX, 4.0 TYP	+30 MIN	+40 dBm	2.0:1
CA812-6115	8.0 - 12.0	30	4.5 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA812-6116	8.0 - 12.0	30	5.0 MAX, 4.0 TYP	+33 MIN	+41 dBm	2.0:1
CA1213-7110	12.2 - 13.25	28	6.0 MAX, 5.5 TYP	+33 MIN	+42 dBm	2.0:1
CA1415-7110	14.0 - 15.0	30	5.0 MAX, 4.0 TYP	+30 MIN	+40 dBm	2.0:1
CA1722-4110	17.0 - 22.0	25	3.5 MAX, 2.8 TYP	+21 MIN	+31 dBm	2.0:1

ULTRA-BROADBAND & MULTI-OCTAVE BAND AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA0102-3111	0.1-2.0	28	1.6 Max, 1.2 TYP	+10 MIN	+20 dBm	2.0:1
CA0106-3111	0.1-6.0	28	1.9 Max, 1.5 TYP	+10 MIN	+20 dBm	2.0:1
CA0108-3110	0.1-8.0	26	2.2 Max, 1.8 TYP	+10 MIN	+20 dBm	2.0:1
CA0108-4112	0.1-8.0	32	3.0 MAX, 1.8 TYP	+22 MIN	+32 dBm	2.0:1
CA02-3112	0.5-2.0	36	4.5 MAX, 2.5 TYP	+30 MIN	+40 dBm	2.0:1
CA26-3110	2.0-6.0	26	2.0 MAX, 1.5 TYP	+10 MIN	+20 dBm	2.0:1
CA26-4114	2.0-6.0	22	5.0 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA618-4112	6.0-18.0	25	5.0 MAX, 3.5 TYP	+23 MIN	+33 dBm	2.0:1
CA618-6114	6.0-18.0	35	5.0 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA218-4116	2.0-18.0	30	3.5 MAX, 2.8 TYP	+10 MIN	+20 dBm	2.0:1
CA218-4110	2.0-18.0	30	5.0 MAX, 3.5 TYP	+20 MIN	+30 dBm	2.0:1
CA218-4112	2.0-18.0	29	5.0 MAX, 3.5 TYP	+24 MIN	+34 dBm	2.0:1

LIMITING AMPLIFIERS

Model No.	Freq (GHz)	Input Dynamic Range	Output Power Range Psat	Power Flatness dB	VSWR
CLA24-4001	2.0 - 4.0	-28 to +10 dBm	+7 to +11 dBm	+/- 1.5 MAX	2.0:1
CLA26-8001	2.0 - 6.0	-50 to +20 dBm	+14 to +18 dBm	+/- 1.5 MAX	2.0:1
CLA712-5001	7.0 - 12.4	-21 to +10 dBm	+14 to +19 dBm	+/- 1.5 MAX	2.0:1
CLA618-1201	6.0 - 18.0	-50 to +20 dBm	+14 to +19 dBm	+/- 1.5 MAX	2.0:1

AMPLIFIERS WITH INTEGRATED GAIN ATTENUATION

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	Gain Attenuation Range	VSWR
CA001-2511A	0.025-0.150	21	5.0 MAX, 3.5 TYP	+12 MIN	30 dB MIN	2.0:1
CA05-3110A	0.5-5.5	23	2.5 MAX, 1.5 TYP	+18 MIN	20 dB MIN	2.0:1
CA56-3110A	5.85-6.425	28	2.5 MAX, 1.5 TYP	+16 MIN	22 dB MIN	1.8:1
CA612-4110A	6.0-12.0	24	2.5 MAX, 1.5 TYP	+12 MIN	15 dB MIN	1.9:1
CA1315-4110A	13.75-15.4	25	2.2 MAX, 1.6 TYP	+16 MIN	20 dB MIN	1.8:1
CA1518-4110A	15.0-18.0	30	3.0 MAX, 2.0 TYP	+18 MIN	20 dB MIN	1.85:1

LOW FREQUENCY AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure dB	Power-out @ P1-dB	3rd Order ICP	VSWR
CA001-2110	0.01-0.10	18	4.0 MAX, 2.2 TYP	+10 MIN	+20 dBm	2.0:1
CA001-2211	0.04-0.15	24	3.5 MAX, 2.2 TYP	+13 MIN	+23 dBm	2.0:1
CA001-2215	0.04-0.15	23	4.0 MAX, 2.2 TYP	+23 MIN	+33 dBm	2.0:1
CA001-3113	0.01-1.0	28	4.0 MAX, 2.8 TYP	+17 MIN	+27 dBm	2.0:1
CA002-3114	0.01-2.0	27	4.0 MAX, 2.8 TYP	+20 MIN	+30 dBm	2.0:1
CA003-3116	0.01-3.0	18	4.0 MAX, 2.8 TYP	+25 MIN	+35 dBm	2.0:1
CA004-3112	0.01-4.0	32	4.0 MAX, 2.8 TYP	+15 MIN	+25 dBm	2.0:1

CIAO Wireless can easily modify any of its standard models to meet your "exact" requirements at the Catalog Pricing.

Visit our web site at **www.ciaowireless.com** for our complete product offering.

Ciao wireless

Ciao Wireless, Inc. 4000 Via Pescador, Camarillo, CA 93012
Tel (805) 389-3224 Fax (805) 389-3629 sales@ciaowireless.com

Visit http://mwj.hotims.com/23286-22 or use RS# 22 at www.mwjournal.com/info

Harris Corp. Awarded $600 M to Modernize US Strategic Satellite Communications

Harris Corp., an international communications and information technology company, has been awarded a 10-year, $600 M contract for the US Army's Modernization of Enterprise Terminals (MET) program. The next-generation military satellite communications terminals developed for the MET program will provide the worldwide backbone for high-priority military communications and missile defense systems. As prime contractor, Harris will develop, test and certify four unique terminal configurations during a 30-month, First Article Test phase. In addition, Harris will provide production hardware under the five-year base contract, with five additional option years, and will support field activities such as site preparation, installation, test, operations and maintenance. The program will be managed by Team DCATS—Project Manager, Defense Communications and Army Transmission Systems.

Harris will replace up to 80 AN/GSC-52, AN/GSC-39, AN/FSC-78 and other aging strategic satellite communications terminals around the world with new, simultaneous X- and Ka-band terminals capable of interfacing with the new Wideband Global Satellite constellation as well as with legacy satellite systems. The new terminals will support Internet Protocol and Dedicated Circuit Connectivity within the Global Information Grid, providing critical reach-back capability for the warfighter.

"MET leverages our long and successful track record of success on the AN/GSC-52 terminal modernization program to provide PMDCATS with an advanced, strategic terminal architecture that achieves a high level of equipment and integration commonality, thereby lowering acquisition and logistics costs," said Wes Covell, President of Defense Programs for Harris Government Communications Systems. "Harris is proud to provide the next generation of strategic, multiband terminals for the Department of Defense, and we look forward to expanding our successful relationship with PMDCATS through the MET program."

Harris teammates on the MET program include General Dynamics SATCOM Technologies, a leader in X- and Ka-band satellite communications products; O'Neil & Associates, a supplier of world-class logistics and interactive, electronic technical manuals; and Janus Research Group, an innovator in training simulation. The hardware will include various fixed ground terminal configurations; a hardened, transportable terminal and a small terminal suitable for rooftop mounting. General Dynamics SATCOM Technologies will develop the X-band antenna feed as well as a dual/simultaneous X- and Ka-band antenna feed capable of meeting the stringent requirements for low intermodulation products. They will also develop 12.2-meter antennas for fixed ground terminals, 7.2-meter antennas for transportable terminals and 4.8-meter antennas for small terminals. The first terminal is scheduled for fielding in early 2011.

Lockheed Martin Rolls Out THAAD Launchers, Fire Control and Communications

Lockheed Martin officially rolled out the new Terminal High Altitude Area Defense (THAAD) Weapon System launcher and Fire Control and Communications unit in a ceremony at the company's THAAD Launcher Integration Complex in Camden, AR. The ceremony, attended by US Senator Mark Pryor and US Congressman Mark Ross, commemorated the delivery of the first THAAD ground segment vehicles to come off the production line in Camden.

The new hardware will be delivered to soldiers at Fort Bliss, TX, who will have a fully operational THAAD battery (equipment and personnel) by the end of 2009. "What the hardworking employees of Lockheed Martin's Camden Operations have accomplished in such a short time is a testament to their dedication to our troops," said US Senator Mark Pryor. "It gives me great pride to know that one of the world's most advanced and proven air defense systems are produced, in part, here in the great state of Arkansas."

"The THAAD system will play a pivotal role in our nation's missile defense, and today's rollout is an encouraging sign of the tremendous progress we are making in this vital technology," said US Congressman Mike Ross. "The Camden area employees of Lockheed Martin have a long history of success and today is no exception. I thank them for their hard work in providing our military with the technology it needs to protect and defend our troops and our homeland."

"This is truly a great day for air defenders," said Tom McGrath, Vice President of the THAAD program at Lockheed Martin. "We are proud to deliver this proven air defense capability to our forces. We are seeing the incredible power of THAAD to protect our warfighters and population centers with each successful test flight, and now we are seeing the reality of production hardware rolling off the line."

Lockheed Martin is the prime contractor and systems integrator for the THAAD Weapon System. The company's new 200,000 square-foot Launcher Integration Complex at Camden Operations currently has an employee population of approximately 600. "This is an outstanding example of government/industry partnership to achieve great things for the warfighter," said Glenn David Woods, Camden Operations Plant Manager for Lockheed Martin Missiles and Fire Control. "Our commitment is to produce the world's most advanced and effective air defense capability for our soldiers and allies."

Northrop Grumman Space & ISR Systems Joins Raytheon-led Team IBCS

Another industry partner has joined the Raytheon Co.-led team for the US Army's Integrated Battle Command System (IBCS) program. Northrop Grumman Corp.'s Space & ISR Systems Division facility in

Boulder, CO, joins the other partners of Team IBCS including Raytheon, General Dynamics, Teledyne Brown Engineering, Davidson Technologies, IBM and Carlson Technologies, as well as academia partners. The new team member brings expertise in evaluating warfighter benefits of space-based data to the IBCS architecture. The Northrop Grumman Space & ISR Systems Division performs work at Buckley and Schriever Air Force Bases elsewhere in Colorado.

IBCS is a US Army and joint development program with a modular, open architecture, system-of-systems construct allowing air and missile defense warfighters to use any sensor and any shooter within an integrated fire control network. Raytheon won the first stage of a competitive, multi-phase Army award for IBCS in late September 2008.

Team IBCS was formed using OpenAIR™, Raytheon's open business model that uses the best of large and small businesses and academia to provide the best value solution. "The addition of Northrop Grumman Space & ISR Systems to the team reinforces our commitment to providing warfighters with advanced capabilities early as well as exemplifying the tenets of our open air objective and best-of-breed approach," said Dan Kirby, the win leader for Team IBCS.

"Raytheon's Team IBCS is a specifically tailored team devoted to partnering with our Army customer to provide our warfighters the next 'unfair advantage' on current and future battlefields against all aerial threats," added John Urias, Vice President of the Raytheon Battlespace Integration Directorate.

Air and Missile Defense systems included in the IBCS program architecture are weapon and sensor systems already developed and produced by Raytheon, including the Patriot air and missile defense system; JLENS (Joint Land-Attack Cruise Missile Defense Elevated Netted Sensor System); SLAMRAAM (Surface-Launched Advanced Medium-Range Air-to-Missile); the Sentinel Radar; and the THAAD (Terminal High-Altitude Air Defense) radar.

A preliminary design review for the Integrated Battle Command System was scheduled for May 2009, and a single award for phase two of the program is expected in late August 2009. Integrated Defense Systems is Raytheon's leader in Global Capabilities Integration providing affordable, integrated solutions to a broad international and domestic customer base, including the United States Missile Defense Agency, the United States Armed Forces and the Department of Homeland Security.

The Best Performance in Convertibility...
WEST·BOND's 454647E Wedge & Ball Bonder

Our exclusive X-Y-Z controlled manual ultrasonic wire bonding machine
The 747677E wedge-wedge and ball-wedge wire bonding machine with convertability for either 45° or 90°, and ball bonding all in one machine.

- *45° and 90° Wire Feed Convertability*
- *Wire or Ribbon Bonding*
- *Ball-Wedge Bonding*
- *Throatless Chassis*
- *ESD Protection*
- *Adjustable Work Platform*
- *Orthogonal X, Y, and Z Axes*

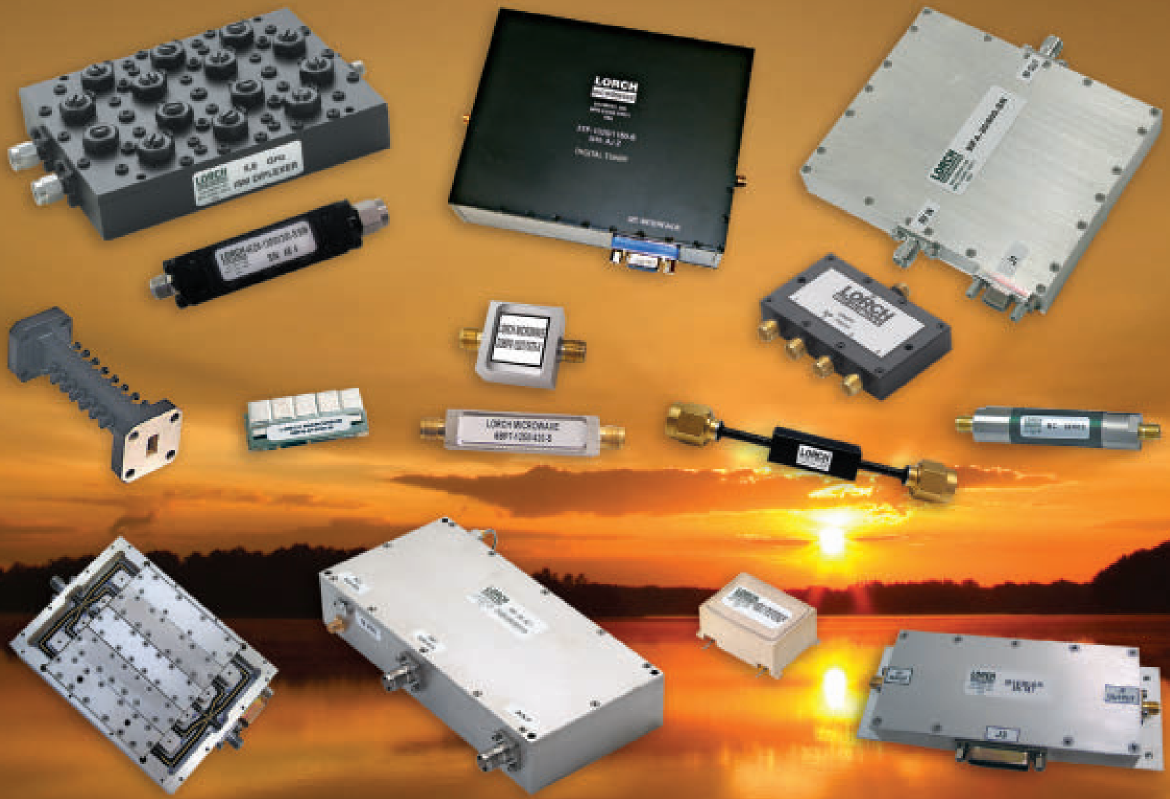
See the West·Bond Model 747677E and other fine West·Bond Equipment at
SEMICON West, San Francisco, Moscone Center, "South Hall", Booth #707, July 14 - 16, 2009

WEST·BOND® INC.
1551 S. Harris Court Anaheim, CA 92806

www.westbond.com
Ph. (714) 978-1551 Fax. (714) 978-0431
email: sales@westbond.com

Visit http://mwj.hotims.com/23286-116

Smart Solutions for Challenging Applications



Lorch Microwave offers more than four decades of experience as an RF and microwave industry leader in product performance, innovation and reliability. By incorporating the latest design and manufacturing technology with the flexibility to meet each customer's unique requirements, we deliver the highest quality products quickly and affordably, whether standard or custom, on time and on budget. Our talented team of sales and application engineers along with our global representatives from 34 sales offices worldwide stands ready to provide solutions for even the most demanding military, space and commercial applications. Give us a call to discuss your challenge.

LORCH MICROWAVE

Salisbury, MD 21802 · USA · 800.780.2169 · 410.860.5100
Brackenholme Y08 6EL, UK · Tel/Fax +44 (0) 1757 633 755
www.lorch.com

smiths
bringing technology to life

Visit http://mwj.hotims.com/23286-48 or use RS# 48 at www.mwjournal.com/info

Searching High & Low?

Look no further.

Reactel has your High Power Lowpass Filters
for all of your amplification requirements.

Visit www.reactel.com/hi-low for details.

Searching High & Low

Passband	Rejection Points
20 - 30 MHz, minimum	≥ 40 dB @ 40 MHz & ≥ 50 dB @ 60 - 400 MHz
20 - 45 MHz, minimum	≥ 40 dB @ 60 MHz & ≥ 50 dB @ 90 - 600 MHz
20 - 75 MHz, minimum	≥ 40 dB @ 90 MHz & ≥ 50 dB @ 135 - 600 MHz
20 - 115 MHz, minimum	≥ 40 dB @ 150 MHz & ≥ 50 dB @ 250 - 600 MHz
20 - 150 MHz, minimum	≥ 40 dB @ 200 MHz & ≥ 50 dB @ 300 - 600 MHz
20 - 220 MHz, minimum	≥ 40 dB @ 300 MHz & ≥ 50 dB @ 450 - 900 MHz
20 - 335 MHz, minimum	≥ 40 dB @ 440 MHz & ≥ 50 dB @ 660 - 1400 MHz
20 - 500 MHz, minimum	≥ 35 dB @ 670 MHz & ≥ 50 dB @ 1005 - 2000 MHz
20 - 700 MHz, minimum	≥ 40 dB @ 980 MHz & ≥ 50 dB @ 1470 - 2000 MHz
20 - 1010 MHz, minimum	≥ 35 dB @ 1400 MHz & ≥ 50 dB @ 2100 - 3000 MHz
20 - 1400 MHz, minimum	≥ 40 dB @ 2000 MHz & ≥ 50 dB @ 3000 - 4200 MHz
20 - 2000 MHz, minimum	≥ 40 dB @ 2800 MHz & ≥ 50 dB @ 4200 - 5000 MHz
20 - 3000 MHz, minimum	≥ 40 dB @ 3940 MHz & ≥ 50 dB @ 5910 - 6000 MHz

Common Specifications

- IL: ≤ 0.3 dB @ PB
- VSWR: ≤ 1.25:1 @ Passband
- Power: 2000 W CW
- Connectors: SC or Type N

* These units are customizable to your exact specifications.

8031 Cessna Avenue • Gaithersburg, Maryland 20879 • Phone: (301) 519-3660 • Fax: (301) 519-2447
For general inquiries, please email reactel@reactel.com • E-mail catalog@reactel.com to receive your Reactel Product Catalog or go online to www.reactel.com to download your copy today.

FM Approvals
ISO 9001:2000 Registered

Visit http://mwj.hotims.com/23286-90 or use RS# 90 at www.mwjournal.com/info

EADS DS and Larsen & Toubro Join Forces in India

EADS Defence & Security (DS) and Indian engineering giant Larsen & Toubro (L&T), Mumbai, are to join forces in the fields of defence technology. Subject to approval by the Indian Government the plan is for the formation of a joint venture company for defence electronics in India, based in Talegaon near Pune.

The proposed joint venture has the potential to become the leading Indian Electronics House for defence and security. The new company will aim at design, development, manufacturing and related services in the fields of electronic warfare, radar, military avionics and mobile systems for military applications.

The Indian defence and security market is growing fast and EADS intends to grow with it. Via this joint venture EADS plans to move beyond just providing high technology sales to India by creating an Indian industrial base with the development of a long-term partnership, including the transfer of technology wherever necessary.

The joint venture company will develop and manufacture indigenous solutions for military requirements of Indian customers as well as the world market. Thus, the Indian JV company will provide the armed forces with locally produced high tech equipment and assured life-time support.

A.M. Naik, chairman and managing director of L&T, said, "For over two decades, L&T has been a major supplier of critical systems to India's defence forces. These include a wide range of products like weapon launchers, naval systems, radar systems, etc. We welcome the formation of this joint venture that will create opportunities for development of state-of-the-art defence electronic products and systems for the Indian defence forces and for the rest of the world."

Dr. Stefan Zoller, CEO of EADS Defence & Security, added, "EADS DS is a high tech company driving the development of integrated system solutions for armed forces and civil security worldwide. We are proud of joining forces with one of India's biggest technology companies. Our joint venture is proof of our commitment to India."

TSB Funds Ultra Fast Broadband Initiative

A new initiative by the Technology Strategy Board (TSB), which addresses the development of Ultra Fast Broadband, looks set to be accelerated following the start of over a dozen innovative research and development feasibility projects. The result could be a major change in the way that businesses operate across the world.

TSB, the organisation that drives technological innovation in the UK, is investing £1 M to help companies carry out initial research that will ultimately lead to the introduction of Internet access technology with speeds of between 1 and 10Gb/s—100 to 1,000 times faster than current broadband speeds.

The feasibility projects—each costing between £30,000 and £100,000—will, in turn, help establish European collaborations that will participate in larger EU-funded research and development initiatives. The ultimate aim, the development of pan-European Ultra Fast Broadband, could see European companies gaining a massive competitive advantage on a global scale.

Commenting on the decision to fund the projects, Mike Biddle, lead technologist at the Technology Strategy Board, said, "The challenge is to identify ways to address the technical issues facing the introduction of Ultra Fast Broadband within the next decade and to build European collaborations to exploit the technology, while generating wealth for the UK. Our intention in providing this funding is to help British companies establish future European collaborations that will participate in larger EU funding initiatives."

NEC Mobile WiMAX Base Station Selected for Japan

UQ Communications Inc., a nationwide Japanese telecommunications carrier capitalizing on mobile WiMAX technologies, has selected NEC Corp. to supply mobile WiMAX base stations. The company has chosen to adopt NEC's recently developed PasoWings BS202 mobile WiMAX base station, which is the first to be equipped with Uplink-Beam Forming (UL-BF) technologies. These technologies improve communications speed and increase the base station coverage area by reducing radio frequency interference between base stations and data transmission terminals.

The system's adoption follows NEC's work to acquire the WiMAX Forum's Wave 2 (2.5 GHz, 3.5 GHz) authentication and its actions to secure international standardization. A wide variety of functions and an external interface based on international standards enable the PasoWings BS202 system to be integrated with a broad range of vendors' equipment, which contributes to the smooth construction of WiMAX networks in short periods of time.

The base stations are compact and the adoption of a high efficiency amplifier enables the integration of outdoor units (ODU), which send and receive transmissions, with indoor units (IDU), which convert signals and control access. Also, reducing the space required to accommodate base stations, the time needed to construct them, and the resources necessary for maintenance reduces costs. NEC regards its selection to provide the PasoWings BS202 to UQ Communications as evidence of the high regard held for its products and services on a worldwide level.

ITP-IET Join Forces to Raise Standards

The Institute of Telecommunications Professionals (ITP) has formed a collaborative partnership with the Institution of Engineering and Technology (IET) to create a joint service exclusively for its members aimed at raising professional standards across the ICT sector.

This joint ITP-IET member registration programme means that ITP members can apply for professional registration, using the IET, which is licensed by the Engineering Council UK to award professional qualifications. ITP members of this programme will be entitled to use qualification designatory letters CEng, IEng, EngTech or ICTTech after their name once they are awarded ECUK registration.

Michelle Richmond, IET Membership and Professional Development Director, said, "In the current economic climate it is more important than ever to set oneself apart from the competition. Professional registration does just this and shows commitment and dedication, as well as demonstrating to employers a range of skills. We are delighted to have formed this partnership, which is part of the IET's collaborative approach to raising professional standards and competence across the industry worldwide."

Motorola and Apprion Complete OEM Agreement

Apprion has signed an OEM agreement with Motorola Inc. that enables the two companies to jointly develop and market integrated wireless application networks for industrial enterprises. By integrating Apprion's industrial-focused wireless appliances and applications with Motorola's comprehensive line of indoor and outdoor wireless networking solutions, industrial enterprises will now be able to leverage best-of-class wireless networks, enabling them to support dozens of applications that utilize numerous wireless radios and protocols.

Through the OEM agreement, the two companies will initially incorporate wireless broadband systems and wireless LAN solutions from Motorola into the Apprion ION System. The second phase of enhancements will result in the full integration of Motorola products and technologies as modular components of Apprion's IONosphere and IONizer solutions.

The combination of technologies from the two companies will enable a wide range of applications. Examples include mobile safety applications, unified voice communications, perimeter security, predictive maintenance, and remote monitoring and optimization of critical assets.

A new addition to the family!

F-Series extra low noise floor crystal oscillators

Pascall

thinking inside the box

www.pascall.co.uk

Phase noise for 100MHz unit

Min guaranteed performance	10Hz	100Hz	1kHz	10kHz	100kHz
level E	-102	-137	-164	-178	-182
level 1	-100	-135	-162	-176	-182

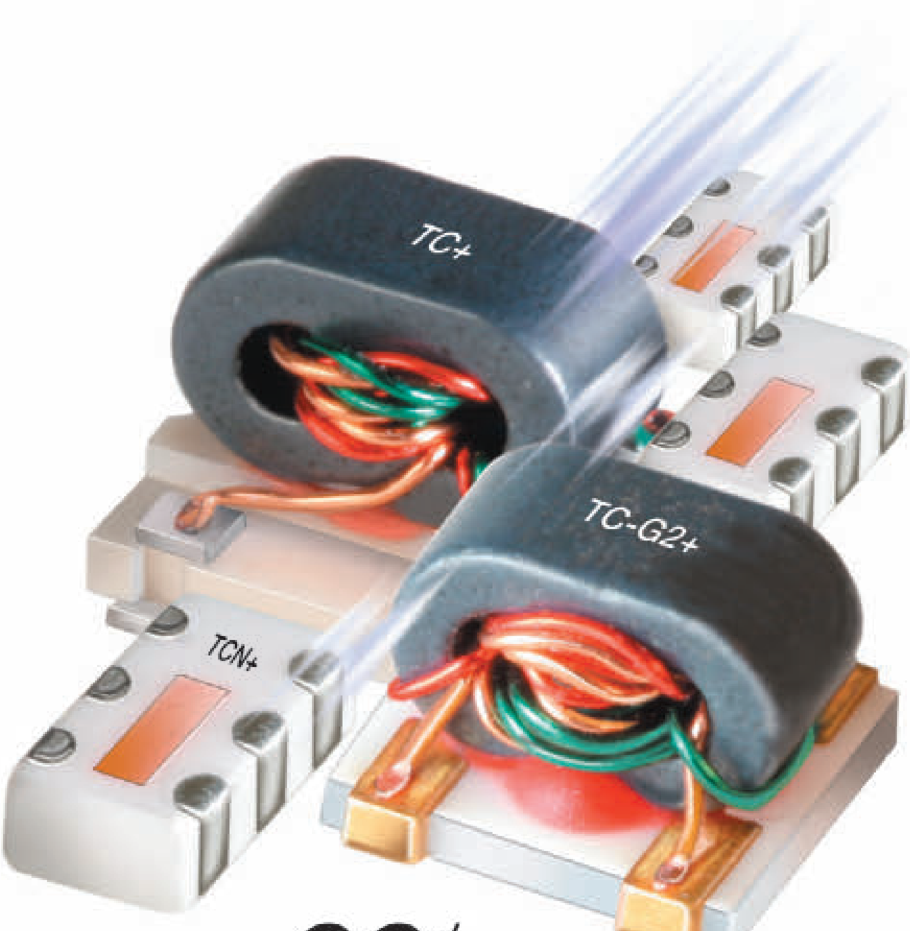
Samples available upon request

Tel +44(0) 1983 817300
Fax +44(0)1983 564708
e-mail enquiries@pascall.co.uk

A subsidiary of Emrise Electronics

Visit http://mwj.hotims.com/23286-87

TINY RF & MICROWAVE TRANSFORMERS



0.3-3000 MHz as low as 99¢ IN STOCK each (qty. 100)

Mini-Circuits wide selection of broadband transformers demonstrates excellent VSWR with impedance ratios from 1:1 up to 16:1, covering from 300 KHz to 3 GHz. To meet your demanding size, performance, and environmental requirements Mini-Circuits offers three package styles to accommodate your transformer Microwave & RF needs.

TCN+ *mini-packaged Low Temperature Co-fired Ceramic transformers deliver outstanding thermal stability high reliability, and permit fast high volume manufacturing.*

TC+ *models have compact open case design, all-welded construction, and offer high-strength plastic base for low cost commercial applications.*

TC-G2+ *ceramic base with gold plated terminations, for military and high reliability requirements.*

These low cost transformers are the best price/performance buy in the business! For detailed specifications, full data, and *Designer Kits* see our Website.

Mini-Circuits...we're redefining what VALUE is all about!

Available as RoHS compliant.

.12" x .06"

.15" x .15"

Mini-Circuits®

ISO 9001 ISO 14001 AS9100 CERTIFIED

minicircuits.com

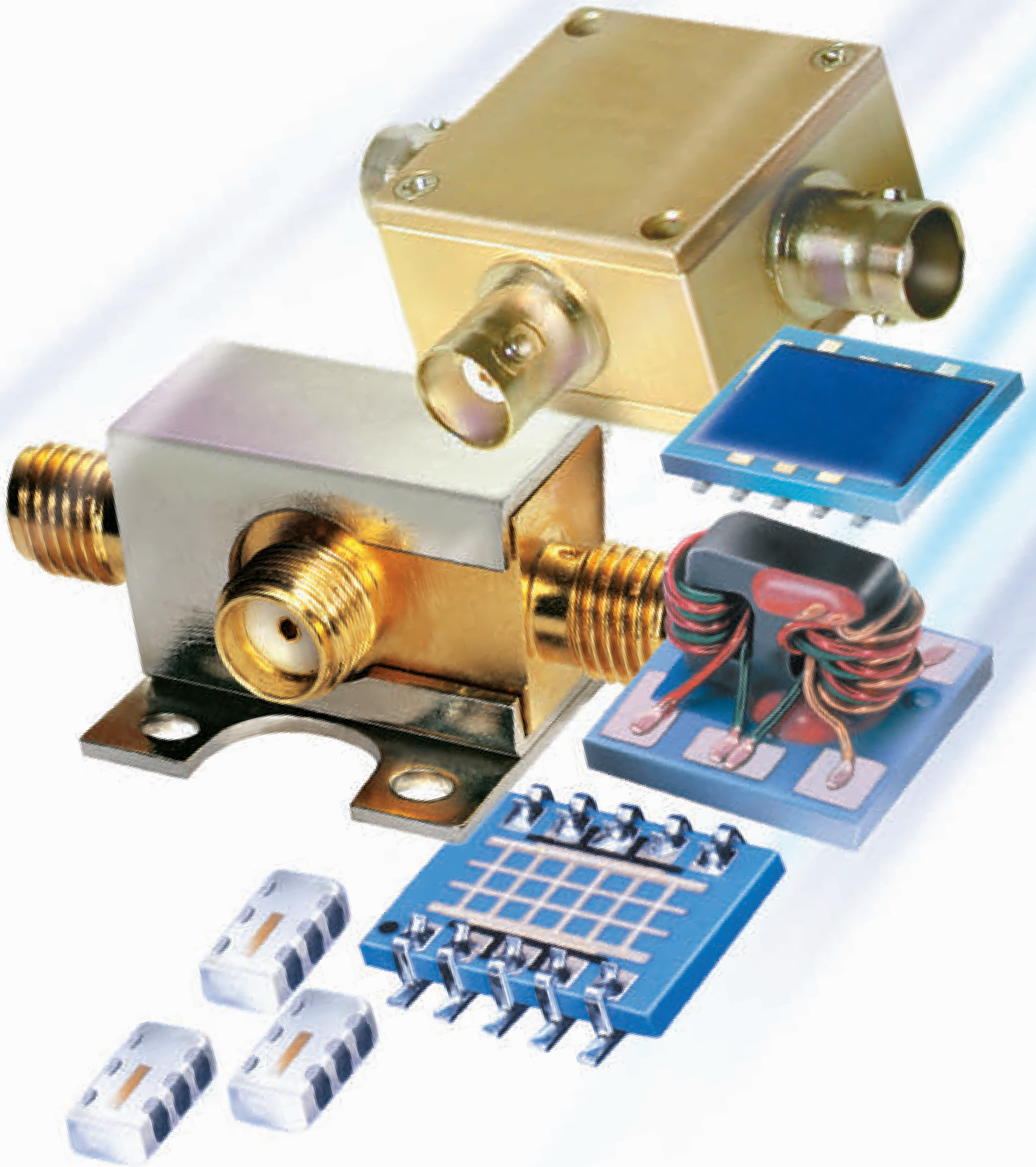
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web

YONI2™ Patent Pending ***The Design Engineers Search Engine*** *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

IF/RF MICROWAVE COMPONENTS

377 Rev M

Visit http://mwj.hotims.com/23286-58 or use RS# 58 at www.mwjournal.com/info



Directional/Bi-Directional

LTCC COUPLER FAMILY

RoHS COMPLIANT

IN STOCK From $1.69 ea. Qty.1000

Mini-Circuits LTCC coupler family offers versatile, low cost solutions for your **5 to 4200 MHz** needs with rugged connectorized models from .74"x.50" to surface mount couplers from .12"x.06", the smallest in the world! Choose from our 50 & 75 Ω directional and bi-directional couplers with coupling ranging from 6-22 dB and with capability to pass DC. Mini-Circuits offers the world's most highly evolved LTCC technology delivering both minimal insertion loss and high directivity with models handling up to 65 W. All of our couplers are ESD compliant and available as RoHS compliant. For full product details and specifications for all our couplers, go to Mini-Circuits web site and select the best couplers for your commercial, industrial and military requirements.

Mini-Circuits...we're redefining what VALUE is all about!

Mini-Circuits®
ISO 9001 ISO 14001 CERTIFIED

ALL NEW minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending

The Design Engineers Search Engine *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

RF/IF MICROWAVE COMPONENTS

396 Rev E

Visit http://mwj.hotims.com/23286-59 or use RS# 59 at www.mwjournal.com/info

Recession or Not, Wireless Backhaul Expansion Continues Strongly

Worldwide revenues from backhaul leasing are expected to double over the next 30 months, according to a new study from ABI Research. The growth curve even accelerates after 2012, resulting in a five-fold revenue increase between 2009 and 2014. Why this powerful performance? According to ABI Research senior analyst Nadine Manjaro, the main driver is the effort by mobile operators to prepare for an upgrade to LTE. "Operators might not deploy LTE immediately," she says, "but they know that before they do, they'll have to upgrade their backhaul capacity."

Backhaul is the bottleneck that can prevent a satisfactory 3G user experience. "AT&T Mobility has found that one iPhone user typically generates as much data traffic as 30 basic feature phone users," notes Manjaro. Wireless network traffic will dramatically increase as iPhone-like devices become the norm and laptop PC card usage increases. Another indicator is the growing capital expenditure on microwave backhaul, which will exceed $8.5 B in 2009.

The market opportunities generated by this growth in backhaul are spread around the backhaul equipment vendors and fixed line operators. Some backhaul infrastructure vendors like Ericsson, Alcatel-Lucent and Nokia Siemens Network will benefit from operators' strong interest in Carrier Ethernet solutions. Major microwave equipment vendors like DragonWave and Harris Stratex will also benefit from increased microwave adoption. And fixed-line operators such as BT, Embarq, AT&T and Verizon Communications will develop new revenue streams by providing leased backhaul services.

Even the business models for backhaul are in flux. "We have observed a movement towards backhaul as a managed service," says Manjaro. "This enables mobile operators to focus on their core business, while guaranteeing a backhaul capacity matched to their changing traffic demands. BT provides that service to four of the top five European operators. In the US, Embarq is moving in the same direction, and I think more cable companies will follow suit. Wireline operators, who typically were losing business to wireless operators, can now get a piece of that wireless pie."

ABI Research's new study, "Mobile Backhaul—Global Market Analysis and Forecast," provides a comprehensive analysis of the global mobile backhaul market, including forecasts by region and technology. It is part of the firm's Mobile Networks Research Service.

ABI Research provides in depth analysis and quantitative forecasting of emerging trends in global connectivity.

Wireless Communications Sector to Benefit from $6.8 B Stimulus Funding

The American Recovery and Reinvestment Act (ARRA, also known simply as the Stimulus Bill) will provide funding for a massive $6.8 B worth of wireless communications upgrades and new deployments over 2009-2010. The Act offers a significant one-off opportunity for wireless equipment vendors, an opportunity that is examined in depth by a new study from ABI Research.

"The ARRA represents a windfall for wireless service providers as well as for satellite service providers," comments vice president Stan Schatt. "It will have an enormous impact on Wi-Fi and wireless broadband vendors. It will also immediately benefit a number of specific vertical industries including healthcare, education, homeland security, the environment, and the nation's electricity infrastructure."

In healthcare, the scope for adding wireless to the technology mix encompasses Wi-Fi-enabled mobile devices and sensors, communications systems linking health networks, telepresence, wireless LAN equipment, and Wi-Fi-enabled video surveillance systems.

In education, already a leading adopter of Wi-Fi solutions, equipment vendors are developing templated solutions in such areas as WLANs for "learning anywhere," voice-over-Wi-Fi, and WLAN equipment and software to track students' progress for "No Child Left Behind" record keeping.

The Department of Homeland Security and US Customs and Border Protection are potential goldmines for wireless vendors because of the many agencies within them that will use ARRA funds for tactical communications equipment, infrastructure equipment, and security equipment. Even critical infrastructure construction projects such as bridges and tunnels often require wireless video surveillance systems.

Mobile Consumers Prepared to Support Green Initiatives

The results of a recent consumer survey conducted in North America by ABI Research suggest that nearly half of those mobile consumers surveyed are somewhat likely or very likely to be influenced by suppliers' green credentials when purchasing services or devices.

Respondents were asked whether they'd be more likely to purchase mobile services or mobile handsets from an operator that makes use of 'green' initiatives, which were described as:

"…gives money to organizations seeking to help the environment, actively employs programs that reduce its carbon footprint, buys network equipment from 'green' equipment vendors."

Paying more than just lip service, 41% (for services) and 45% (for devices) of the 1,000+ respondents indicated that they'd be significantly or somewhat more likely to do so. Younger consumers showed a greater willingness to pursue "eco-groovy" mobile activities than older ones.

The service providers first to connect with environmentally conscious businesses and consumer subscribers will have an edge in this growing trend. Additional education remains necessary to communicate issues surrounding battery disposal and the accumulation of e-waste.

"If consumers are simply unaware of the environmental issues surrounding mobile devices and services," Orr adds, "then the industry should increase its efforts to get the message across. Some other verticals—the inkjet print industry, for example—are more proactive in motivating consumers to help. And other ABI Research studies have found little motivation among handset vendors, except the two or three largest, to offer 'green' mobile device product lines."

Mobile Computing and Consumer Electronics Devices to Drive GPS Growth

Although cellular handsets will continue to dominate shipments of devices with integrated GPS, the next growth spurt will come from mobile consumer electronics (CE) and mobile computing applications, reports In-Stat. Mobile computing and CE devices will comprise over 100 million units in 2013.

"With growing attach rates and market maturity, GPS chipset providers must carefully evaluate which technologies to integrate into single chip solutions," says Jim McGregor, In-Stat's chief technology strategist.

Recent research by In-Stat found the following:

- Although the number of devices shipping with integrated GPS is increasing, the attach rates and the devices shipments have been hampered by the faltering economy.
- By 2012, there will be more CE devices with integrated GPS shipping than there are stand alone personal navigation devices.
- Mobile computing holds a lot of promise for GPS with 26 million GPS enabled units shipping in 2013, but there are barriers. In the netbook segment, for example, cost, integrating yet another antenna, only one mini-card slot will inhibit adoption.
- CPUs must be integrated (ARM, x86, Mips, etc.) to manage the host processor load.
- Infrastructure radios (802.11, WiMAX, LTE, etc.) are likely candidates for integration.
- The research, "GPS—'Locating' Its Way into Mobile Devices," covers the worldwide market for GPS chipsets and end products. It includes:
- Total Available Market and GPS attach rate forecasts for mobile CE and mobile computing through 2013.
- GPS chipset unit and revenue forecasts through 2013.
- GPS supplier breakdowns.
- Analysis of device OEM needs by market segment.

Visit http://mwj.hotims.com/23286-29

"Show me a handheld RF tool that can help me do more out there."

We'll show you three.

Your field work is increasing, not decreasing. You need an analyzer that can keep up. Ultra-fast Agilent handheld RF analyzers can help you test and monitor more sites in less time. With significantly faster measurement speeds, longer battery life, streamlined data transfer and optional built-in calibration you'll spend less time waiting and more time doing. Field-rugged, backlit keys, bright screens. Go Agilent. Do more.

Handheld RF Testers:

- RF Cable and Antenna Tester (N9330B)
- FieldFox RF Analyzer (N9912A) – cable/antenna, spectrum analyzer, power meter and more
- Spectrum Analyzer (N9340B)

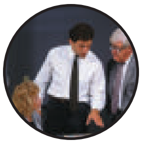
Choose a FREE Option*
and order a FREE Poster
www.agilent.com/find/rfhandheld

© Agilent Technologies, Inc. 2009 *Limited Time Offer

u.s. 1-800-829-4444 canada: 1-877-894-4414

Agilent Technologies

Visit http://mwj.hotims.com/23286-8 or use RS# 8 at www.mwjournal.com/info



INDUSTRY NEWS

For up-to-date news briefs, visit www.mwjournal.com.

■ **Harris Corp.**, an international communications and information technology company, has signed a definitive agreement to acquire the **Tyco Electronics Wireless Systems** business (formerly known as M/A-COM), an established provider of mission-critical wireless communications systems for law enforcement, fire and rescue, and public service organizations. Tyco Electronics Wireless Systems, a business segment of Tyco Electronics Ltd., was formed in 1999 and grew through the acquisition of ComNet Ericsson in 2001 to create Tyco Electronics Wireless Systems (Wireless Systems). Wireless Systems will be combined with the Harris RF Communications business segment, creating a dynamic new organization that will provide end-to-end wireless network solutions to the growing $9 B global land mobile radio systems market. Under the definitive agreement, Harris will purchase the Wireless Systems assets of Tyco Electronics for $675 M in cash, subject to post-closing adjustments.

■ **Microsemi Corp.**, a manufacturer of high performance analog mixed signal integrated circuits and high reliability semiconductors, and **Endwave Corp.**, a provider of high frequency RF solutions for mobile communications markets, announced that Microsemi has acquired Endwave's defense electronics and security (D&S) business. Microsemi intends to combine Endwave's high frequency product portfolio with its own, creating one of the leading high reliability RF product offerings in the market today and covering the technology spectrum up to 100 GHz. Under the terms of the agreement, Microsemi is acquiring the D&S assets for a total equity value of $28 M in cash plus the assumption of specified liabilities. Microsemi expects the acquisition to be accretive immediately.

■ **Codan Ltd.** has announced a strategic expansion of its satellite communications business, acquiring Pennsylvania-based **Locus Microwave Inc.** Locus is a specialist microwave technology company based in State College, PA, primarily focused on the design, manufacture and supply of microwave radio products for satellite communications. Under Codan's ownership, Locus will remain a US-based business with its design, manufacturing and sales led by the company's founders and current executive team comprising Jim Dixon, Gary McGovern and Dana Wilt. The acquisition will enable Codan to establish closer contact with the North American Satellite market with the addition of Locus's product development and manufacturing base in State College.

■ **Superconductor Technologies Inc.** (STI), a provider of advanced wireless solutions, innovative adaptive filtering and world class cryogenic products for commercial and government applications, will be participating with a major wireless original equipment manufacturer (OEM) in a long-term evolution (LTE) field trial with a tier-one US wireless operator for its new 700 MHz network. The trial is scheduled to be completed in the fourth quarter of 2009.

■ **Centellax Inc.**, a manufacturer of high performance, low cost test equipment, announced the opening of its first international sales office in Shenzhen, China, as well as the expansion of its international sales team to meet the growing demand from their customers. Centellax made the decision to open an office in China because of an increase of business opportunities in the region.

■ Asylum Research's wholly owned UK subsidiary has moved and expanded its offices. **Asylum Research UK** opened for business nearly three years ago and its successful growth has led to the need for more office space to accommodate staff and demonstration equipment, including the new Cypher™ AFM. The new office is located in Bicester, Oxfordshire.

■ **Aeroflex** announced support for new NXDN radios being developed for the land mobile radio market. As a member of the NXDN™ Forum, Aeroflex is leading the way with new test features that aid in the research and development of this exciting new radio technology.

■ **Texas Instruments Inc.** (TI) announced the company's strong endorsement of the ZigBee Alliance's recent announcement to integrate Internet Protocol (IP) and open standards. The plan to incorporate global IT standards from the Internet Engineering Task Force (IETF) will allow continued growth of smart grid applications beyond the smart meter with the proven ZigBee Smart Energy public application profile.

■ **Agilent Technologies Inc.** introduced a new option—arbitrary load impedance X-parameters—for its PNA-X Nonlinear Vector Network Analyzer. The option, when used in conjunction with **Maury Microwave** tuners and software, enables the capability to accurately measure and simulate nonlinear component behavior at all load impedances. The result is the highest level of insight into nonlinear DUT behavior, making the NVNA capability especially useful for scientists researching new RF technologies and engineers involved in designing today's high performance active devices.

■ **AWR**, an innovation leader in high frequency electronic design automation (EDA), announced that users of AWR's Microwave Office design software now have access to XML library data for a broad array of microwave amplifiers from **TriQuint Semiconductor Inc.**'s San Jose design center (formerly WJ Communications). The devices include packaged gain-blocks, field effect transistors (FET) and heterojunction bipolar transistor (HBT) amplifiers. The library provides measurement-based models and footprints used for printed circuit board (PCB) and module layouts. It is available to users

MINIATURE FOOTPRINT VCO'S

SYNERGY®
MICROWAVE CORPORATION

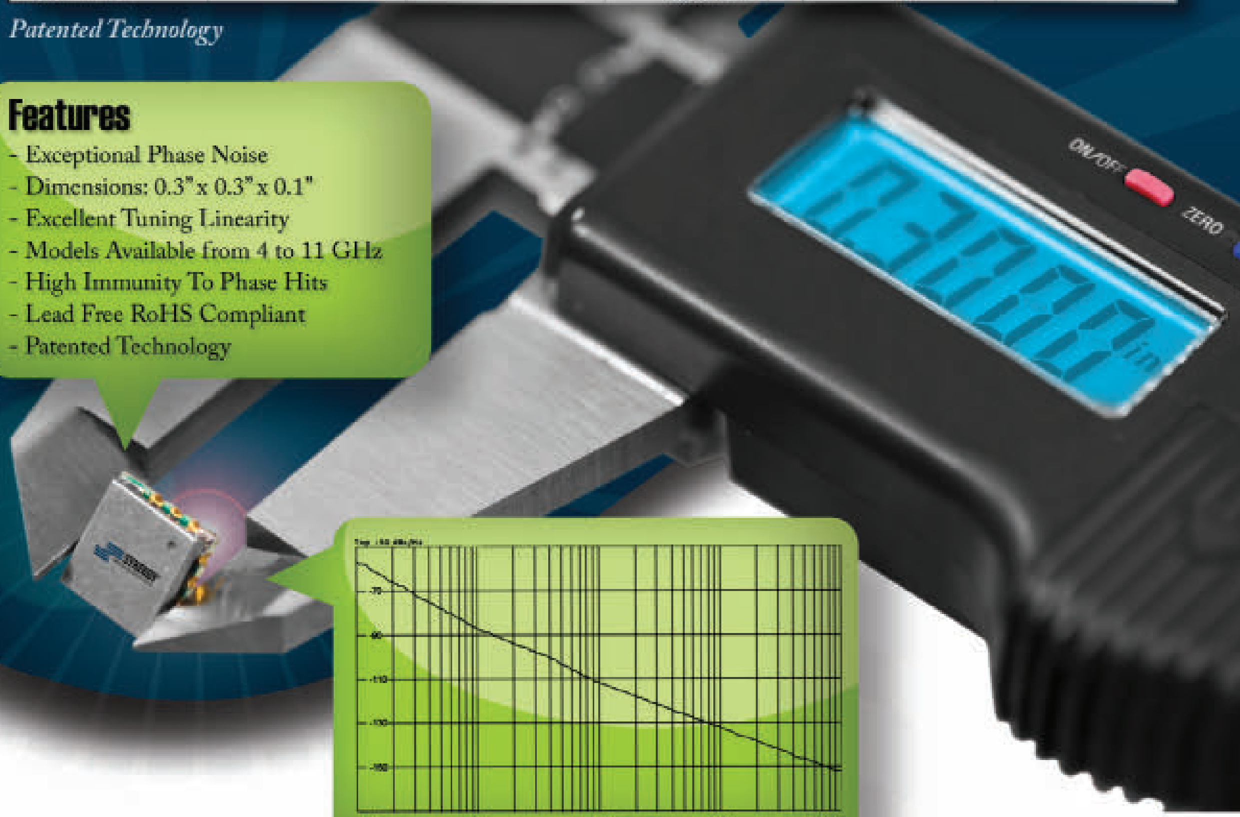
Model	Frequency Range (MHz)	Tuning Voltage (VDC)	DC Bias VDC @ I [Typ.]	Phase Noise @ 10 kHz (dBc/Hz) [Typ.]	Size (Inch)
DCO Series					
DCO1198-8	1198.4 - 1198.7	0.5 - 7.5	+8 @ 30 mA	-116	[illegible]
DCO170340-5	**1700 - 3400**	**0.5 - 24**	**+5 @ 24 mA**	**-90**	[illegible]
DCO200400-5 **DCO200400-3**	**2000 - 4000**	**0.5 - 18**	**+5 @ 35 mA** **+3 @ 35 mA**	**-90** **-89**	**0.3 x [illegible]**
DCO300600-5 **DCO300600-3**	**3000 - 6000**	**0.5 - 18**	**+5 @ 35 mA** **+3 @ 35 mA**	**-80** **-78**	**0.3 x 0.3 x 0.1**
DCO400800-5 **DCO400800-3**	**4000 - 8000**	**0.5 - 18**	**+5 @ 35 mA** **+3 @ 35 mA**	**-78** **-76**	**0.3 x 0.3 x 0.1**
DCO432493-5 DCO432493-3	4325 - 4950	0.5 - 11	+5 @ 17 mA +3 @ 17 mA	-88 -86	0.3 x 0.3 x 0.1
DCO473542-5 DCO473542-3	4730 - 5420	0.5 - 22	+5 @ 20 mA +3 @ 20 mA	-88 -86	0.3 x 0.3 x 0.1
DCO490517-5 DCO490517-3	4900 - 5175	0.5 - 5	+5 @ 22 mA +3 @ 22 mA	-88 -86	0.3 x 0.3 x 0.1
DCO495550-5 DCO495550-3	4950 - 5500	0.5 - 12	+5 @ 22 mA +3 @ 22 mA	-87 -85	0.3 x 0.3 x 0.1
DCO608634-5 DCO608634-3	6080 - 6340	0.5 - 5	+5 @ 22 mA +3 @ 22 mA	-86 -84	0.3 x 0.3 x 0.1
DCO615712-5 DCO615712-3	6150 - 7120	0.5 - 18	+5 @ 22 mA +3 @ 22 mA	-85 -83	0.3 x 0.3 x 0.1
DXO Series					
DXO810900-5 DXO810900-3	8100 - 8800	0.5 - 16	+5 @ 22 mA +3 @ 22 mA	-82 -80	0.3 x 0.3 x 0.1
DXO900965-5 DXO900965-3	9000 - 9650	0.5 - 16	+5 @ 22 mA +3 @ 22 mA	-80 -78	0.3 x 0.3 x 0.1

New! Wideband Models

Patented Technology

Features

- Exceptional Phase Noise
- Dimensions: 0.3" x 0.3" x 0.1"
- Excellent Tuning Linearity
- Models Available from 4 to 11 GHz
- High Immunity To Phase Hits
- Lead Free RoHS Compliant
- Patented Technology



For additional information, contact Synergy's sales and application team.
Phone: (973) 881-8800 Fax: (973) 881-8361 E-mail: sales@synergymwave.com
201 McLean Boulevard, Paterson, NJ 07504

RoHS COMPLIANT

Visit http://mwj.hotims.com/23286-104
or use RS# 104 at www.mwjournal.com/info

Visit Our Website At WWW.SYNERGYMWAVE.COM of AWR's Microwave Office software through the XML library link accessible from the software.

■ **Metelics Inc.**, Sunnyvale, CA, was named the Discrete Semiconductor Commodity Supplier of the Year 2009 by Rockwell Collins. The award was presented during the company's Annual Supplier Conference. The Supplier of the Year award is an acknowledgment of significant contributions made during the year by suppliers and is based upon quality, delivery, total cost of ownership, lead time and customer service.

■ **Teledyne Storm Products'** Microwave Group recently obtained AS9100(B) certification. As an AS9100 registered company, Teledyne Storm–Microwave's quality management system meets not only ISO 9001 standards, but also the additional standards formulated by the International Aerospace Quality Group (IAQG) to specifically address specialized requirements of the aviation, space and defense industries. Teledyne Storm Products–Microwave provides high performance interconnect solutions to domestic and international defense/aerospace, telecommunications, and test & measurement markets.

■ **Electronic Assembly Manufacturing Inc.** (EAM), an RF/microwave coaxial cable assembly supplier, has recently announced the receipt of its ISO 9001:2000 certification. The certificate of registration assures adherence to the BS EN ISO 9001:2000 standard as it applies to the manufacture of standard and custom cable assemblies, and related products for military, medical and commercial applications. The certification was granted through IMS International, which has been improving and enhancing the technical excellence of its clients since 1989.

■ In an effort to reduce the company's carbon footprint, use less energy and water, and significantly increase efficiencies, **Jazz Semiconductor Inc.**, a Tower Group company, and leading Orange County chipmaker, is conducting an ongoing efficiency overhaul. To be more energy efficient in the operation of its globally competitive 24/7 fabrication facility, the company has already instituted new technology and practices that have resulted in a savings of more than 7.5 million kilowatt hours per year, resulting in the avoidance of 5,386 tons of greenhouse gas (GHG) emissions—the equivalent of taking 986 cars off the road.

■ The 17th Annual SMT Vision Award has announced **LPKF Laser & Electronics** as the winner for innovation and excellence in products and service, within the Assembly Tools category. The ProtoLaser U is a UV laser for depaneling of flex, rigid and rigid-flex material.

■ **L-com**, a leader in the manufacture of wired and wireless connectivity solutions, announced that it is the recipient of the prestigious 2008 Boeing Performance Excellence Award (BPEA).

CONTRACTS

■ **XIO Strategies Inc.**, a supply chain management and communications consulting firm, announced that it has been awarded a subcontract by **Northrop Grumman** to provide active RFID consulting services to the US Department of Defense under their RFID III contract, a multiple award, indefinite delivery/indefinite quantity contract with a $429 M ceiling available for task orders.

■ **Cobham plc** has received a contract modification from the US Navy to produce 51 ALQ-99 Low Band Transmitters (LBT) and provide spare parts for US$72 M. This contract, initially valued at US$37 M, was previously announced by the company in October 2008.

■ **Micronetics Inc.** announced that its New Jersey-based subsidiary, **Microwave Concepts** (Micro-Con), has received advanced funding of approximately $5 M from a major defense OEM for highly integrated microwave subassemblies. These subassemblies are used as part of a complex jamming system. In addition to this advanced funding, full funding of production quantities is expected within 90 days. The anticipated period of performance on this program is approximately 24 months.

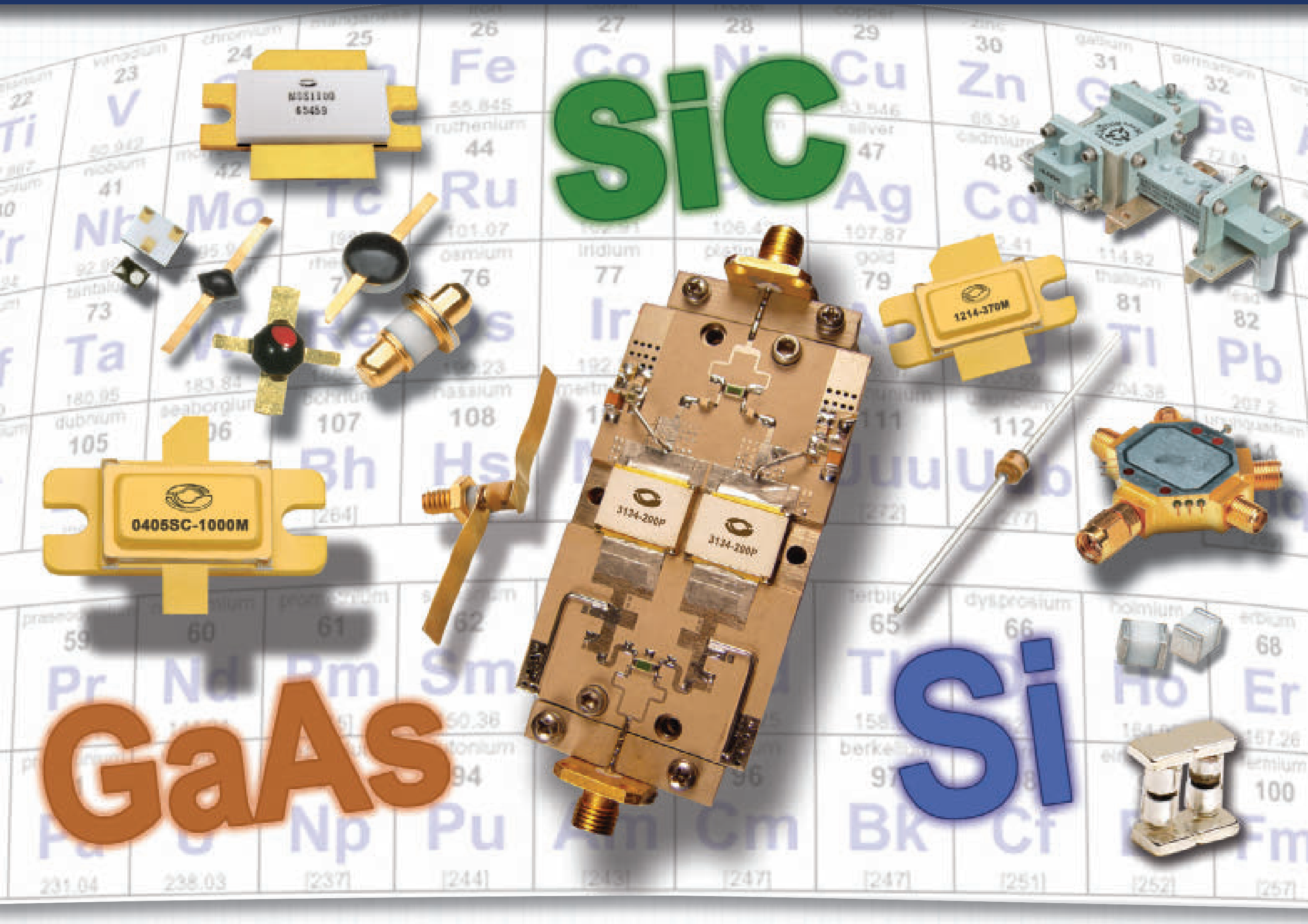
■ **Radio Waves Inc.** has announced that a North American wireless communications carrier has selected its high quality microwave antenna systems. Both Radio Waves SP standard performance and HP high performance products as well as Radio Waves newest UHP ultra high performance models will be utilized by the carrier. These microwave antennas will support the carrier's geographical expansion and network capacity enhancement. Radio Waves was selected for this expansion due to its ability to deliver high quality antennas made in the US at its Billerica, MA global headquarters more rapidly than other manufacturers.

■ **Communications & Power Industries Inc.** (CPI) has been awarded approximately $3.1 M by **Sierra Nevada Corp.** to supply integrated microwave assemblies and transmitters for use in the US Navy's AN/APN-245 Automatic Carrier Landing System (ACLS) Beacon. CPI, a subsidiary of CPI International Inc. (CPII), is a provider of microwave, radio frequency, power and control solutions for critical defense, communications, medical, scientific and other applications.

■ **Comtech Telecommunications Corp.** announced that its New York-based subsidiary, **Comtech PST Corp.**, received a $2 M contract for broadband, solid-state, high power RF microwave amplifier system spares from an international original equipment manufacturer (OEM). These spares are being provided in support of previously fielded communications jamming high power amplifier systems for the electronic warfare market.

■ **RF Micro Devices Inc.** (RFMD), a leader in the design and manufacture of high performance semiconductor components, announced that the company has been selected by a smartphone manufacturer to supply its RF2815 GPS LNA module for use in a soon to be released CDMA smartphone. This new smartphone is

IT'S ELEMENTAL



Choice of Materials Delivers Superior Components for Your Best RF/Microwave Solutions

Here's the breadth of materials and component design technology you need to support your most demanding RF/Microwave systems.

From breakthrough Silicon Carbide RF power transistors cramming the highest peak power into the smallest packages, to high performance, high reliability Silicon and GaAs PIN diodes, varactors, oscillators and modules backed by more than three decades of manufacturing expertise, Microsemi has got you covered.

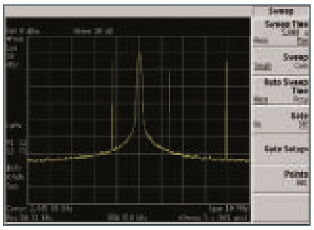
Check out our website's newly enhanced RF and microwave product directory for the broad range of superior components your design deserve. Whether you application is in Radar, Avionics, Communications or Defense systems, Microsemi's got you covered.

See all of our solutions at: www.microsemi.com

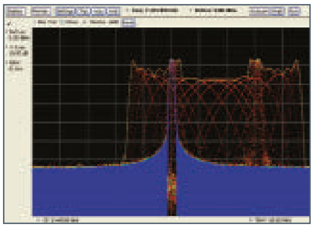
Microsemi®

© 2009 Microsemi Corporation

Visit http://mwj.hotims.com/23286-54 or use RS# 54 at www.mwjournal.com/info



Traditional Spectrum Analyzer
5 seconds



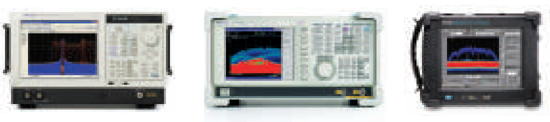
Tektronix
5 seconds

The two screens represent a traditional swept tuned spectrum analyzer and a Tektronix Real-Time Spectrum Analyzer running DPX™, each detecting an identical signal that changes every 1.28 seconds.

Tektronix DPX Technology—See What You've Been Missing.

Discover what's real with Tektronix DPX™ Technology. Now you can see your time-varying signals live with DPX technology, available on all Real-Time Spectrum Analyzers from Tektronix. DPX displays a live RF view of your signal changing over time. It shows you RF signal characteristics that are practically invisible with prior architectures.

See a live RF demo
www.tektronix.com/rtsa-dpx



Tektronix®

© 2009 Tektronix. All rights reserved. Tektronix products are covered by U.S. and foreign patents, issued and pending. TEKTRONIX and the Tektronix logo are registered trademarks of Tektronix, Inc.

Visit http://mwj.hotims.com/23286-108

expected to launch in the second half of calendar 2009 in North America. The feature-rich, dual-band CDMA device will be manufactured by the leading Taiwan-based smartphone manufacturer and will feature a leading open source mobile operating system.

FINANCIAL NEWS

■ **WiSpry Inc.**, a leader in programmable RF semiconductor products for the wireless industry, announced its first closing for a Series C financing of $10 M dollars. The round was led by a new investor in the company, Paladin Capital Group, which is also gaining a seat on WiSpry's board of directors, as well as existing investors L-Capital Partners and Blue Print Ventures. A new strategic investor, MuRata Manufacturing Co. Ltd., and additional existing investors American River Ventures, In-Q-Tel, Tech Coast Angels and Shepherd Ventures also participated. A second close of the Series C, anticipated to be at least $5 M, is expected to be completed this summer.

PERSONNEL

■ Park Electrochemical Corp. announced the appointment of **Marty Kendrick** as Vice President of Operations. In this new position, Kendrick will be responsible for the Park's operations in Asia, Europe and North America with the exception of the company's advanced composite materials operation located in Waterbury, CT. Most recently, Kendrick was Vice President of North American Operations of Park with responsibility for Park's Neltec Inc., Nelco Products Inc., Park Aircraft Technologies Corp. and Park Aerospace Structures Corp. subsidiaries. The company also announced the appointment of **Tom Pursch** as the President of the company's aircraft composite parts subsidiary in Lynnwood, WA and the company's aircraft composite materials and technologies subsidiary. Since joining the company in October of 2008, Pursch was President of Park's Nelco Products Inc. electronics materials subsidiary located in Fullerton, CA.

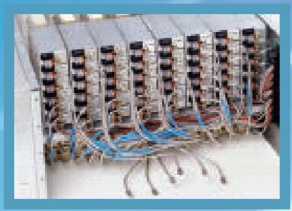
■ Peregrine Semiconductor Corp., a supplier of high performance RF CMOS and mixed-signal communications ICs, announced that it has appointed **Jay Biskupski** to the role of chief financial offer, responsible for the company's financial and site services organizations. Prior to joining Peregrine, Biskupski served as chief financial officer of publicly traded Xantrex Technology Inc.

▲ *Jay Biskupski*

■ Emerson & Cuming Microwave Products Inc. announced the appointment of **Devin Sullivan** as RFID Program Manager. This addition comes as a prelude to the launch of MetalTag™ Impact, a ruggedized addition to the MetalTag product line. In response to the growing RFID industry, and the need for Read-On-Metal and Liquid solutions, the company is expanding its presence

Test, Simulation, RF Distribution Subsystems…
Smart Solutions at Work!

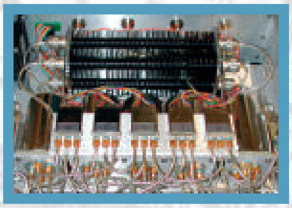
AEROFLEX
WEINSCHEL


Attenuation Matrices &
Multi-Channel Subsystems


RF Distribution Networks


Switch Matrices


RF/Microwave Frequency
Translators


Cellular & Wireless Subsystems
with Low IM Performance


Mobile Unit (Radio & WLAN)
Fading Simulators


Cable Modem Redundant
Switches & Test Systems

Aeroflex / Weinschel offers smart solutions to challenging test, simulation and RF distribution requirements by offering subsystem products that are either off-the-shelf or designed to customer specifications. Our subsystems feature:

- Standard communication interfaces (IEEE-488, RS-232, Ethernet) with proprietary SmartStep® Technology;
- Flexible, high-density mechanical layout & packaging;
- 50 & 75 configurations.

Our subsystems are employed in telecommunications, radar and CNI, satellite and ground communication systems, base station and mobile unit software conformance verification, signal analysis, cable modem and VoIP testing, production test systems and precision microwave related test instruments.

Aeroflex / Weinschel, Inc.
800-638-2048, 301-846-9222
www.aeroflex.com/weinschel
weinschel-sales@aeroflex.com

www.aeroflex.com/microwave

AEROFLEX
A passion for performance.

Visit http://mwj.hotims.com/23286-6 or use RS# 6 at www.mwjournal.com/info

Rosenberger

Customized Footprints

The performance of surface mount RF connectors is dependent on a variety of parameters, e.g. substrate thickness, board-stack up etc.

At Rosenberger, we not only provide you with the surface mount connectors, we provide – as a free service – a footprint that is optimized for your application.

RF surface mount connectors from Rosenberger – along with optimized footprints – are available in various standard interfaces – SMP, Mini-SMP, MCX, SMA, QMA and for various test & measurement connectors.

Exploring new directions

Ask us for more information:

North America:
Rosenberger of North America, LLC · Greenfield Corporate Center
P.O.Box 10113 · USA – Lancaster, PA 17605-0113
Phone: 717-290-8000 · Fax: 717-399-9885 · info@rosenbergerna.com

Europe:
Rosenberger Hochfrequenztechnik GmbH & Co. KG
P.O.Box 1260 · D-84526 Tittmoning
Phone: +49-8684-18-0 · Fax: +49-8684-18-499 · info@rosenberger.de

Visit http://mwj.hotims.com/23286-100

by adding a dedicated individual to focus on the need for its Read-On-Metal, RFID transponder product line. Sullivan will be responsible for sales of products into the RFID sales channel. His responsibilities will include identifying trade partners, setting market pricing and making recommendations for product promotion, and related marketing support.

■ MI Technologies announced the appointment of **Jan Kendall** as Director, Product Marketing, and **Bill Hawkins**, Strategic Account Manager. In the new position of Director, Product Marketing, Kendall is responsible for ensuring the company's product management and customer support efforts align with overall strategies and market trends by providing focused product marketing and marketing communications management. Hawkins comes to MI Technologies with more than 17 years sales experience. Prior to joining the company, Hawkins served as a Field Sales Engineer for Agilent Technologies where he coordinated all facets of sales of multimillion-dollar testing solutions to the semiconductor industry.

▲ *Jan Kendall*

▲ *Bill Hawkins*

REP APPOINTMENTS

■ **Reactel Inc.**, a manufacturer of RF and microwave filters, multiplexers, switched filter banks and sub-assemblies to the commercial, military, industrial and medical industries, announced the appointment of WES-K as the company's representative in Southern California. For more information about WES-K, visit www.wes-k.com or telephone Randy Salmont at (661) 714-5414.

■ **International Manufacturing Services Inc.** (IMS), a manufacturer and supplier of high quality thick film resistors, terminations, attenuators, thermal management products, planar dividers and planar filters to the electronics industry, announced the appointment of Joe Ruvolo of **K&R Engineering** as its Northern New Jersey sales representative. Ruvolo has more than twenty years' experience in the electronics industry working in purchasing and sales. He worked for ITT for seven years before joining K&R Engineering of Succasunna, NJ. He has been with K&R Engineering since 1995, covering Northern New Jersey. Contact Joe Ruvolo, K&R Engineering, 275 Route 10 East, Suite 220-285, Succasunna, NJ 07876; e-mail: joe@kreng.com; ph: (973) 584-5235.

■ **Precision Connector Inc.**, a manufacturer of precision coaxial connectors, has appointed **RF Connections LLC** as Sales Representative in the Southeast United States. RF Connections will cover the states of Florida, Georgia, North Carolina, South Carolina, Tennessee, Mississippi and Alabama.

SUPER ULTRA WIDEBAND

AMPLIFIERS

+24 dBm output... 0.7 to 21 GHz from $845 ea.

Simply calling the ZVA-183X and ZVA-213X "wideband" amplifiers doesn't begin to describe them. The super ultra wideband ZVA-183X amplifier operates from 0.7 to 18.0 GHz while the ZVA-213X amplifier covers even more "spectral ground," with a range of 0.8 to 21.0 GHz. Both super ultra wideband amplifiers deliver +24 dBm typical output power at 1 dB compression by merit of 26 dB typical small-signal gain with ±1 dB typical gain flatness. Both provide wide dynamic range along with the bandwidth, with typical noise figure of 3 dB and typical IP3 of +33 dBm. These versatile amplifiers are ideal for broadband commercial and military applications, from radar systems to test equipment. The ZVA-183X and ZVA-213X amplifiers are unconditionally stable. In fact, they are so rugged, they can even withstand load mismatches as severe as an open or short circuit at full 1dB compression output power.

Mini-Circuits...we're redefining what VALUE is all about!

TYPICAL SPECIFICATIONS

MODEL	FREQ. (GHz)	GAIN (dB)	P_{OUT} (dBm) @ 1 dB Comp.	NOISE FIG. (dB)	PRICE (1-9)
ZVA-183X+	0.7-18	26	+24	3.0	845.00
ZVA-213X+	0.8-21	26	+24	3.0	945.00
ZVA-183+	0.7-18	26	+24	3.0	895.00
ZVA-213+	0.8-21	26	+24	3.0	995.00

Note: Alternative heat-sink must be provided to limit maximum base plate temperature.

All models IN STOCK!

RoHS compliant

Mini-Circuits®

ISO 9001 ISO 14001 AS9100 CERTIFIED

minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending

The Design Engineers Search Engine *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

IF/RF MICROWAVE COMPONENTS

440 Rev B

Visit http://mwj.hotims.com/23286-60 or use RS# 60 at www.mwjournal.com/info

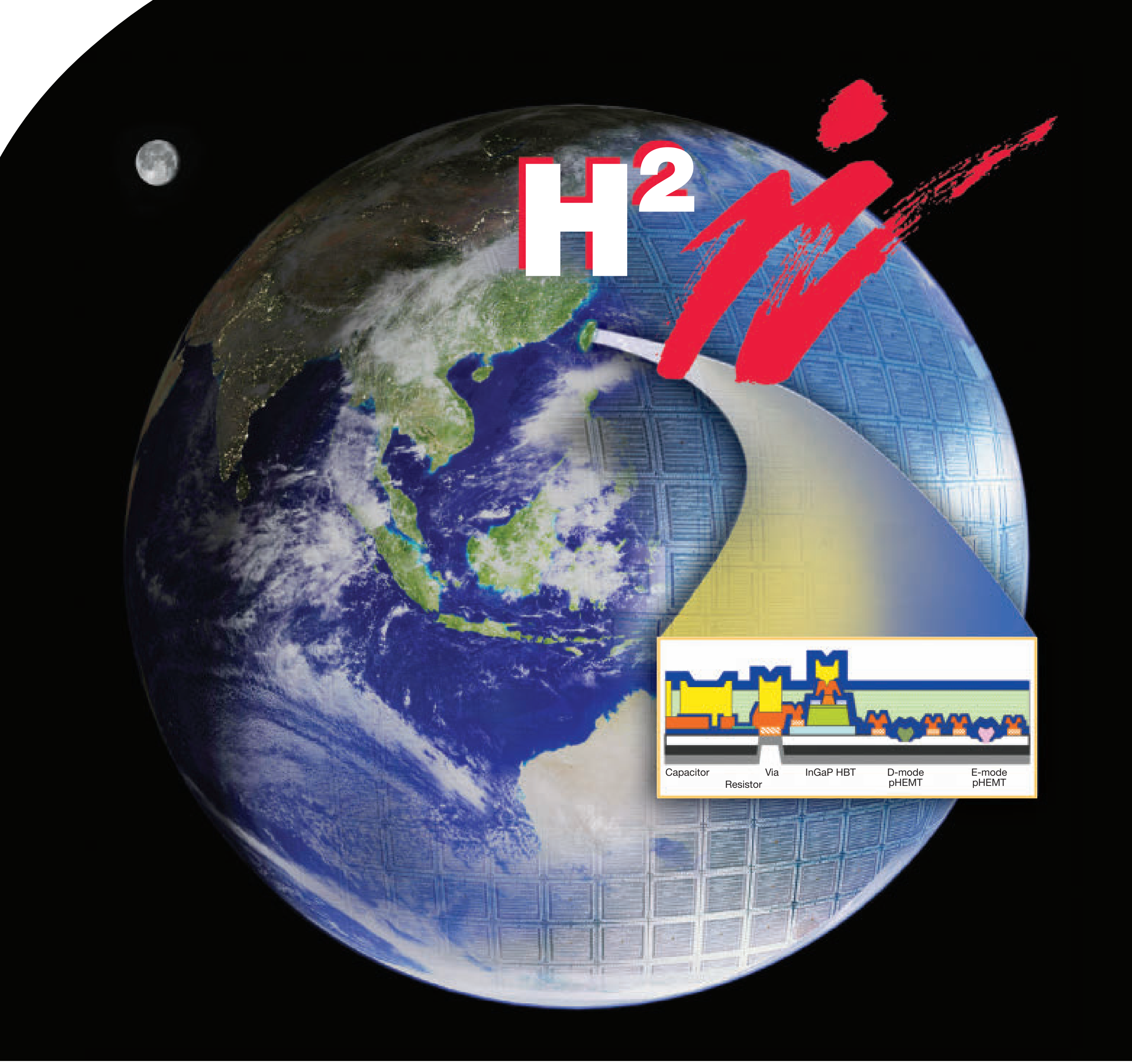
BACKFIRE DISK-ON-ROD ANTENNA FOR LONG-RANGE POINT-TO-POINT COMMUNICATIONS

This article describes a handy design method for a long backfire antenna, called for short a backfire antenna (BFA). It consists of the following basic elements: A feed F (dipole or assembly of crossed dipoles), a surface wave (SW) structure S (dipole array, metal disk-on-rod, dielectric rod, dielectric-covered metal rod or endfire dipole array), and two parallel disk reflectors: A small or feed R_1 and a big or surface-wave reflector R_2. The SW structure in use is a metal disk-on-rod (cigar) construction, although the same design method can be applied to backfire antennas with other types of SW rods. The presented design scheme is based on simple empirical equations, graphs and tables, and is validated by measurements of BFA prototypes with disk-on-rod structures, two to four wavelengths long, though by a simple extrapolation the scheme can be extended to antennas up to six wavelengths long. The gain range from 17 to 25 dB is covered by 2 to 5λ backfire antennas operating at the lower microwave WLAN, ISM, GPS and other bands between 1.5 and 3.5 GHz.

As a specific case, a 4λ backfire disk-on-rod antenna for the WLAN/ISM frequency band 2.4 to 2.5 GHz was designed, built and studied experimentally. To obtain a maximum gain of approximately 24 dBi, the big antenna reflector was made with a plane-conical profile. This BFA was contrasted to a commercial parabolic antenna of similar gain and dimensions, and it was found that for the chosen frequency band and required gain the well optimized BFA is a more compact and effective radiator.

The backfire antenna (BFA) was created by H.W. Ehrenspeck and his associates at the Air Force Cambridge Research Center, Bedford, MA, in 1959.[1,5] Because of its compact and robust construction and very good radiation performance, this antenna has been used in various wireless systems, mostly military, earth and spacecraft. A BFA comprises an axial surface wave (SW) structure typically 2 to 4 wavelengths long. If the BFA is equal or shorter than one wavelength, the SW structure becomes unnecessary and the antenna is converted into a short backfire antenna (SBFA). The SBFA is very popular today, mainly in satellite communications and WLAN links. It has a medium directivity and gain of approximately 12 to 16 dB. For long-range point-to-point applications, say WLAN, WISP and satellite links, a bigger

GEORGI S. KIROV
Technical University of Varna, Bulgaria
HRISTO D. HRISTOV AND RODOLFO FEICK
Universidad Técnica Federico Santa Maria Valparaiso, Chile



Innovative GaAs integration technology

HBT + pHEMT @ WIN = H^2W

	Parameter	Spec
HBT	Beta	75
HBT	Ft	30 GHz
HBT	Fmax	110 GHz
HBT	BVceo	19 V
e-pHEMT	Gm_Peak	500 mS/mm
e-pHEMT	Idss	0.01 uA/mm
e-pHEMT	BVdg	21 V
e-pHEMT	Vth	0.35 V
e-pHEMT	Fmin	0.44 dB
e-pHEMT	Ft	30 GHz
e-pHEMT	Fmax	90 GHz
d-pHEMT	Gm_Peak	330 mS/mm
d-pHEMT	Idss	230 mA/mm
d-pHEMT	BVdg	20 V
d-pHEMT	Vp	-1.0 V
d-pHEMT	Ron	2.0 Ohm-mm
d-pHEMT	Fmin	0.31 dB
d-pHEMT	Ft	30 GHz
d-pHEMT	Fmax	70 GHz

It's a **whole new world** for designers with breakthrough integration technology from WIN Semiconductors.
Combining GaAs HBT, enhancement and depletion pHEMT technologies on a single wafer enables innovative product solutions.

WIN Semiconductors-the world's leading GaAs foundry.

www.winfoundry.com

WIN SEMICONDUCTORS CORP.

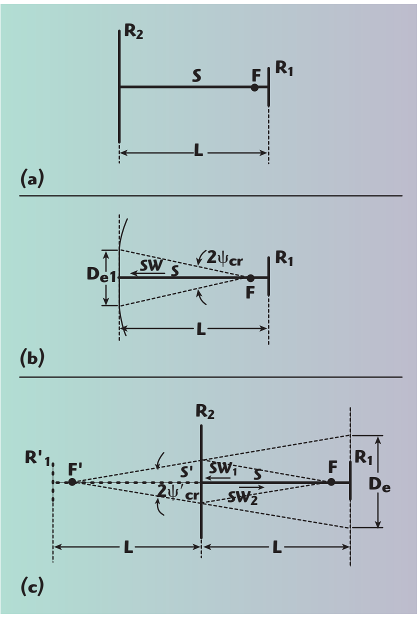
Visit http://mwj.hotims.com/23286-117 or use RS# 117 at www.mwjournal.com/info

gain from 17 to 25 dB is desired, and the BFA along with the parabolic dish antenna (PDA) and antenna dipole arrays proved to be very good choices. For comparison, a 4λ long S-band BFA, with a Yagi-type SW structure, is almost comparable in gain to an array of 16 (4 x 4) Yagi antennas, each of them comprised of nine elements.[6] Both antennas, the BFA and the Yagi array, have a gain of approximately 23.5 dB, but while the BFA has sidelobe levels more than 20 dB below the main lobe, the Yagi array sidelobes are much higher (-11 dB). Furthermore, the BFA is more compact, has a simpler feed system and reduced complexity.

The BFA geometry is illustrated in ***Figure 1***. It consists of the following basic elements: A feed F (dipole or assembly of crossed dipoles), SW rod S (dipole array, metal disk-on-rod, dielectric rod, dielectric-covered metal rod or endfire dipole array), and two parallel disk reflectors: A small or feed reflector R_1 and a big or surface-wave reflector R_2. In the figure, the antenna length L is the distance between R_1 and R_2.

The dipole feed location between the two reflectors is of great importance for the BFA radiation and input characteristics. The antenna works normally only for two feed locations: Superior, if the feed F is near the small reflector R_1, and inferior, if F is near the big reflector R_2. In both cases, the distance between the feed and respective reflector is λ/4. Other feed location points along the SW structure are not recommended. In this article, only a BFA with superior feed location has been considered, since it has approximately 3 to 4 dB higher gain, compared to the BFA with inferior feed location.[6,7]

The simplified radiation mechanism of a BFA has been described in early references[1-5] and can be summarized as follows. A larger amount of the spherical wave radiated from F is transformed by S into a traveling wave, aimed at the big reflector R_2. The feed or launching efficiency is measured as the ratio between the power carried by the surface wave and the total radiated power. Thus, the feed efficiency is considered big if the power coupled to the spherical wave is small compared to power tied to



▲ *Fig. 1 Simplified operation of the back-fire antenna: (a) geometry, (b) end-fire antenna model and (c) image model.*

the surface wave. If R_2 is not present, the assembly R_1-F-S acts as an endfire antenna (EFA) with an effective aperture of diameter D_{e1} radiating in the axial direction. The big reflector R_2 turns back the surface wave towards the BFA virtual aperture, where it is partially reflected by the small reflector R_1. Thus, according to this simple image approach, R_2 forces the surface wave to traverse the physical antenna length L at least twice. As a result, the BFA operates as an EFA of effective length equal to double the physical length, or $L_e = 2$ L. Consistent with the Hansen-Woodyard (HW) condition,[5,8] the maximum gain of the EFA is proportional to the length of its surface wave structure, provided that the SW phase velocity v is adjusted to its optimum value corresponding to the effective length L_e. This implies that the BFA design may have an effective radiation aperture of diameter D_e much larger than the corresponding endfire aperture D_{e1}. The BFA with an optimum SW phase velocity v (L_e = 2 L) should yield as a minimum four times (6 dB) higher gain than the EFA having an optimum SW phase velocity v (L).

More rigorous theoretical and further experimental studies of the BFA[6,8] have revealed that the successive SW reflections (and diffractions) by the small and big reflectors produce more complicated standing-wave field modes between them. The best BFA gain performance is obtained if the antenna physical length is approximately equal to a multiple of the free-space half wavelength. Our experiments with backfire antennas have shown that L_e equal to 6L is a better choice in finding the optimum surface wave velocity. Such approximation of the inner standing wave process corresponds to six forward and backward travels along the surface wave structure or to a triple wave reflection from the big reflector.

RELATIONS BETWEEN SURFACE-WAVE PHASE VELOCITY AND ANTENNA LENGTH

Based on the experimental and computer phase visualization of the EFA, it is assumed[2,6,8] that at its end plane, in the limits of so-called critical angle Ψ_c (or if $\Psi \leq \Psi c$), the SW has a quasi-plane phase front and effective radiation aperture of diameter D_{e1}. Otherwise, if $\Psi > \Psi_{cr}$, the phase surface wave front looks like a spherical one. This deviation from the plane SW is due to the primary feed field radiated directly as a free-space spherical wave. The critical angle depends on the SW phase velocity v and is approximately found by[2,4]

$$\tan \Psi_{cr} = \sqrt{\xi_s^2 (L/\lambda) - 1} \qquad (1)$$

where

$$\xi_s (L/\lambda) = \frac{c}{v(L/\lambda)} = 1 + 0.23 \frac{\lambda}{L} \qquad (2)$$

Here, v (L/λ) is the SW velocity delay factor as a function of the length expressed in wavelengths. Equation 2 is derived from the simplified single-image model of BFA and the Hansen-Woodyard optimum phase condition for a surface wave rod with an effective length L_e = 2 L; c is the free-space wave velocity.[2,5] The ideal image model is introduced[2] for the case of a big reflector of infinite dimension. The multiple reflection and diffraction effects on both reflectors and the feed dipole should also be taken into account. The studies have shown[6-8] that the simple image model and Equation 2 are not suitable for making a correct BFA design, and thus, a bigger L_e should be chosen.

Here, an effective BFA length that is equal to six physical lengths is supposed, that is L_e = 6 L. This assump-

Ka band optical gate technology

MilliMeter Wave pHEMT Technology @ WIN=M^{2}W

Parameter	Value
Ft	70 GHz
IDSS	480 mA/mm
Idmax	630 mA/mm
Gm (peak)	540 mS/mm
Vb	14 V
Pinchoff Voltage	-1.15 V
P1dB*	600 mW/mm
Ron	1 Ohm-mm
Epi Resistor	135 ohm/sq
Thin Film Resistor	50 ohm/sq
MIM Capacitor	600 pF/mm2

* f=29 GHz, Vdd=6 V

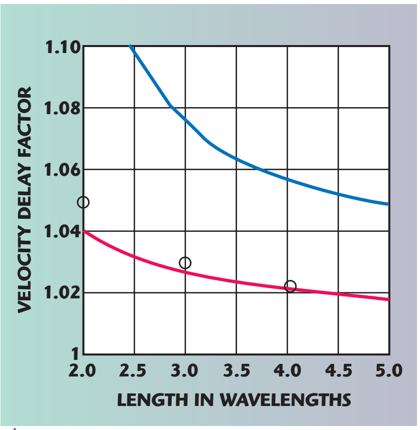
Low cost, high performance microwave and millimeter wave technology is ready for your high volume applications.

WIN Semiconductors-the world's leading GaAs foundry.

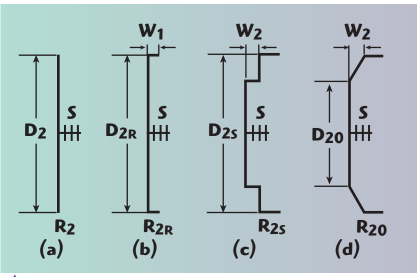
www.winfoundry.com

WIN SEMICONDUCTORS

Visit http://mwj.hotims.com/23286-118 or use RS# 118 at www.mwjournal.com/info



▲ *Fig. 2 Phase velocity factor vs. length for different number of reflections from the big reflector.*



▲ *Fig. 3 Big reflector profiles.*

tion corresponds to six wave travels along the physical antenna length or three reflections from the big reflector. For $L_e = 6$ L, Equation 2 is modified to

$$\xi_s(L/\lambda) = 1 + 0.08\frac{\lambda}{L} \quad (3)$$

Figure 2 illustrates the change of velocity delay factor ξ_S as a function of the BFA antenna physical length L in wavelengths, calculated for an effective length L_e equal to 2L (blue line or Equation 2) and 6L (red line or Equation 3). Three measured values[3,7] of the SW velocity delay factor versus the physical antenna length expressed in wavelengths, or= Ψ_S (L/λ), for an optimally designed disk-on-rod BFA SW rod: Ψ_S =1.05, 1.03 and 1.02 for L/λ = 2, 3 and 4, are shown with circles. These points agree well with Equation 3 and the corresponding red line.

As mentioned in the previous section, the BFA can be considered as a parallel-plane resonator antenna with a standing surface wave field excited inside. In the antenna aperture that is partially closed by the small reflector R_1 two basic wave phenomena take place: Multiple partial reflections from R_1 and multiple intensive radiations from the open aperture area. The length of such radiating cavity can be expressed as

$$L = n\frac{\lambda_s}{2} + \Delta L, \text{ for } n = 1, 2, 3..., \quad (4)$$

where λ_S = v/f is the surface-wave wavelength, ΔL is the length correction due to the radiation, n is a real integer called standing-wave number and f is the design (resonance) frequency.

On the other hand, the BFA studies have shown that its length L takes discrete resonance values, equal to n free-space half wavelengths, or

$$L = n\frac{\lambda}{2} \quad (5)$$

where n has the same integral values as in Equation 4.

In practice, the standing-wave number n usually takes values from 4 to 8 to which correspond the next five values of L/λ = 2, 2.5, 3, 3.5 and 4. For n = 1, the BFA is just a half-wavelength long and becomes a short backfire antenna or SBFA. In this case, the SW structure is missing.

The length correction ΔL in Equation 4 is found by the equality of Equations 4 and 5, or

$$\Delta L = n\frac{\lambda}{2}\left(1 - \frac{1}{\xi_s(L/\lambda)}\right) \quad (6)$$

From Equations 3 and 5, the backfire antenna Equation 6 becomes

$$\Delta L = L\left(1 - \frac{1}{1 + 0.08\frac{L}{\lambda}}\right) \quad (7)$$

ΔL is small compared to the BFA length L. For instance, if L/λ varies from 2 to 4, the ratio ΔL ranges from 0.038 to 0.02.

BIG REFLECTOR PROFILES

Four different profiles of the big reflector are shown in ***Figure 3***: (a) disk reflector R_2 of diameter D_2, (b) rimmed disk reflector R_{2R} of diameter D_{2R}, (c) rimmed stepped-corrected disk reflector R_{2S} of diameter D_{2S} and (d) rimmed conically-corrected disk reflector R_{2C} of diameter D_{2S}.[7] The effective diameter D_{e1} of the EFA effective aperture area depends on the antenna length L and the critical angle Ψ_{cr}, or

$$D_{e1} = 2L\tan\Psi_{cr} \quad (8)$$

which, having in mind Equation 4, can be approximately given as a function of L/λ as

$$D_{e1} = 1.4\,\lambda\sqrt{\frac{L}{\lambda}} \quad (9)$$

In the image model, the big reflector of BFA lays in the EFA effective aperture plane and its minimum diameter D_2 is equal to the constant-phase effective aperture, or $D_2 = D_{e1}$.

With the increase of the disk diameter, so that $\Psi > \Psi_{cr}$, the phase front becomes spherical and a quadratic phase distortion on the reflector plane occurs. If the tolerable phase distortion at the disk edge is π/2, the disk diameter D_2 set equal to D_e will be bigger than D_{e1}, and can be found roughly as[2]

$$D_2 = 2\,\lambda\sqrt{\frac{L}{\lambda}} \quad (10)$$

The disk reflector R_{2R} with a quarter-wavelength rim ($w_1 = 0.25\,\lambda$) has a diameter D_{2R} equal to that of reflector R_2, that is $D_{2R} = D_2$. The rim reduces the sidelobe and backlobe levels, and results in an antenna gain increase.

The step-phase correction in reflector R_{2S} and the conical-phase correction in reflector R_{2C} allow further enlargement of reflector diameter and antenna gain. These two reflectors are normally used for antenna lengths equal or greater than 3λ. The inner or disk area diameter D_{20}, and the outer (peripheral) diameters D_{2S} and D_{2C} of the two reflectors R_{2S} and R_{2C}, respectively, are given by[2,6]

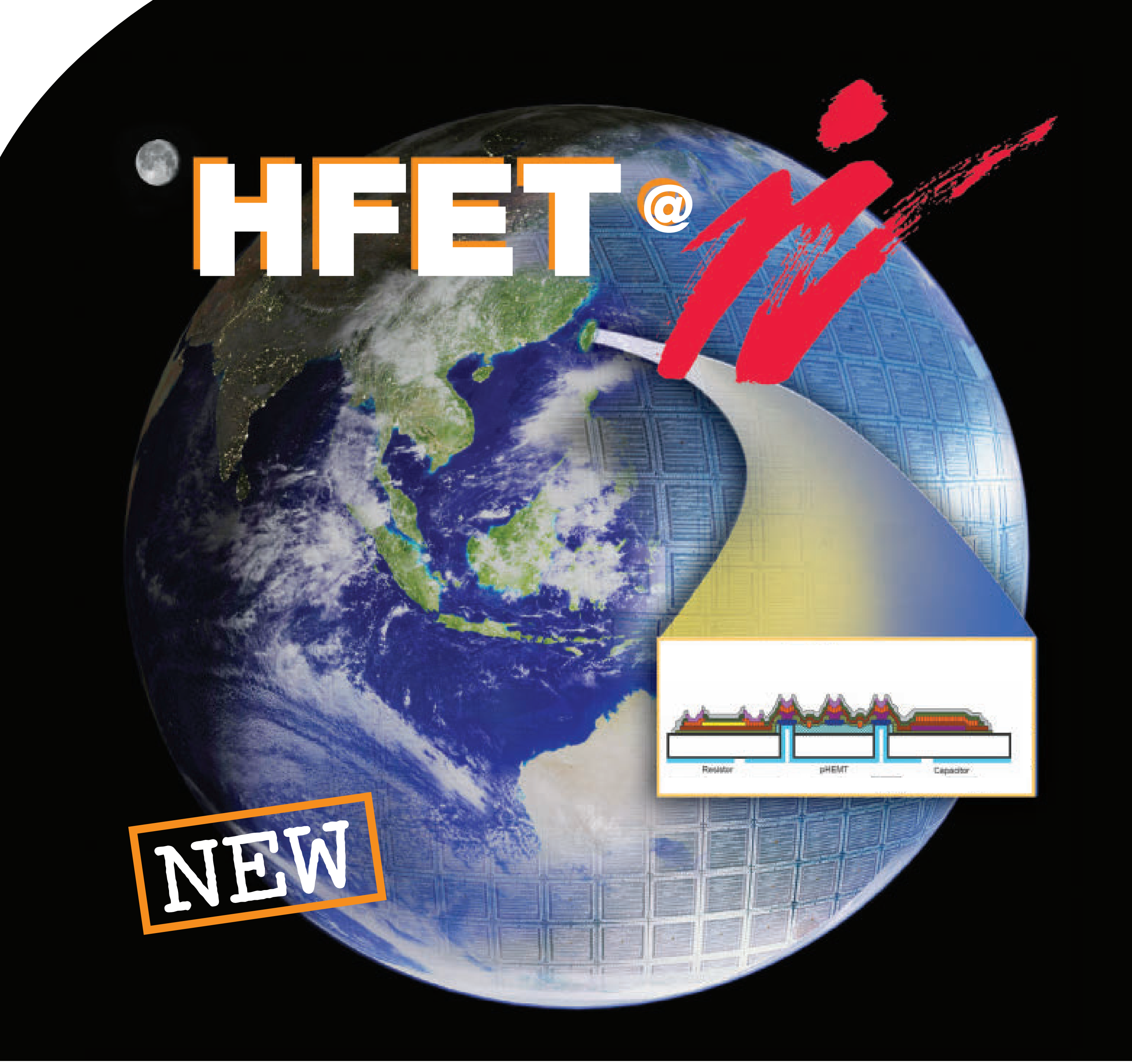
$$D_{20} = (1.9 \div 2.0)\lambda\sqrt{L/\lambda} \quad (11)$$

$$D_{2C} = D_{2S} = (2.9 \div 3)\lambda\sqrt{L/\lambda} \quad (12)$$

The step width w_2 and rim width w_1 are also chosen equal for both reflectors, or

$$w_1 = w_2 = 0.25\lambda \quad (13)$$

Though the BFA with large reflectors R_{2S} and R_{2C} are equal in diameter, the phase-correction in the latter is slightly better and the antenna gain is a bit higher.[2] Naturally, the compound plane-parabolic reflector will



High linearity high voltage technology

High Voltage HFET @ WIN

Parameter	Value
Ft @VDS=4 V	12.5 GHz
BVDGO @ VGS=-3.0 V	33 V
IDSS @VDS=4V	175 mA/mm
Idmax @VDS=4V, VGS=+0.5V	250 mA/mm
VPO @VDS=4 V	-1.1 V
MIM Capacitance	500 pF/mm^2
CGS	1900 pF/mm^2
EPI Sheet Resistance	250 Ohm/sq
TFR Sheet Resistance	50 Ohm/sq

High linearity, high breakdown power process is ready for your most demanding applications.

WIN Semiconductors-the world's leading GaAs foundry.

www.winfoundry.com

WIN SEMICONDUCTORS

Visit http://mwj.hotims.com/23286-119 or use RS# 119 at www.mwjournal.com/info

Harmonic (Comb) Generators
for Output 0.1 to 50 GHz

You can now select any input frequency from 10 MHz to 10 GHz and obtain output frequencies up to 50 GHz

GC Series
* No Bias Required with Specified 1/2 Watt Drive
* Miniature Sizes
* Drop-In Miniature or with Connectors

GCA Series
With Integral Preamplifier
* 0 dBm or +10 dBm Input
* Drop-In Modules Available
* +5V DC Power Supply or Integral Regulator for +12V or +15V Bias

* Please call factory for limits

Your Source for the Most Complete Line of Comb Generators

Other Herotek Products:
Detectors . Limiters . Amplifiers
Switches . Multipliers
Subassemblies

Herotek
The Microwave Products Source

Herotek, Inc.
155 Baytech Drive
San Jose, CA 95134
Tel: (408) 941-8399
Fax: (408) 941-8388
Email: Info @ herotek.com
Website: www.herotek.com

Visa Mastercard Accepted

have the best phase correction, but this would require more complex fabrication technology.

Note: The equations and experimental results for the antenna parameters presented next are applicable for backfire antennas having either type of big reflectors: R_{2R} or R_{2C}. The study concentrated on them only, because the BFA antenna with reflector R_{2R} is of simpler construction and has fairly low side and back lobes, while the BFA antenna with reflector R_{2C} produces higher gain, compared to the other antenna's reflectors.

SMALL REFLECTORS

The small reflector R_1 in all BFA antennas is usually a simple thin disk with a diameter D_1. It has a great importance on the SW launch process and aperture field distribution. For very small values of D_1, the BFA essentially radiates as an EFA. For a constant big reflector diameter and antenna length, the small reflector has an optimum diameter for which the BFA antenna reaches a maximum gain. If D_1 is bigger than its optimum size, the antenna gain reduces, and for values of D_1 close to the big reflector diameter, the antenna practically does not radiate as it is transformed into a very high quality-factor resonator. The experimental study has proved that, for all types of big reflector, the BFA small reflector optimum diameter can be found by[7]

$$D_1 = (0.25 \div 0.45)\lambda\sqrt{L/\lambda} \qquad (14)$$

With the BFA length increasing, both the big and the small reflectors grow in diameter according to the quadratic relations in Equations 10 to 12 and 14. The minimum and maximum values in Equations 11, 12 and 14 define the optimum ranges of diameters D_{20}, D_{2S} (or D_{2C}) and D_1 in different practical BFA designs. They have been validated for BFA lengths from 2λ to 4λ.[1-4,6,7]

DIRECTIVE GAIN AND BEAM WIDTH

In what follows, the empirically obtained equations for the directive gain G of EFA and BFA as a function of L/λ (the directive gain or directivity will be simply called the gain) are listed.

Gain of EFA

This antenna should be designed according to the original HW phase condition, where $L_e = L$ and the SW velocity v(L/λ) satisfies the equation $\xi_S(L/\lambda) = 1 + 0.46\ \lambda/L$. Under this condition, the gain of a very long homogeneous EFA is proportional to L/λ, or[5,8]

$$G = 10\log(7L/\lambda),\ \text{dB} \qquad (15)$$

If the design is based on the HW phase condition and the SW rod is tapered accordingly, the gain of the EFA for L between 3 and 8λ is[5,8]

$$G = 10\log(10L/\lambda),\ \text{dB} \qquad (16)$$

Gain of BFA

The BFA gain is much higher than the gain of EFA and can be found by the basic aperture antenna equation[8,9]

$$G = (4\pi/\lambda^2)A_e\eta_e \qquad (17)$$

where $A_e = \pi(D_e/2)^2$ is the effective aperture area, expressed by the effective aperture diameter D_e. In decibel form, Equation 17 is given by

$$G = 20\log(\pi D_e/\lambda) + 10\log\eta_e,\ \text{dB} \qquad (18)$$

In Equation 18, $D_e = D_{2R}$ for the rimmed disk reflector is calculated with Equation 10, and for a rimmed disk-conical reflector $D_e = D_{2C}$, by Equation 11; η_e is the radiation efficiency, which takes into account the field amplitude distribution in the BFA effective aperture.

Independently of the partial blockage by R_1, the BFA has a relatively constant field distribution outside the blocked aperture area, which makes the aperture radiation efficiency too big. In accordance with the gain measurements, η_e may be set as $\eta_e = 0.6$ to 0.8.

The average antenna beamwidth may be defined as $B = \sqrt{B_E B_H}$, in degrees, where B_E and B_H are the E- and H-plane –3 dB beamwidths. If the BFA has a phase-corrected big reflector R_{2C} its average beamwidth can be found approximately by[6]

$$B = 22\sqrt{\lambda/L},\ \text{deg} \qquad (19)$$

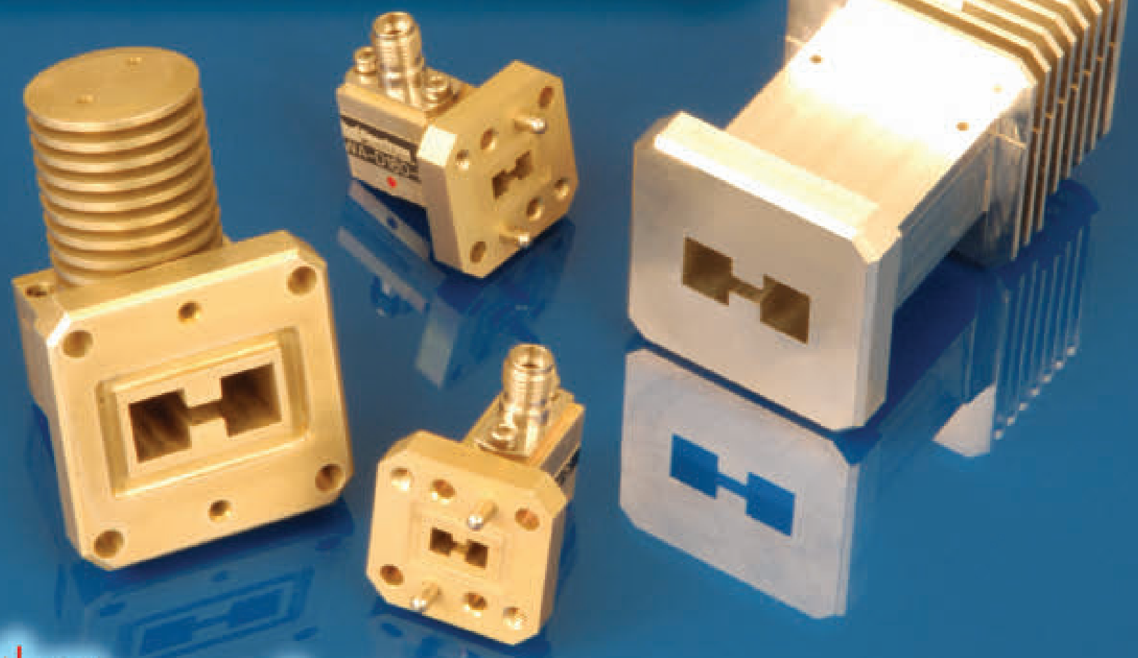
Knowing B, the BFA gain can be computed by the following empiric equation, valid for a moderately high gain aperture antenna[8,9]

$$G = 10\log\left(33000/B^2\right),\ \text{dB} \qquad (20)$$

Adapters, Attenuators, Blind Mate Connectors, Cable Assemblies, Connectors, Delay Lines, Duplexers Equalizers, Fine Grain Equalizers, Gain Amplitude Equalizers, Line Stretchers, Machines, Phase Adjusters, Push - On Connectors & Adapters, Quick Connections, Terminations (Coax-), Tools, Waveguide to Coax - Adapters & Transmissions, and.................

WG/Coax Adapters

Rectangular WG & Double Ridge WG, End Launched & Top Launched
Aluminum, Copper, Brass, all Standard Flanges available
WR 650 to WR 22, and WRD 200 to WRD-750
Most Coax Connectors Series at NO Surcharge.



Spectrum Elektrotechnik GmbH

when Quality is needed

80905 Munich, Germany

P.O. Box 450533

Telephone: +49-89-3548-040

Facsimile: +49-89-3548-0490

WWW.SPECTRUM-ET.COM

Email: sales@spectrum-et.com

Visit http://mwj.hotims.com/23286-103 or use RS# 103 at www.mwjournal.com/info

WG-CoaxE3

Equation 19 is not valid for the BFA with a rimmed disk reflector R_{2R}, which for the same SW rod length has a much smaller effective aperture. Equation 19 was corrected as follows to match better the realistic beamwidth and gain values in the case of a BFA having a reflector R_{2R}

$$B = 33\sqrt{\lambda / L}, \text{deg} \tag{21}$$

Table 1 illustrates the gain property of BFA depending of the large reflector size and shape, and SW rod length. The gain values have been estimated by use of Equations 18 or 20 in the case of reflector R_{2C} or by Equations 18 or 21 and 20 for a BFA with reflector R_{2R}. From this table, it is evident that for all BFA lengths, the use of the plane-conical reflector R_{2C} leads to an approximately 3.5 dB higher gain, compared to a BFA with a plane reflector R_{2R}. On the other hand, if a gain of approximately 20 to 21 dB or less is needed, the more compact and simpler BFA having a reflector R_{2R} is to be preferred. For instance, the 2λ-long BFA with reflector R_{2C} has approximately the same gain as the 4λ-long BFA with a reflector R_{2R}, but the former is of more complex construction and occupies 1.5 times as much volume. The studies have shown that the more complex BFA with a phase-correcting reflector R_{2C} (or R_{2S}) should be considered only when gain values equal or greater than 22 to 24 dB are required.

DISK-ON-ROD (CIGAR) SURFACE-WAVE STRUCTURE

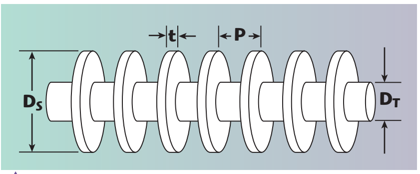
Feed Location and Design

The phase velocity delay factor ξ_S (L/λ) of the SW rod is found from Equation 3 or Figure 2 (red line). For a given ξ_S (L/λ), the basic dimensions of the disk-on-rod (or in fact disk-on-tube) structure (see ***Figure 4***) are: DS or the outer diameter of the SW structure rings, DT or the inner rings' diameter (outer tube diameter), and P, the disk array period (inter-disk distance). They can be found by use of the known disk-on-metal rod design procedure.[9-12]

The metal disk-on-rod SW structure, known also as disk-on-rod SW waveguide, usually consists of rings welded on a tube T, which serves also as an outer (shield) conductor of the feed rigid coaxial line. In a heavy-duty BFA, the disk-on-tube assembly can be replaced by a single-piece corrugated rod (tube).

Next, the design procedure of disk-on-rod surface wave structure is summarized. For a given antenna length L and design wavelength λ, the phase delay factor ξ_S was calculated from Equation 3. In ***Table 2*** are some typical BFA values of ξ_S corresponding to different pairs of disk-on-rod dimensions $\Delta D = D_S - D_T$ and P. The table was prepared on the basis of two classical references on the subject.[10,11] The thickness t of the disks (rings) is usually taken according to $0.01\lambda \leq \tau \leq 0.02\lambda$.

One of the possible ways of BFA



▲ *Fig. 4 Sketch of the surface-wave disc-on-rod structure.*

TABLE I

ESTIMATED GAIN OF A BFA WITH REFLECTOR R_{2R} OR R_{2C} FOR THREE ANTENNA LENGTHS

BF antenna length in wavelengths	2λ	3λ	4λ
Diameter of reflector R_{2R}, (m)	0.35	0.42	0.49
Diameter of reflector R_{2c}, (m)	0.52	0.64	0.73
Gain for reflector R_{2R}, (dB), eqs. (18) or (21)/(20)	17.7/17.8	19.5/19.6	20.7/20.8
Gain for reflector R_{2c}, (dB), eqs. (18)/(20)	21.2/21.3	23.0/23.1	24.2/24.4

TABLE II

COMBINATIONS OF Δ_D/λ AND P/λ THAT MATCH SPECIFIC VALUES OF ξ_S

Δ_D/Δ	0.200		0.225		0.250		0.275	
P/λ	0.125	0.250	0.125	0.250	0.125	0.250	0.125	0.250
ξ_s	1.02	1.01	1.02	1.01	1.03	1.01	1.05	1.02

Now! MULTIPLY

UP TO 20 GHz

Frequency Multipliers from $5.95 qty. 10-49

For your leading-edge synthesizers, local oscillators, and Satellite up/down converters, Mini-Circuits offers a large selection of ***broadband doublers, triplers, quadruplers, and x12 frequency multipliers.***

Now generate output frequencies from 100 kHz to 20 GHz with excellent suppression of fundamental frequency and undesired harmonics, as well as spurious. All featuring low conversion loss and designed into a wide array of, off-the-shelf, rugged coaxial, and surface mount packages to meet your requirements.

Visit our website to choose and view comprehensive performance curves, data sheets, pcb layouts, and environmental specifications. And you can even order direct from our web store and have a unit in your hands as early as tomorrow! *Mini-Circuits...we're redefining what VALUE is all about!*

Mini-Circuits®
ISO 9001 ISO 14001 CERTIFIED

minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending *The Design Engineers Search Engine* Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

IF/RF MICROWAVE COMPONENTS

455 rev. org.

Visit http://mwj.hotims.com/23286-61 or use RS# 61 at www.mwjournal.com/info

Universal Microwave Components Corporation

UMCC

RF & Microwave Design and Manufacturing
Covering Frequencies from DC to 20 Ghz
Serving the Industry Since 1993

"Quality Products at Competitive Prices"
"Custom Designs are Available"

Product Line:
- Solid State Variable Attenuators
- Solid State Switches
- Directional Couplers
- Hybrid Couplers (90/180 Deg)
- Power Dividers / Combiners
- DC-Blocks & Bias Tee's

5702-D General Washington Drive
Alexandria, Virginia 22312 USA
Tel: (703) 642-6332, Fax: (703) 642-2568
Email: sales @ umcc111.com

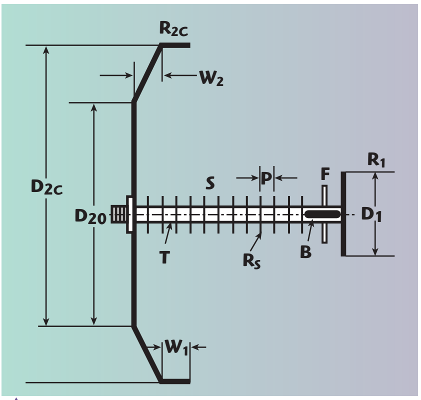
www.umcc111.com

TABLE III

BACKFIRE AND PARABOLIC DISH ANTENNAS: COMPARATIVE DATA

Antenna Data / Antenna Brand	BFA (prototype)	PDA (commercial)
Design frequency f, GHz, wavelength λ, (m)	2.45/0.12245	2.45/0.12245
Design gain G, (dB)	24	24
Length L in wavelengths/in meters	4.0/0.49, eq. (5)	3.6/0.44
SW velocity delay factor $\xi_s(L/\lambda)$	1.02, eq. (3)	No
Diameter D_{20}, (m)	0.6, eq. (11)	No
Aperture diameter, m (D_{2C} in case of BFA)	0.73, eq. (12)	0.89
Diameter D_1, (m)	0.11, eq. (14)	No
Step and rim widths $w_1 = w_2$, (m)	0.31, eq. (13)	No
Antenna cylindrical volume V_a, (m^3)	0.21	0.28
Outer tube diameter D_T (selected), (m)	0.012	No
Period P (selected), (m)	0.015	No
Diameter difference Δ_D, (m), by Table II	0.024	No
Outer ring diameter $D_S = \Delta_D + D_T$, (m)	0.036	No
Estimated gain, (dBi)	24.3, eq. (18)	–
Measured gain, (dBi)	23.8	24
Average beamwidth, (deg)	10.2	10
Max. E-plane sidelobe, (dB)	-22	-23
Max. H-plane sidelobe, (dB)	-26	–
Backlobe level, (dB)	-30	–
Linear polarization	V/H	V/H
Aperture efficiency	0.75	0.55
Maximum VSWR in 2.4 to 2.5 GHz band	1.5:1	1.5:1
Minimum Gain, dBi in 2.4 to 2.5 GHz band	23	23.5

feeding is by means of a dipole backed by a small reflector. All the results presented in this article have been obtained with BFA prototypes having the following feed configuration. An input coaxial-type connector is bonded at one side of a rigid feed coaxial line and fixed to the big reflector rear. The inner cylindrical conductor of the coaxial line is set along the antenna axis and is air-spaced from the outer tube conductor. On the opposite side, the feed coaxial line is short-circuited at the small reflector plane and the dipole feed F is connected to the coaxial line by means of a half-wave slot balun, known as a split coaxial line-dipole balun. This feed construction is a classical topic and can be found in many references.[8,9]



▲ *Fig. 5 Sketch of the BFA prototype constructed.*

PRACTICAL BFA DESIGN AND STUDY

Based on the equations listed in this article, several backfire antennas with metal disk-on-tube SW struc-

Visit http://mwj.hotims.com/23286-111

Natural Perfection!

Frequency Synthesizers 85 MHz to 11 GHz

- High performance, ultra-low phase noise ceramic resonator PLLs
- Fixed frequency solutions that eliminate external programming
- Integer-N and Fractional-N
- Sizes ranging from 0.5” x 0.5” to 1” x 1”
- Large selection of narrow to wide bandwidths
- Quick turn around on custom solutions
- Fractional reference spur suppression < -75 dBc
- Small channel spacing and lock times as low as < 6 µs
- Unmatched pricing with fast delivery time

Z~Communications, Inc.
ISO 9001:2000 Certified

RoHS Compliant

VISIT OUR NEW WEBSITE AT WWW.ZCOMM.COM

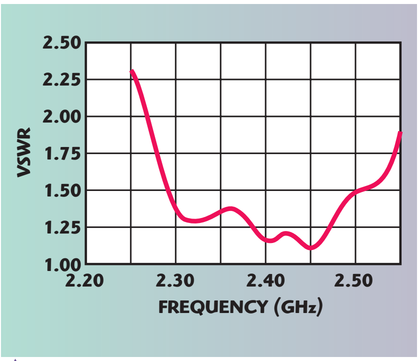
Made in the USA

9939 Via Pasar, San Diego, CA 92126 | Tel: (858) 621-2700 | Fax: (858) 621-2722 | sales@zcomm.com

Visit http://mwj.hotims.com/23286-120 or use RS# 120 at www.mwjournal.com/info

▲ *Fig. 6 Photograph of the BFA prototype.*

tures of different resonant lengths (L = 2λ, 3λ and 4λ), tuned at the design frequency f = 2.5 GHz and working over the frequency band of 2.4 to 2.5 GHz, were built and examined experimentally. As an example, the BFA prototype that produced the largest gain is described. This is a 4λ-long backfire antenna with a big plane-conical reflector R_{2C}. The sketch of this antenna is shown in ***Figure 5*** and a picture of the prototype is shown in ***Figure 6***.



▲ *Fig. 7 Measured VSWR as a function of frequency.*

Figure 7 illustrates the input match bandwidth of the experimental BFA antenna. Its dimensions, design and measured parameters are listed in ***Table 3***. The equations used for obtaining the BFA table data are quoted in round brackets.

At the design frequency of 2.45 GHz, the VSWR curve has a bare minimum of about 1.1. The input frequency bandwidth is 11 or 8.5 percent at a VSWR level of 2.0 or 1.5, respectively. This band is more than double the whole WiFi/ISM spectrum that ranges from 2.4 to 2.5 GHz. For comparison, the basic antenna data of a commercial WLAN parabolic dish antenna (PDA), operating in the same frequency band and having similar gain and radiation patterns,[13] is also listed. Compared to the BFA, the PDA is not as compact and has a 35 percent less radiation efficiency. Obviously, the PDA is not acting in a typical quasi-optical manner, because its dimensions are relatively small compared to the design wavelength. ■

ACKNOWLEDGMENT

H.D. Hristov and R. Feick wish to acknowledge the financial support under the Chilean Conicyt Bicentenario Project ATC-11/2004.

References

1. H.W. Ehrenspeck, "The Backfire Antenna, a New Type of Directional Line Source," *Proceedings of the IRE*, Vol. 48, No. 1, January 1960, pp. 109-110.
2. F.J. Zucker, "The Backfire Antenna: A Qualitative Approach to its Design," *Proceedings of the IEEE*, Vol. 53, No. 7, July 1965, pp. 746-747.
3. J.A. Strom, "A Dielectric-rod Backfire Antenna," *AFCRL Report 69-0347*, 1969.

HIGH SPEED LOGIC MODULES

ULTRA LOW JITTER PERFORMANCE FOR COMMUNICATION & MEASUREMENT SYSTEMS!

Analog & Mixed-Signal ICs, Modules, Subsystems & Instrumentation

NEW!

50 Gbps, 1:2 Fanout Buffer Connectorized Module

♦ Low Additive RMS Jitter: < 200fs
♦ Very Low Power Consumption: 455 mW
♦ Single-Ended or Differential Operation
♦ Inputs Terminated Internally in 50Ω
♦ Hermetically Sealed Module
♦ -40 to +70 °C Operation

IN-STOCK CONNECTORIZED HIGH SPEED DIGITAL LOGIC MODULES

	Data / Clock Rate (Gbps / GHz)	Function	Rise / Fall Time (ps)	Deterministic Jitter (ps)	Differential Output Voltage Swing (Vpp)	DC Power (mW)	DC Power Supply (Vdc)	Package / Connector	Part Number
NEW!	50 / 25	AND / NAND / OR / NOR	9 / 10	2	0.5	560	-3.3	C-13 / 1.85mm	HMC-C065
NEW!	50 / 30	1:2 Fanout Buffer	9.5 / 11	2	0.5	455	-3.3	C-13 / 1.85mm	HMC-C062
NEW!	43 / 43	D-Type Flip-Flop	9 / 10	1.5	0.5	580	-3.3	C-13 / 1.85mm	HMC-C060
NEW!	50 / 25	D-Type Flip-Flop Double Edge Triggered	9 / 11	1.5	0.5	690	-3.3	C-13 / 1.85mm	HMC-C061
NEW!	50 / 25	XOR / XNOR Gate	6.5 / 10	2	0.5	550	-3.3	C-13 / 1.85mm	HMC-C064

Contact Us With Your High Speed Analog, Digital & Mixed-Signal Product Requirements

Hittite MICROWAVE CORPORATION

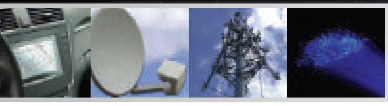
20 Alpha Road Chelmsford, MA 01824
Phone: 978-250-3343 • Fax: 978-250-3373 • sales@hittite.com

Order On-Line at: www.hittite.com
Receive the latest product releases - click on "My Subscription"

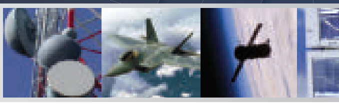
Visit http://mwj.hotims.com/23286-38

Fiber Optics Solutions

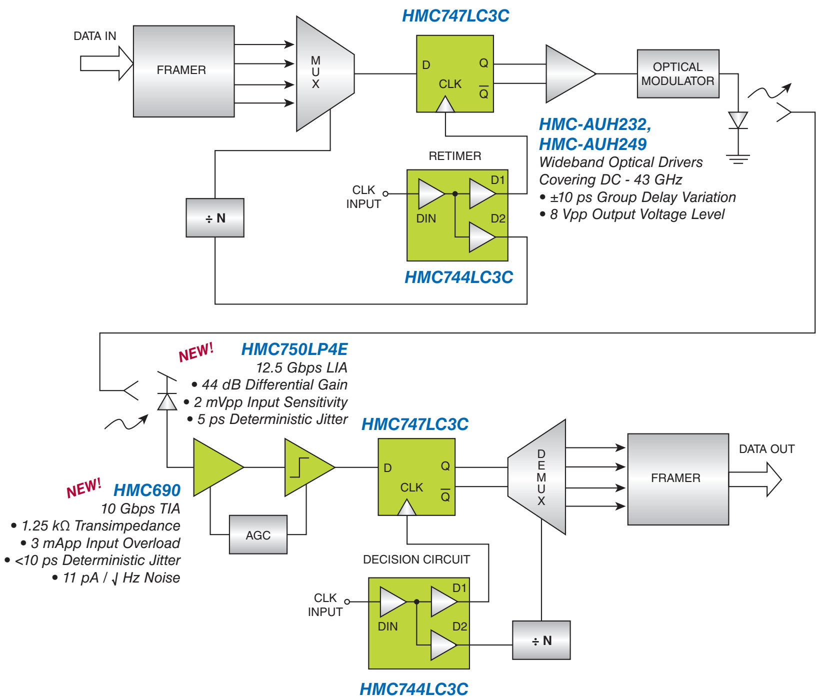
Fiber Optic & High Speed Digital Solutions to 100 Gbps!



Analog & Mixed-Signal ICs, Modules, Subsystems & Instrumentation



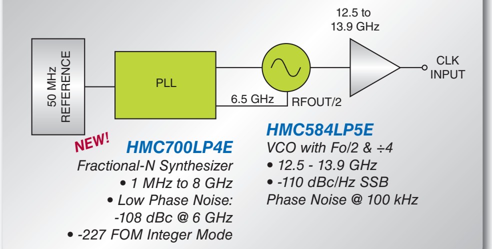
Typical Serial Fiber Optic Data Transmission System



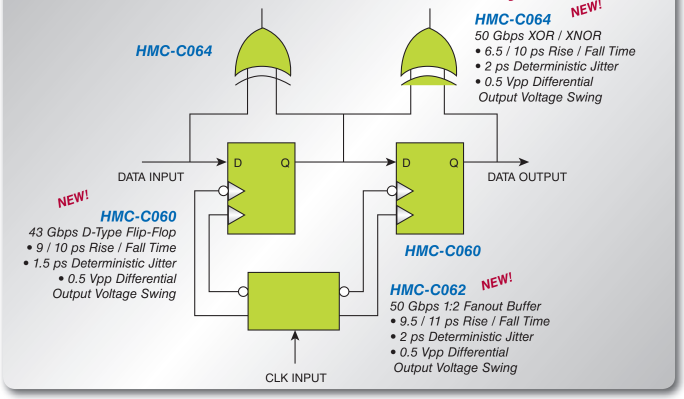
NEW! **HMC744LC3C**
13 Gbps 1:2 Fanout Buffer
- 22 / 20 ps Rise / Fall Time
- 2 ps Deterministic Jitter
- 0.6 to 1.1 Vpp Differential Output Voltage Swing

NEW! **HMC747LC3C**
13 Gbps D-Type Flip-Flop
- 22 / 20 ps Rise / Fall Time
- 2 ps Deterministic Jitter
- 0.7 to 1.3 Vpp Differential Output Voltage Swing

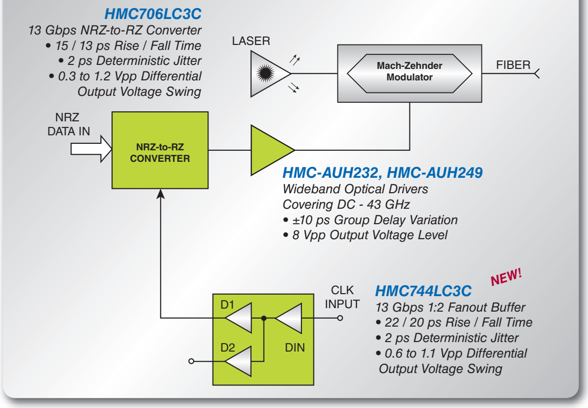
Clock Drive Circuit



43 Gbps Hogge Phase Detector for Clock & Data Recovery



13 Gbps, NRZ-to-RZ Conversion



OC-192, OC-768, 100G Ethernet Solutions for Commercial & Military Communications & Sensors!
Custom Integration & Development Available, Contact FO@hittite.com For Inquiries.

Hittite MICROWAVE CORPORATION

Hittite Microwave Corporation		
Corporate Headquarters	Ph 978-250-3343	sales@hittite.com
HMC Europe, Ltd.	Ph +44-870-766-4355	europe@hittite.com
HMC Deutschland GmbH	Ph +49-8031-97654	germany@hittite.com
Northern Europe - HMC Europe, Ltd.	Ph +44-870-766-4355	nordic@hittite.com
HMC Asia Co., Ltd.	Ph +82-2-559-0638	korea@hittite.com
HMC Co., Ltd. Shanghai	Ph +86-21-6209-8809	china@hittite.com
Hittite KK	Ph +81-3-6853-6854	japan@hittite.com

Order On-Line www.hittite.com

ISO/TS 16949 TÜV SÜD ISO 9001

Receive the latest product releases at www.hittite.com - click on "My Subscription"

Visit http://mwj.hotims.com/23286-39 or use RS# 39 at www.mwjournal.com/info

4. F.J. Zucker and J.A. Strom, "Experimental Resolution of Surface-wave Antenna Radiation into Feed and Terminal Patterns," *IEEE Transactions on Antennas and Propagation*, Vol. 18, No. 3, July 1970, pp. 420-422.
5. H. Bach, "Applicability of Hansen-Woodyard Condition," *Proceedings of the IEEE*, Vol. 119, No. 1, January 1972, pp. 38-40.
6. G.S. Kirov, "Engineering Method for Design of Backfire Antennas," *3rd Conference on Electronic Circuits Digest*, Prague, September 1979.
7. A. Kumar and H.D. Hristov, *Microwave Cavity Antennas*, Artech House Inc., Norwood, MA, 1989.
8. H. Jasik, *Antenna Engineering Handbook*, R.C. Johnson (Editor, 3rd Edition), McGraw-Hill, New York, NY, 1999.
9. T.A. Milligan, *Modern Antenna Design*, John Wiley & Sons Inc., Hoboken, NJ, 2005.
10. J. C. Simon and G. Weill, "Un Nouveau Type d'Aérien à Rayonnement Longitudinal," *Annales de Radioélectricité*, Tome VIII, No. 33, 1953.
11. L. Thourel, *Les Antennes*, Dunod, Paris, France, 1971.
12. S.A. Brunstein and R.F. Thomas, "Characteristics of a Disk-on-rod Antenna," *JPL Quarterly Technical Review*, Vol. 1, No. 2, July 1971, pp. 87-95.
13. Cushcraft-Laird Technologies, "Wireless LAN Antennas, Parabolic Reflector Antenna S24024PDNF 2400/2500 MHz," www.cushcraft.com.

Georgi S. Kirov *received his MSc and PhD degrees in radio engineering from the University of Varna, Bulgaria. In 1969, he joined the department of radio engineering and, in 1999, became the head of the department. From 1981 to 1986, he was with the University of Setif, Algeria, as a lecturer in the field of telecommunications. He specialized in microwave antennas at Moscow Technical University and the Moscow Technical University of Communications and Informatics. He was also a researcher at the University of Magdeburg, Germany. His research interests include high frequency electromagnetism, antennas and wave propagation, microwave/optical devices and wireless communications.*

Hristo D. Hristov *received his PhD and DSc degrees in radio engineering from the Technical University, Sofia, Bulgaria. Since 1965, he has been with the Technical University of Varna, Bulgaria. He is currently a research professor with Universidad Técnica Federico Santa Maria, Valparaiso, Chile. He was a researcher at the Strathclyde University of Technology, Queen Mary College and the Eindhoven University of Technology. His research interests include high frequency electromagnetism, antennas, propagation, microwave devices and wireless communications.*

Rodolfo Feick *received his degree in ingeniero civil electronico from Universidad Técnica Federico Santa Maria, Chile, in 1970, and his MSc and PhD degrees in electrical engineering from the University of Pittsburgh in 1972 and 1975, respectively. He has been with the department of electronics engineering at Universidad Técnica Federico Santa Maria since 1975, where he is now the head of the telecommunication group. His research interests include wireless systems and data communications.*

SYNTHESIZERS TO 20 GHz

AFFORDABLE HIGH PERFORMANCE FOR YOUR LABORATORY!

Analog & Mixed-Signal ICs, Modules, Subsystems & Instrumentation

$7,998.00

- 10 MHz to 20 GHz
- Output Power: +27 dBm
- Power Resolution: 0.1 dB
- Frequency Resolution: 10 kHz
- SSB Phase Noise @ 100kHz: -113 dBc/Hz @ 1 GHz
- Spurious @ 1 GHz: -80 dBc
- USB, GPIB & Ethernet Control

IN-STOCK SYNTHESIZED SIGNAL GENERATION

	Frequency (GHz)	Function	Frequency Resolution (MHz)	Maximum Power Output (dBm) @ 2 GHz	Maximum Power Output (dBm) @ 6 GHz	100kHz SSB Phase Noise (dBc/Hz) @ 1 GHz	100kHz SSB Phase Noise (dBc/Hz) @ 4 GHz	Spurious @ 1 GHz (dBc)	Switching Speed @ 100 MHz Steps (µs)	Part Number
NEW!	0.01 - 20	Signal Generator	0.01	+27	+27	-113	-101	-80	<300	HMC-T2100
	0.7 - 8.0	Signal Generator	1	+20	+15	-78	-87	-57	<200	HMC-T2000

Expand The Capability of the HMC-T2100 & HMC-T2000 With Our Connectorized Module Products
Contact TE@hittite.com To Find Out How!

Hittite MICROWAVE CORPORATION
20 Alpha Road Chelmsford, MA 01824
Phone: 978-250-3343 • Fax: 978-250-3373 • sales@hittite.com

Order On-Line at: www.hittite.com
Receive the latest product releases - click on "My Subscription"

Visit http://mwj.hotims.com/23286-40

DUAL CHANNEL LNAs

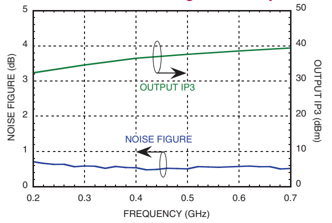
FOR CELLULAR / 3G, WiMAX / 4G & AUTOMOTIVE TELEMATICS

Analog & Mixed-Signal ICs, Modules, Subsystems & Instrumentation

High Linearity Dual Channel LNAs, 230 to 2200 MHz

- Noise Figure As Low As 0.5 dB
- High Gain Up to 22 dB
- High Output IP3 to +40 dBm
- Single Supply: +3V to +5V
- 50 Ohm Matched I/Os

HMC816LP4E - Noise Figure & Output IP3



A SELECTION OF IN-STOCK DUAL CHANNEL LOW NOISE AMPLIFIERS

	Frequency (GHz)	Function	Gain (dB)	OIP3 (dBm)	NF (dB)	P1dB (dBm)	Bias Supply	Package	Part Number
NEW!	0.23 - 0.66	Low Noise, Dual Channel	24	37	0.5	19	+5V @ 93mA	LP4	HMC816LP4E
NEW!	0.55 - 1.2	Low Noise, Dual Channel	16	37	0.5	21	+5V @ 88mA	LP4	HMC817LP4E
NEW!	1.7 - 2.2	Low Noise, Dual Channel	20.5	35	0.85	21	+5V @ 112mA	LP4	HMC818LP4E

Hittite Microwave is ISO/TS 16949 Certified for Standard & Custom Products

Hittite MICROWAVE CORPORATION

20 Alpha Road Chelmsford, MA 01824
Phone: 978-250-3343 • Fax: 978-250-3373 • sales@hittite.com

Order On-Line at: www.hittite.com
Receive the latest product releases - click on "My Subscription"

Visit http://mwj.hotims.com/23286-41 or use RS# 41 at www.mwjournal.com/info

BiCMOS MIXERS

HIGH LINEARITY MIXERS FOR CELLULAR & BROADBAND INFRASTRUCTURE!

Analog & Mixed-Signal ICs, Modules, Subsystems & Instrumentation

HMC785LP4E & HMC786LP4E High IP3 Mixers, 0.7 to 2.2 GHz

- High Input IP3 to +40 dBm
- Up and Downconversion
- 0 dBm LO Drive
- High Side & Low Side LO Versions
- Excellent Isolations
- Compact 4x4 mm SMT Packages

A SELECTION OF OUR HIGH LINEARITY MIXER PRODUCTS

	RF Freq. (GHz)	Function	IF Freq. (GHz)	Conversion Gain (dB)	LO/RF Isolation (dB)	IIP3 (dBm)	Package	Part Number
	0.7 - 1.0	High IP3, DBL-BAL, 0 LO	DC - 0.45	-7	23	32	LP4	HMC684LP4E
	0.7 - 1.1	High IP3, DBL-BAL, 0 LO	DC - 0.5	-7.5	24	34	LP4	HMC686LP4E
NEW!	0.7 - 1.1	High IP3, DBL-BAL, 0 LO	DC - 0.5	-7.5	22	40	LP4	HMC786LP4E
	1.7 - 2.2	High IP3, DBL-BAL, 0 LO	DC - 0.5	-8	30	35	LP4	HMC685LP4E
	1.7 - 2.2	High IP3, DBL-BAL, 0 LO	DC - 0.5	-8	31	34	LP4	HMC687LP4E
NEW!	1.7 - 2.2	High IP3, DBL-BAL, 0 LO	DC - 0.5	-8	28	38	LP4	HMC785LP4E
	2.2 - 2.7	High IP3, DBL-BAL, 0 LO	DC - 0.45	-7.5	25	31	LP4	HMC688LP4E
	2.2 - 2.7	High IP3, DBL-BAL, 0 LO	DC - 0.45	-7.5	26	31	LP4	HMC689LP4E
	3.3 - 3.9	High IP3, DBL-BAL, 0 LO	DC - 0.6	-8.5	28	30	LP4	HMC666LP4E

Ideal for Cellular/3G & LTE/WiMAX/4G, Transmitters & Receivers

Hittite MICROWAVE CORPORATION

20 Alpha Road Chelmsford, MA 01824
Phone: 978-250-3343 • Fax: 978-250-3373 • sales@hittite.com

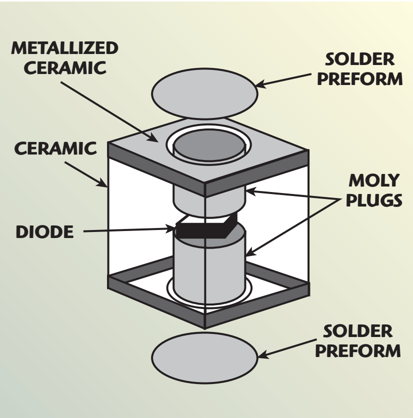
Order On-Line at: www.hittite.com
Receive the latest product releases - click on "My Subscription"

Visit http://mwj.hotims.com/23286-42 or use RS# 42 at www.mwjournal.com/info

PIN DIODE PERFORMANCE TRADEOFFS ACROSS PACKAGE AND PROCESS TYPES

In today's global wireless industry, demands for semiconductor performance are becoming increasingly more challenging. Higher power and higher operating frequencies are two themes that permeate throughout this market space. Applications such as Magnetic Resonance Imaging (MRI) and UHF/VHF Tactical Radios require extremely high power handling PIN diodes at lower frequencies. Alternatively, broadband and high frequency applications such as Test Instrumentation, RADAR and Sensors require PIN diodes to push frequency ranges beyond 70 GHz.

PIN diodes typically come in several semiconductor flavors—Silicon, GaAs and AlGaAs. Not only does the semiconductor process play a significant role in the performance of PINs, but also the packaging medium. Many suppliers have subsequently developed unique process and packaging technologies designed to address the various frequency, power and mounting needs of customers. Three PIN diode products that have pioneered the diode industry are Silicon Metal Electrode Leadless Face (MELF) packaged PINs for high power applications, packageless PINs for broadband surface-mount applications, and flip chip AlGaAs PINs for ultra-high frequency applications. In this paper, the processes and packages of these devices will be explored, compared and contrasted.



▲ *Fig. 1 MELF package construction.*

MELF PIN DIODES

MELF package PIN diodes were designed with the intention of operating in high power, low frequency environments. The rugged MELF design hermetically encloses the PIN diode in ceramic, as shown in ***Figure 1***. The diode is sandwiched between two Molybdenum plugs from the top and bottom. With a thermal conductivity at 20°C of 142 W/mK, these Moly plugs provide an optimal thermal contact with the diode die to facilitate heat conduction. A solder preform is then added on the external side of the plug. The combination of this RoHS solder preform and the metallized ceramic on the top and bottom of the package allows for these devices to be surface mounted using Sn63/Pb37 solder or some other RoHS compliant solders. The tin plated, rectangular construction was done intentionally to enhance

KEVIN HARRINGTON AND
SCOTT VASQUEZ
M/A-COM Technology Solutions
Lowell, MA

SPM
Ablestik
EPOXY TECHNOLOGY
Henkel
Emerson & Cuming
GAISER precision bonding tools

bonding source

…NO MINIMUMS, NO WAITING…IT'S EASY!

Bonding Source supplies the microelectronics and RF/Microwave industry with immediate delivery of epoxy films, pastes, bonding wire, and bonding accessories with no minimum charges.

DELIVERY OF EPOXY PRE-FORMS IN JUST ONE WEEK!

Since 2006, suppliers to the defense and commercial markets have relied on Bonding Source's quick delivery and responsive customer service as a flexible and economical alternative. The friendly and courteous Bonding Source team makes sure the full range of customer needs are met. Whether ordering one spool of wire for R&D or epoxy pre-forms for high-volume assembly, Bonding Source delivers.

Bonding Source Also Provides JIT Shipments To Match Your Manufacturing Schedule, And Drop Ships At No Extra Charge.

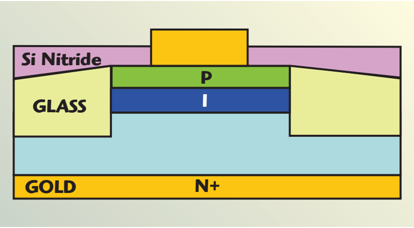
So why wait? Contact us:

603-595-9600

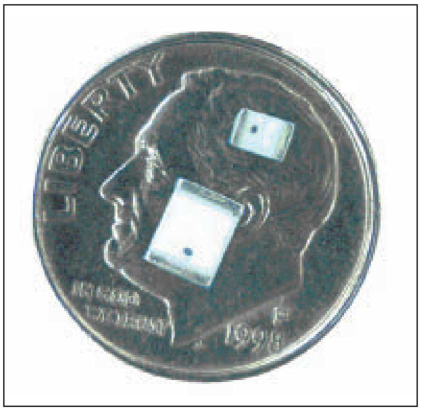
www.BondingSource.com

NO MINIMUMS…NO WAITING…
IT'S EASY!

Visit http://mwj.hotims.com/23286-20 or
use RS# 20 at www.mwjournal.com/info



▲ *Fig. 2 Silicon PIN diode construction.*

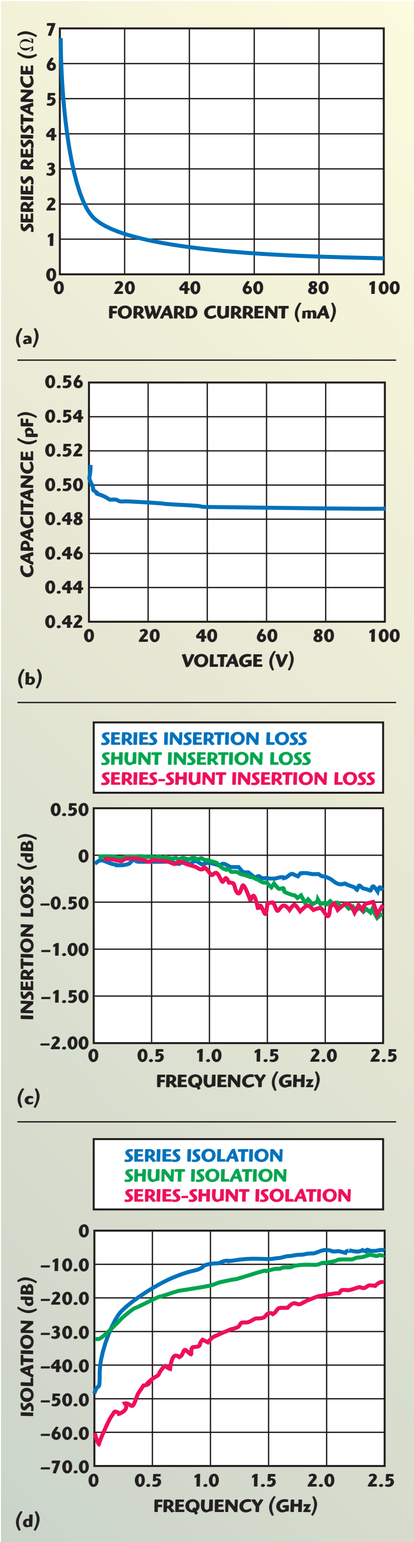


▲ *Fig. 3 MELF package styles.*

solderability and aid in high volume, pick and place environments.

The construction of the MELF PIN is critical to an RF designer due to the efficient heat dissipation and consequent power handling up to 200 W. In addition, PIN diodes with different I-region thicknesses ranging from 30 to 350 micron can be mounted into this package style. Thicker I-regions handle higher RF voltages and provide higher linearity (IIP3) due to the increased breakdown voltage (Vb). In contrast, thinner I-regions will have faster switching/settling speeds as well as lower series resistance (Rs). ***Figure 2*** shows the construction of the PIN diode. These MELF PINs work well down to 300 kHz and up to about 2 GHz before package parasitics impact their RF performance.

MELF PIN diodes have two package styles, as shown in ***Figure 3***. The first is the smallest MELF with a parasitic capacitance of 0.16 pF and a parasitic inductance of 0.15 nH per Moly plug. ***Figure 4*** shows the DC and RF performance of a typical MELF PIN with the DC parameters measured by an impedance analyzer on a single diode, and the S-parameter performance measured on a vector network analyzer. The series resistance, capacitance, insertion loss and isolation are shown for a MELF PIN soldered



▲ *Fig. 4 DC and RF performance of a MELF PIN diode.*

down onto a Rogers 4350 microstrip line in series. Insertion loss and isolation are also shown for a shunt MELF PIN soldered to ground. Combining both series and shunt MELF PINs into a single configuration shows that the isolation improves dramatically without significantly degrading the insertion loss.

The performance can be optimized for both bandwidth and high frequency performance very easily with additional matching elements. These PINs are typically used as building blocks for more complex circuits such as multi-throw RF switches and attenuators. The low Rs is critical for low insertion loss series switching applications while the low distortion versus forward current is equally as important for attenuator applications.

These diodes are also available in non-magnetic packages for MRI applications, which require high voltage handling below 1 GHz. The existence of magnetic materials in a PIN diode structure distorts the static magnetic fields associated with various coils and will interfere with calibration and accuracy. Consequently, non-magnetic MELFs have the ability to optimally receive low power return signals from the human body.

HMIC SURMOUNT PIN DIODES

M/A-COM Technology Solutions has developed a Heterolithic Microwave Integrated Circuit (HMIC) process. It is a silicon and glass-based process that uses silicon pedestals embedded in a low loss, low dispersion glass. Selective backside metallization is utilized with via connectivity to the topside RF traces and air-bridges to produce a surface-mount device. The topside of the die is fully encapsulated with silicon nitride, and has an additional polymer layer to help protect against damage during handling and assembly. This surface mountable solution effectively created is called "surmount" throughout this article. A cross-section of the HMIC process as applied to both series and shunt configured PIN diodes is shown in ***Figure 5***.

The shunt diode is realized with the anode, cathode and "I" region contained within a silicon pedestal. The cathode of the PIN diode serves as an electrical contact to the ground plane, and since silicon has a thermal conductivity approximately one third that of gold, acts as a low thermal resistance heat spreader. In addition, HMIC provides a simultaneous cathode contact on the top surface

What's *your* hot button?

Faster data rates. Richer content. An ever-more competitive marketplace… As a player in the wireless infrastructure sector, you need to be able to count on *your* suppliers like never before.

That's why you should insist on Xinger®-II brand couplers from Anaren. Part after part, nothing beats our complete line of miniature directionals. Whether you're looking for low insertion loss, low return loss, and isolation. Quality control and RF testing. RoHS compliance. Or unfailing on-time delivery that keeps pace with your aggressive production schedule.

To see for yourself why we've earned, and continue to earn, the most positions in the category – email xinger2@anaren.com or contact one of our world-class stocking distributors.

Doesn't your equipment demand the best? Not every stripline coupler is a "Xinger." Insist on bona-fide Xinger-II brand couplers from Anaren – proven to be reliable ever since we invented the category in 1995!

Part Number	Frequency (GHz)	Power (W)
XC0450E-20	0.46–0.47	100
XC0900P-10	0.8–1.0	55
XC0900A-05	0.8–1.0	250
XC0900A-10	0.8–1.0	250
XC0900A-20	0.8–1.0	200
XC0900B-30	0.8–1.0	355
XC1500A-20	1.0–2.0	150
1P510	1.7–2.0	20
1P520	1.7–2.0	25
XC1900E-10	1.7–2.0	175
XC1900A-05	1.7–2.0	200
XC1900A-10	1.7–2.0	175
XC1900A-20	1.7–2.0	150
JP506	2.0–2.3	20
JP510	2.0–2.3	20

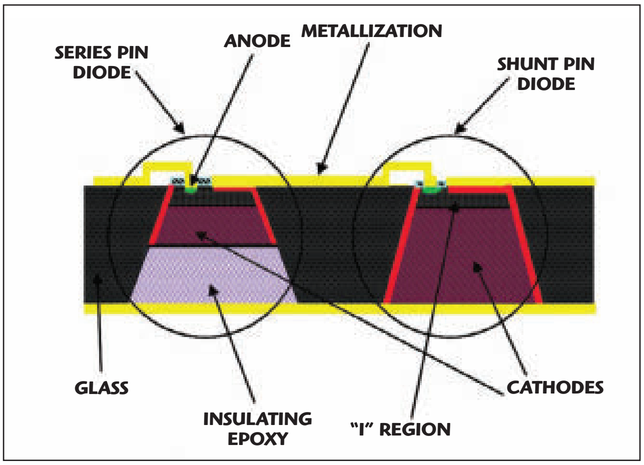
Part Number	Frequency (GHz)	Power (W)
JP520	2.0–2.3	25
XC2100E-10	2.0–2.3	165
XC2100A-05	2.0–2.3	175
XC2100A-10	2.0–2.3	175
XC2100A-20	2.0–2.3	150
XC2100A-30	2.0–2.3	120
XC2100B-30	1.8–2.7	300
1P610	2.3–2.7	20
1P620	2.3–2.7	25
XC2500P-20	2.3–2.7	20
XC2500E-10	2.3–2.7	145
1M710	3.3–3.7	22
XC3500P-20	3.3–3.8	45
XC3500M-20	3.3–3.8	60
1M810	5.0–6.0	15

Anaren®
What'll we think of next?®

800-411-6596 > www.anaren.com
In Europe, call 44-2392-232392
ISO 9001 certified
Visa/MasterCard accepted (except in Europe)

Richardson Electronics Engineered Solutions · AVNET · BFi OPTiLAS

Visit http://mwj.hotims.com/23286-10 or use RS# 10 at www.mwjournal.com/info



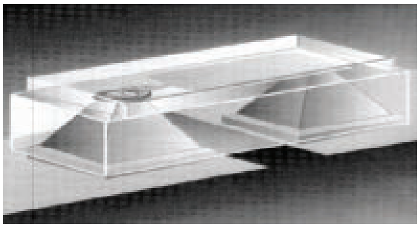
▲ *Fig. 5 HMIC process cross-section.*

of the via enabling more complex switch configurations to be realized. Silicon vias to achieve vertical connections (front to back) are a natural consequence of the HMIC fabrication process. The top surface of these vias typically serves as the "active" layer for the formation of the required diode-based active devices and as interconnection paths for the requisite passive elements. The various circuit elements, either active or passive, are then laterally linked using standard photolithography and metallization techniques.

The shunt diode has the highest power handling so it has a very high thermal conductivity from the surface to ground since its cathode is directly connected to the backside. A series diode, by contrast, is always the weak thermal link in the design since it has the lowest thermal conductivity. A thermally conductive but electrically insulating epoxy isolates the cathode of the diode from the backside of the entire structure. The formation of the series diode is initially identical in formation to the shunt diode. A cavity is created in the silicon cathode using a selective etch that is then packed with a low dielectric constant, high field strength, silica filled epoxy. This epoxy works very well as a DC and RF isolation medium. The limitation with the surmount diode lies with the silica filled epoxy used to isolate the diode when in series from the RF ground plane. The silica filled material is essentially a thermal open and the only heat sinking that is occurring in the series diode is a result of heat flow along the metallization structures to the nearest silicon via. Using 175°C as the maximum reliable operating junction temperature of the switch, which always occurs at the series diode, the diode insertion loss and thermal resistance become the limiting factors to incident power levels.

Combining glass and silicon enables the high frequency and high power handling properties of the two materials to be optimized while allowing true surface-mount device structures to be produced using standard semiconductor processing equipment and techniques. Glass has a low dielectric constant and a low, high frequency loss tangent, while silicon has high thermal conductivity and low electrical resistance. In addition, both materials have a nearly identical thermal coefficient of expansion.

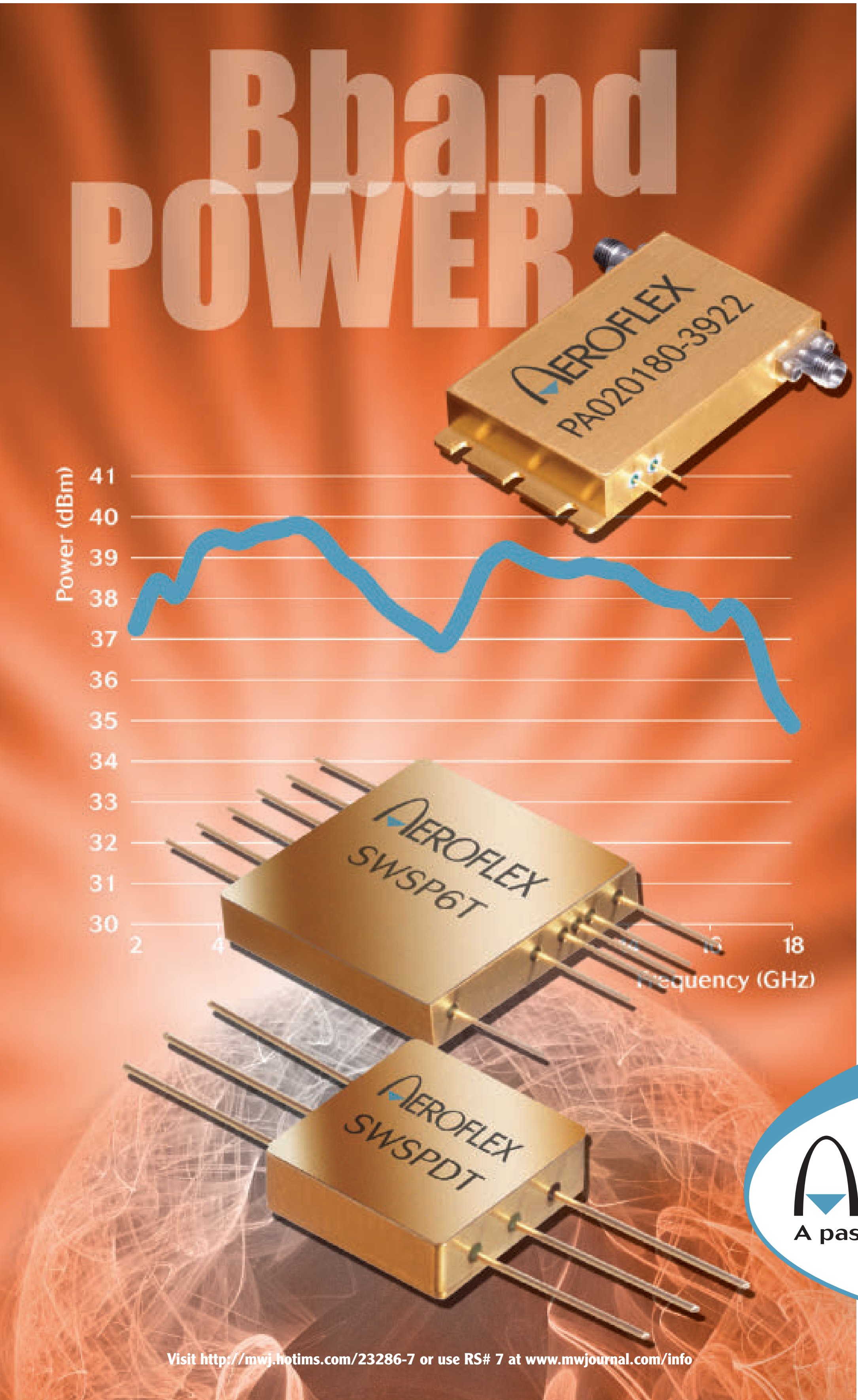
When using this process to design discrete surmount PIN diodes, as shown in ***Figure 6***, the shunt construction shown in Figure 5 is used. The anode connection at the top of the pyramid pedestal on the left is connected to an air-bridge. This air-bridge extends over to a via on the right. This via creates an RF connection from the anode through the air-bridge down the via to the backside of the device. The cathode of the diode is also connected to the backside of the device, yielding a direct cathode heatsink and provides for optimal heat transfer. These backside connections also provide for the surface mountable ability. In addition, thermal conductivity and dissipated power are optimized because these diodes are



▲ *Fig. 6 Discrete surmount PIN diode.*

Visit http://mwj.hotims.com/23286-11

Meet the industry's first compact 2 to 18 GHz 8W power amplifiers



NEW 2 to 18 GHz 8W power amplifiers

- 2 to 18GHz 8W CW output power with typical current < 1.3 amps @ +28V
- Available with typical gain of 22dB or 38dB
- Compact 2.7 x 1.6 x 0.42″

Space switches

- Direct replacement for legacy switches
- High isolation >45dB
- Compact hermetic packages
- Integrated control logic
- Available in Class K

Broadband power amps

- Designs up to 65GHz
- High efficiency and linearity
- Power up to 150W pulsed, 50W CW
- High reliability

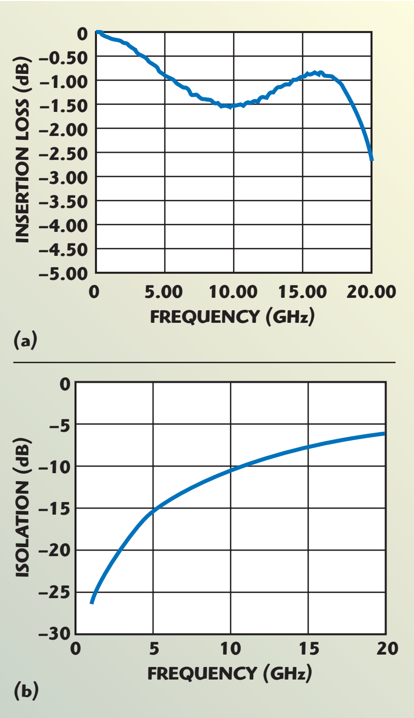
At Aeroflex Plainview, we're all about experience, and offering cost-effective solutions that do not sacrifice performance and quality. We combine extensive space design and packaging expertise with cutting-edge, proven technologies to provide highly-integrated microwave assemblies, amplifiers, switches, and up/down converters that operate up to 65GHz.

800-645-8862

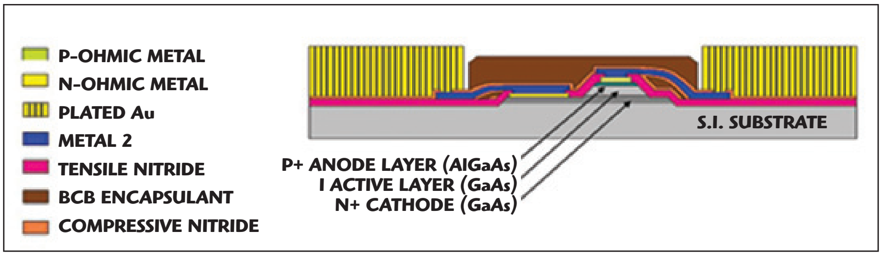
aeroflex.com/bband

AEROFLEX

A passion for performance.



▲ *Fig. 7 S-parameters of a surmount diode.*



▲ *Fig. 8 AlGaAs flip chip process.*

electrically in series, but thermally in shunt. Surmount diodes have I-region widths that range from 10 to 50 microns are available in different sizes. HMIC surmount PINs are useable in MRI applications as they are non-magnetic devices.

Surmount PIN diodes can exceed 100 W CW power handling at 2 GHz. The "packageless" surmount construction minimizes parasitic capacitances and inductances to minimal values, resulting in performance from 50 MHz to 26 GHz. ***Figure 7*** demonstrates the broadband small-signal performance of a series mounted surmount diode. Power and bandwidth are two critical attributes and are major differentiators for the HMIC surmount PIN diode option.

FLIP CHIP AlGaAs PIN DIODES

One chip type that currently transcends multiple semiconductor platforms is flip chip PIN diodes. The AlGaAs diodes combine Aluminum (in the P+ region) and Gallium Arsenide (in the I and N regions), which improves the insertion loss significantly at higher frequency ranges. Due to the reduced recombination rate for electrons and the higher carrier injection rate with an Aluminum-GaAs heterojunction, a greater number of carriers can flow through the I-region, thereby lowering the effective resistivity of the I-region. Fabricated AlGaAs diodes effectively have lower diode "ON" resistance than conventional GaAs devices by as much as 25 percent. Consequently, AlGaAs PIN diodes outperform silicon beam leads and chip devices for a variety of broadband switching applications. ***Figure 8*** shows the vertical construction of the PIN diode and ***Figure 9*** shows several flip chips from the top view.

A flip chip PIN diode connects to a substrate from the top pads of the package. Consequently, the chip has to be flipped and epoxied down to a medium using electrically conductive Ag epoxy. The BCB encapsulant covering the die acts as protection upon the flipping of the diode. This flip chip package construction combined with the AlGaAs process yields a device with capacitance as low as 0.025 pF and operational frequencies beyond 70 GHz. The AlGaAs PIN diode flip chip has good broadband high frequency performance and the fastest switching performance because of its low parasitics and thin I-regions. A common tradeoff with high frequency performance is lower power handling capability, as is the case with flip chips. The PIN diodes are rated up to 23 dBm of CW input power. ***Figure 10*** shows small-signal S-parameter data for a typical AlGaAs flip chip in a series configuration. The device pro-

Visit http://mwj.hotims.com/23286-113

DC to 8 GHz

MMIC Amplifiers

SOT-89
Actual Size

from 99¢ ea. (qty. 25)

These Tiny SOT-89 cascadable 50 ohm wideband gain blocks cover from below 10 KHz up to 8 GHz in a single model. Built to outlast the equipment it will be used in, these transient protected units are ruggedly constructed and will meet level 1 moisture sensitivity testing.
Check out our web site, over 24 models available with performance data, curves, environmental specs and easy downloading of S parameters from the web to your simulation software. Models are available to provide the performance you need from high gain, low noise, high IP3 or low DC current. Don't wait; choose the MMIC model that meets your performance/price requirements, ***Available from Stock***.

Mini-Circuits…we're redefining what VALUE is all about!

- Power output to 21 dBm
- High IP3 up to 38 dBm
- Transient and ESD protected
- Fixed voltage, GVA 84+
- Gain from 12-26 dB
- Noise figure from 2.7 dB
- InGaP HBT
- 2 year guarantee

AMPLIFIER DESIGNER'S KITS

K3-Gali_GVA+: Only $99.95
Contains 10 Ea. of Gali 24+, 74+, 84+, GVA 84+ (40 pieces total)

K4-Gali+: Only $99.95
Contains 10 Ea. of Gali 1+, 2+, 3+, 4+, 5+, 6+, 21+, 33+, 51+ (90 pieces total)

K5-Gali+: Only $64.95
Contains 10 Ea. of Gali 4F+, 5F+, 6F+, 51F+, 55+ (50 pieces total)

Evaluation Boards Available, $59.95 ea.

All models protected under U.S. patent # 6,943,629.

RoHS compliant.

Mini-Circuits®
ISO 9001 ISO 14001 CERTIFIED

ALL NEW minicircuits.com

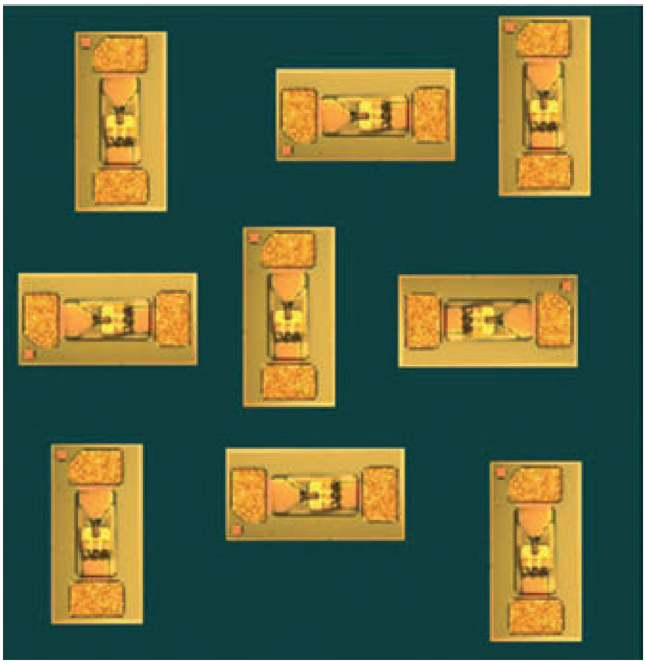
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending
The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

RF/IF MICROWAVE COMPONENTS

346 rev N

Visit http://mwj.hotims.com/23286-62 or use RS# 62 at www.mwjournal.com/info



▲ *Fig. 9 Flip chips—top view under magnification.*

vides significant circuit tuning advantages due to the low total capacitance Ct (< 18 fF), series resistance Rs (4 ohms at 20 mA) and series inductance Ls (0.5 nH). These specifications provide a 0.072 ps RC time constant that affords greater operating bandwidth.

COMPARISON OF TECHNOLOGIES

One major advantage to discrete PIN diodes is that customers are able to easily and quickly customize their diode topology to meet their RF performance needs. ***Table 1*** shows three popular PIN diode switch topologies and each of their strengths and weaknesses. These three switch topologies are the most basic, but there are also designs with multiple cascaded series diodes and multiple shunt diodes on a single arm.

All the Power You Need at Your Fingertips

The New Thinking in Wireless Technology

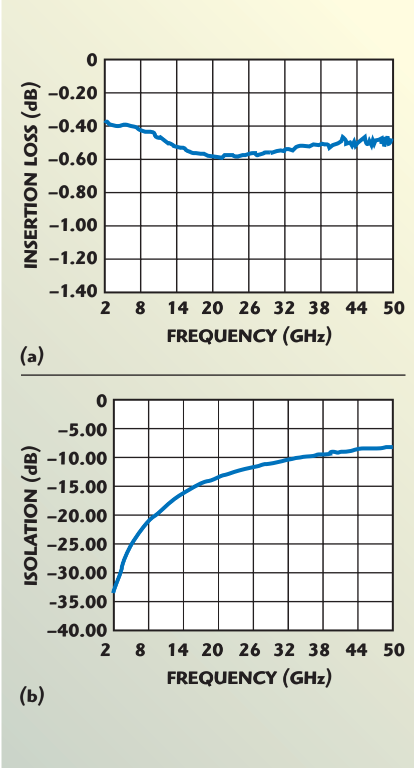
Renaissance offers an expanded line of high quality integrated RF and Microwave Assemblies and Sub-systems.

- Passive Products: Ferrites, Switches, Combiners, Filters, Couplers
- High Reliability Designs to Sustain High RF Power
- Compact Designs for Radar, Missile and Airborne Applications
- Entire Range of Microstrip, Stripline, Waveguide and Lumped Element Configurations
- Switches – Industry First Completely Hermetic, Laser Welded Switch and 10 Million Cycle Electromechanical Switch
- Combiners/Dividers: High, Medium and Low Power Wilkinson Dividers
- A Broad Line of Active Microwave and mmw Components
- Custom Integrated Subassemblies, "Turnkey" Gigabit Ethernet Radios

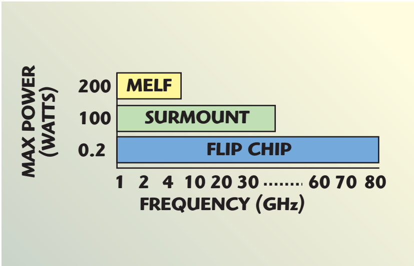
AEROSPACE MILITARY/DEFENSE INDUSTRIAL TELECOMMUNICATIONS AVIONICS MEDICAL

Call Today for a Quote!
978-772-7774 sales@rec-usa.com
or Go Online at www.rec-usa.com.

RENAISSANCE ELECTRONICS CORPORATION



▲ *Fig. 10 S-parameters of a AlGaAs flip chip.*



▲ *Fig. 11 Diode comparison, frequency vs. power.*

Figure 11 shows how the three diode processes and packaging technologies compare with each other over frequency and maximum CW input power. The trend in performance is typically the maximum operating frequency and maximum CW incident power are inversely related. The MELF PIN diode can handle up to 200 W of CW incident power, but has the narrowest and lowest frequency band of operation. Alternatively, the flip chip PIN diode has been shown to operate beyond 80 GHz with the broadest bandwidth performance, but with limited power handling of 0.2 W incident power. The optimal compromise between frequency and power was described with the HMIC surmount PIN diodes, which can han-

Visit http://mwj.hotims.com/23286-91

Visit http://mwj.hotims.com/23286-1 or use RS# 1 at www.mwjournal.com/info

TABLE I SWITCH TOPOLOGY STRENGTHS AND WEAKNESSES			
	Switch Design Configurations		
Parameter	***Series Diodes***	***Shunt Diodes***	***Series-shunt Diodes***
Insertion Loss	Best at Higher Freq.	Best at Lower Freq.	Moderate
Isolation	Worst	Moderate	Best
Return Loss	Moderate	Worst	Best
RF Incident Power	Worst	Best	Moderate
RF Power Dissipation	Worst	Best	Moderate
Switching Speed	Worst	Best	Moderate
DC Power Consumption	Best	Moderate	Worst
PIN Diode Driver Simplicity	Best	Moderate	Worst

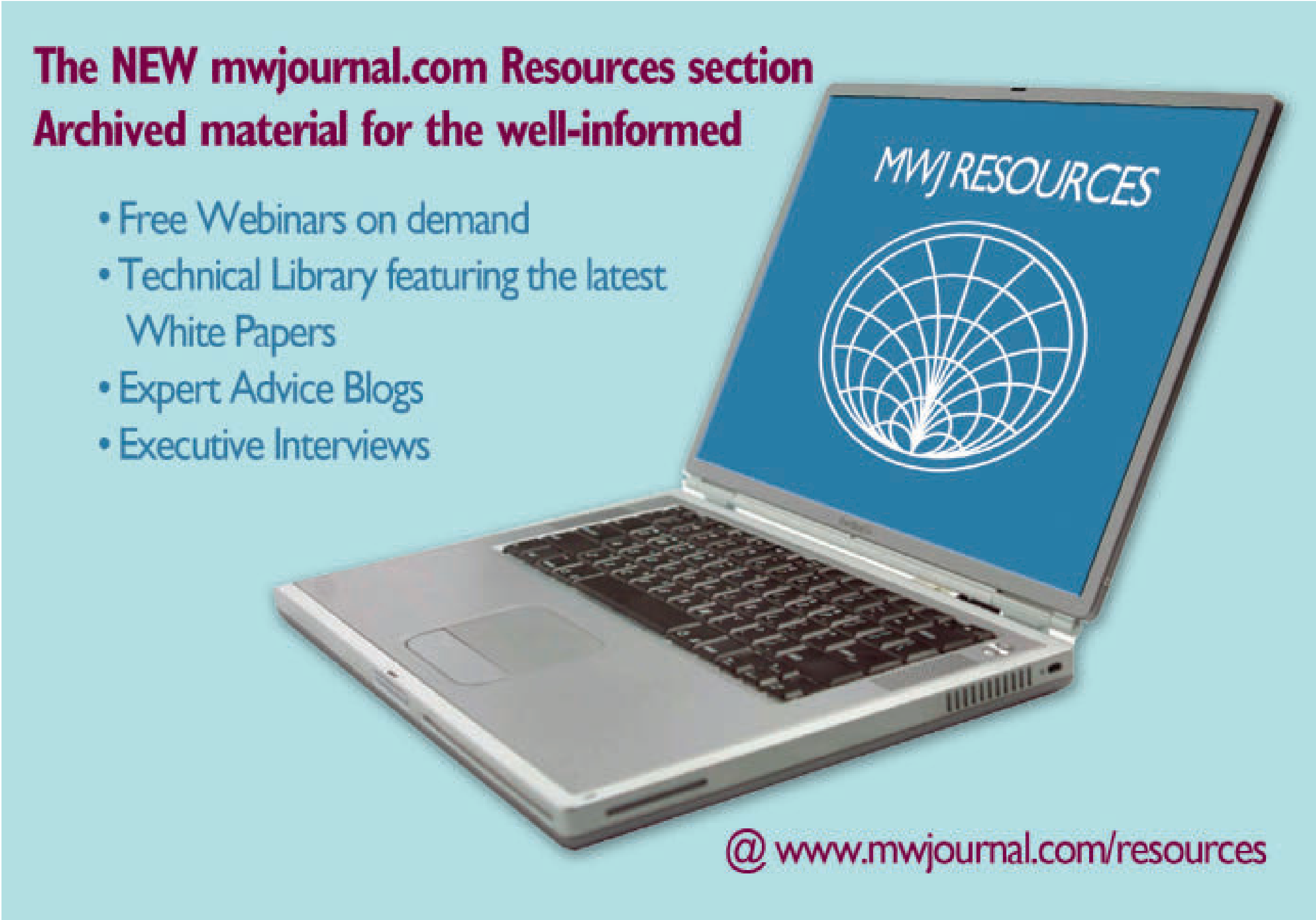
dle up to 100 W of incident power while still achieving broadband performance up to 26 GHz.

CONCLUSION

MELF, surmount and AlGaAs flip PIN diodes were described and compared against each other. Each type of PIN diode has clear advantages, depending on the end application. The PIN starting material, I-region thickness and packaging technology play major roles in the diode performance.

Kevin Harrington *holds his MS degree in Electrical Engineering from the University of Massachusetts, Amherst. He brings to M/A-COM Technology Solutions more than 13 years of experience in GaAs RF IC design and five years of product management. He is currently Product Development Manager responsible for HMIC diode & GaAs IC product development across multiple markets.*

Scott Vasquez *holds his MS degree in Electrical Engineering from Tufts University. He has been an applications engineer with M/A-COM Technology Solutions for over two years. He is currently a Product Manager responsible for diode-based products.*



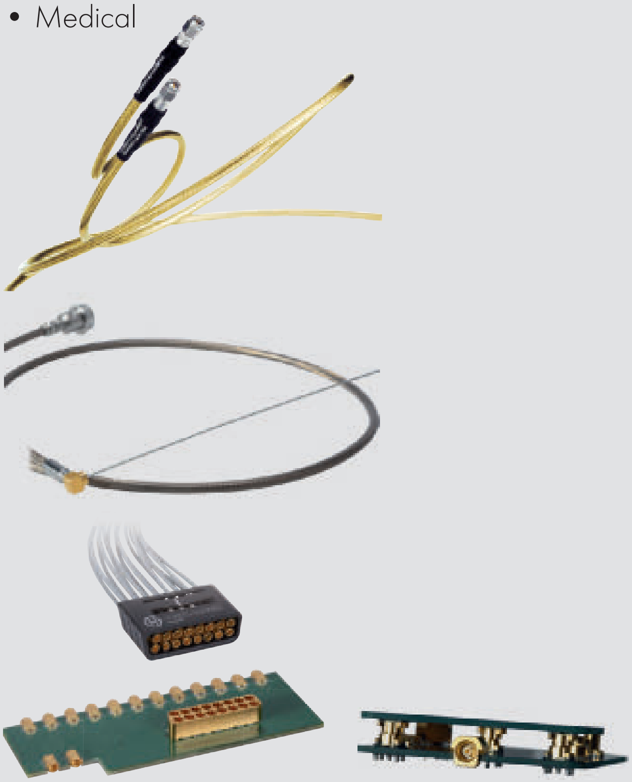
HUBER+SUHNER
Excellence in Connectivity Solutions

RF and microwave solutions for industrial applications

HUBER+SUHNER –
your partner for highest performance

HUBER+SUHNER offers a comprehensive range of RF and microwave cables, connectors and assemblies as well as antennas and EMP protectors. Customized solutions for applications in the markets of

- Test+Measurement
- Space
- Defence
- Medical



HUBER+SUHNER AG Degersheimerstrasse 14 CH-9100 Herisau
T +41 71 353 4111 info@hubersuhner.com

hubersuhner.com

THEORY AND PROPOSED METHOD FOR DETERMINING LARGE-SIGNAL RETURN LOSS OR "HOT S_{22}" FOR POWER AMPLIFIERS

Power amplifiers (PA) are a critical functional block in today's wireless communications. They are found in every cell phone, cordless phone, RF remote controller, etc. Any application requiring the wireless transmission of analog or digital signals will require a PA. In wireless equipment, the PAs are usually placed as close as possible to the antenna to minimize RF losses, maximize power efficiency and maximize battery life. RF systems engineers need to determine the PA return loss under actual output power drive levels. This so-called "Hot S_{22}" is needed to calculate the mismatch loss at the antenna interface and to determine the actual wireless system transmit power (a key requirement for regulatory bodies, such as the FCC).

The verification of a PA output return loss has proven to be a problematic and challenging endeavor when the PA is delivering high output power. High power PAs will inadvertently heat up as the output power levels are increased. Under high output power conditions, the power transistor's parameters may significantly change as temperature and bias conditions change.[1] Therefore, the PA output return loss may be substantially different when operated under low output power versus high output power. Most PA suppliers will only publish return loss values under small-signal conditions. These values should be checked against actual high power conditions when conducting systems transmit power budgets. A number of test equipment suppliers have "off-the-shelf" test hardware for measuring the return loss of high power units,[2,3] but these solutions are usually very expensive, and may not justify the investment for engineers conducting only occasional high power tests.

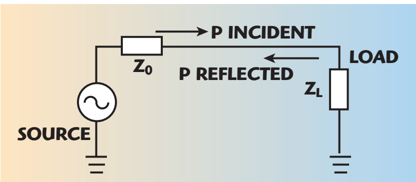


Fig. 1 Power transmission from source to load.

This article outlines a simple and cost-effective solution for determining the return loss of a high power PA. A test procedure is outlined, based on a mathematical approach, to determine the PA large- (or small-) signal return loss by measuring the insertion phase variation of the PA at specific VSWRs, using an inexpensive and simple test arrangement.

PA REFLECTION COEFFICIENT

Any RF test configuration can be expressed by a source impedance Z_L, and a characteristic impedance (Z_0), as shown in ***Figure 1***. If the load impedance is equal to the source characteristic impedance then the reflected traveling

PATRICK NARAINE AND
CHANDRA MOHAN
Skyworks Solutions Inc., Woburn, MA

RFMD®

RF1193 & RF1194

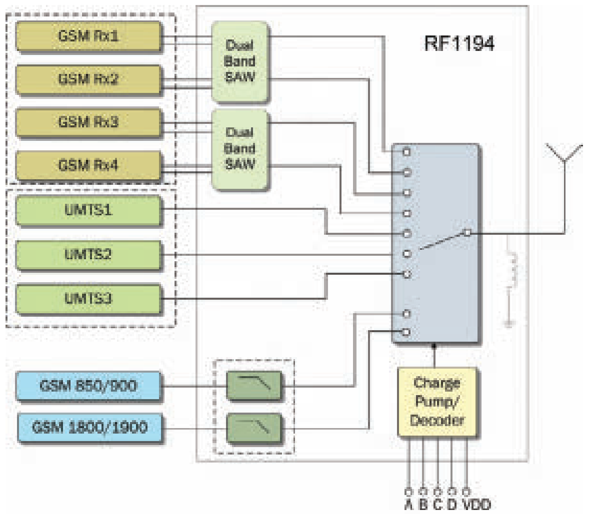
3G Multimode Switch Filter Modules

Leading the way for RFMD's new lineup of cellular front end switch and filter module solutions are the RF1193 and RF1194, both of which are optimized for use in multi-band and multimode 3G handsets. The RF119x family of switch modules helps to simplify the complex signal routing and filtering requirements demanded by the current multitude of co-existing air interface standards.

RF1193 & RF1194 OVERVIEW

						Input Power			*Insertion Loss*									
Part Number	*Switch Type*	*Interface*	*Integrated Harmonic Rejection LPF's*	*Integrated Rx SAW's*	*DC Blocking Capacitors*	*GSM LB (dBm)*	*GSM HB (dBm)*	*UMTS (dBm)*	*GSM LB Tx (dB)*	*GSM HB Tx (dB)*	*UMTS Tx (LB/HB) (dB)*	*UMTS Rx (LB/HB) (dB)*	*GSM Rx (LB/HB) (dB)*	*Second Harmonics (dBc)*	*Third Harmonics (dBc)*	*IIP2 (dBm)*	*IIP3 (dBm)*	*Pkg Size (mm)*
RF1193 SP10T	ASM (QB GSM, QB UMTS)	GPIO	Yes	No	Not Required	35	33	26	1.05	1.3	0.5 / 0.75	0.5 / 0.75	0.8 / 1.2	<-78	<-78	110	65	3.0 x 3.8 x 0.85
RF1194 SP9T	SFM (QB GSM, TB UMTS)	GPIO	Yes	Yes	Not Required	35	33	26	1.2	1.3	0.75 / 1.0	0.75 / 1.0	2.3 / 3.1	<-78	<-73	110	65	4.5 x 4.5 x 1.3

Sample Availability: NOW



FEATURES

RF1193 (SP10T) Multimode Antenna Switch Module (ASM)

- Best-in-class harmonic attenuation with integrated LPF
- Suitable for multimode GSM/EDGE/WCDMA applications
- Lowest BOM cost and small solution size with no external DC blocking capacitors required

RF1194 (SP9T) Multimode Switch Filter Module (SFM)

- Integrated inductor to provide 8 kV CD compliance
- Best-in-class harmonic attenuation with integrated LPF
- Integrated GSM Rx SAWs

For sales or technical support, contact RFMD at 336.678.5570 or sales-support@rfmd.com
7628 Thorndike Rd., Greensboro, NC 27409-9421 USA • Phone 336.664.1233 • Fax 336.931.7454

RFMD

rfmd.com

This product complies with RFMD's green packaging standards.

RFMD® is a trademark of RFMD, LLC. All other trade names, trademarks and registered trademarks are the property of their respective owners. ©2009 RFMD.

Visit http://mwj.hotims.com/23286-97 or use RS# 97 at www.mwjournal.com/info

wave does not exist (as is the case for a matched load). However, when Z_L is not equal to the PA output impedance Z_0, then the traveling wave V between the PA to the load contains two components: one is traveling in the +z direction and the other traveling in the -z direction.

$$V=V_+e^{-\gamma Z}+V_-e^{+\gamma Z} \quad (1)$$

The traveling wave in the +z direction is the incident power, and the traveling wave on the -z direction is the reflected power.

$$V_{inc}=V_+e^{-\gamma \bullet Z} \quad (2)$$

$$V_{ref}=V_-e^{+\gamma \bullet Z} \quad (3)$$

where γ is the propagation constant.

Now replace the source with an actual PA and the load with a phase tuner, which rotates the phase by 2π radians and causes, in theory, full reflection back to the PA, as illustrated in ***Figure 2***. The reflection coefficient is determined to be the ratio between the reflected and the incident vector as follows:

$$\Gamma_L=|\Gamma_L|\cdot e^{j\theta}$$

$$\Gamma_L=\frac{V_-e^{j\omega_0 t+(\theta+\phi)}}{V_+e^{j\omega_0 t+\phi}} \quad (4)$$

$$\Gamma_{PA}=|\Gamma_{PA}|\cdot e^{j\Psi}$$

$$\Gamma_{PA}=\frac{V'_+e^{j\omega_0 t+(\theta+\phi+\Psi)}}{V_-e^{j\omega_0 t+(\theta+\phi)}} \quad (5)$$

where:

Φ is the shifted phase caused by the PA

Θ is the phase angle of the reflection coefficient Γ_L

Ψ is the phase angle of the reflection coefficient Γ_{PA}

The summing vector, V, in the coupled port contains three vectors that are directed from three different paths, that is:

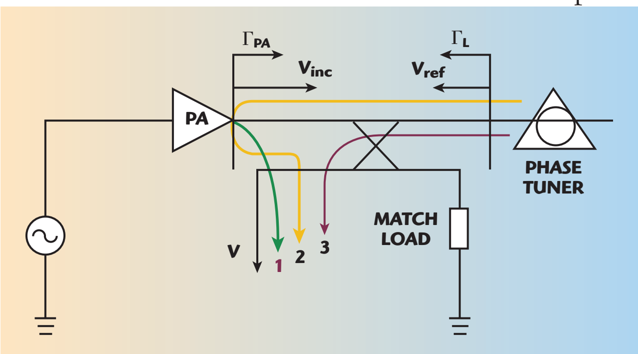


Fig. 2 PA in a mismatch system.

$$V_1=V_{inc}\cdot CF \quad (6)$$

$$V_2=V_{inc}\cdot \Gamma_{PA}\cdot \Gamma_L\cdot CF \quad (7)$$

$$V_3=V_{inc}\cdot \Gamma_L\cdot CF\cdot DR \quad (8)$$

where CF is the bidirectional coupling factor and DR is the directivity for the bidirectional coupler.

$$V=V_1+V_2+V_3 \quad (9)$$

$$V=CF\cdot V_+e^{j\omega_0 t+\phi}+ CF\cdot\Gamma_{PA}\cdot\Gamma_L\cdot V_+e^{j\omega_0 t+\phi}+ CF\cdot DR\cdot\Gamma_L\cdot V_+e^{j\omega_0 t+\phi} \quad (10)$$

Using directional couplers with DR > 20 dB, ensures that V_3 is much smaller than V_2, that is:

$$V_2>>V_3$$

$$V_{inc}\cdot \Gamma_{PA}\cdot \Gamma_L\cdot CF>>V_{inc}\cdot\Gamma_L\cdot CF\cdot DR$$

$$\Gamma_{PA}>>DR \quad (11)$$

It is recommended that the directivity for the bidirectional coupler should be higher than the PA return loss by 15 dB. This will ensure that the vector V_3 will remain negligible.

Directivity≥ PA R.L + 15 dB

If V_3 is negligible, then the vector V can be reduced to:

$$V=V_1+V_2 \quad (12)$$

$$V=CF\cdot V_+e^{j\omega_0 t+\phi}(1+|\Gamma_{PA}|\cdot|\Gamma_L|\cdot e^{j(\theta+\psi)}) \quad (13)$$

$$\Gamma_{Total}=\Gamma_{PA}\cdot\Gamma_L=\frac{V'_+e^{j\omega_0 t+(\theta+\phi+\Psi)}}{V_+e^{j\omega_0 t+\phi}} \quad (14)$$

$$V=CF(V_+e^{j\omega_0 t+\phi}+V'_+e^{j\omega_0 t+(\theta+\phi+\psi)}) \quad (15)$$

The summing vector V, as illustrated in ***Figure 3***, contains the vector V_1, which represents the incident wave and the vector V_2, which represents the reflected wave.

The angle φ is the angle between the incident vector V_1 to the summing vector V and is also determined as the variation in PA insertion phase between the PA insertion phase at VSWR=1:1 to the PA insertion phase when the phase tuner is shifted within 2π radians with VSWR>1.

There are two locations on the phase tuner where the maximum and minimum PA insertion phase is achieved. At these two locations, the reflected vector is perpendicular to the incident vector

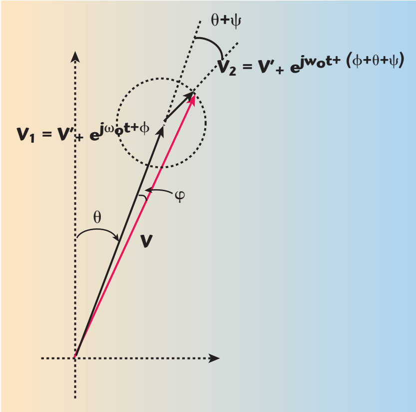


Fig. 3 The reflected wave vector is rotating 2π radians across the incident wave vector.

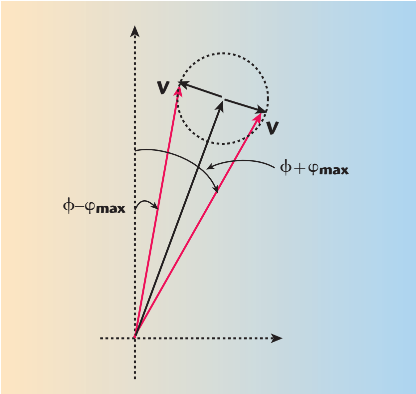


Fig. 4 Vector diagram for maximum and minimum insertion.

$$(\theta+\Psi=\frac{\pi}{2}\text{ or }\theta+\Psi=-\frac{\pi}{2})$$

and the angle φ reaches the highest value, φ_{MAX}, as shown in ***Figure 4***. At these two locations of 90° insertion phase, the product of the load and PA reflection coefficients can be written as:

$$\Gamma_{Total}=\Gamma_L\cdot\Gamma_{PA}=\frac{V'_+e^{j\omega_0 t+(\phi+\frac{\pi}{2})}}{V_+e^{j\omega_0 t+\phi}}=$$

$$\frac{V'_+e^{j\omega_0 t+(\phi-\frac{\pi}{2})}}{V_+e^{j\omega_0 t+\phi}}=\tan\varphi_{max} \quad (16)$$

$$-20\log|\Gamma_{Total}|=-20\log\tan\varphi_{max} \quad (17)$$

$$-20\log|\Gamma_{PA}|-20\log|\Gamma_L|=-20\log\tan\varphi_{max} \quad (18)$$

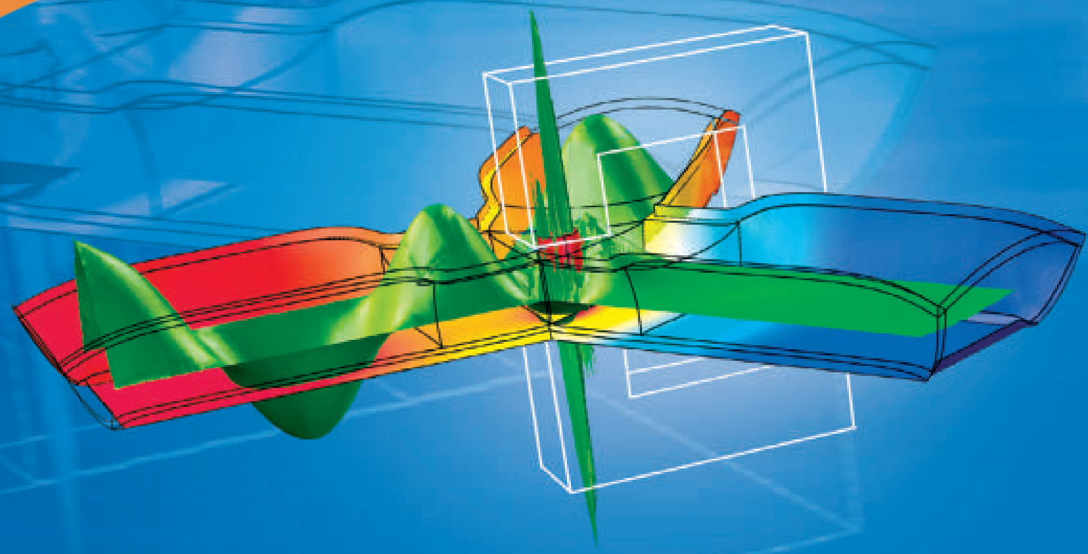
$$-20\log|\Gamma_{PA}|=-20\log\tan\varphi_{max}+20\log|\Gamma_L| \quad (19)$$

Since the phase tuner has a full reflection then $G_{L=1}$ and the PA return loss (in dB) can be expressed as:

$$PA\_R.L=-20\log\tan\varphi_{max} \quad (20)$$

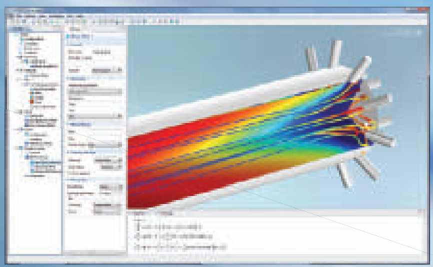
φ_{MAX} can be found by rotating the

COMSOL MULTIPHYSICS®



Electromagnetics Simulation goes Multiphysics!

Coming Soon
COMSOL MULTIPHYSICS 4



The COMSOL® environment lets you conduct realistic computer simulations using multiphysics capabilities. COMSOL features a fully flexible model setup, easy-to-use application interfaces, and seamless CAD-import.

USER APPLICATION EXAMPLES

- Microwave and RF heating
- MEMS and RFID tags
- Sea bed logging
- SAR analysis
- Waveguides and photonics
- Antennas
- Semiconductor fabrication
- Plasma modeling
- Induction heating
- Piezoelectric modeling
- Motors and generators
- EMC and EMI
- Import from SPICE netlists
- HVDC

Get a free RF Simulations Kit CD at: www.comsol.com/intro/rf

www.comsol.com

COMSOL

COMSOL, COMSOL MULTIPHYSICS, COMSOL REACTION ENGINEERING LAB, AND FEMLAB ARE REGISTERED TRADEMARKS OF COMSOL AB.

Visit http://mwj.hotims.com/23286-25 or use RS# 25 at www.mwjournal.com/info

phase tuner within 2π radians and the maximum insertion phase can be searched using a phase detector with the test setup shown in ***Figure 5***.

PA REFLECTION COEFFICIENT WITH A DETERMINED MISMATCH LOAD

In practice, PAs are specified over a limited VSWR range. The PA can be damaged or unstable with a load VSWR above what has been specified by the vendor.

Therefore, the same analysis will be given when the load phase tuner is connected to the PA through an attenuator in order to limit the VSWR that will reflect on the PA (see ***Figure 6***).

$$V=V_1+V_2 \quad (21)$$

$$V=CF\cdot(V_+ e^{j\omega_0 t+\phi}+(Att)^2\cdot V'_+ e^{j\omega_0 t+(\theta+\phi+\psi)}) \quad (22)$$

$$\tan\varphi_{max}=(Att)^2\cdot\frac{V'_+ e^{j\omega_0 t+(\theta+\phi+\psi)}}{V_+ e^{j\omega_0 t+\phi}}=(Att)^2\cdot\Gamma_L\cdot\Gamma_{PA} \quad (23)$$

$$\Gamma_{PA}=\frac{\tan\varphi_{max}}{(Att)^2\cdot\Gamma_L} \quad (24)$$

$$PA\_R.L=-20\log\Gamma_{PA}=-20\log\left(\frac{\tan\varphi_{max}}{(Att)^2\cdot\Gamma_L}\right) \quad (25)$$

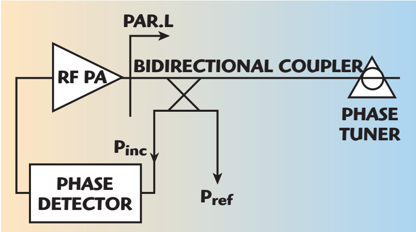
Since the phase tuner has a full reflection, $\Gamma_{L=1}$, the PA return loss can be expressed as:

$$PA\_R.L=-20\log\Gamma_{PA}=-20\log\left(\frac{\tan\varphi_{max}}{(Att)^2}\right) \quad (26)$$

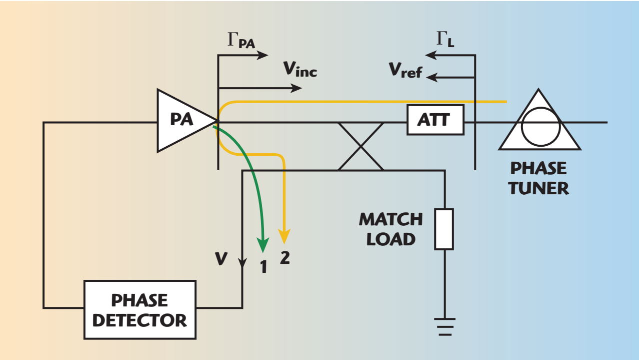
or

$$-20\log(\tan\varphi_{max})=PA\_R.L(dB)+2\cdot Att(dB) \quad (27)$$

If the PA return loss is high and the attenuator used between the PA to the phase tuner is high, then the phase angle φ_{MAX} may be small and difficult to measure in order to have accurate results. Therefore, it is suggested to use a small attenuator (1 to 3 dB) between the PA and the phase tuner.



▲ *Fig. 5 Test setup for measuring maximum insertion phase.*



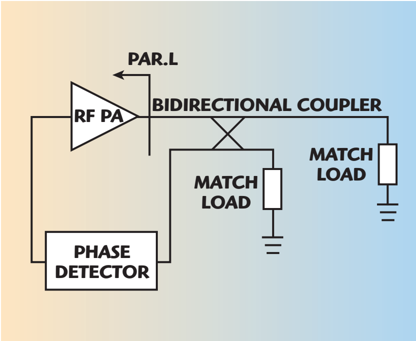
▲ *Fig. 6 Test setup for measuring maximum insertion phase with limited VSWR.*

TEST METHOD

Step 1:

Connect the PA as illustrated in ***Figure 7*** using a 50 Ω load at the output of a bidirectional coupler (additional attenuation can be connected in front of the phase detector whenever it is desired to measure the return loss for a very high power PA).

Measure the insertion phase at the various frequencies of interest using small-signal or large-signal input power. The insertion phase with a 50 Ω load will be the reference insertion phase before loading the PA with different VSWRs.



▲ *Fig. 7 Test setup for matched load.*

Visit http://mwj.hotims.com/23286-106

UP TO 100 Watt AMPLIFIERS

20 MHz TO 2.5 GHz

from **$945** ea. qty. (1-9)

Model	Freq. (MHz) f_L - f_U	Gain (dB) Typ.	Max. P_{OUT} (dBm) @ Compression 1 dB	3 dB	Dynamic Range NF (dB) Typ.	IP3 (dBm) Typ.	DC Pwr. Volt (V) Nom.	Current (A) Max.	Price $ea. Qty. 1-9
With Heat Sink/Fan									
LZY-1+	20-512	43	+47	-	8.6	+54	26	7.3	1995.00
LZY-2+	500-1000	46	+45	-	8.0	+54	28	8.0	1995.00
ZHL-5W-2G	800-2000	45	+37	+38	8.0	+44	24	2.0	995.00
ZHL-10W-2G	800-2000	43	+40	+41	7.0	+50	24	5.0	1295.00
• ZHL-20W-13	20-1000	50	+41	+43	3.5	+50	24	2.8	1395.00
ZHL-30W-252+	700-2500	50	+44	+46	5.5	+52	28	6.3	2995.00
• ZHL-50W-52	50-500	50	+46	+48	4.0	+55	24	9.3	1395.00
• ZHL-100W-52	50-500	50	+47	+48.5	6.5	+57	24	10.5	1995.00
○ ***Without Heat Sink/Fan***									
LZY-1X+	20-512	43	+47	-	8.6	+54	26	7.3	1895.00
LZY-2X+	500-1000	46	+45	-	8.0	+54	28	8.0	1895.00
ZHL-5W-2GX	800-2000	45	+37	+38	8.0	+44	24	2.0	945.00
ZHL-10W-2GX	800-2000	43	+40	+41	7.0	+50	24	5.0	1220.00
• ZHL-20W-13X	20-1000	50	+41	+43	3.5	+50	24	2.8	1320.00
ZHL-30W-252X+	700-2500	50	+44	+46	5.5	+52	28	6.0	2920.00
• ZHL-50W-52X	50-500	50	+46	+48	4.0	+55	24	9.3	1320.00
• ZHL-100W-52X	50-500	50	+47	+48.5	6.5	+57	24	10.2	1920.00

• *Protected under U.S. Patent 7,348,854*

○ *With heat sink/fan removed, customer must provide adequate cooling to ensure that the base plate temperature does not exceed specified temperature. See data sheets on Mini-Circuits web site.*

Heavy duty, ruggedness and reliable operation to meet your demanding communication applications describe ***Mini-Circuits collection of 5, 10, 20, 30, 50 and 100 Watt ZHL high power amplifiers!*** Covering 20 MHz up to 2.5 GHz, these broadband solutions are available with or without integrated heat sink/fan to fit your system requirements. Each amplifier operates with low current consumption and is designed to work off a single DC supply, including the fan! Plus, each model can withstand open or short output load without damage under full CW output power. They also offer built-in protection against over-voltage, thermal overloads, and an internal regulated power supply to handle fluctuations from the supply source and *still* deliver high performance. Need a ***robust*** power amplifier solution? Then come to Mini-Circuits where quality & reliability is built into every unit.

IN STOCK! FAST DELIVERY!

Mini-Circuits…we're redefining what VALUE is all about!

Mini-Circuits®

ISO 9001 ISO 14001 AS 9100 CERTIFIED

minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending

The Design Engineers Search Engine *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

IF/RF MICROWAVE COMPONENTS

416 rev J

Visit http://mwj.hotims.com/23286-63 or use RS# 63 at www.mwjournal.com/info

TECDIA

Solution for GaN FET

SBT-GF0702 BIAS-T

Tecdia introduces the SBT-GF0702 high voltage Bias-T.

The SBT-GF0702 is capable of handling up to 10 amps of DC current at 150V to apply bias to RF signals within the range of 2~7 GHz.
For many years Tecdia has produced top of the line high current (5, 10 and 20A) bias tee models capable of handling a DC bias voltage of 30V, and RF power of 50W. Now, to meet the higher voltage and power requirements of GaN devices, Tecdia is introducing this new design that has the following specifications :

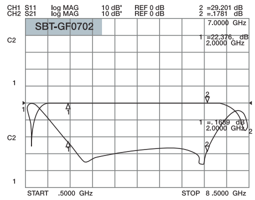
SPECIFICATION

Series		SBT	
Model		SBT-GF0702	
Frequency Range		2~7GHz	
Insertion Loss		0.5dB max.	
VSWR (Return loss)		1.22 max. (20dB min.)	
Connectors	RF	APC-7	
	DC	BNC-R (Female)	
RF Power		50W max.	100W max.
Bias Current		20A max.	10A max.
Bias Voltage		30V max.	150V max.
Dimensions (mm)*		50 x 52 x 20	
Weight		200g	

* Excluding Connectors

Typical VSWR & Insertion Loss

SBT-GF0702
These Bias-Ts are the optimum choice for measurement of high-power devices.



www.tecdia.com

In ***Table 1***, the measured value for a high power (2 W), 350 to 470 MHz, Skyworks' PA (SKY65141), is shown.

Step 2:

Disconnect the 50 Ω load at the output of the bidirectional coupler and connect a 1.5 dB pad in order to present the PA with a VSWR = 6. Place a phase tuner after the fixed attenuator pad. The phase tuner must be capable of continuously varying the insertion phase from 0 to 360°. The test setup is illustrated in ***Figure 8***. Adjust the phase tuner in order to find the highest and lowest insertion phase and calculate at each frequency what the maximum phase variation is, compared to the insertion phase at 50 Ω, as indicated in ***Table 2***. Note that the attenuator value is selected to be within the specified PA load VSWR range. The total output insertion loss should be measured at each maximum insertion phase location on the phase tuner in order for the return loss to be calculated accurately.

In theory $\varphi_{MAX} = \varphi_{MIN}$, therefore the following equation is valid:

$$\frac{\varphi_{max} - \varphi_{min}}{2} = \varphi_{max} - \varphi_{50\Omega} = \varphi_{50\Omega} - \varphi_{min} \tag{28}$$

However, in practice φ_{MAX} and φ_{MIN} may not be equal since the phase tuner may not be ideal and symmetric. Therefore, the insertion phase at VSWR = 1 ($\varphi_{50\Omega}$) is subtracted from the absolute value for the maximum phase variation ($\phi-\varphi_{MAX}$ or $\phi+\varphi_{MAX}$).

The return loss of the PA is calculated according to the following formula:

$$PA\_R.L = -20\log\left[\frac{\tan\varphi_{max}}{(Att)^2}\right] \tag{29}$$

where θ_{MAX} is in degrees and Att is the measured attenuation from the PA output to the phase tuner input.

TEST RESULTS

The theoretical analysis shown in the above sections was verified using a high power 2 W SMT PA from Skyworks (SKY65141). The PA was tested over its entire operating frequency range, 350 to 470 MHz. The actual return loss measurement was made with a network analyzer at small input signal and the results are given in ***Figure 9***.

The measurement results are compared to the calculated return loss using the proposed phase measurement procedures outlined in the above sections.

The new test procedure was done using different load VSWRs to demonstrate that the return loss measurements are repeatable at different VSWRs. The return loss obtained using the new proposed phase technique is shown in ***Figures 10*** and ***11***.

TABLE I

INSERTION PHASE WITH VSWR=1 FOR A SKYWORKS PA

Frequency (MHz)	*Insertion Phase at VSWR 1:1 and Pin=4 dBm $\theta_{50\Omega}$*
350	171.4
410	71.2
470	-30.5

TABLE II

MEASURED MAXIMUM AND MINIMUM INSERTION PHASE WITH VSWR=6

Frequency (MHz)	*Minimum Insertion Phase ($\phi-\varphi_{max}$)*	*Maximum Insertion Phase ($\phi+\varphi_{max}$)*	*Maximum Insertion Phase Variation φ_{max}*
350	157.1	179.9	12.2
410	62.3	75	6.7
470	-42	-26.2	8.6

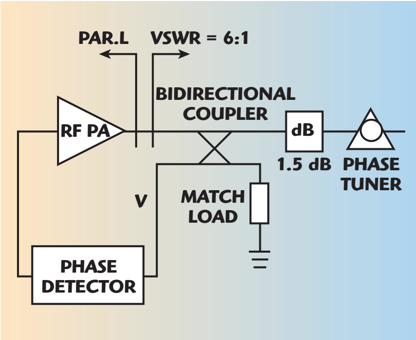


Fig. 8 Test setup for mismatched load.

EWT

Where Performance Counts

Bandpass • Bandreject • Highpass • Lowpass • Transmit • Receive • Duplexers • Multiplexers

Military • Commercial
Wireless • Space

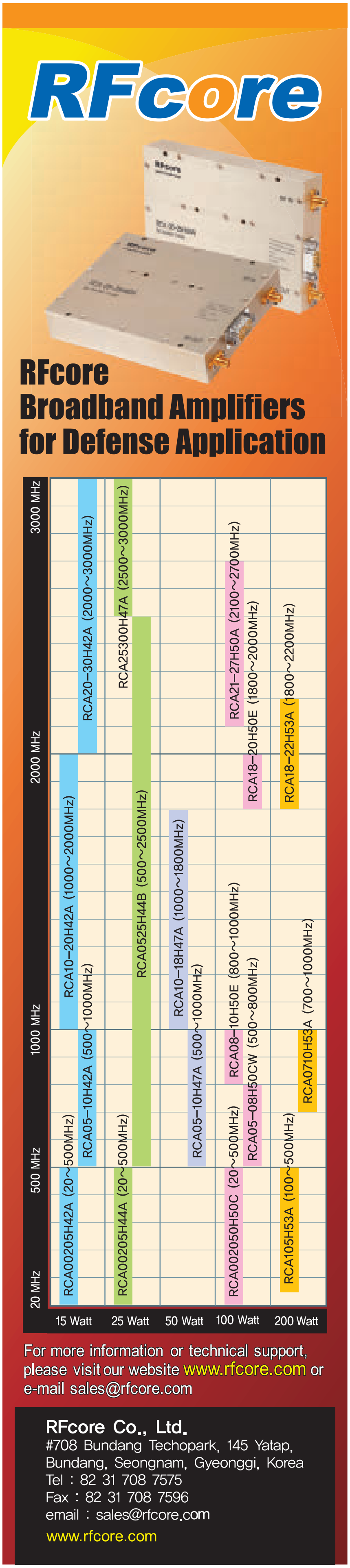
Eastern Wireless TeleComm understands just how much is on the line with each and every product we make. We continually provide the highest quality filter products, design support, and service to our customers each and every time. Where Performance Counts, Count on EWT.

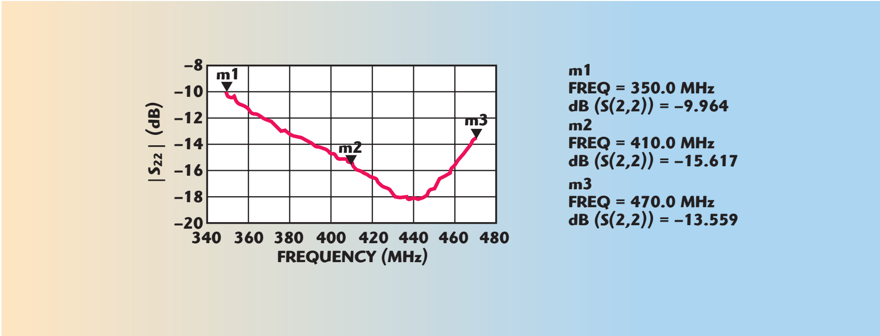
Specializing in custom design and manufacturing of RF and Microwave filters and filter based products to 50 GHz.

www.ewtfilters.com

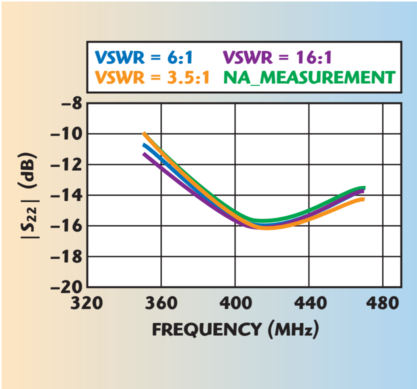
Eastern Wireless TeleComm, Inc.
Tel: 410.749.3800 Fax: 410.749.4852
sales@ewtfilters.com

Visit http://mwj.hotims.com/23286-30 or use RS# 30 at www.mwjournal.com/info

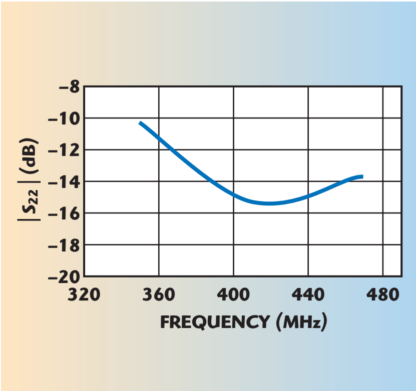




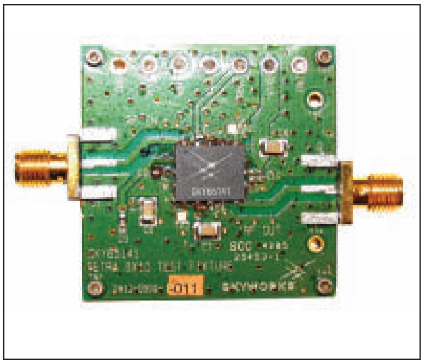
▲ *Fig. 9 Return loss measured at low power.*



▲ *Fig. 10 Calculated PA return loss at P_{in} = –30 dBm.*



▲ *Fig. 11 Calculated return loss P_{in} = –4 dBm and VSWR = 3.5.*



▲ *Fig. 12 Photo of high power PA (SKY65141) mounted in its test fixture.*

The same method was used to calculate the PA return loss using higher input signal with VSWR = 3.5. A photo of the PA mounted in its test fixture is shown in ***Figure 12***.

CONCLUSION

A PA return loss is a parameter, which can vary depending on the PA output power, the PA bias current, etc. Therefore, the PA return loss under high output power conditions should be measured and not be assumed to be the same as the return loss measured under small-signal output power conditions. The PA return loss can be calculated from the phase between the summing (incident and reflected vectors) to the incident vector, which is measured with a matched-load.

This article demonstrates that the "hot" PA return loss can be accurately calculated by measuring the maximum insertion phase variation at any given VSWR, and at any given input drive level. The proposed return loss measurement technique can be implemented using low cost test components, eliminating the need for costly network analyzers. ■

References

1. L. Liou, J. Ebel and C. Huang, "Thermal Effects on the Characteristics of AlGaAs/GaAs Heterojunction Bipolar Transistors Using Two-dimensional Numerical Simulation," *IEEE Transactions on Electron Devices*, Vol. 40, No. 1, January 1993, pp. 35-40.
2. "Recommendations for Testing High-power Amplifiers," *Agilent Application Note 1408-10.*
3. "Hot S_{22} and Hot K-factor Measurements," *Anritsu Application Note AN11410-00295.*

The Leader in Switching Solutions

The global provider of coaxial switches with more than 40 years of technical experience. Our switches offer low passive intermodulation (PIM), long cycle life and proven repeatability.

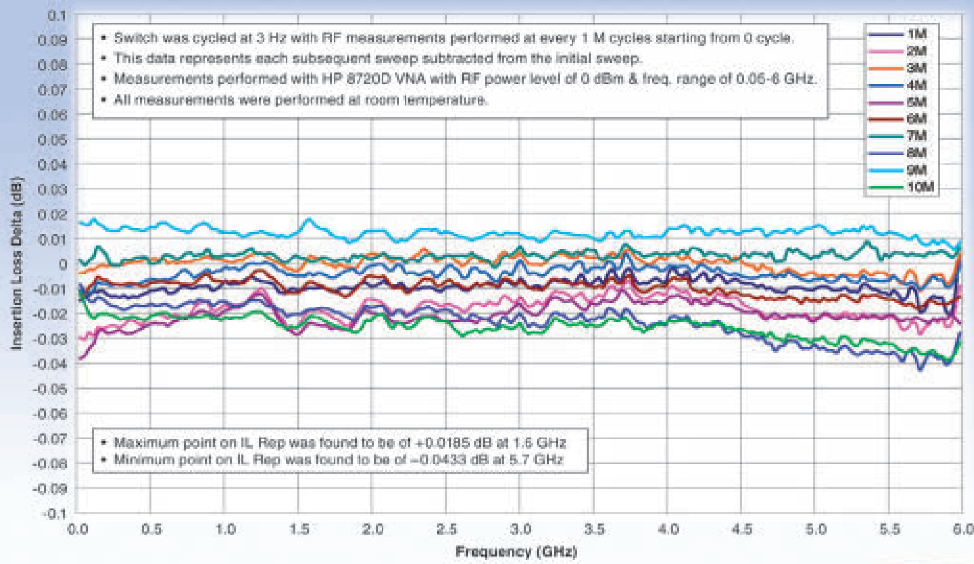
Our products meet a wide range of applications in the defense, aerospace, industrial, commercial, RF, Test & Measurement and Space markets.

MICROWAVE COAXIAL SWITCHES

- SPDT, Transfer, Multi-Throw Switches and Switch Matrices
- 5 million cycles characteristic life
- DC to 33 GHz
- Custom products
- 3-State attenuated switch

RELIABLE, REPEATABLE SWITCHING

SPDT Coaxial Switch 10 M Cycles Insertion Loss Repeatability



800-351-7368 • www.teledynecoax.com

TELEDYNE
COAX SWITCHES

RoHS or Non-RoHS: Your Choice!

Visit http://mwj.hotims.com/23286-109 or use RS# 109 at www.mwjournal.com/info

KA-BAND BANDPASS FILTER USING A CPW STRUCTURE TECHNOLOGY WITH COPPER ON AN AL_2O_3 SUBSTRATE

This article presents the performance of a Ka-band bandpass filter (BPF) using a coplanar waveguide (CPW) topology on an Al_2O_3 substrate. A copper (Cu) metallization was also used in this investigation to improve the characteristics of the filter. The measured results of the BPF, with a chip size of 2423 × 424 µm, show a return loss of 25.3 dB and an insertion loss of 0.6 dB at 27 GHz. A comparison between the simulated and experimental results shows good agreement. The overall filter characterization exhibits a broad bandwidth of 18.8 to 38.2 GHz, a high return loss and a low insertion loss, which illustrate that the BPF shows favorable RF characteristics in Ka-band with a compact circuit size.

The communication applications have increased noticeably in recent years. Apparently, the RF channel bandwidth allocated to communication system applications is approaching saturation. The providers of communication systems are now interested in the microwave band for the next-generation terrestrial systems, including military and satellite communication systems in Ka-band. Several researchers[1,2] have reported that microwave monolithic integrated circuits (MMIC) using coplanar waveguide have been adopted in transmitter communication systems. In the CPW structure, the ground plane is placed on the top surface of the substrate. Thus, many advantages have been obtained with this CPW schematic layout, such as unnecessary backside fabrication, good electronic isolation property and compact drawing in the circuit layout.[1-3]

As clearly shown in some review papers, CPW has been extensively studied for MMIC applications. However, little attention has been devoted to the conductor losses in the signal transmission path.[2,3] A copper metal, with an extremely low electrical resistivity (1.7×10^{-8} Ωm), could significantly improve the insertion loss in the BPF.[4] This study investigated a Ka-band BPF circuit using a CPW structure and a copper metallization on the Al_2O_3 substrate. A Ka-band BPF was fabricated and its S-parameters were measured with a vector network analyzer. The results demonstrated that the fabricated Ka-band BPF exhibited favorable MMIC characteristics within a small size.

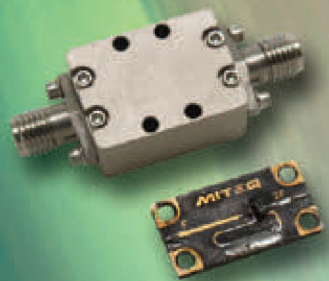
CHIA-SONG WU AND HSING-CHUNG LIU
Vanung University, Taiwan, ROC
HSIEN-CHIN CHIU AND YI-FENG LIN
Chang Gung University, Taiwan, ROC

Delivery From Stock!

MIXERS

Model Number	RF/LO Frequency (GHz)	IF Frequency (GHz)	LO Power (dBm)	Conversion Loss (dB) Typ./Max.	LO-to-RF Isolation (dB) Min.
DOUBLE-BALANCED VERSIONS					
DM0052LA2	0.5 – 2	DC – 0.5	7 – 13	6.5/8.5	30
DM0104LA1	1 – 4	DC – 1	7 – 13	5.5/7	30
DM0208LW2	2 – 8	DC – 2	7 – 13	7/8	30
DM0408LW2	4 – 8	DC – 2	7 – 13	5/6	30
DM0812LW2	8 – 12	DC – 4	7 – 13	4.5/6	30
DM0416LW2	4 – 16	DC – 4	7 – 13	7/8	30
DB0218LW2	2 – 18	DC – 0.75	7 – 13	6.5/8.5	22
DB0226LA1	2 – 26	DC – 0.5	7 – 13	9/10	20
DB0440LW1	4 – 40	DC – 2	10 – 15	9/10	20
M2640W1	26 – 40	DC – 12	10 – 15	10/12	28
TRIPLE-BALANCED VERSIONS					
TB0218LW2	2 – 18	0.5 – 8	10 – 15	7.5/9.5	20
TB0426LW1	4 – 26	0.5 – 8	10 – 15	10/12	20
TB0440LW1	4 – 40	0.5 – 20	10 – 15	10/12	18

PASSIVE DOUBLERS



Model Number	Input Frequency (GHz)	Input Power (dBm)	Output Frequency (GHz)	Conversion Loss (dB) Typ./Max.	Rejection (dBc) Typ. Fund.	Rejection (dBc) Typ. Odd Harm.
DROP-IN VERSIONS						
SXS01M	0.5 – 3	8 – 12	1 – 6	13/16	-20	-25
SXS04M	2 – 9	8 – 12	4 – 18	13/15	-20	-25
SXS07M	3 – 13	8 – 12	6 – 26	13/18	-18	-25
CONNECTORIZED VERSIONS						
SXS2M010060	0.5 – 3	8 – 12	1 – 6	13/16	-20	-25
SXS2M040180	2 – 9	8 – 12	4 – 18	13/15	-20	-25
SXS2M060260	3 – 13	8 – 12	6 – 26	13/17	-18	-25
MX2M130260	6.5 – 13	8 – 12	13 – 26	11/13	-15	-15
MX2M004010	0.02 – 0.5	8 – 12	0.04 – 1	10.5/13	-25	-25

Additional models available with 60 day lead time, please contact MITEQ.
Above models also available with optional LO power ranges, please contact MITEQ.

RoHS compliant Available

Fastest Delivery Available! + 3 YEAR WARRANTY = MITEQ

For additional information or technical support, please contact our Sales Department at (631) 439-9220 or e-mail components@miteq.com

MITEQ
100 Davids Drive, Hauppauge, NY 11788
(631) 436-7400 FAX: (631) 436-7430
www.miteq.com

Visit http://mwj.hotims.com/23286-78 or use RS# 78 at www.mwjournal.com/info

DESIGN AND FABRICATION OF A KA-BAND BANDPASS FILTER

The Ka-band BPF circuit was designed using a CPW structure. ***Figure 1*** shows the schematic layout of the Ka-band BPF, which uses two series open stubs with a characteristic impedance $Z_0 = 50\ \Omega$ and a length (l), which was designed to be approximately a quarter wavelength at the Ka-band center frequency (λ_{eff}), that is, $l = \lambda_{eff}/4$.[5] Ports 1 and 4 are the input and output of the filter, while Ports 2, 3, 5 and 6 are connected to ground. The lumped equivalent circuit model of the BPF is shown in ***Figure 2***. In effect, each open stub is equivalent to three LC tanks (L_1/C_1, L_2/C_2 and L_3/C_3) with an air-gap (C_0) series connection. This circuit permits a low transmission loss and easy fabrication.[3] These resonators, with LC tanks, can operate in a wideband BPF. The resonators are operating in a mixed coupled mode, meaning partially magnetically and partially electrically coupled.

The S-parameters of the coupled resonating filter were simulated with the Advanced Design System (ADS), and the effect of the electric-magnetic coupling within the Ka-band BPF layout were computed with the HP-Momentum. Subsequently, the Ka-band BPF was laid-out and fabricated on an Al_2O_3 substrate 0.5 mm thick and with a conductor layer 2 µm thick, consisting of a Ti layer, 300 Å thick, to enhance adherence, the copper layer and a thin Au layer, 2000 Å thick, to prevent oxidation. ***Figure 3*** shows a microphotograph of the Ka-band BPF, with a chip area of 2423 × 424 µm.

THE S-PARAMETERS OF A KA-BAND BANDPASS FILTER

Figures 4 and ***5*** show the measured and simulated S-parameters of the Ka-band BPF. A simulated insertion loss (S_{21}) of -0.6 dB and return loss (S_{11}) of -10 dB were obtained within a bandwidth of 21.6 GHz, in the range 17.2 to 38.8 GHz. The BPF showed an input return loss exceeding -20 dB, from 25 to 35 GHz, in both measurements and simulation, as well as a maximum simulated return loss of -55 dB at 30 GHz.

The results indicate that the measured return loss is slightly degraded and shifted in frequency, compared with the simulation. The most likely explanation was that the variations in fabrication might be the cause of the negligible shift in the center frequency and the small degradation in the return loss. The simulated and measured S_{21} results agree fairly well, with the insertion loss remaining approximately constant in the range of 20 to 35 GHz. Overall, the S-parameters characterization confirms the low insertion loss and high return loss in this Ka-band BPF.

Finally, the S-parameters of the Ka-band BPF are summarized in ***Table 1***.

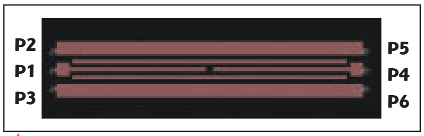


Fig. 1 Schematic of the CPW Ka-band bandpass filter.

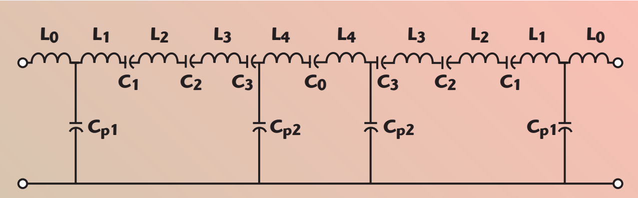


Fig. 2 Equivalent circuit of the Ka-band bandpass filter.

The experimental results appeared to be consistent with the simulation values. These S-parameter results indicate that the Ka-band BPF filter was well designed, demonstrating that the CPW structure with copper metallization on an Al_2O_3 substrate is adequate for the MMIC applications.

CONCLUSION

In this article, a Ka-band bandpass filter, using a CPW structure on an Al_2O_3 substrate with a copper metallization, was described. The use of copper metallization, which has a high conductivity, can reduce the insertion loss and improve the return loss of the circuit. The Ka-band BPF design uses two series open stubs with a characteristic impedance $Z_0 = 50\ \Omega$, whose lumped element equivalent circuit consists of three LC tanks. The measured S-parameters agreed well with the simulation values. The Ka-band BPF exhibits a low insertion loss and a high return loss, which shows that a

Fig. 3 Microphotograph of the Ka-band bandpass filter fabricated on an Al_2O_3 substrate.

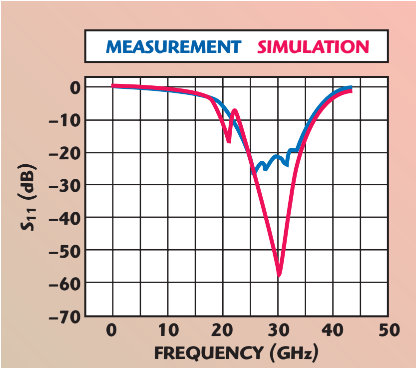


Fig. 4 Measured and simulated S_{11} of the bandpass filter.

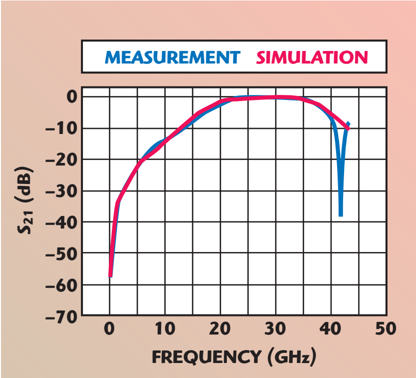


Fig. 5 Measured and simulated S_{21} of the bandpass filter.

TABLE I

SUMMARY OF MEASURED AND SIMULATED S-PARAMETERS OF THE KA-BAND BANDPASS FILTER

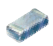
Ka-band Bandpass Filter	*Simulated*	*Measured*
Center frequency	30 GHz	27.7 GHz
Bandwidth	21.6 GHz @ 17.2 to 38.8 GHz	19.4 GHz @ 18.8 to 38.2 GHz
Return loss (S_{11})	-57 dB @ 30 GHz	-25.3 dB @ 27.7 GHz
Insertion loss (S_{21})	-0.6 dB @ 30 GHz	-0.6 dB @ 27.7 GHz

WILD CARD FILTER KITS

only $98^{00}

select any 8 models,
receive 5 of each, total 40 pieces

Over 120 Low Pass and High Pass models...80 MHz to 13 GHz



Tiny
0.12"x0.06"x0.04"

Measuring only 0.12" X 0.06", these tiny hermetically sealed filters utilize our advanced ***Low Temperature Co-fired Ceramic*** (LTCC) technology to offer superior thermal stability, high reliability, and very low cost, making them a must for your system requirements. Visit our website to choose and view comprehensive performance curves, data sheets, pcb layouts, and environmental specifications. And you can even order the KWC-LHP Filter Kit direct from our web store and have units in your hands as early as tomorrow!

Mini-Circuits...Your partners for success since 1969

RoHS compliant

Mini-Circuits®
ISO 9001 ISO 14001 AS 9100 CERTIFIED

minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ *Patent Pending*

The Design Engineers Search Engine *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

IF/RF MICROWAVE COMPONENTS

454 rev A

Visit http://mwj.hotims.com/23286-64 or use RS# 64 at www.mwjournal.com/info

CPW structure with copper metallization on an Al_2O_3 substrate should be adopted for MMIC applications. ■

References

1. M. Muraguchi, T. Hirota, A. Minakawa, K. Ohwada and T. Sugeta, "Uniplanar MMICs and Their Applications," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 36, No. 12, December 1988, pp. 1896-1901.
2. A.Q. Liu, A.B. Yu and Q.X. Zhang, "Broadband Bandpass and Bandstop Filters with Sharp Cut-off Frequencies Based on Series CPW Stubs," *2006 IEEE MTT-S International Microwave Symposium Digest*, pp. 353-356.
3. M. Riaziat, I. Zubeck, S. Bandy and G. Zdasiuk, "Coplanar Waveguides Used in 2 to 18 GHz Distributed Amplifier," *1986 IEEE MTT-S International Microwave Symposium Digest*, pp. 337-338.
4. C.S. Wu, H.C. Liu, Z.P. Liu and H.C. Chiu, "Compact K-band Bandpass Filter on High-k $LiNbO_3$ Substrate," *Solid State Electronics*, Vol. 51, No. 6, June 2007, pp. 965-968.
5. J. Helszajn, *Microwave Planar Passive Circuits and Filters*, John Wiley & Sons Ltd., Chichester, UK, 1994.

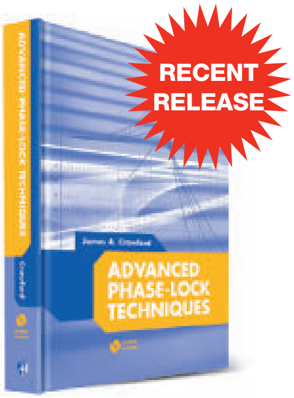
Chia-Song Wu *received his MSEE degree from Tsing Hua University, Hsinchu, in 1985, and his PhD EE degree from National Central University, Chungli, Taiwan, in 1998. In 1986, he joined the Chung Shan Institute of Science and Technology (CSIST), where his focus was on infrared detector technology. In 2003, he joined the EE department of Vanung University. His current research is on microwave and millimeter-wave integrated circuits.*

Hsing-Chung Liu *received his PhD EE degree from Kent State University in 1985. That same year he joined the Chung Shan Institute of Science and Technology (CSIST), where his focus was on infrared detector technology. In 2002, he joined the Dean of the R&D office at Vanung University. His current research is on microwave and millimeter-wave integrated circuits.*

Hsien-Chin Chiu *received his BS and PhD degrees in electrical engineering from National Central University, Chungli, Taiwan, in 1998 and 2003, respectively. He joined WIN Semiconductors Corp., Tao Yuan, Taiwan, where he was engaged in research and development of 6-inch GaAs PHEMTs and related integrated circuits. In 2004, he joined the EE department faculty team of Chang Gung University to focuses on microwave and millimeter-wave integrated circuits, fiber optic communication circuits and nano-technology.*

Yi-Feng Lin *received his MS degree in electronic engineering from Chang Gung University, Tao Yuan, ROC, in 2007. He is now a technology research engineer at Cyntec Corp., Hsinchu. His research interests include RFIC design and measurements and microwave passive devices.*

unlock the potential of PLLs



Advanced Phase-Lock Techniques
James A. Crawford

This practical reference offers a unified approach to phase-lock technology, spanning large and small signal-to-noise applications. It takes you from continuous-time systems through hybrid time-sampled systems to fractional-N synthesis techniques. Supported with more than 1,200 equations and 480 figures, this in-depth resource provides:

- Extensive coverage of frequency synthesis.
- Techniques used to develop RFICs for 3GPP, GSM/EDGE/WCDMA, WiMAX and other applications
- Numerous computer simulation techniques that enable you to analyze phase-locked systems.

Hardcover. 516 pp. 2008
ISBN: 978-1-59693-140-4
Order Book No. MW081408
$139/£82

CD-ROM Included! Contains practical tools to aid in the design process such as Visio figures and Matlab code.

Find complete description and order at www.ArtechHouse.com

Order at www.artechhouse.com or contact the office nearest you: US FAX Purchase orders and credit card orders to 1-781-769-6334 **PHONE** Toll-Free 1-800-225-9977, ext. 4030 or 1-781-769-9750 **E-MAIL** artech@artechhouse.com **UK FAX** Purchase orders and credit card orders 24 hours a day to +44 (0)20 7630-0166 **PHONE** +44 (0)20 7596-8750 **E-MAIL** artech-uk@artechhouse.com **All orders plus shipping/handling and applicable taxes.**

ARTECH HOUSE BOSTON | LONDON
685 Canton Street, Norwood, MA 02062 USA
46 Gillingham Street, London, SW1V 1AH, UK

Visit http://mwj.hotims.com/23286-17

Antenna Magus is the first antenna design tool of its kind.
Its huge searchable collection of antennas can be explored to find, design and export models of designed antennas to CST MICROWAVE STUDIO® and FEKO.

www.antennamagus.com

AntennaMagus
Explore. Design. Deliver.

Visit http://mwj.hotims.com/23286-13 or use RS# 13 at www.mwjournal.com/info

MICROWAVE JOURNAL REVIEWED EDITORIAL BOARD

DESIGN OF SOURCE DEGENERATED CASCODE DUAL FUNCTIONALITY LNA/PA FOR IEEE 802.15.4 (ZIGBEE)

EXPERT ADVICE

ALI MUHAMMAD ABUELMA'ATTI DISCUSSES NEW DESIGN TECHNIQUES USING CMOS INTEGRATION. VISIT WWW.MWJOURNAL.COM.

This paper presents a new compact and comprehensive design methodology for RF CMOS source degenerated cascode dual functionality low noise amplifier (LNA) and power amplifier (PA) for the IEEE 802.15.4 standard (commercially known as ZigBee). Due to the need to meet the far apart performance requirements of both the LNA and the PA, the proposed design methodology is based on simultaneous graphical visualization of the relationship between all relevant performance parameters and the corresponding design parameters. To demonstrate the effectiveness of the proposed methodology, a design example is presented. The simulated performance of the designed amplifier at 2.4 GHz satisfies both the requirements of the ZigBee LNA and PA with noise figure (NF) of 1.6 dB, input third-order intercept point (IIP3) of 6 dBm and a 1 dB compression point (P1dB) of -3.5 dBm. At the high input power of 0 dBm, the amplifier achieves 24 percent power added efficiency (PAE) with 8 dB gain and 22 mW power consumption.

INTRODUCTION

Over the years, the design of low noise amplifiers in CMOS technology has attracted the attention of many researchers. This is attributed to the rapidly improving CMOS technology as a result of transistor scaling. In designing a LNA the following should be considered: Power gain, noise figure, impedance matching, reverse isolation, stability, distortion and power

ALI M.T. ABUELMA'ATTI AND IAN THAYNE
University of Glasgow, Glasgow, Scotland
MUHAMMAD TAHER ABUELMA'ATTI
King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia

Introducing Two New Reasons to Smile

In addition to offering the most consistent service, Aeroflex / Metelics continues to expand our vast product line. Our latest introductions include high performance, surface mount silicon PIN diodes and high power surface mount SP2T switches. The Semi-Scale™ family of PIN diodes are designed with our proprietary diode process which provides ultra-low parasitic qualities, ideal for high frequency and high power applications up to 20 GHz. Our new SP2T switches are produced with a proven hybrid manufacturing process incorporating high voltage PIN diodes and passive devices within a 8mm x 5mm x 2.5 mm ceramic package. They offer 0.25 dB loss and 100 W performance up to 6 GHz.

Innovation—it's just another reason to smile.

www.aeroflex.com/metelics

AEROFLEX
A passion for performance.

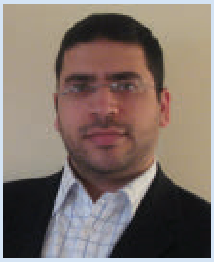
consumption. On the other hand, the design of the power amplifier is the most challenging task in a wireless communication transceiver. This is attributed to the trade-offs between the DC power supply voltage, output power, power efficiency and linearity. In designing a PA the following should be considered: High transmitted power, low power consumption, power added efficiency (PAE) nonlinear amplifier characteristics and design parameters, like third-order input intercept point (IIP3), carrier-to-intermodulation ratio (C/I), the input 1 dB gain compression point (P1dB) and adjacent channel power ratio (ACPR). Therefore, the LNA and PA designers are in front of a difficult trade-off among the competing goals of high performance in both amplifiers. In modern wireless communication systems, these two amplifiers are designed separately. No attempt has been reported, so far, for combining the two amplifiers in one.

In the IEEE 802.15.4 (ZigBee) standard, since the output power requirement is relatively modest, it is possible to consider the design of a single amplifier block that can act as a LNA in the receiver chain and a PA on the transmitter side. This would reduce the power consumption, chip area and size leading to cost savings of the transceiver that is vital to the widespread utilization of the ZigBee standard. However, since the achievable performances of the LNA and the PA are mainly limited by the CMOS transistors' parameters and operating conditions, the selection and implementation of a design methodology, leading to the solution of several design problems, is the crucial point in the design of such a dual functionality LNA/PA.

This article presents a new design methodology for a dual functionality LNA/PA. The proposed design methodology is based on simultaneous 3D graphical visualization of the relationship between all relevant performance parameters and corresponding design parameters. In this regard, it is intended to generate and provide a set of design graphs that can be used by the designer. A design example is then presented to demonstrate the effectiveness of the proposed methodology and the quality of trade-offs it allows the designer to make.

To read this article in its entirety, please visit the online version of the June issue at www.mwjournal.com. ■

EXPERT ADVICE ONLINE



Dr. Ali Muhammad Abuelma'atti, Device Modeling Engineer at RFMD (UK), talks about the design and optimization of low power, low noise and power amplifiers.

Compulsive do-it-yourselfer?

Get Info – all by yourself!

Visit the InfoZone to follow-up on the ad or editorial item that caught your eye.
Request information by company
or product category.

The MWJ InfoZone
Product Information System

mwjournal.com/info

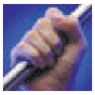
Microwave Journal

Easy. Fast. Free.
For the do-it-yourselfer.

ultra small

2, 3 AND 4 WAY SPLITTERS

0.5-7200 MHz



Value Packed Recession Busters! *from* 96¢ *ea. qty. 25*

In today's tough economic situation there is no choice: Reducing cost while improving value is a must. Mini-Circuits has the solution…***pay less and get more*** for your purchases with our industry leading ultra small power splitters.

Choose from over a hundred models...

These rugged LTCC and semi conductor power splitters are available with narrowband and broadband coverage through 7200 MHz. *Small in size and cost, but big on performance*, they can handle as much as 1.5 W input power, with high isolation and low insertion loss. Yet they won't take up valuable circuit board space, with 2 and 3 way power splitters measuring from 0.126 x 0.063 x 0.035 in. and 4 way splitters as small as 0.210 x 0.063 x 0.077 in. The small size also contributes to minimal amplitude and phase unbalance with outstanding unit-to-unit repeatability. All Mini-Circuits 2, 3, and 4 way surface-mount power splitters fit easily within your design, and your budget!

Visit our website to choose and view comprehensive performance curves, data sheets, pcb layouts, and environmental specifications. And you can even order direct from our web store and have a unit in your hands as early as tomorrow!

Mini-Circuits…we're redefining what VALUE is all about!

RoHS compliant

Mini-Circuits®

ISO 9001 ISO 14001 AS 9100 CERTIFIED

minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending *The Design Engineers Search Engine* Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

IF/RF MICROWAVE COMPONENTS

459 Rev. B

Visit http://mwj.hotims.com/23286-65 or use RS# 65 at www.mwjournal.com/info

NETWORK ANALYSIS DUO OFFERS EXTENDED FEATURES

The R&S ZVA24 network analyzer and the new R&S ZVAX24 extension unit combine to form a solution that adapts to user requirements. This combination facilitates faster and easier measurements on active components because it does not require any additional equipment or rewiring. Depending on the application, the extension unit can be equipped with combiners, harmonic filters, pulse modulators and power couplers. It is a scalable and compact test and measurement solution. Although the R&S ZVAX24 has been tailored to the R&S ZVA24, it can also be used with all other network analyzers of Rohde & Schwarz' R&S ZVA and R&S ZVT families.

PLUG IN AND MEASURE

The combination of a network analyzer and the R&S ZVAX24 extension unit is suitable for use in the development and production of active components. This powerful and modular test solution especially benefits developers and manufacturers of amplifiers for mobile phones and base stations as well as of components for the automotive sector, e.g. car radar.

It facilitates complex measurements and can be used for measurements to satisfy aerospace and defense requirements or for tests on antennas or amplifiers under pulsed conditions. The R&S ZVAX24 occupies only two height units in a 19-inch rack and can be easily placed underneath the R&S ZVA. Semi-rigid cables connect the instruments so that they constitute a single unit.

The extension unit and the components it contains are basically looped into the generator or receiver path by using the direct generator/receiver access. Only a USB cable (for path switching) and an LVDS (LAN) cable (for controlling the pulse modulators) are required as control lines. The unit is operated from the R&S ZVA network analyzer using a block diagram, shown in ***Figure 1***, and dialog windows.

Depending on the measurement task, the required RF components such as combiners, pulse modulators or harmonic filters can be switched into the measurement path. The T&M solution's high level of integration means that both present and future functions of the R&S ZVA can be used to perform complex lin-

ROHDE & SCHWARZ
Munich, Germany

Budget Limited?

An *economic solution* to millimeter two port "S" parameter measurements

T/R Module

T Module

- One Path Two Port – Reflection and Transmission Measurement
- Obtain the other two "S" parameters by reversing the DUT

As future budgets allow
the T Module can be upgraded to a T/R Module for
full two port "S" parameter measurements

OML modules are available from 33 to 500 GHz and are compatible with:

- ☑ Agilent 20 Ghz or higher PNA (E836xx) or PNA-X (N5242A) with N526xAController
- ☑ Agilent N5250A Millimeter Wave System
- ☑ Agilent 8510C with 85105A Controller
- ☑ Anritsu 20 GHz or higher Vector Star (MS4640A series) VNA Lightning (37000D series) with 3738A Controller
- ☑ Anritsu ME7808B/C Panorama System

OML Inc.

Innovation in Millimeter Wave Measurements

300 Digital Drive • Morgan Hill, CA 95037 • Tel: (408) 779-2698 • Fax: (408) 778-0491 • email: info@omlinc.com • www.omlinc.com
Outside US: Radar Systems Technology • Tel: (650) 949-8041 • Fax: (650) 949-8082 • email: sales@rst-radar.com

Visit http://mwj.hotims.com/23286-86 or use RS# 86 at www.mwjournal.com/info

ear and nonlinear measurements, in particular on active components (intermodulation measurements, pulse profile measurements, etc.).

INTERMODULATION MEASUREMENTS

Intermodulation products are unwanted spectral components that are caused by nonlinear circuit elements and a two-tone signal is required to measure them. If a conventional network analyzer with only one internal generator is used, an external generator and a combiner must be added to the test setup. This is not necessary with the R&S ZVA and R&S ZVAX24 combination because the internal combiner of the extension unit uses the two sources of the four-port network analyzer and generates a two-tone signal for intermodulation measurements. ***Figure 2*** shows a typical intermodulation output signal from the Rohde & Schwarz solution in blue and from a conventional one in yellow.

This signal is directly output on one of the four ports. This feature plus the intermodulation wizard make it very easy and convenient to measure the intermodulation parameters of amplifiers or mixers as a function of frequency and power. The combiner can also be used to measure the group delay of mixers without LO access.

PULSE MODULATORS

Many applications require that DUTs be characterized by using pulsed signals instead of CW signals. The pulse width for these applications typically varies between a few hundred nanoseconds and the upper microsecond range. To be able to characterize the pulse profile distortion of components, the network analyzer must have a time resolution that is considerably higher than the pulse duration.

For applications where the DUT requires a pulse-modulated input signal, either a pulse modulator or a generator with pulse modulation can be used. Since the R&S ZVA-B16 hardware option enables direct access to the network analyzer generator path, the pulse-modulated RF signal (instead of the unmodulated signal) is directly fed to the network analyzer test set.

The pulse modulators of the R&S ZVAX24 offer even more measure-

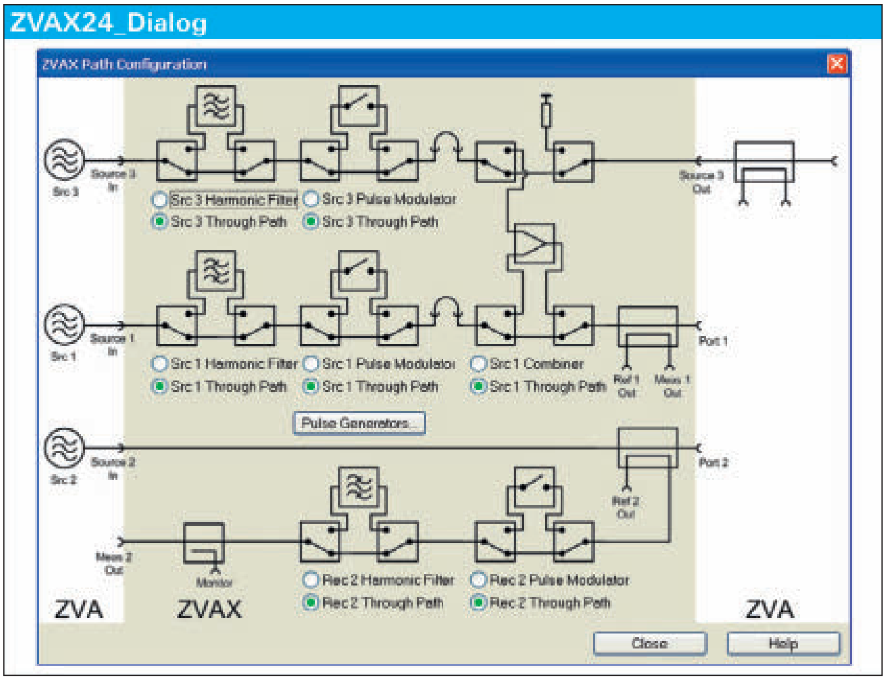


Fig. 1 Easy and convenient control of the R&S ZVAX24 extension unit using the graphical user interface of the R&S ZVA.

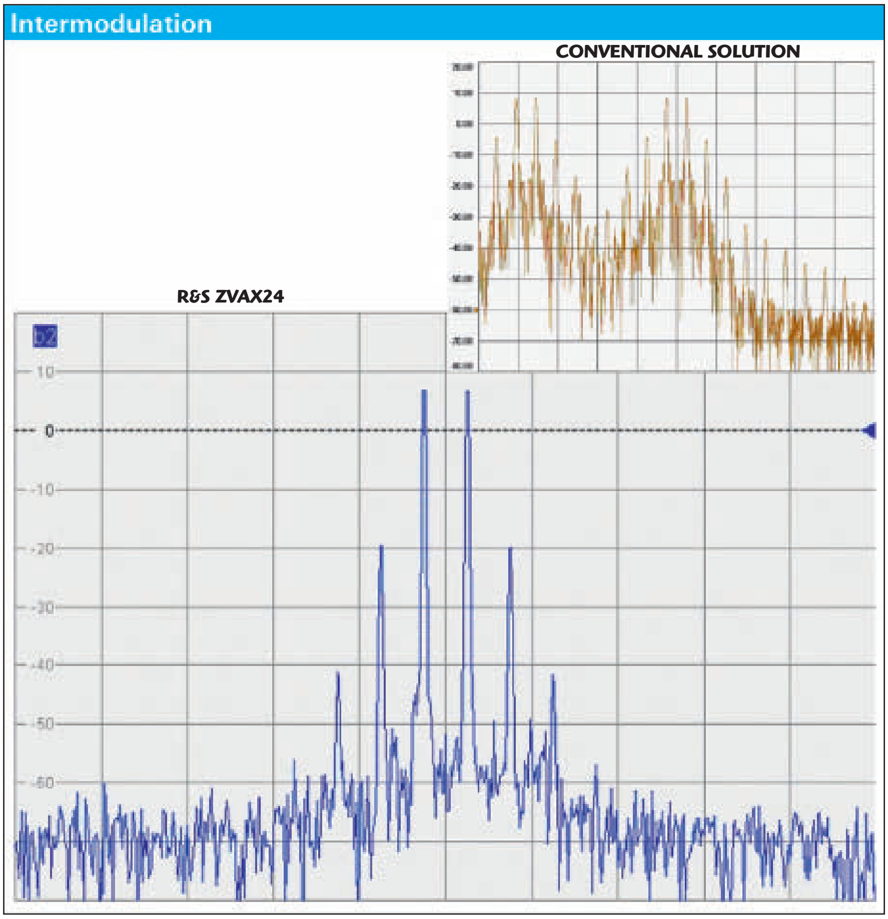
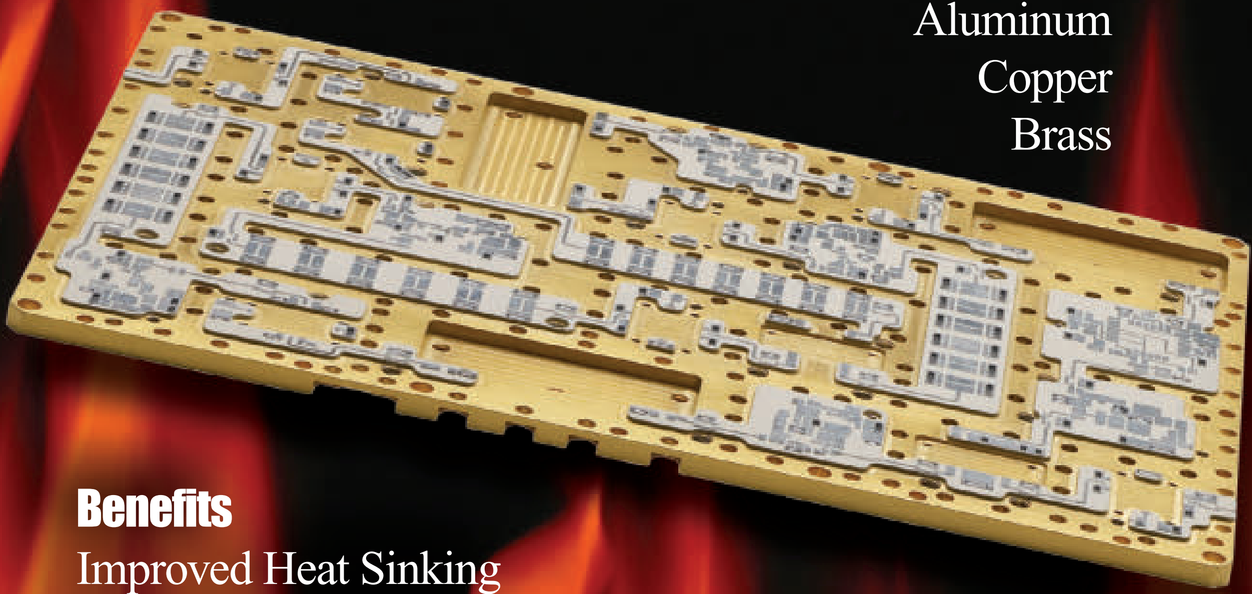


Fig. 2 Comparison of intermodulation signals: R&S ZVAX24 (blue curve) and conventional solution (yellow curve).

Beat the Heat!

Backing Materials
Aluminum
Copper
Brass



Benefits
Improved Heat Sinking
Dimensional Stability
Easier Component Mounting
Improved RF Grounding
Less Assembly Process Time and Better Yields

Metal-Backed Microwave Boards from MCN

When thermal efficiency is critical, choosing a metal-backed board design can provide improved thermal disbursement capabilities for high power applications. The thick metal ground plane can provide a rigid, flat base for component attachment increasing the reliability and durability of your product. At MCN, our 25 plus years of microwave experience has led to the development of proprietary processes to meet your design requirements for high precision performance. An in-house technical support team at MCN will work with you from material selection, design for manufacturing through the assembly process to provide the best solution and value for your board level requirements.

Other Capabilities:
- PTFE Hybrid & Metal Core Multilayers
- Precision Laser Cutting
- Conductive Epoxy Attachment

MCN
Modular Components National
105 E. Jarrettsville Road • PO Box 453 Forest Hill, MD 21050
Tel: 410/879-6553 • Fax: 410/638-7356
www.modularcomp.com

Visit http://mwj.hotims.com/23286-82 or use RS# 82 at www.mwjournal.com/info

RF Power Amplifier

A801M302-5353-R

■Frequency: 800M-3000MHz
■Power: 200W
and more.....

Model	Frequency	P@1dB (min)
A101K102-4141M/R	100k-1000MHz	+41dBm
A001M102-4141M/R	1M-1000MHz	+41dBm
A001M102-4343M/R	1M-1000MHz	+43dBm
A001M102-4747M/R	1M-1000MHz	+47dBm
A001M102-5050M/R	1M-1000MHz	+50dBm
A020M102-5353M/R	20M-1000MHz	+53dBm
A080M102-5757 R	80M-1000MHz	+57dBm
A080M102-6060 R	80M-1000MHz	+60dBm
A201M102-6363 R	200M-1000MHz	+63dBm
A501M272-3737M/R	500M-2700MHz	+37dBm
A501M272-4040M/R	500M-2700MHz	+40dBm
A501M272-4343M/R	500M-2700MHz	+43dBm
A501M272-4747M/R	500M-2700MHz	+47dBm
A501M272-5050 R	500M-2700MHz	+50dBm
A801M202-3737M/R	800M-2000MHz	+37dBm
A801M202-4040M/R	800M-2000MHz	+40dBm
A801M202-4343M/R	800M-2000MHz	+43dBm
A801M202-4747M/R	800M-2000MHz	+47dBm
A801M202-5050 R	800M-2000MHz	+50dBm
A801M202-5353 R	800M-2000MHz	+53dBm
A801M202-5757 R	800M-2000MHz	+57dBm
A801M202-6060 R	800M-2000MHz	+60dBm
A801M252-3737M/R	800M-2500MHz	+37dBm
A801M252-4040M/R	800M-2500MHz	+40dBm
A801M252-4343M/R	800M-2500MHz	+43dBm
A801M252-4747M/R	800M-2500MHz	+47dBm
A801M252-5050 R	800M-2500MHz	+50dBm
A801M252-5353 R	800M-2500MHz	+53dBm
A801M252-5757 R	800M-2500MHz	+57dBm
A801M252-6060 R	800M-2500MHz	+60dBm
A801M302-3737M/R	800M-3000MHz	+37dBm
A801M302-4040M/R	800M-3000MHz	+40dBm
A801M302-4343M/R	800M-3000MHz	+43dBm
A801M302-4747M/R	800M-3000MHz	+47dBm
A801M302-5050 R	800M-3000MHz	+50dBm
A801M302-5353 R	800M-3000MHz	+53dBm

* M-Module type, R-Rack type

R&K Company Limited

Tel : +81-545-31-2600 http://rk-microwave.com
Fax : +81-545-31-1600 E-mail: info@rkco.jp

Visit http://mwj.hotims.com/23286-88

RF Power Amplifier

A010K401-5353R

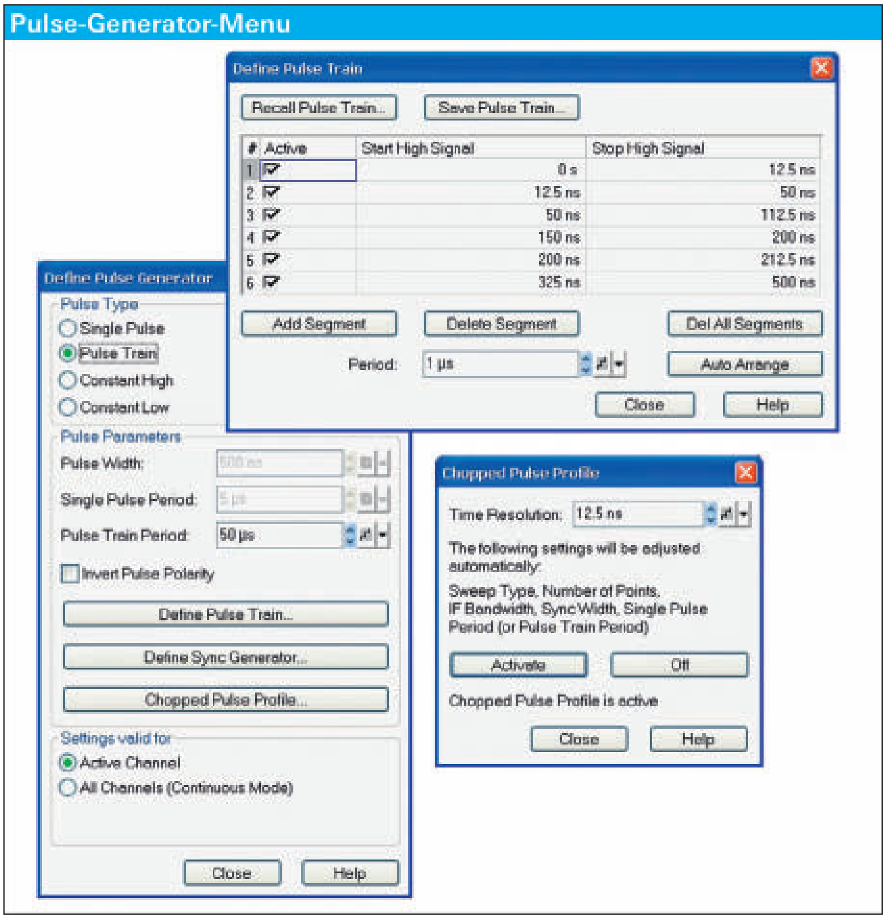
■Frequency: 10k-400MHz
■Power: 200W
and more.....

Model	Frequency	P@1dB (min)
A001K101-4444M/R	1k-100MHz	+44dBm
A010K251-4444M/R	10k-250MHz	+44dBm
A010K401-4444M/R	10k-400MHz	+44dBm
A001K101-4747M/R	1k-100MHz	+47dBm
A010K251-4747M/R	10k-250MHz	+47dBm
A010K401-4646M/R	10k-400MHz	+46dBm
A001K101-4949M/R	1k-100MHz	+49dBm
A010K251-4949M/R	10k-250MHz	+49dBm
A010K401-4848M/R	10k-400MHz	+48dBm
A001K101-5353M/R	1k-100MHz	+53dBm
A010K251-5353M/R	10k-250MHz	+53dBm
A010K401-5353M/R	10k-400MHz	+53dBm
A010K101-5757 R	10k-100MHz	+57dBm
A101K251-5757 R	100k-250MHz	+57dBm
A010K101-6060 R	10k-100MHz	+60dBm
A101K251-6060 R	100k-250MHz	+60dBm
A101K080-6363 R	100k- 80MHz	+63dBm
A101K251-6363 R	100k-250MHz	+63dBm
A101K080-6767 R	100k- 80MHz	+67dBm
A101K251-6767 R	100k-250MHz	+67dBm
A101K080-7070 R	100k- 80MHz	+70dBm
A101K251-7070 R	100k-250MHz	+70dBm

* M-Module type, R-Rack type

R&K Company Limited

Tel : +81-545-31-2600 http://rk-microwave.com
Fax : +81-545-31-1600 E-mail: info@rkco.jp



▲ *Fig. 3 The R&S ZVA-K27 option offers two independent, integrated pulse trigger generators in the R&S ZVA that deliver single pulses and user-configurable pulse trains.*

ment convenience. They are configured and controlled via the graphical user interface of the network analyzer, shown in ***Figure 3***, so that no additional switches or trigger generators are required. For measurements with pulsed signals, the extension unit contains two modulators for pulse generation (see Figure 1). Single pulses, periodic pulses or variable pulse trains can be generated.

The R&S ZVA-K7 pulsed measurements option with easy setup enables direct recording of amplitude and phase versus time. This functionality makes it possible to analyze the time-dependent behavior in T/R modules, amplifiers and mixers with a resolution of 12.5 ns. This high resolution, ten times higher than any solution currently available on the market, enables a more accurate characterization of short pulses. At a maximum IF bandwidth of 30 MHz, the signal rise/fall time can be determined with a resolution of up to 33 ns.

Since the pulse generators support user-configurable pulse trains (see Figure 3), the user can generate arbitrary sequences of any width, duration and power, and also characterize components under real-world conditions. Significantly, this measurement does not require a repetitive signal because the user can work with any pulse trains.

The high dynamic range and measurement speed of the new solution are complemented by an easy test setup and straightforward operation. In addition to typical measurements such as high-PRF-mode or point-in-pulse measurements, the R&S ZVA-K7 option offers a very convenient pulse profile measurement facility.

A third modulator in the receiver path, shown in Figure 1, 'chops' the pulses. This can be useful in antenna measurements (e.g. in the case of pulsed radar cross-section [RCS] measurements), for example, because time gating allows direct crosstalk be-

 Visit http://mwj.hotims.com/23286-89

Tough Times Demand Creative Solutions!

RENTAL

AR Helps You Afford The Quality Equipment You Need … Because We're All In This Together.

Times are tough. Budgets are getting smaller. And competition is more fierce than ever. So you can't afford to take chances with outdated or second-rate test equipment.

We've created a flexible rental program that makes it easier to get the best and most innovative test equipment. Think of it as our latest innovation to help you through these challenging times.

Under the new program, most AR equipment is available for rental. For as little as three months to however long you need it. You don't need to make a commitment up front, just decide from month to month if you want to keep it. And if you choose to buy the equipment, you can do so at any time; and 90% of your rental payments will be applied toward purchase – up to 95% of the list price.

Power. Quality. Support. 40 years of experience. Now for rent!

And, of course, you're not only getting the best equipment when you go with AR – you're getting the full backing of AR's global support network. We've been around for over 40 years; and we'll be there for you when you need us. Any time. Any where.

With the combined resources of all the AR companies, AR is your source for everything from power amplifiers, antennas, complete test systems, probes, monitors, software, and receivers to amplifer modules that can be customized to meet the toughest specs.

To learn more – and to see just how affordable AR equipment can be – visit www.ar-worldwide.com or call us at 215-723-8181.

40 years ar And Still Going Strong

ISO 9001:2000 Certified

ar

rf/microwave instrumentation

Other ar divisions: modular rf • receiver systems • ar europe

USA 215-723-8181. For an applications engineer, call 800-933-8181.

In Europe, call ar United Kingdom 441-908-282766 • ar France 33-1-47-91-75-30 • emv GmbH 89-614-1710 • ar Benelux 31-172-423-000

Visit http://mwj.hotims.com/23286-16 or use RS# 16 at www.mwjournal.com/info

Copyright © 2009 AR. The orange stripe on AR products is Reg. U.S. Pat. & TM. Off.

tween transmit and receive antennas with short delay and high amplitude. Pulse profile measurements can be implemented very easily by using the conventional high-PRF-mode.

The pulse modulators of the R&S ZVAX24 can be controlled either via an external trigger generator or directly by the R&S ZVA24 using the new R&S ZVA-K27 internal pulse generator option. The trigger signals are fed in via BNC connectors (if an external trigger generator is used) or via an RJ-45 cable (if the internal R&S ZVA pulse generators are used).

GROUP DELAY MEASUREMENTS

Mixers and frequency converters form the core of wireless and satellite communications systems. Especially in satellite systems, these frequency converters have to satisfy ever more demanding requirements regarding frequency response and phase linearity. Therefore, the measurement of relative and absolute group delay, of relative phase and of the group delay derivations (dispersion and scattering) in T/R modules is playing an increasingly important role.

Since there is no access to the local oscillator (LO), Rohde & Schwarz has developed the R&S ZVA-K9 option as a new method for characterizing the group delay and derived parameters without exactly knowing the LO signal. This option makes it possible to determine absolute and relative group delay, relative phase and scattering (group delay derivations).

This innovative method requires a four-port network analyzer with two sources for feeding a two-tone signal to the converter. The R&S ZVA24 measures the phase deviation between the two signals at the input and at the output of the DUT and determines the group delay. Neither the frequency drift nor the frequency modulation of the internal and unknown LO influences the measurement results. The R&S ZVA-K9 calculates the relative phase by integrating the group delay, and it calculates the DUT scattering by group delay derivation.

The conventional methods for determining group delay require a complicated test setup and a calibration. They are also associated with a significant level of uncertainty because they depend on the stability of the LO. Moreover, it is almost impossible to perform group delay measurements on converters having multiple mixer stages. This new approach, however, offers easy setup and calibration, and is independent of the LO's frequency stability. This method is ideal for investigating DUTs with multiple mixer stages.

HARMONIC AND INTERFERENCE TEST FILTERS

Two harmonic filters in the generator paths, shown in the block diagram of Figure 1, improve the spectral purity of the signals. Harmonic suppression is typically 60 dBc for the second and 70 dBc for the third harmonic. An additional filter in the receive path (see Figure 1) expands the receiver's dynamic range at test port 2, which is a crucial advantage when measuring harmonics or interference signals. The filter also allows very low harmonic levels to be measured. Harmonic measurements are carried out using the R&S ZVA-K4 option.

COUPLERS

The R&S ZVAX24 can also be equipped with two high-power couplers, shown in Figure 1, to cover power levels up to 43 dBm (standard test port: 27 dBm). Preamplifiers can be inserted into the source path using connectors on the unit's rear panel in order to further increase the available power levels. A coupler in the measurement path allows the signals of port 2 to be monitored in parallel using a spectrum analyzer or power meter. Signal monitoring is a very helpful feature for complementary measurements or when controlling signals during S-parameter or intermodulation measurements. All these features enable the user to measure DUTs without reconnecting them.

CONCLUSION

The scalable T&M solution that consists of the R&S ZVAX24 extension unit and the R&S ZVA24 vector network analyzer (or any other R&S ZVA or ZVT network analyzer) enables linear and nonlinear measurements on active components without extra equipment and without reconnecting the DUT. This is a big step toward higher efficiency and measurement accuracy. Depending on the measurement task to be solved, users can customize a powerful test solution by adding combiners, harmonic filters, pulse modulators and high-power couplers in line with their needs.

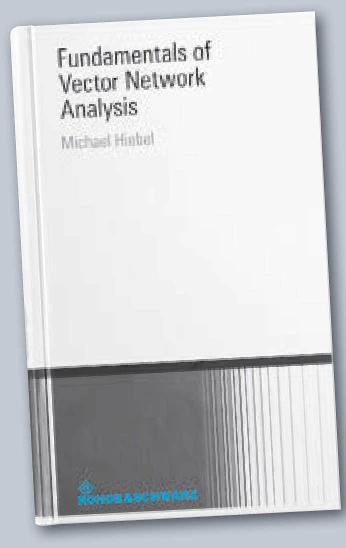
Rohde & Schwarz – Europe, Munich, Germany +49 1805 12 4242, customersupport@ rohde-schwarz.com; Americas: +1 888 837 8772, customer.support@ rsa.rohde-schwarz.com; Asia: +65 65130 488, customersupport.asia@ rohde-schwarz.com.

RS No. 300

Expertise for free!

Rohde & Schwarz is giving away five copies of the technical book entitled "Fundamentals of Vector Network Analysis" by Michael Hiebel.

To take part in the drawing, simply register at: www.rohde-schwarz.com/ad/nwa-a/mwj



The winners will be notified in writing. Legal proceedings are not permitted. Deadline for participation: July 15, 2009.

USB POWER SENSOR

-30 to +20 dBm 1 to 6000 MHz

POWER SENSOR PWR-6G+ Package

only $695 ea. (qty.1-4)

Includes:
PWR-SEN-6G+ Power Sensor Unit
Power Data Analysis Software
SMA Adaptor, USB Cable

Fully loaded software features

- *Power data analysis*
- *Power level offset*
- *Scheduled data recording*
- *Averaging of measurements*
- *Interface with test software*
- *Multi sensor support software* (up to 16 sensors support software)
- *Compatible with LabVIEW™, Delphi, C++ and Visual Basic software*

LabVIEW is a registered trademark of National Instruments Corp. Delphi and C++ are registered trademarks of Codegear LLC. Visual Basic is a registered trademark of Microsoft Corporation. The Mini-Circuits USB Power Sensor is not affiliated with any of the programming software referenced above.

Now, Mini-Circuits offers a USB Power Sensor and software together with your laptop that will ***reduce your equipment costs*** and provide new application features that will simplify your power measurements. Having a measurement range of -30 to +20 dBm at frequencies from 1 to 6000 MHz. The PWR-6G+ is supplied with easy-to-use, Windows-compatible measurement software to speed and simplify your power measurements, allowing you to set as many as 999 averages and to record results for further analysis. The PWR-6G+ USB Power Sensor provides 0.01-dB measurement resolution and impressive accuracy over temperature.
Visit the Mini-Circuits' web site at www.minicircuits.com to learn more.

Mini-Circuits…we're redefining what VALUE is all about!

Mini-Circuits®
ISO 9001 ISO 14001 AS9100 CERTIFIED

minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending ***The Design Engineers Search Engine*** *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

IF/RF MICROWAVE COMPONENTS

457 rev D

Visit http://mwj.hotims.com/23286-66 or use RS# 66 at www.mwjournal.com/info

AN OMNI-DIRECTIONAL ANTENNA FOR INDUSTRIAL AND TRANSPORTATION APPLICATIONS

EXECUTIVE INTERVIEW SERIES

MWJ SPEAKS WITH BERND NIEDERMANN, HEAD OF CORPORATE COMMUNICATIONS, HUBER+SUHNER. VISIT WWW.MWJOURNAL.COM TO READ THIS IN-DEPTH INTERVIEW.

Wireless communications has revolutionized the way our society functions. It is a key element of modern life and its reach is extending far and wide, with new applications constantly coming to the fore. To address the increasing demand to connect the various types of devices and networks, HUBER+SUHNER has developed the new SENCITY® SWA-0825/360/5/30/DFRX30 antenna, which is a rugged omni-directional multiband antenna for GSM 900, GSM 1800, GSM 1900, UMTS, 2.4 GHz band and GPS/Galileo, aimed specifically at industrial and transportation applications.

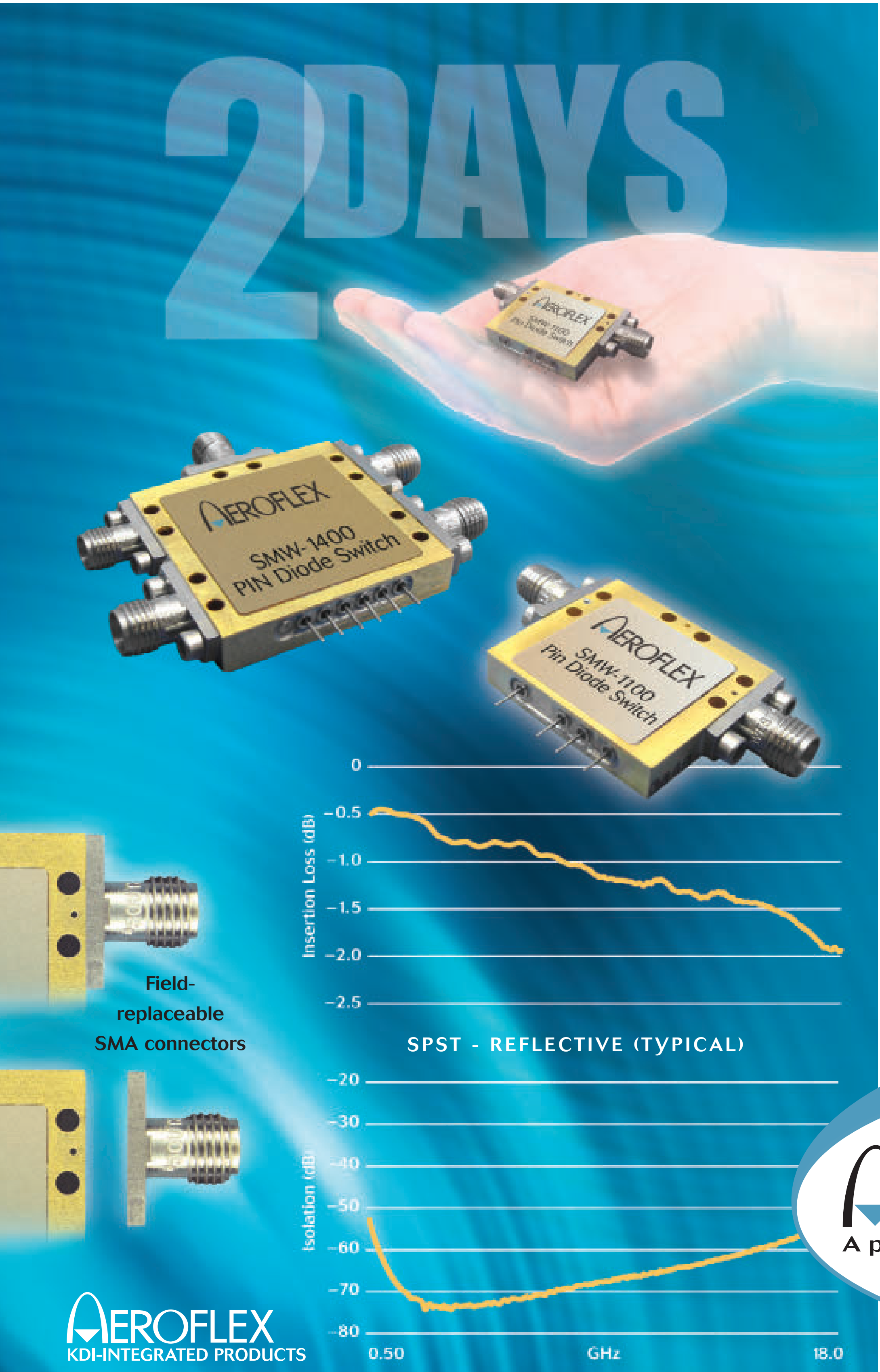
The need for and proliferation of antennas in the transportation and industrial sectors is increasing rapidly. For instance, a modern car is equipped with numerous antennas for different tasks: mobile communication, GPS navigation, Bluetooth connection between the mobile phone to the radio, the car key, etc. Also, more and more antennas are being used in industrial applications such as industrial automation, sensor data transfer, heavy vehicles like mine trucks, fork lifts, wind turbines, trains and ships.

In car applications the focus is primarily on short-range communication and the need for antennas to be as small and as cheap as possible, whereas in the industrial sector the need is for high reliability, protection against vandalism, high electrical performance (gain, VSWR) and the need to resist the impact of vibration, water, salt, dust and chemicals.

Antennas are used for mobile communication, WiFi, ZigBee/Bluetooth, WiMAX or RFID applications. There is a large variety of existing products that focus on the car industry and these products have been used in the industrial environment as well. However, there are often issues with both electrical performance and mechanical stability.

HUBER+SUHNER AG
Herisau, Switzerland

Ultra-broadband pin diode switches shipped to you from stock*



Visit http://mwj.hotims.com/23286-4 or use RS# 4 at www.mwjournal.com/info

Need it in your hand right now? Aeroflex / KDI-Integrated Products will ship design quantities to you in two working days.

APPLICATIONS

- EW/ECM
- Communication systems
- Switch matrices
- Phased arrays

FEATURES

- Ultra-broadband performance from 0.5 to 18 GHz.
- SPST - SP4T absorptive and reflective configurations
- Field-replaceable SMA connectors
- Low-voltage TTL control
- Epoxy-sealed

The Aeroflex / KDI-Integrated Products' SWM series features fast switching speeds with high isolation over the entire bandwidth. Higher RF peformance, wider bandwidths, LVTTL, ECL and other custom configurations available upon request.

** based on current availability*

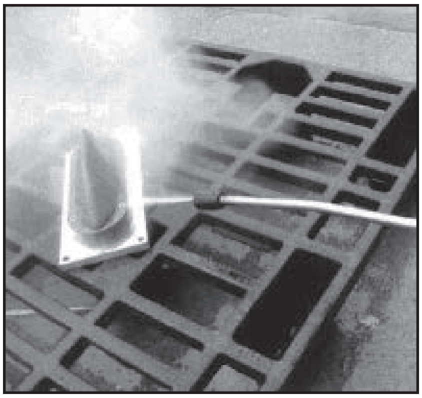
973-887-5700

www.aeroflex.com/ KDI-Integrated

KDI-integrated-sales @aeroflex.com

AEROFLEX

A passion for performance.



▲ *Fig. 1 Water testing of SENCITY antenna.*

ANTENNA SPECIFICATIONS

The SENCITY® SWA-0825/360/5/30/DFRX30 antenna addresses these issues. It measures 145 by 100 by 40 mm and can operate in a temperature range of -40° to +85°C. In multiband its frequency ranges are 870 to 960 MHz, 1710 to 2170 MHz and 2400 to 2500 MHz. Impedance is 50 Ω and VSWR is 1.7. Polarization is linear, vertical and the maximum power is 100 W (CW) at 50°C.

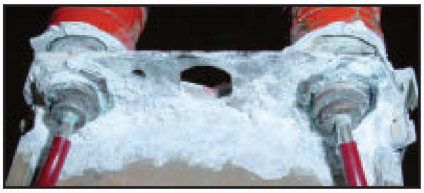
In GPS/Galileo the frequency range is 1575.42 MHz ± 1.023 MHz, impedance is 50 Ω and VSWR is 1.6. The operating voltage is 3.0 to 5.0 VDC feed at the center conductor of the GPS antenna. Polarization is RHCP, gain LNA is 27 dB and the noise figure is 1 dB.

The antenna is 2002/95/EC (RoHS) compliant and also meets: IP68 (when correctly installed) EN50155, high current protection according to DB specifications (protection against short circuit of 40 kA) and electromagnetic compatibility (EN50121-3-2) standards.

These standards are particularly significant for industrial and transportation applications. It is important to put them into context for antennas operating outdoors and in harsh environments. A high level of salt in the air can cause corrosion of the product. It may be subject to shock and vibration and needs to be resistant to water and dust ingression, all of which are covered by EN 50155.

IP RATINGS

Most products meet an IP65 or even IP66 level, but vehicles are often hosed down with a high-pressure cleaning device. This is the case when cleaning the roofs of trains. Thus, the higher IP rating of the SENCITY SWA-0825/360/5/30/DFRX30 antenna is significant. ***Figure 1*** shows an antenna being water tested.



▲ *Fig. 2 Effect of galvanic corrosion.*

The antenna is also protected against high voltage impacts. This could be a lightning strike or, for trains, contact with the catenary line that can carries up to 28 kV. In fact, for the roof-top application of antennas on trains there has to be protection in case of a contact with the catenary line (UIC Code 533). If the catenary line breaks, it could damage the radome of the antenna and detach the metallic radiator and the high voltage could create a fire inside the vehicle.

Another serious consideration when designing the new antenna was galvanic corrosion, which often reduces the lifetime of an installed product in an outdoor environment. ***Figure 2*** shows the effect of galvanic corrosion. Choosing the right material mix helps to reduce the corrosion effect. Thus, the SENCITY SWA-0825/360/5/30/DFRX30 antenna has been developed following the MIL-F-14072A (EL) standard with regards to surface combinations.

Other design considerations were fire and rain (and hail). With regards to the antenna's behavior in a fire, the design goal was to limit any toxic materials and to reduce the flammability of the product (NF F101-16, DIN 5510 or BS 6853). Also, trains running at up to 400 km/h or antennas on industrial vehicles will not stop running in bad weather, so the SENCITY antenna has passed tests against hail and rain.

ACCESSORIES

Cables, connectors, filters and the radio unit also have to meet strict requirements. As a specialist for connector solutions, HUBER+SUHNER provides a particular solution for the contact between connector and radiator. It avoids completely the soldering process to guarantee optimal breakout.

▲ *Fig. 3 The selection of the cable assembly for the antenna is critical.*

The selection of the cable assembly (shown in ***Figure 3***) is also significant. Usually, the cable will be selected by the parameters related to loss and bending radius. Additionally, in the industrial and transportation environment, the shock and vibration requirements need to be considered. H+S offers EN 50155 railway approved diplexer products to split mobile applications from WiFi or WiMAX frequencies. Also, the integrated GPS antenna is protected by the mechanical design of the broadband radiator antenna.

CONCLUSION

Antennas in industrial and transportation applications are special products that have to meet tough requirements and the electrical performance and mechanical performance can be more important than price. For the SENCITY SWA-0825/360/5/30/DFRX30 antenna the design goal is to ensure high reliability and to cope with different installation scenarios. The product has been designed to withstand vandalism, corrosion, UV radiation, temperature drops, vibration, hail impact, rain, snow and cleaning over a long period without maintenance.

HUBER+SUHNER AG, Herisau, Switzerland, +41 71 353 41 11, www.hubersuhner.com.

RS No. 301

i²S® INTELLIGENT INTERACTIVE SYNTHESIZERS

FEATURES: Over an octave bandwidth tuning, Small step size resolution, Outstanding spectral purity, High spurious rejection, Fast lock settling time

MTS2500-110250-10

Output Frequency	1100 - 2500 MHz		
Bandwidth	1400 MHz		
External Reference	10 MHz		
Step Size	Programmable to 1 Hz		
Bias Voltage	+5 / +3.3 V		
Output Power	+9 dBm (Min.)		
Spurious Suppression	60 dB (Typ.)		
Harmonic Suppression	15 dB (Typ.)		
Typical Phase Noise	Offset	dBc/Hz.	
	1 kHz	-93	
	10 kHz	-95	
	100 kHz	-110	
Settling Time	Within 1 kHz	<22 mSec	
	Within 10 Hz	<36 mSec	
Operating Temperature Range	-20 to +70 °C		

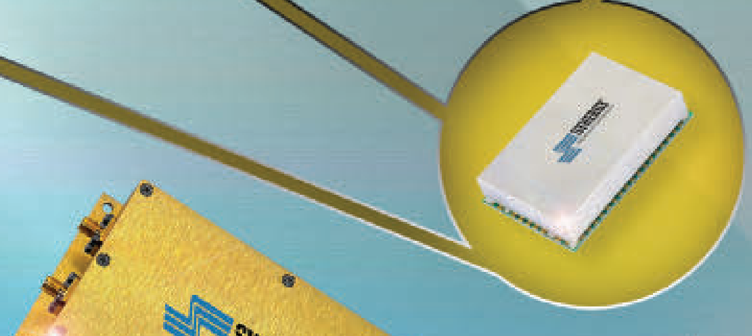
MTS2500-200400-10

Output Frequency	2000 - 4000 MHz		
Bandwidth	2000 MHz		
External Reference	10 MHz		
Step Size	Programmable to 1 Hz		
Bias Voltage	+5 / +3.3 V		
Output Power	+5.5 dBm (Min.)		
Spurious Suppression	60 dB (Typ.)		
Harmonic Suppression	10 dB (Typ.)		
Typical Phase Noise	Offset	dBc/Hz.	
	1 kHz	-88	
	10 kHz	-87	
	100 kHz	-100	
Settling Time	Within 1 kHz	<10 mSec	
	Within 10 Hz	<20 mSec	
Operating Temperature Range	-20 to +70 °C		

MTS2500-300600-10

Output Frequency	3000 - 6000 MHz		
Bandwidth	3000 MHz		
External Reference	10 MHz		
Step Size	Programmable to 1 Hz		
Bias Voltage	+5 / +3.3 V		
Output Power	+2 dBm (Min.)		
Spurious Suppression	60 dB (Typ.)		
Harmonic Suppression	20 dB (Typ.)		
Typical Phase Noise	Offset	dBc/Hz.	
	1 kHz	-87	
	10 kHz	-83	
	100 kHz	-108	
Settling Time	Within 1 kHz	<6 mSec	
	Within 10 Hz	<12 mSec	
Operating Temperature Range	-20 to +70 °C		

Patented Technology



Programming Interface:
-- 3.3V SPI (Standard)
-- RS232

Also available in connectorized package with the following options.
-- Internal reference (TCXO & OCXO)
-- Divider output for lower bands
-- Low phase noise option

Available Frequencies Ranging Up To 8000 MHz

SYNERGY® MICROWAVE CORPORATION

Visit http://mwj.hotims.com/23286-105 or use RS# 105 at www.mwjournal.com/info

For additional information, contact Synergy's sales and application team.
201 McLean Boulevard, Paterson, NJ 07504 | Phone: (973) 881-8800
Fax: (973) 881-8361 | E-mail: sales@synergymwave.com

Visit Our Website At WWW.SYNERGYMWAVE.COM

RF/Microwave Products

VENDORVIEW

Anatech Electronics announced it has launched three new websites that allow RF and microwave designers to more easily select from its families of RF and microwave filters and other components, and to order many products online. Anatech Microwave (AMC) (www.anatechmicrowave.com) covers the company's standard products. Anatech Electronics (AEI) (www.anatechelectronics.com) covers the company's custom products. AMCrf (www.amcrf.com) is an e-commerce site that features specific standard products that can be ordered online.

Anatech Electronics Inc.,
70 Outwater Lane, Garfield, NJ 07026

www.amcrf.com

AR's Bargain Corner

VENDORVIEW

There is more than one way to get the quality equipment you need. If your budget is tight, the AR Bargain Corner is a good place to find some great values. Discontinued and demonstration equipment is available at a fraction of its original price. Visit AR's website to view the company's Bargain Corner.

AR RF/Microwave Instrumentation,
160 School House Road,
Souderton, PA 18964

www.ar-worldwide.com

RF Coaxial Cable Assemblies

VENDORVIEW

The website features an easy-to-use product selector, broken down by cable type. Each cable type is available in a wide range of standard and custom lengths with a variety of connector choices. All connector/cable combinations can be reviewed using the company's Fast Quote tool, which also appears on each product page. The tool allows users to virtually design their own cable assemblies, with the ability to specify the cable type, length, connectors on both ends, and test requirements.

Electronic Assembly Manufacturing Inc.,
126 Merrimack Street,
Methuen, MA 01844

www.eamcableassemblies.com

ICs, Modules, Subsystems & Instrumentation

VENDORVIEW

Hittite's redesigned website includes crisp webpage designs and a dynamic homepage featuring full specifications for over 740 products across 20 product lines, press releases and featured articles. Comprehensive individual product "Splash Pages" containing in-depth product information and technical content are located on one easy to navigate page. Engineers will find improved Product Support and streamlined Quality & Reliability pages containing invaluable reference materials.

Hittite Microwave Corp.,
20 Alpha Road, Chelmsford, MA 01824

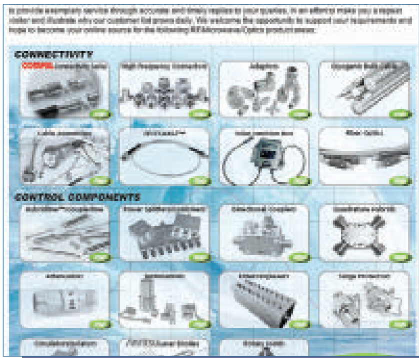
www.hittite.com

Filtering Solutions

K&L Microwave's redesigned website features improved product navigation and an integrated quote cart that enhances the customer's ability to review available products, simplify identification and specification of custom design solutions, and speed direct communication with the factory. Also, the new product catalog is available to download. The entire catalog or specific sections of interest can be downloaded by using provided links.

K&L Microwave,
2250 Northwood Drive,
Salisbury, MD 21801

www.klmicrowave.com
www.klfilterwizard.com



Component and Connectivity Products

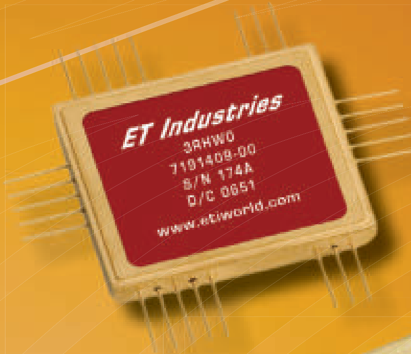
VENDORVIEW

Response Microwave Inc. announced the launch of its new website selection guide. The new site has migrated to a products focus and provides an overview of corporate capabilities and selection tables of the company's passive component and connectivity product offering that covers DC to 60 GHz. The site also offers application notes on the company's HYBRIDLINE series of drop-in quad hybrids and couplers.

Response Microwave Inc.,
94 Jackson Road, Suite 110,
Devens, MA 01434

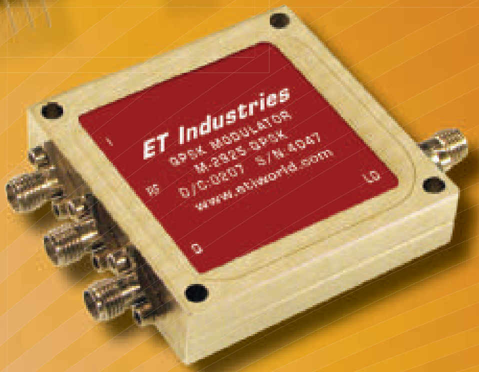
www.responsemicrowave.com

Modulators Demodulators



Vector Modulators

- 360 Degree Phase Shift
- 0-20 dB Amplitude Adjustment
- Digitally Controlled

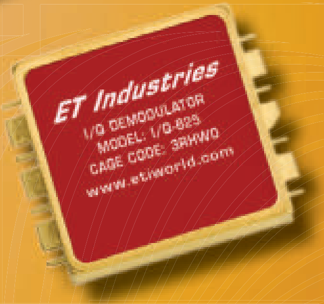


QPSK Modulators

- 0, 90, 180, 270 Degree Phase Shift
- Built-in Output Amplifier
- Built-in Low-Pass Filtering
- High Carrier Suppression

BPSK Modulators

- 0, 180 Phase States
- Fast Switching Speed



Demodulators

- I&Q Outputs With Linear Phase
- Wide Video Bandwidth
- Integrated Internal Low Noise Amplifier

et industries

Electromagnetic Technologies Industries, Inc.
50 Intervale Rd. Boonton, NJ 07005 U.S.A. Tel: 973-394-1719 Fax: 973-394-1710
email: sales@etiworld.com website: www.ETIworld.com

Visit http://mwj.hotims.com/23286-32 or use RS# 32 at www.mwjournal.com/info

FIVE DAYS ■ FOUR CONFERENCES ■ ONE EXHIBITION

EuMW2009 PUTS CUTTING EDGE TECHNOLOGY ON A GLOBAL STAGE

EuMW 2009
S. P. Q. R.
Science, Progress and Quality of Radiofrequencies
EUROPEAN MICROWAVE WEEK
Rome
28 September - 2 October 2009
www.eumweek.com

The historical, cultural and stylish city of Rome will be the backdrop for the 12th European Microwave Week when it plays host to Europe's premier Microwave, RF, Wireless Technology and Radar event for the very first time. The vibrant Italian capital complements the focussed and challenging Week, which covers FIVE days, encompassing FOUR cutting edge conferences and ONE dynamic trade and technology exhibition featuring leading players from across the globe.

THE CONFERENCES

- European Microwave Integrated Circuits Conference (EuMIC) - 28-29 September 2009
- European Microwave Conference (EuMC) - 29 September - 1 October 2009
- European Wireless Technology Conference (EuWiT) - 28 - 29 September 2009
- European Radar Conference (EuRAD) - 30 September - 2 October 2009

Plus Workshops and Short Courses

For full information on attending European Microwave Week log onto

www.eumweek.com

Co-sponsored by: MTT-S, GAAS

Supported by: IET — A new Institution from the IEE and IIE

Endorsed by: IEEE, AP-S, Electron Devices Society, AESS, EurAAP

Organised by: horizon house, EuMA European Microwave Association

Official Publication: Microwave Journal

39TH EUROPEAN MICROWAVE CONFERENCE 2009
The 39th European Microwave Conference

EuWiT 2009
The 2nd European Wireless Technology Conference

EuRAD 2009
The 6th European Radar Conference

EuMIC 2009
The 4th European Microwave Integrated Circuits Conference

Visit http://mwj.hotims.com/23286-33 or use RS# 33 at www.mwjournal.com/info

Europe's Premier Microwave, RF, Wireless and Radar Event

EuMW 2009
S. P. Q. R.
Science, Progress and Quality at Radiofrequencies

EUROPEAN MICROWAVE WEEK
Rome
28 September - 2 October 2009
www.eumweek.com

European Microwave Week is the largest event dedicated to RF, Microwave, Radar and Wireless Technologies in Europe. Capitalising on the success of the previous shows, the event promises growth in the number of visitors and delegates.

EuMW2009 will provide:

- 7,500 sqm of gross exhibition space •
- 5,000 key visitors from around the globe •
- 1,700 - 2,000 conference delegates •
- In excess of 250 exhibitors •

Running alongside the exhibition are 4 separate, but complementary Conferences plus Workshops and Short Courses.

Interested in exhibiting? Book online NOW!

Visit http://mwj.hotims.com/23286-34 or use RS# 34 at www.mwjournal.com/info

www.eumweek.com

For further information please contact:

Richard Vaughan
Horizon House Publications Ltd.
16 Sussex Street, London SW1V 4RW, UK
E:rvaughan@horizonhouse.co.uk
Tel: +44 20 7596 8742
Fax: +44 20 7596 8749

Kristen Anderson
Horizon House Publications Inc.
685 Canton Street, Norwood, MA 02062, USA
E:kanderson@mwjournal.com
Tel: +1 781 769 9750
Fax: +1 781 769 5037

Co-sponsored by: MTT-S

Endorsed by: IEEE

Organised by: horizon house

EuMA European Microwave Association

39th European Microwave Conference 2009
The 39th European Microwave Conference

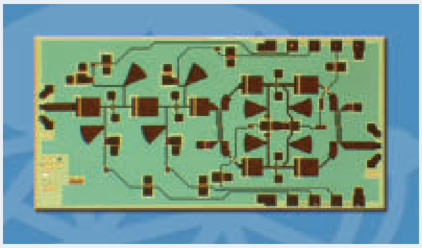
EuWiT 2009
The 2nd European Wireless Technology Conference

EuRAD 2009
The 6th European Radar Conference

EuMIC 2009
The 4th European Microwave Integrated Circuits Conference

GaAs HEMT LNA Die

VENDORVIEW



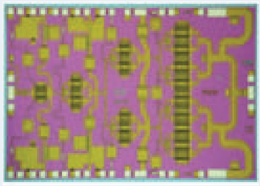
The HMC-ALH508 is a three-stage GaAs HEMT MMIC low noise amplifier (LNA) chip that operates between 71 and 86 GHz, replacing the HMC-ALH459. The HMC-ALH508 features 13 dB of small-signal gain, 4.5 dB of noise figure and an output power of +7 dBm at 1 dB compression. The HMC-ALH508 operates from two supply voltages at 2.1 and 2.4 V respectively, while consuming only 30 mA of supply current. All bond pads and the die backside are Ti/Au metallized and the amplifier is fully passivated for reliable operation. This versatile LNA is compatible with conventional die attach methods, as well as thermocompression and thermosonic wire bonding, making it ideal for MCM and hybrid microcircuit applications.

Hittite Microwave Corp., Chelmsford, MA (978) 250-3343, www.hittite.com.

RS No. 217

MMIC High Power Amplifier

VENDORVIEW



This GaAs MMIC high power amplifier (HPA) features +37 dBm saturated output power and 27 dB small-signal gain. This HPA, identified as XP1058-BD, uses a dual-sided bias architecture, covers 14.5 to 16 GHz, and achieves +44 dBm OIP3. The device is well suited for millimeter-wave military, radar, satellite and weather applications.

Mimix Broadband Inc., Houston, TX (281) 988-4600, www.mimixbroadband.com.

RS No. 257

Ultra-thin MOSFETs

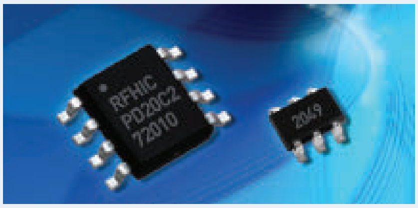
Targeting battery-powered appliances and driver MOSFETs in DC/DC converters, the new N0100P, N0301P, N0302P and N0301N MOSFETs, in a SOT-23F package, employ a flat lead structure instead of the conventional gull wing structure. This has made it possible to decrease the package height by 0.1 mm, thus enabling designers to realize a smaller design footprint. This flat lead structure also means that the packages of the new MOSFETs are capable of carrying larger chips, yet can still provide the high current capabilities of up to 4.5 A (N0301N). A 20 percent reduction on-resistance compared to existing MOSFETs is achieved. The new devices include three P-channels and one N-channel MOSFET enabling designers to choose the best option depending on the specific system.

NEC Electronics (Europe) GmbH, Düsseldorf, Germany +49 (0) 211 65 03 0, www.eu.necel.com.

RS No. 218

Two-way Power Dividers

VENDORVIEW



These ten new low cost SMD type two-way-divider/splitter/combiners are designed for LTE and WiMAX frequencies. It is now proposed to have 2.6 GHz for Europe, 1800 to 2000 MHz for China, and 700 MHz for US LTE bands. PD09C2 (700 to 960 MHz), PD18C2 (1.7 to 1.9 GHz), PD20C2 (1.9 to 2.2 GHz), PD23C2 (2.2 to 2.4 GHz), and PD26C2 (2.5 to 2.7 GHz) has been released in an industry standard SOIC-8 type plastic package and is lead-free/RoHS compliant. All these devices will be available with SOT-23-6L package, which has the same footprint with SOT-6 and SOT-26. Cost advantage is increasingly becoming an important strategic advantage and this low cost divider can be the correct solution for many infrastructure telecommunication equipment manufacturers.

RFHIC Corp., Suwon, GyeongGi-do Korea 82-31-250-5011, www.rfhic.com.

RS No. 231

Integrated Configurable Components

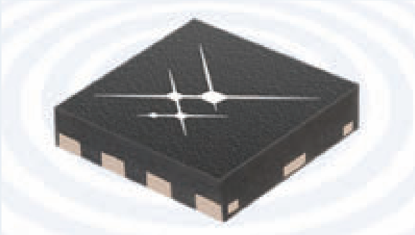
VENDORVIEW

RFMD has extended its portfolio of integrated configurable components to include products for the cellular repeater and Wireless Local Area Network (WLAN) markets. The new integrated configurable components include the RF2057 RF synthesizer with integrated mixers and the RF2059 RF transverter. RFMD's integrated configurable components deliver unmatched levels of flexibility and functional integration to designers of radio systems. By integrating multiple common RF functions into highly integrated, size-reduced packages, the integrated configurable components enable designers to develop radio systems that operate over a wide dynamic range and across a broad range of frequencies and channel bandwidths. The RF2057 and RF2059 join the RF2051, RF2052 and RF2053, which were introduced in April 2008 and have been adopted in markets as diverse as cellular, defense and broadband cable systems.

RFMD, Greensboro, NC (336) 664-1233, www.rfmd.com.

RS No. 256

PHEMT GaAs IC SP3T Switch



This pseudomorphic high electron mobility transistor (PHEMT) gallium arsenide (GaAs) integrated circuit (IC) SP3T switch is designed for 0.1 to 6 GHz. The SKY13317-373LF symmetric switch offers low insertion loss and high isolation with a 44 percent reduction in size than SKY13309-370LF. Featuring higher overall transmit efficiency and linearity, less board space is used with greater design/layout flexibility, equating to a small and thin end product. Appropriate for high volume, consumer products — end users will also discover better linearity and a clearer signal. The SKY13317-373LF is currently being used with wireless local area network (WLAN) and Bluetooth® combo chipsets.

Skyworks Solutions Inc., Woburn, MA, (781) 376-3000, www.skyworksinc.com.

RS No. 219

RF Power Transistors

HVVi Semiconductor introduces the HVV1011-500, the latest in its family of extremely rugged L-band (1030 to 1090 MHz) RF power transistors aimed at IFF, TCAS and transponder/interrogator markets. This robust 50 V device achieves output power over 500 W P1dB providing 19 dB gain and 50 percent drain efficiency under the following pulse condition (50 µs P.W., 5 percent D.C.), while withstanding industry leading output load mismatch tolerance of 20:1 VSWR. The HVV1011-500 is a single-ended pulsed power transistor assembled in an HV800, two-lead, bolt-down, metal flanged package with LCP lid.

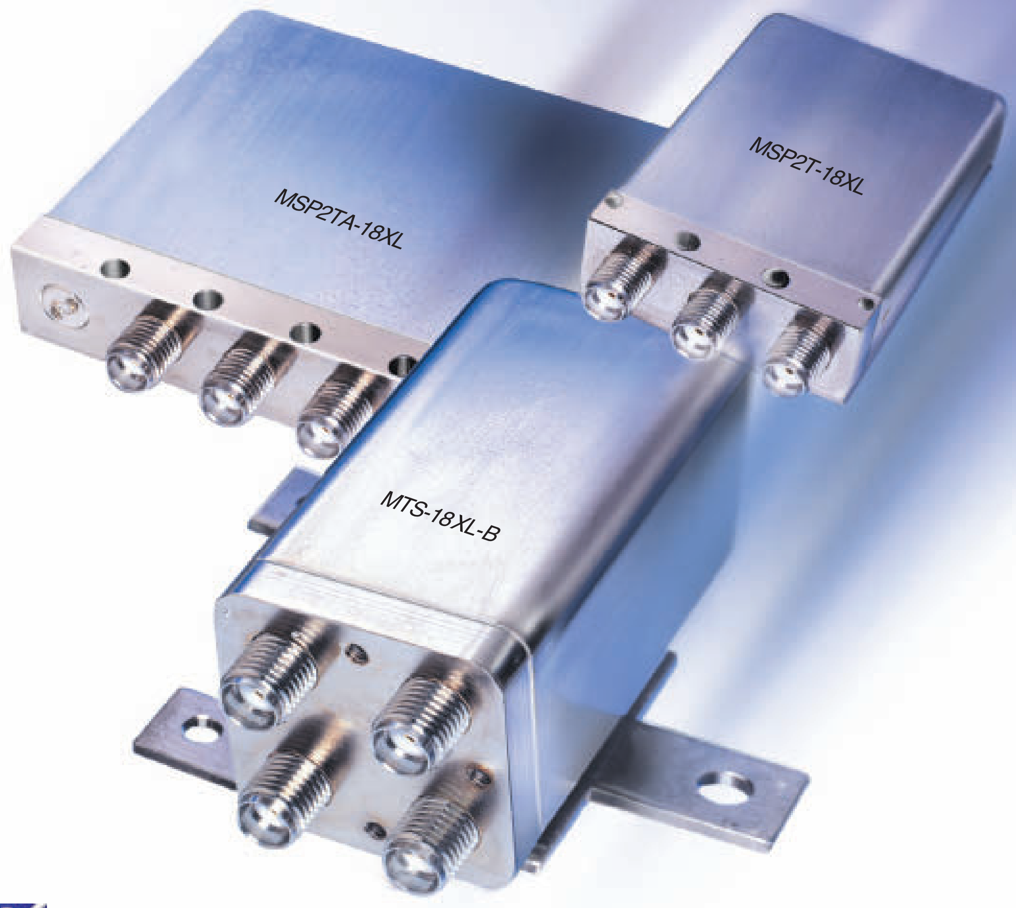
HVVi Semiconductors Inc., Phoenix, AZ (480) 776-3800, www.hvvi.com.

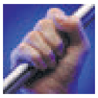
RS No. 255

MICROWAVE SWITCHES

NOW! 100 MILLION CYCLES

DC-18 GHz





Value Packed Recession Busters!

from 139^{95} IN STOCK

Tired of the high cost and lost time that come with constantly having to replace your current mechanical switches? Then why not change over to Mini-Circuits ultra reliable DC to 18 GHz switches, (three versions available; SPDT reflective, SPDT absorptive and Transfer switches) ***– you could start saving up to 90% right away.***

How? Our RF/microwave mechanical switches use breakthrough, advanced technology to eliminate springs and other life shortening moving parts. The result? Switches that are so reliable they're backed by our 1-year, 10 million cycle warranty, extendable to a 10-year, 100 million cycle warranty. In fact, they're so robust we've even tested them in sleep mode for up to four years without a single start up failure. Plus, they still deliver the superior performance, good impedance matching, low insertion loss, and high isolation (up to18 GHz), you've come to expect from any of Mini-Circuits high quality components. For details, please see our website.

10 YEAR EXTENDED WARRANTY

10 Yr.
100 Million Cycles*
**10 year agreement required*
See website for details

Outstanding performance. Unmatched reliability. Guaranteed.
It's all part of our commitment to giving you the best in value.
Mini-Circuits...Your partners for success since 1969

Protected by patents 4,908,588 5,272,458 6,650,210

Mini-Circuits®
ISO 9001 ISO 14001 AS9100 CERTIFIED

minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending ***The Design Engineers Search Engine*** *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

IF/RF MICROWAVE COMPONENTS

460 rev B

Visit http://mwj.hotims.com/23286-67 or use RS# 67 at www.mwjournal.com/info

New Products

Components

Four-way Power Divider

VENDORVIEW

Model AM-900PD1196 is a four-way power divider designed for applications such as wireless and industrial scientific and medical (ISM) that operate between 800 to 1000 MHz. The module splits an input signal into four separate outputs, and features low insertion loss and excellent amplitude and phase balance. The model AM900PD1196 operates over a frequency range of 800 to 1000 MHz, with insertion loss of 1.5 dB or less, isolation of at least 25 dB, amplitude balance of 0.3 dB or less, and phase balance of 5 deg. or less. Size: 4" × 2.15" × 1".

Anatech Microwave,
Garfield, NJ (201) 772-4242,
www.anatechmicrowave.com.

RS No. 220

E-band Components

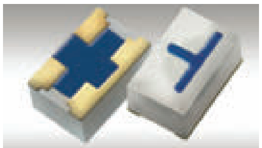
The newly developed E-band (WR-12 waveguide band) component family enables the rapid development of short-haul communication links operating license-free from 71 to 86 GHz. The component family includes oscillators, multipliers, low noise and power amplifiers, subharmonically pumped mixers and up-converters, filters and diplexers. All products are available as separate components or combined as integrated assemblies.

Ducommun Technologies Inc.,
Carson, CA (310) 847-2859,
www.ducommun.com.

RS No. 221

Temperature Variable Chip Attenuator

VENDORVIEW



The AN7 is a new solution for temperature compensation with an SMT planar style chip design. This new AN7 offers a small 0805 package size for TVA line and has excellent frequency response from DC to 6 GHz. The AN7 is suitable for high volume, pick & place and targeted for telecom and WiMAX applications. The AN7 variable attenuator is available in designs of 1 through 6 dB in one dB increments with temperature attenuation coefficients (TCA) of -.003 through -.009, dB/dB/deg C and an operating temperature range of -55° to +125°C. Size: 0.080" × 0.050".

EMC Technology,
Stuart, FL (772) 286-9300,
www.emct.com.

RS No. 222

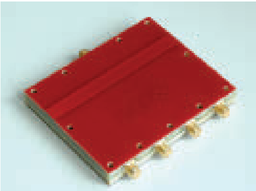
Voltage-controlled Oscillator

The RP-148258-01 model is designed to meet the stringent performance requirements of the aerospace industry. This model is compliant with MIL-PRF-38534 specification essential to high reliability, military and space applications. The operating frequency range is 1420 to 2500 MHz with an operating temperature range of -40° to +85°C. Tuning voltage is 1.85 to 12.65 V DC with 3.4 to 4.0 dBm power output. Modulation bandwidth is 5.5 MHz and typical phase noise is -96 dBc/Hz at 10 kHz.

Emhiser Research Inc.,
Verdi, NV (775) 345-0461,
www.emhiser.com.

RS No. 223

4 to 6 GHz RF Coupler



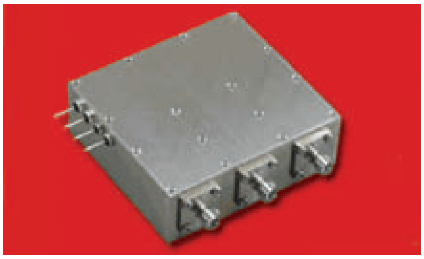
The low cost CPS4060-4 four-way reactive power divider/combiner has a frequency range of 4 to 6 GHz, which has been developed for splitting or combining four RF-signals in phase while providing isolation between the four signals. It has a maximum insertion loss of 0.9 dB (over 6 dB), isolation > 20 dB, comes in a small package measuring 85 by 70 by 10 mm and operates within the commercial ambient temperature range of 0° to +70°C. The configuration is a four-way in phase splitter/combiner with a maximum matched input power of 2 W and an impedance of 50 Ω.

eubus GmbH,
Munich, Germany +49(0) 89 4522 57811,
www.eubus.net.

RS No. 224

Solid-state Switches

VENDORVIEW



The 50S-1820 and 50S-1821 are the latest innovations in JFW's high power solid-state RF switches. The 50S-1820 is capable of switching 100 W of RF power from 800 to 2700 MHz (cold switch), while the 50S-1821 will switch 75 W from 800 to 3000 MHz. Both switches boast 10 microsecond switching speeds and a minimum isolation of 55 dB. Available with SMA, N, BNC or TNC connectors.

JFW Industries,
Indianapolis, IN (317) 887-1340,
www.jfwindustries.com.

RS No. 225

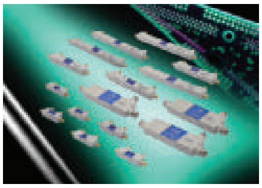
808 MHz Bandpass Filter

KR Electronics introduces part number 2907, a small surface-mount 808 MHz bandpass filter. The filter has a typical insertion loss of 3 dB and minimum 3 dB bandwidth of 25 MHz (35 MHz typical). The filter is supplied in a surface-mount package measuring 0.52" × 0.84" × 0.44". The filter can be customized for other center frequencies and bandwidths.

KR Electronics Inc.,
Avenel, NJ (732) 636-1900,
www.krfilters.com.

RS No. 226

Directional Coupler Range



The new LYNX directional couplers cover the frequency range from 500 MHz to 18 GHz and are suitable for use in a wide variety of commercial and military applications. They can be specified with a choice of SMA-type or N-type female connectors and are available with coupling values of 5, 6, 7, 10, 15, 20 or 30 dB. Featuring insertion losses as low as 0.4 dB, the couplers offer VSWR values from 1.2:1 to 1.6:1, a frequency sensitivity of ±0.7 dB or ±1.0 dB, and a directivity of 10, 12, 18 or 20 dB. The couplers have an operating temperature range of -55° to 85°C and are suitable for integration into mobile-phone infrastructure or satellite communications equipment.

Link Microtek Ltd.,
Basingstoke, UK +44 (0)1256 355771,
www.linkmicrotek.com.

RS No. 227

Band Reject Filter

Lorch model 6BRX-2257/X65-SR is a band reject filter with a center frequency of 2257 MHz. Insertion loss is 1 dB from 1400 to 2100 MHz and 3 dB from 2375 to 5500 MHz. Rejection is 40 dB from 2225 to 2290 MHz. Operating temperature is -40° to +85°C.

Lorch Microwave,
Salisbury, MD (410) 860-5100,
www.lorch.com.

RS No. 228

Reactive Power Splitters

Model Dx-19FN series is a collection of low cost two-, three- and four-way wideband reactive power splitters. The new series has been designed to a bandwidth of 700 to 2700 MHz, to

Phase Locked And Crystal Oscillators

Features:

- Band Coverage from VHF through Ka-Band
- Proven Performance in Various Applications
- Single and Dual Loop Models available with Internal and External Reference
- Small Modular Assemblies from 2.25" x 2.25" x 0.6"
- High Power and Low Harmonic Options available

3 YEAR WARRANTY · ISO 9001 Registered · ANAB · RoHS compliant

Model	Frequency Range	Type	Typical Phase Noise 10	100	1K	10K	100K	1M	Output Frequency	Output Power (dBm, Min.)
XTO-05	5-130 MHz	Ovenized Crystal	-95	-120	-140	-155	-160	-	100 MHz	11
PLD	30-130 MHz	P.L. Crystal	-95	-115	-140	-155	-155	-	100 MHz	13
PLD-1C	130-1000 MHz	P.L. Mult. Crystal	-80	-100	-120	-130	-135	-	560 MHz	13
BCO	.100-16.5 GHz	P.L. Single Loop	-65	-75	-80	-90	-115	-	16.35 GHz	13
VFS	1-14 GHz	Multiple Freq. Dual Loop	-60	-75	-110	-115	-115	-	12.5 GHz	13
DLCRO	.8-26 GHz	P.L. CRO Dual Loop	-60	-85	-110	-115	-115	-138	10 GHz	13
PLDRO	2-40 GHz	P.L. DRO Single/Dual	-60	-80	-110	-115	-120	-145	10 GHz	13
CP	.8-3.2 GHz	P.L. CRO Single Loop	-80	-110	-120	-130	-130	-140	2 GHz	13
CPM	4-15 GHz	P.L. Mult. Single Loop	-60	-90	-105	-110	-115	-130	12 GHz	13
ETCO	.1-24 GHz	Voltage Tuned CRO	-	-	-70	-100	-120	-130	2-4 GHz*	13

* Octave band.

For additional information or technical support, please contact our Sales Department at (631) 439-9220 or e-mail components@miteq.com

MITEQ
100 Davids Drive, Hauppauge, NY 11788
(631) 436-7400 FAX: (631) 436-7430
www.miteq.com

include the common cellular, Wi-Fi and WiMAX frequencies, now being incorporated in indoor distributed antenna systems. An added benefit of this series is the guaranteed PIM performance of <-150 dBc when tested with two 20 W test signals. The extremely high reliability required of DAS systems is most easily met with a passive network approach.
Microlab, Wireless Telecom Group, Parsippany, NJ (973) 386-9696, www.wtcom.com.

RS No. 252

Precision Phase Shifters

VENDORVIEW

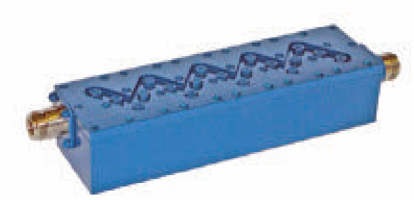
These precision coaxial phase shifters are designed for 1 to 5 GHz and 1 to 12.4 GHz that provide a high level of accuracy with maximum phase shift of 180 deg. The model 3752 covers 1 to 5 GHz and provides 180 deg. of phase shift at 1 GHz. It has insertion loss of 0.5 dB or less and maximum VSWR of 1.25. The model 3753B covers 3.5 to 12.4 GHz and provides 180 deg. of phase shift at 3.5 GHz. It offers insertion loss of 0.7 dB and maximum VSWR of 1.4. Both models can handle 200 W average and 1 kW peak power, have accuracy of ±0.5 dB/GHz, use Type N connectors, and have a digital dial display of phase shift.
Narda Microwave-East, Hauppauge, NY (631) 231-1700, www.nardamicrowave.com/east.

RS No. 229

Wi-Fi Bandpass Filter

VENDORVIEW

Reactel part number 8CX9-2436.5-X60N11 is a bandpass filter suitable for IEEE 802.1



applications. This unit is centered at 2436.5 MHz and has a minimum passband of 60 MHz and insertion loss of less than 0.75 dB. With high selectivity and a weather proof exterior, this unit is a great fit for your application.
Reactel Inc., Gaithersburg, MD (301) 519-3660, www.reactel.com.

RS No. 230

Programmable Step Attenuators

RLC Electronics' PA Series Attenuators are binary programmable step attenuators designed to operate from DC to 20 GHz. Two basic models offer attenuation ranges of 15 and 70 dB. Control is in standard format: 1-2-4-8. The attenuators are available with failsafe or latching operation, 12 or 28 V coils and optional TTL drivers, with a choice of frequency ranges.
RLC Electronics Inc., Mount Kisco, NY (914) 241-1334, www.rlcelectronics.com.

RS No. 232

Right Angle Adapters

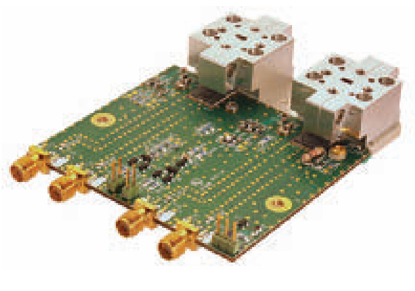
VENDORVIEW

The UG-27 C/U is a right angle adapter that features solderless construction. The solder-

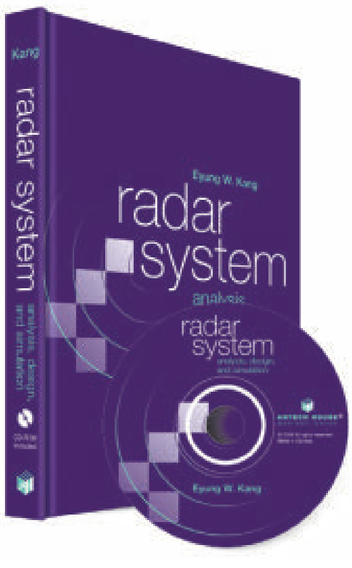
free construction offers dependability equal to a straight plug while achieving 90° bends. The solder-free adapters also address RoHS compliancy issues by reducing lead content. The 50 ohm UG-27 C/Us perform efficiently up to 11 GHz and are rated for operating voltages of 1000 V RMS. The right angle adapters have a maximum dielectric withstanding voltage of 2000 V RMS at 60 Hz at sea level. They are designed for a temperature range of -65° to +165°C and meet interface standards in accordance with MIL-STD-348. VSWR is 1.15 from DC to 6 GHz, and 1.35 from 6 to 11 GHz.
San-tron Inc., Ipswich, MA (978) 356-1585, www.santron.com.

RS No. 233

60 GHz Converter



The FC1001V/00 broadband converter is a versatile building block for 60 GHz applications. It combines an up-converter and a down-converter in a single unit. Both operate independently and can thus be used for both frequency



Radar System Analysis, Design and Simulation
Eyung W. Kang

Contents: Matrix, Vector and Linear Equation. Pseudo-Random Number, Noise and Clutter Generation. Filter, FIR and IIR. Fast Fourier Transform. Ambiguity Function. Antenna. Target Detection. Kalman Filter. Monte Carlo Method and Function Integrations. Constant False Alarm Rate (CFAR) Processing. Moving Target Indicator (MTI). Miscellany. Index.

CD-ROM Included! Contains over 200 valuable simulation and implementation tools, written in C++, to help you with your challenging projects in the field.

To order this book, contact:

Artech House · 685 Canton St. · Norwood, MA 02062 · (781) 769-9750 ext. 4030; or
16 Sussex St. · London SW1V 4RW, UK · +44 (0) 207-8750
367 pages; $139, £75 · ISBN: 978-1-59693-347-7

Visit http://mwj.hotims.com/23286-85 or use RS# 85 at www.mwjournal.com/info

FeaturedWhitePapers

The information you need, from the technology leaders you trust.

ROHDE&SCHWARZ

Rohde & Schwarz Develops a New Technique for Group Delay Measurements without LO Access
Thilo Bednorz, Product Management & Applications Engineering, Spectrum and Network Analysis, Rohde & Schwarz

AWR

EM Analysis within the Design Flow
Dr. Mike Heimlich, AWR

SPIRENT Communications

A-GPS Over the Air Test Method: Business and Technology Implications
Spirent Communications

ANALOG DEVICES

Correcting Imperfections in IQ Modulators Improves RF Signal Fidelity
Eamon Nash, Analog Devices

Check out these new online Technical Papers featured on the home page of Microwave Journal and the MWJ white paper archive in our new Technical Library (www.mwjournal.com/resources)

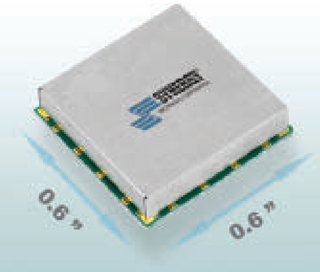
Microwave Journal

multiplexed and time multiplexed applications. The converter has the advantage of using external LO sources, with the user having full control of phase noise and frequency selection. Frequency multipliers (x8) are integrated in both the up-converter and the down-converter. The LO injection is done at 7 GHz with +0 dBm power. Other features include: 57 to 63 GHz RF bandwidth, > 1 GHz IF bandwidth and +10 dBm typical output power. Applications include point to point or multipoint radio, EW, secure communication and measurement.
Sivers IMA AB,
Kista, Sweden +46-8-7036800,
www.siversima.se.

RS No. 234

Surface-mount Intelligent Synthesizers

VENDORVIEW



The MFSH series of tiny surface-mount intelligent synthesizers with on-board microcontroller allows for self-programmable fixed frequency or wideband signal generation from a 0.6" package. Several models are available starting with frequencies from 1350 to 6500 MHz. Models are available with step size starting at 500 kHz.
Synergy Microwave Corp.,
Paterson, NJ (973) 881-8800, www.synergymwave.com.

RS No. 251

Surface-mount Feedthrus

This mini surface-mount 50 ohm feedthru is based on Thunderline's successful initial SMT Bell Pin offering. This new product has been designed to emulate the existing design, but will be one third less in size and will be built with a smaller pin. The use of a smaller pin in its new mini surface-mount package will enable Thunderline customers to use this part in both J-band and K-band frequency ranges. Based on initial expectations Thunderline anticipates this part will perform to limits somewhere between 22 and 25 GHz.
Thunderline-Z,
Hampstead, NH (603) 329-4050,
www.thunderlinez.com.

RS No. 235

Voltage-controlled Oscillator

This RoHS compliant voltage-controlled oscillator (VCO) model ZRO1560A1LF is designed for L-band. The ZRO1560A1LF operates at 1560 MHz with a tuning voltage range of 0 to 5 VDC. This VCO features a typical phase noise of -121 dBc/Hz at 10 kHz offset and a typical tuning sensitivity of 0.7 MHz/V. The ZRO1560A1LF is designed to deliver a typical output power of 0 dBm at 5 VDC supply while drawing 18 mA (typical) over the temperature range of -40° to 85°C. This VCO features typical 2nd harmonic suppression of -30 dBc and comes in Z-Comm's industry standard MINI-16 package measuring 0.5" × 0.5" × 0.22".
Z-Communications Inc.,
San Diego, CA (858) 621-2700,
www.zcomm.com.

RS No. 236

2 W & 5 W
DC to 18 GHz ATTENUATORS

from **$29.95** ea. (1-49)

Rugged Stainless Steel Construction, High Repeatability, Miniature Size, Low Cost, and Off-The-Shelf Availability are some of the features that make Mini-Circuits "BW" family of precision fixed attenuators stand above the crowd! This extremely broad band DC to 18 GHz series is available in 5 watt Type-N and 2 & 5 watt SMA coaxial designs, each containing 15 models with nominal attenuation values from 1 to 40 dB. Built tough to handle 125 watts maximum peak power, these high performance attenuators exhibit excellent temperature stability, 1.15:1 VSWR typical, and cover a wealth of applications. So contact Mini-Circuits today, and capture this next generation of performance and value! *Mini-Circuits…we're redefining what VALUE is all about!*

MODELS (Add Prefix BW-)

2 W SMA	5 W SMA	5 W Type-N	Attenuation (dB)	
$29.95	$44.95	$54.95	Nominal	Accuracy*
S1W2	S1W5	N1W5	1	±0.40
S2W2	S2W5	N2W5	2	±0.40
S3W2	S3W5	N3W5	3	±0.40
S4W2	S4W5	N4W5	4	±0.40
S5W2	S5W5	N5W5	5	±0.40
S6W2	S6W5	N6W5	6	±0.40
S7W2	S7W5	N7W5	7	-0.4, +0.9
S8W2	S8W5	N8W5	8	±0.60
S9W2	S9W5	N9W5	9	-0.4, +0.8
S10W2	S10W5	N10W5	10	±0.60
S12W2	S12W5	N12W5	12	±0.60
S15W2	S15W5	N15W5	15	±0.60
S20W2	S20W5	N20W5	20	-0.5, +0.8
S30W2	S30W5	N30W5	30	±0.85
S40W2	S40W5	N40W5	40	-0.5, +1.5

*At 25°C includes frequency and power variations.

***Now Available!* Adapters** (Prices: qty. 1-49)

Type-N to SMA **DC-18 GHz** $22.95 ea.
SMA to SMA / ***QUICK CONNECT*** SMA **DC-18 GHz** *from* $4.95 ea.
SMA to BNC **DC-2 GHz** $3.95 ea.
Type-N to Type-N **DC-6 GHz** $9.95 ea.

RoHS COMPLIANT

***To order Attenuators as RoHS, add + to base model No.** Example: BW-S1W2+*
Adapters available as RoHS, see web site.

Mini-Circuits®
ISO 9001 ISO 14001 CERTIFIED

ALL NEW minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending ***The Design Engineers Search Engine** Provides ACTUAL Data Instantly From MINI-CIRCUITS At: **www.minicircuits.com***

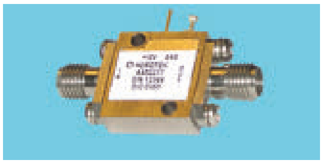
RF/IF MICROWAVE COMPONENTS

331 Rev K

Visit http://mwj.hotims.com/23286-68 or use RS# 68 at www.mwjournal.com/info

Amplifier

Miniature RF Amplifier



Herotek's model A402277 operates in a frequency range from 26 to 40 GHz and provides the user with an amplifier in its small package "1C" (size: 0.62" × 0.66" × 0.22"). It offers gain of 30 dB and gain variation of ±2.0 dB. Noise figure of 6.0 dB and P Out at 1 dB and compression is +16 dBm. Nominal DC current at 12 V is 400 mA. Application includes telecom infrastructure MW Radio and VSAT.

Herotek Inc.,
San Jose, CA (408) 941-8399,
www.herotek.com.

RS No. 237

Antennas

Flat Panel Antenna

Model FPA13-2.2R/1533 is a small (195 by 163 by 12.6 mm) flat panel antenna with directional beam pattern, 40° azimuth by 40° elevation. Its frequency range is 2.2 to 2.35 GHz and it has 13 dBi gain with right hand circular polarization. It is designed for use within an information system for telemetry applications in the defence and surveillance industries. It can be incorporated into an existing multi-sector framework, and conforms to existing technical and environmental specifications. The antenna can be used in a range of applications, providing operators with flexibility when designing network systems, and may also be used in industries where data is commercially valuable.

Cobham Antenna Systems,
Microwave Antennas,
Cheveley, Newmarket, UK
+44 (0) 1638 732177,
www.cobham.com/antennasystems.

RS No. 238

Broadband Horn Antennas

Cobham Sensor Systems' H-1498 series broadband linear horn antennas provide superior performance for use in a wide variety of laboratory, commercial and military applications. With excellent input VSWR over the 2 to 18 GHz band, these antennas provide high gain across the frequency range and consistent pattern performance. They have become a laboratory standard as a reference horn in anechoic chambers and outdoor ranges. The H-1498 is available with SMA female connector (standard) and TNC female connector (H-1498T). A further option is a radome/aperture cover (H-1498R) for outdoor use.

Cobham Sensor Systems,
Lansdale, PA (215) 996-2416,
www.cobhamdes.com.

RS No. 239

GPS Antenna Module

The A1035-H antenna module, with a footprint of 16.5 by 30.5 mm^2, is based on the company's A1084 GPS receiver. It is designed around the SiRFstar III GPS chip and is optimized for use with passive antennas. With the on-module antenna tuned to the receiver, a high level of sensitivity is

300 MHz-12 GHz

LTCC MIXERS

from $3.95 ea. (Qty.1000) IN STOCK

For Commercial, Military, and Industrial Use, Mini-Circuits proudly presents the MCA1 series of Low Temperature Co-fired Ceramic (LTCC) frequency mixers. Highly reliable, only 0.080" in height, and "tough as nails", these patented mixers have all circuitry hermetically imbedded inside the ceramic making them temperature stable and impervious to most environmental conditions. The process also gives you high performance repeatability and very low cost. There's a variety of broadband models and LO power levels to choose from, so you can use these mixers in a multitude of designs and applications. And MCA1 mixers are ideal for the COTS program! Just check all the specs on our web site. Then, choose the model that best fits your needs. Our team is ready to handle your requirements with quick off-the-shelf shipments, custom designs, and fast turn-around/high volume production.

Mini-Circuits...we're redefining what VALUE is all about!

Model	LO Level (dBm)	Freq. Range (MHz)	Conv. Loss (dB)	LO-RF Isol. (dB)	Price $ ea. (Qty. 10)
MCA1-85L	4	2800-8500	6.0	35	9.45
MCA1-12GL	4	3800-12000	6.5	38	11.95
MCA1-24	7	300-2400	6.1	40	5.95
MCA1-42	7	1000-4200	6.1	35	6.95
MCA1-60	7	1600-6000	6.2	30	7.95
MCA1-85	7	2800-8500	5.6	38	8.95
MCA1-12G	7	3800-12000	6.2	38	10.95
MCA1-24LH	10	300-2400	6.5	40	6.45
MCA1-42LH	10	1000-4200	6.0	38	7.45
MCA1-60LH	10	1700-6000	6.3	30	8.45
MCA1-80LH	10	2800-8000	5.9	35	9.95
MCA1-24MH	13	300-2400	6.1	40	6.95
MCA1-42MH	13	1000-4200	6.2	35	7.95
MCA1-60MH	13	1600-6000	6.4	27	8.95
MCA1-80MH	13	2800-8000	5.7	27	10.95
MCA1-80H	17	2800-8000	6.3	34	11.95

Dimensions: (L) 0.30" x (W) 0.250" x (H) 0.080"
U.S. Patent # 7,027,795

For RoHS compliant requirements,
ADD + SUFFIX TO BASE MODEL No. *Example: MCA1-85L+*

Mini-Circuits®
ISO 9001 ISO 14001 CERTIFIED

ALL NEW minicircuits.com

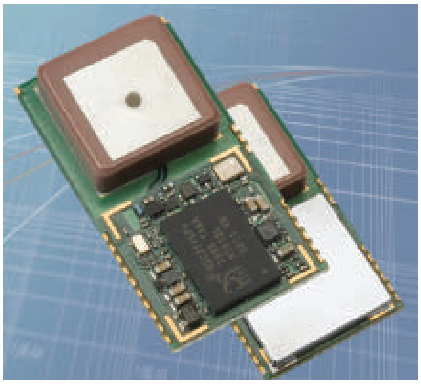
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending ***The Design Engineers Search Engine*** *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

RF/IF MICROWAVE COMPONENTS

385 Rev J

Visit http://mwj.hotims.com/23286-69 or use RS# 69 at www.mwjournal.com/info



achieved. Furthermore, the A1035-H has been especially designed for an extremely low current draw (an average of 85 mW in tracking mode), fulfilling the latest requirements for more integration and cost-saving solutions.
Vincotech GmbH, Unterhaching, Germany +49 (0) 89 8780 670, www.vincotech.com.

RS No. 240

Material

RFID Tag

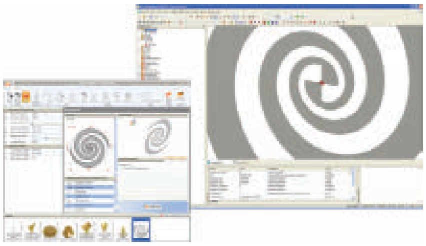
MetalTag™ Impact is a Read-on-Metal EPC Gen 2 RFID tag. MetalTag Impact is constructed of a ruggedized outer coating, using a patented elastomer with a robust exoskeleton. The tag is ideal for challenging environmental conditions, such as severe weather, wide temperature variations, direct and prolonged UV exposure and significant physical impact. Its small form factor makes it amenable to a wide variety of surfaces often associated with asset tracking and supply chain applications. The tag is also available with an optional metallic ground plane for read on liquid applications, custom color coded labels and pre-encoded bar codes.
Emerson & Cuming Microwave Products Inc., Randolph, MA (781) 961-9600, www.eccosorb.com.

RS No. 241

Software

Antenna Design Tool

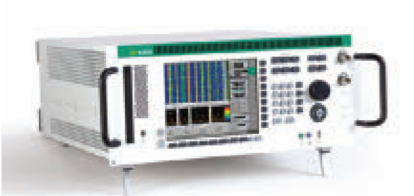
VENDORVIEW



Antenna Magus is an expert system for antenna design with a large database of antennas that makes it suitable for a broad range of applications. Its feature set is targeted at aiding engineers to get to the customization phase of an antenna design quickly and reliably. Validated, parametric models of the initial design are exported seamlessly into CST MICROWAVE STUDIO or FEKO, where customization can be done in tried-and-trusted analysis tools. Antenna Magus will expand both the number of antennas it can design and export, as well as in the number of analysis tools it interfaces with. It will aid antenna design engineers, EMC engineers requiring antenna models and system integrators who require antenna models for antenna placement studies.
Computer Simulation Technology (CST) AG, Darmstadt, Germany +49 6151 7303 0, www.cst.com.

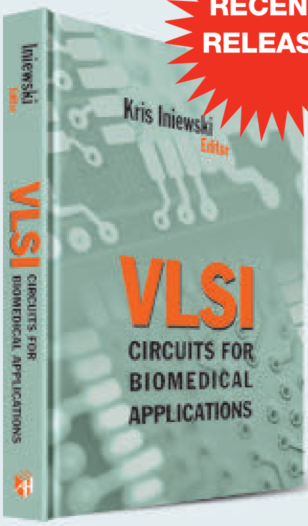
RS No. 242

Location Finding Software



New location finding software for the IZT R3000 receiver series for both commercial and military applications has been introduced. It is a low-cost method that enables users to add location finding capabilities to their monitoring stations. Using cost efficient Time-Difference-Of-Arrival (TDOA) methods, the software resides on a central station and connects multiple IZT R3000 receivers in different remote locations. Comparing their receive signals results in accurate delay measurements that are then used to derive the location of the signal's source. Re-

RECENT RELEASE



VLSI Circuits for Biomedical Applications
Kris Iniewski, *Editor*

Written by top-notch international experts in industry and academia, this ground-breaking resource presents a comprehensive, state-of-the-art overview of VLSI circuit design for a wide range of applications in biology and medicine. Supported with over 280 illustrations and over 160 equations, the book offers cutting-edge guidance on designing integrated circuits for:

- Wireless and wired biosensing;
- Body implants and microneedles;
- Biosensing interfaces with human body;
- Molecular biology dealing with DNA and bacteria.

• Hardcover • Approx. 280 pp. • 2008 • ISBN: 978-1-59693-317-0
• Order Book No. MW083178 • **$149/£86**

Find complete description and order at www.ArtechHouse.com

Order at www.artechhouse.com or contact the office nearest you: US FAX Purchase orders and credit card orders to 1-781-769-6334 **PHONE** Toll-Free 1-800-225-9977, ext. 4030 or 1-781-769-9750 **E-MAIL** artech@artechhouse.com **UK FAX** Purchase orders and credit card orders 24 hours a day to +44 (0)20 7630-0166 **PHONE** +44 (0)20 7596-8750 **E-MAIL** artech-uk@artechhouse.com **All orders plus shipping/handling and applicable taxes.**

ARTECH HOUSE BOSTON | LONDON

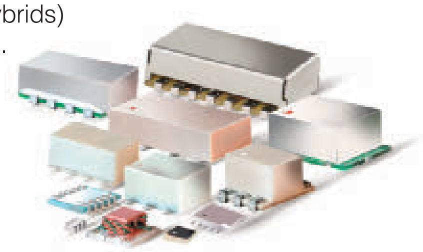
685 Canton Street, Norwood, MA 02062 USA
46 Gillingham Street, London, SW1V 1AH, UK

Visit http://mwj.hotims.com/23286-18

90° SPLITTERS

5 MHz to 7.2 GHz from $3.95 ea. qty. 5-49

At Mini-Circuits, we understand that two-way 90° power splitters (hybrids) are critical building blocks in a wide array of RF design solutions. That's why we offer them in extra-tight phase and amplitude balance to ensure your expected high-performance design results. Plus, our robust, rugged units deliver repeatable performance and are available in over 91 different models, in the widest range of frequencies in the industry (from 5 MHz to 7.2 GHz), and in package sizes as small as 0.08" x 0.05".



RoHS compliant

For full performance details and product availability, visit our web site *www.minicircuits.com*. You can order online and have units in-hand as soon as next-day.

Mini-Circuits...Your partners for success since 1969

Mini-Circuits®

ISO 9001 ISO 14001 AS9100 CERTIFIED

minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending *The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com*

IF/RF MICROWAVE COMPONENTS

463 Rev.Orig.

Visit http://mwj.hotims.com/23286-70 or use RS# 70 at www.mwjournal.com/info

sults are displayed on a map.
IZT, Erlangen, Germany +49/9131/4800-181, www.izt-labs.de.
RS No. 243

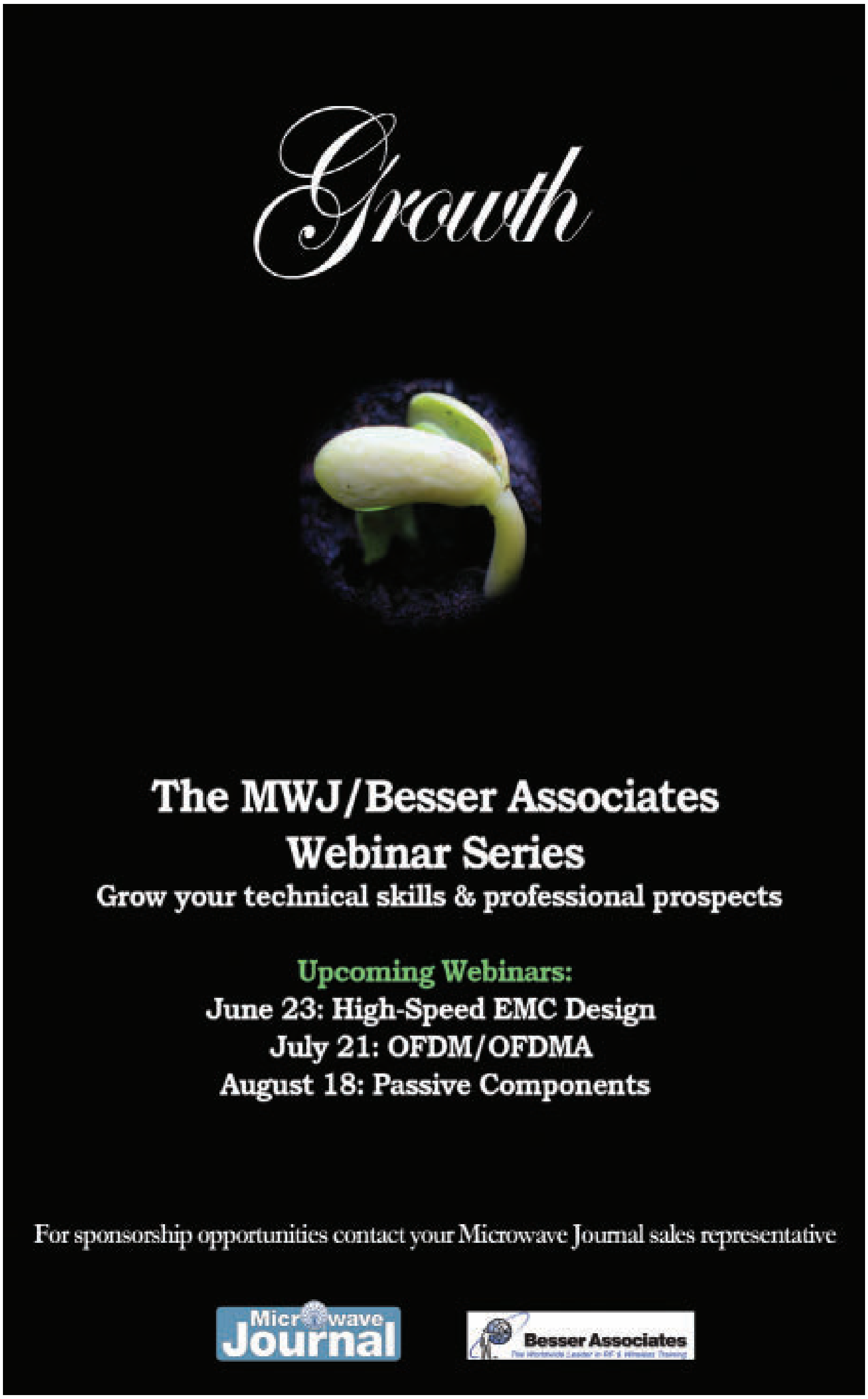
Subsystems and Systems

Rental Offer

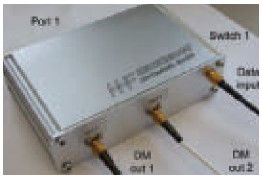
VENDORVIEW

AR has introduced a new rental plan with great

low rates and an incredible buyout to make it easy to get the AR equipment you need now. With a three-month minimum rental, credit towards a buyout will accumulate at 90 percent of each rental payment—up to 95 percent of the list price. For full details on AR's rental program, please visit the company's website at www.ar-worldwide.com.
AR RF/Microwave Instrumentation, Souderton, PA (215) 723-8181, www.ar-worldwide.com.
RS No. 254



2.45 GHz Radio Modem



The MiniTrans 2401 is an OEM 2.45 GHz radio modem for data rates up to 25 Mbit/s for point to point data transfer with digital input and digital output. Spread spectrum transmission is possible with the integrated noise generator (~10 MHz) or an external signal source, leading to a secure, rugged and tap-proof link. It is also suitable for UWB applications.
Heuermann HF-Technik GmbH, Aachen, Germany +49 (0) 241 6009-52108, www.hhft.de.
RS No. 216

SSPA and Transmitter Systems

VENDORVIEW

MITEQ introduces new medium power X-band rack-mount solid-state power amplifier (SSPA) and transmitter systems. The new PA-R Model series is an SSPA rack-mounted system designed using a modular approach to provide flexible solutions to meet a variety of applications. This approach allows for simple redundant configurations, as well as higher-power phase combined configurations. These SSPA systems provide for over-temperature, over-current and high output VSWR safety protection.
MITEQ Inc., Hauppauge, NY (631) 436-7400, www.miteq.com.
RS No. 245

Tactical Transceivers

Achieving cosite interference protection in environments of multiple VHF/UHF tactical transceivers is now a reality through Pole/Zero's introduction of the Mega-Pole high power (50 W) electronically tunable filter product line. When placed between the antenna and transceiver, the Mega-Pole yields excellent selectivity with minimal insertion loss, even in frequency hopping modes of operation.
Pole/Zero Corp., West Chester, OH (513) 870-9060, www.polezero.com.
RS No. 246

FLEX TEST™ CABLES

DC to 18 GHz from $68.95 ea. (qty.1-9) IN STOCK

Strength, ruggedness, and reliability…*supercharged!* That's what you get when you choose Mini-Circuits ultra-flexible precision test cables. Engineered to be a workhorse for your day-to-day test operations, these triple shielded cable assemblies are qualified to at least 20,000 bends, employ an advanced strain relief system, and are equipped with passivated stainless steel connectors, *so you can rely on them to* ***flex, connect and disconnect over and over and over again!*** They're so rugged, each test cable is backed by our 6 month guarantee*! With low insertion loss and very good return loss, you can also rely on getting good performance over the wide DC-18 GHz band. Visit our website to choose and view comprehensive performance curves, data sheets, and environmental specifications.

Mini-Circuits…we're redefining what VALUE is all about!

New! ***Tough Armored Cables*** *are steel triple shielded and qualified to at least 25,000 bends. They're so rugged they can even pass a crush test of a 600lb. nitrogen tank over the cable 1000 times, without any change in electrical performance.*

RoHS compliant

Frequency Range: DC-18 GHz, Impedance: 50 ohms

Models	Connector Type	Length (Ft.)	Inser. Loss (dB) Midband Typ.	Return Loss (dB) Midband Typ.	Price $ ea. Qty.(1-9)
FLEX TEST CABLES		Male to Male			
CBL-1.5FT-SMSM+	SMA	1.5	0.7	27	68.95
CBL-2FT-SMSM+	SMA	2	1.1	27	69.95
CBL-3FT-SMSM+	SMA	3	1.5	27	72.95
CBL-4FT-SMSM+	SMA	4	1.6	27	75.95
CBL-5FT-SMSM+	SMA	5	2.5	27	77.95
CBL-6FT-SMSM+	SMA	6	3.0	27	79.95
CBL-10FT-SMSM+	SMA	10	4.8	27	87.95
CBL-12FT-SMSM+	SMA	12	5.9	27	91.95
CBL-15FT-SMSM+	SMA	15	7.3	27	100.95
CBL-25FT-SMSM+	SMA	25	11.7	27	139.95
CBL-2FT-SMNM+	SMA to N-Type	2	1.1	27	99.95
CBL-3FT-SMNM+	SMA to N-Type	3	1.5	27	104.95
CBL-4FT-SMNM+	SMA to N-Type	4	1.6	27	112.95
CBL-6FT-SMNM+	SMA to N-Type	6	3.0	27	114.95
CBL-15FT-SMNM+	SMA to N-Type	15	7.3	27	156.95
CBL-2FT-NMNM+	N-Type	2	1.1	27	102.95
CBL-3FT-NMNM+	N-Type	3	1.5	27	105.95
CBL-6FT-NMNM+	N-Type	6	3.0	27	112.95
CBL-10FT-NMNM+	N-Type	10	4.7	27	156.95
CBL-15FT-NMNM+	N-Type	15	7.3	27	164.95
CBL-20FT-NMNM+	N-Type	20	9.4	27	178.95
CBL-25FT-NMNM+	N-Type	25	11.7	27	199.95
		Female to Male			
CBL-3FT-SFSM+	SMA-F to SMA-M	3	1.5	27	93.95
CBL-2FT-SFNM+	SMA-F to N-M	2	1.1	27	119.95
CBL-3FT-SFNM+	SMA-F to N-M	3	1.5	27	124.95
CBL-6FT-SFNM+	SMA-F to N-M	6	3.0	27	146.95
ARMORED CABLES		Male to Male			
APC-6FT-NM-NM+	N-Type	6	3.0	27	181.95
APC-10FT-NM-NM+	N-Type	10	4.8	27	208.95
APC-15FT-NM-NM+	N-Type	15	7.3	27	243.95

Metric Sizes Available On Our Website

6 mo. GUARANTEE *Mini-Circuits will repair or replace your test cable at its option if the connector attachment fails within **six** months of shipment. This guarantee excludes cable or connector interface damage from misuse or abuse.

Mini-Circuits®
ISO 9001 ISO 14001 AS 9100 CERTIFIED

minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web

YONI2™ Patent Pending ***The Design Engineers Search Engine*** *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

IF/RF MICROWAVE COMPONENTS

403 Rev L

Synthesizers

SMT Frequency Synthesizer

The CLX-500 phase-locked oscillator operates fixed at 500 MHz in surveillance radar applications. The CLX maximizes system performance with excellent phase noise (<-140 dBc/Hz at 1 kHz), +7 dBm output power and supply of +5 V DC at 120 mA, typical. The CLX Series is available in a surface-mount package, 0.75" × 0.75" × 0.25". CLX units are available in custom frequencies from 200 to 4000 MHz and are ideal for commercial and military systems requiring a fixed-frequency and exceptional performance.

EM Research Inc.,
Reno, NV (775) 345-2411,
www.emresearch.com.

RS No. 247

Miniature Frequency Synthesizer

The SLSM5 is a new family of frequency synthesizers that operates to 12.5 GHz and covers up to octave bandwidths. This synthesizer features excellent phase noise (-95 dBc/Hz at 10 kHz at X-band) and excellent spurious performance (-60 dBc min). With 1 kHz steps and frequency controlled via convenient RS485 interface this synthesizer is a system friendly component. The SLSM5 operates on an external 10 MHz input or an internal TCXO. Only a single +5 V supply is needed to power this miniature (2.5" × 2.5" × 0.6") unit. This high performance source is suitable for applications in communications, radar and instrumentation. In its class, this is an exciting new product with many advanced features at a low cost.

Luff Research,
Floral Park, NY (516) 358-2880,
www.luffresearch.com.

RS No. 248

Tunable Narrow Bandwidth Synthesizers

VENDORVIEW

For applications requiring tunable bandwidths of center frequency ±10 percent (or less), Mini-Circuits' custom narrowband frequency synthesizers can be specified to 6010 MHz with low phase noise, low harmonics, and spurious levels of -85 dBc or better. Available with customer-specified step sizes, these high performance synthesizers are housed in compact surface-mount or connectorized packages. Typical settling times of 30 ms or less and harmonics of -20 dBc or better.

Mini-Circuits,
Brooklyn, NY (718) 934-4500,
www.minicircuits.com.

RS No. 249

Ultra-low Noise Synthesizer

PTS introduces the fast-switching ultra-low noise LN310 synthesizer, an upgrade to the current PTS 310 product line. The synthesizer covers the 1-310 band with 0.1 Hz resolution and < 5 μs frequency switching

Get Info – all by yourself!

Visit the InfoZone to follow-up on the ad or editorial item that caught your eye.
Request information by company or product category.

The MWJ InfoZone
Product Information System

mwjournal.com/info

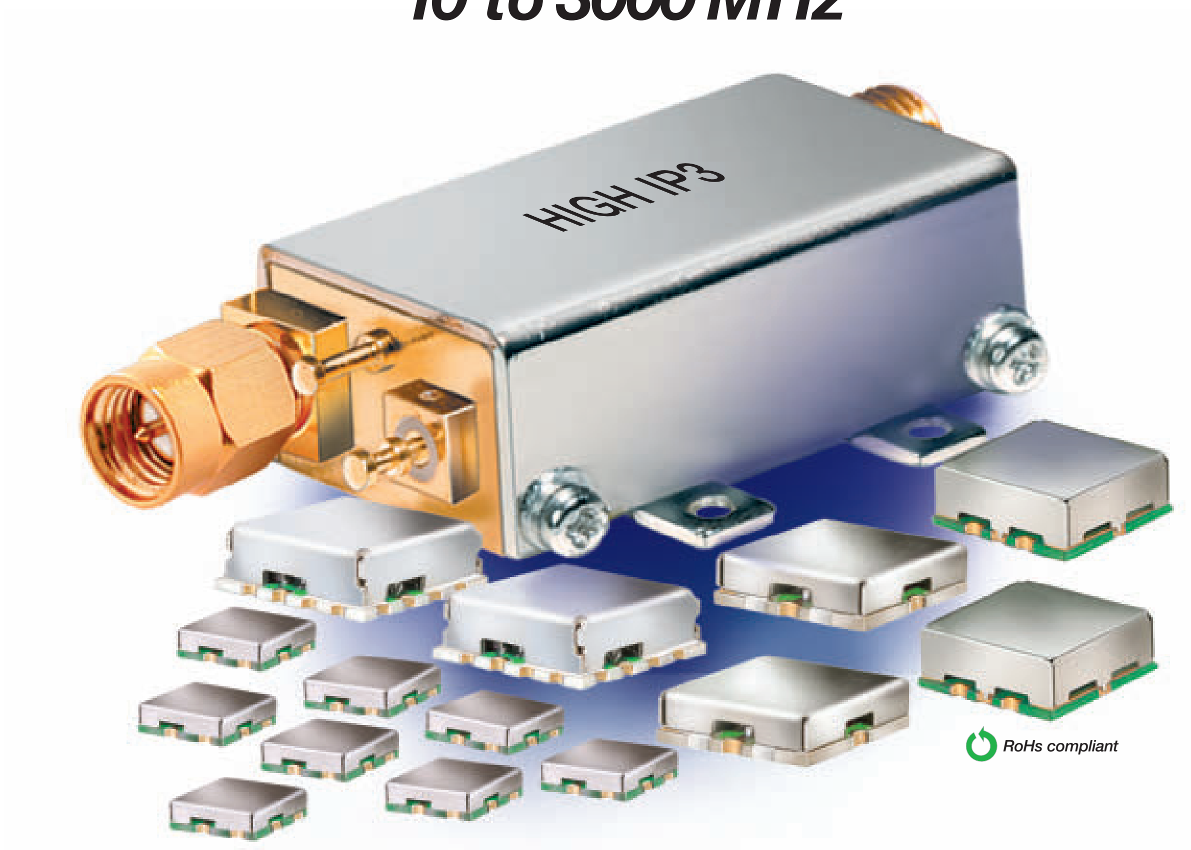
Microwave Journal

Easy. Fast. Free.
For the do-it-yourselfer.

Constant Impedance

VVAs

10 to 3000 MHz



from $3.95 ea. qty. 10-49

Voltage Variable Attenuators (VVAs) deliver as high as 40 dB attenuation control over the 10 MHz through 3.0 GHz range. Offered in both 50 and 75 Ω models these surface-mount and coaxial low-cost VVAs require no external components and maintain a good impedance match over the entire frequency and attenuation range, typically 20 dB return loss at input and output ports. These high performance units offer insertion loss as low as 1.5 dB, typical IP3 performance as high as +56 dBm, and minimal phase variation low as 7°.

Mini-Circuits VVAs are enclosed in shielded surface-mount cases as small as 0.3" x 0.3" x 0.1". Coaxial models are available with unibody case with SMA connectors. Applications include automatic-level-control (ALC) circuits, gain and power level control, and leveling in feedforward amplifiers. Visit the Mini-Circuits website at www.minicircuits.com for comprehensive performance data, circuit layouts, environmental specifications and real-time price and availability.

Mini-Circuits...we're redefining what VALUE is all about!

Mini-Circuits®
ISO 9001 ISO 14001 CERTIFIED

ALL NEW minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending *The Design Engineers Search Engine* Provides ACTUAL Data Instantly From MINI-CIRCUITS At: ***www.minicircuits.com***

IF/RF MICROWAVE COMPONENTS

449 rev org

New Modco MCR Series Ceramic Resonator VCO

These Voltage Controlled Oscillators offer exceptionally low Phase Noise in the industry Standard one half inch square package. Model MCR1270-1290MC with an Input Voltage of +5.0V, Tuning Voltage of 0.5V to 4.5V and a Frequency Range of 1270-1290MHz is rated -122dBc @ 10khz offset. Many other catalog models are available and custom designs can be supplied with no NRE

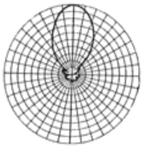
www.modcoinc.com

RS 80

RS 101

Applied Radar, Inc.
www.appliedradar.com

Introducing Our New
Antenna Characterization Service



2-18 GHz
Quick Turnaround

For more info email
antennameasurement@appliedradar.com

RS 14

RS 46

speed. Specifications include <-80 dBc discrete spurious, -152 dBc/Hz (100 kHz offset) phase noise at 100 MHz output. Priced at $3,990 with BCD interface, available Q2; with GPIB/USB/LAN interfaces available Q3. Compatible with numerous other PTS options.
Programmed Test Sources Inc., Littleton, MA (978) 486-3400, www.programmedtest.com.

RS No. 250

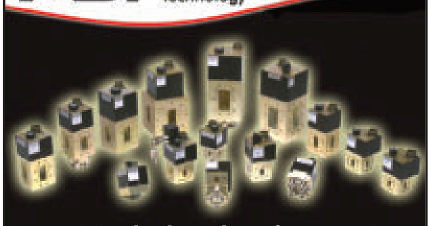
Test Equipment

Multifunction RF Tester

The 2801 Multilock is a small, lightweight communication tester providing multiple test capabilities in a single instrument, which can be configured for a wide range of laboratory and field applications. The tester features an extra-large and bright display for operation in sunlight and has options for battery operation, remote control, cable fault finding, etc. It is designed to support service shops repairing radio terminals and other RF equipment, up to 3 GHz. It is future-proof as it supports digital and conventional two-way radio systems.
Willtek Communications GmbH, Ismaning, Germany +49 (0) 99641 200, www.willtek.com.

RS No. 253

AST Advanced Switch Technology



Come join the long list of companies switching to AST

AST's quality & lightning fast delivery cannot be beat & has become the gold standard in the industry

754 Fortune Cr, Kingston, ON, K7P 2T3, Canada
Tel: 613 384 3939 Fax: 613 384 5026
e-mail: info@astswitch.com
www.astswitch.com

RS 2

PUSH-ON SMA & N Adapters

K Adapters

Custom Connectors

Test Cable Assemblies

RF TEC
Since 1993

www.rftec.com

RS 93

ULTRA LOW PHASE NOISE VCO

Modco MD Series VCOs offer very low Phase Noise in a half inch package. Models are low cost and available for a variety of Frequency Bands. No NRE for custom designs.

Model MD108MST
902–928 MHz
Vcc: 5 V
Vt: 0.5 to 4.5 V
Current: 16 ma
Power: +4 dBm
2nd Harmonics: –45 dBc
Pushing: 0.4 MHz/V
Pulling: 0.6 MHz with a 12 dB return loss
Phase Noise: –117 dBc @10 KHz

Modco, Inc.
Sparks, NV (775) 331-2442
www.modcoinc.com

RS 81

NEW

CERAMIC HERMETICALLY-SEALED RF SWITCHES

HIGH ISOLATION... 0.3 MHz to 6 GHz from $4.95 ea. (Qty. 10-49)

On land, sea, and in the air, demanding critical applications call for a switch that is a cut above the rest. Mini-Circuits rugged CSWA2-63DR+ ceramic RF/microwave SPDT switch is that switch. From 0.5 to 6 GHz this switch operates in the absorptive mode (good output VSWR in off state). From 0.3 MHz to 500 MHz in the non absorptive mode (Output ports reflective in off state). The CSWA2-63DR+ at only 4 x 4 x 1.2 mm handles tight spaces; provide protection against high moisture environments, and offers outstanding performance. For tough RF/microwave switch requirements in commercial, industrial, or military applications, think Mini-Circuits' new ceramic switch. Visit our website to view comprehensive performance data, performance curves, data sheets, pcb layout, and environmental specifications. And, you can even order direct from our web store and have it in your hands as early as tomorrow!

Mini-Circuits...we're redefining what VALUE is all about!

CSWA2-63DR+ In Stock

- *Very High Isolation: 63 dB @ 1 GHz to 44 dB @ 6 GHz*
- *Low Insertion Loss: 1.2 dB*
- *High IP3: +45 dBm*
- *Integral CMOS Driver*
- *Supply current of only 18 micro amps*
- *23 ns typical rise/fall time*
- *Operating temperature -55° to +125°C*

4 mm Square Package

RoHs compliant

ALL NEW minicircuits.com

Mini-Circuits®

ISO 9001 ISO 14001 CERTIFIED

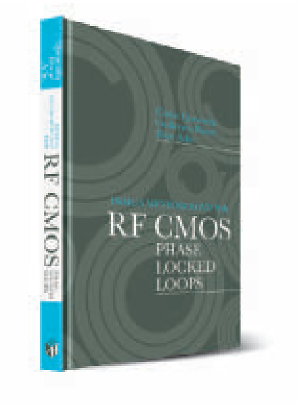
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending ***The Design Engineers Search Engine** Provides ACTUAL Data Instantly From MINI-CIRCUITS At: **www.minicircuits.com***

IF/RF MICROWAVE COMPONENTS

434 Rev B

Visit http://mwj.hotims.com/23286-73 or use RS# 73 at www.mwjournal.com/info



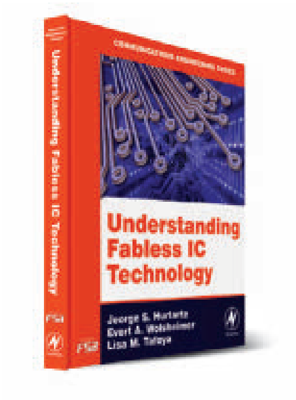
Design Methodology for RF CMOS Phase Locked Loops

Carlos Quemada, Guillermo Bistué and Iñigo Adin

Blast through phase-locked loop challenges fast with this practical book guiding you every step of the way from specs definition to layout generation. You get a proven PLL design and optimization methodology that lets you systematically assess design alternatives, predict PLL behavior, and develop complete PLLs for CMOS applications that meet performance requirements no matter what IC challenges you come up against. After a review of PLL essentials, this comprehensive workbench guide takes you step-by-step through operation principles, design procedures, phase noise analysis, layout considerations and CMOS realizations for each PLL building block.

To order this book, contact:

Artech House · 685 Canton St. · Norwood, MA 02062 · (781) 769-9750 ext. 4030; or
16 Sussex St. · London SW1V 4RW, UK · +44 (0) 207-8750
238 pages; $117, £63 · ISBN: 978-1-59693-383-5



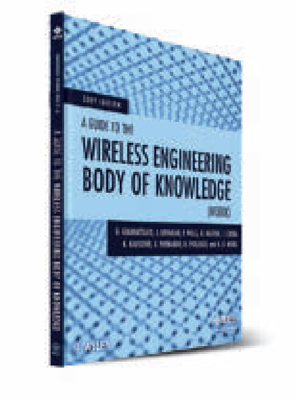
Understanding Fabless IC Technology

Jeorge S. Hurtarte, Evert A. Wolsheimer and Lise M. Tafoya

Fabless IC techniques are growing rapidly and promise to become the standard method of IC manufacturing in the near future. This book will provide readers with what will be important knowledge on the subject. Other books on IC fabrication deal with the strictly physical process aspects of the topic and assume all factors in IC fabrication are under the control of the IC designing company. By contrast, this title recognizes that fabless IC design is often as much about managing business relationships as it is about physical processes.

To order this book, contact:

Elsevier · 11830 Westline Industrial Drive · St. Louis, MO 63146 · (800) 545-2522
296 pages; $73.95 · ISBN: 978-0-7506-7944-2



A Guide to the Wireless Engineering Body of Knowledge (WEBOK)

G. Giannattasio, J. Erfanian, P. Wills, H. Nguyen, T. Croda, K. Rauscher, X. Fernando, N. Pavlidou and K.D. Wong

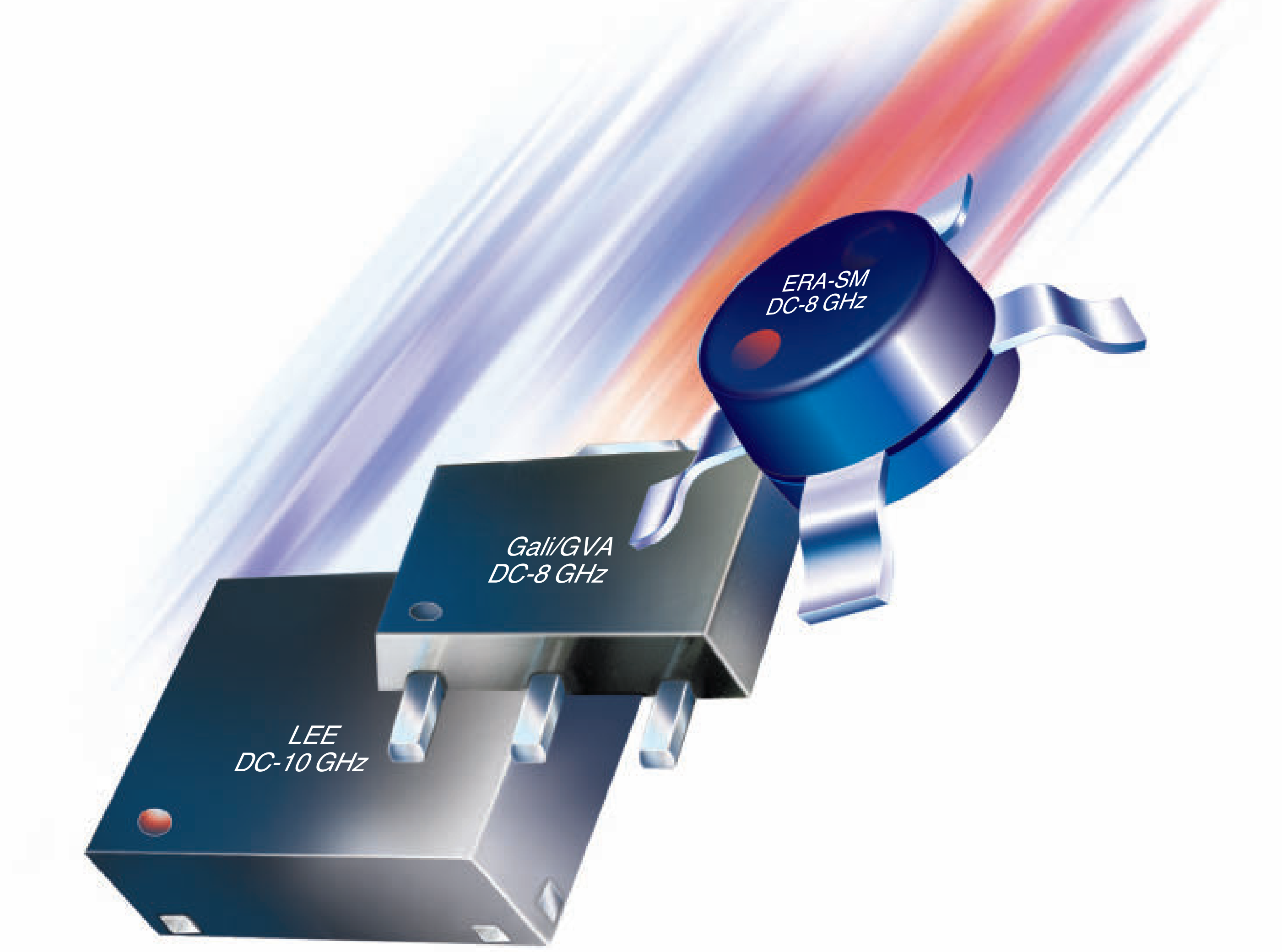
Responding to requests from industry for a program to ensure consistency and excellence among wireless technical professionals, the IEEE Communications Society (ComSoc) created its Wireless Communication Engineering Technologies (WCET) Certification. ComSoc is holding the WCET testing twice a year at locations worldwide. The WEBOK is organized according to the areas of expertise in the WCET Delineation, namely RF Engineering; Propagation & Antennas; Wireless Access Technologies; Network & Service Architecture; Network Management & Security; Facilities Infrastructure; Agreements, Standards, Policies & Regulations; and Fundamental Knowledge. Included in the WEBOK is a list of additional publications and documents that candidates should review to become completely prepared for the WCET exam.

To order this book, contact:

John Wiley & Sons Inc. · 111 River Street · Hoboken, NJ 07030 · (201) 748-6395
250 pages; $69.95 · ISBN: 978-0-470-43366-9

MMIC AMPLIFIERS

DC-10 GHz as low as 99¢ ea. (qty. 30)



Gain up to 26 dB, Output power up to 21 dBm, High IP3 up to 38 dBm

MMIC amplifiers with just the right performance and size to fit your design, Mini-Circuits skinny Sigma LEE, Gali, ERA-SM and our new fixed voltage GVA. All MMIC's are transient protected against DC current surges and are available in a variety of over 50 models. These affordable compact amplifiers have low thermal resistance for high reliability. Available in three packages;

Leadless 3x3 mm Low Profile package
SOT-89 for superior grounding and heat dissipation
Plastic Micro-X with surface mount leads, for easy configuration and assembly.

Complete performance specs, data and a wide selection of Amplifier Designer's Kits geared for your development needs are available on our web site.

All models protected under U.S. patent # 6,943,629.

Available as RoHS compliant.

Mini-Circuits®

ISO 9001 ISO 14001 AS 9100 CERTIFIED

minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending

The Design Engineers Search Engine *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

IF/RF MICROWAVE COMPONENTS

376 Rev G

Visit http://mwj.hotims.com/23286-74 or use RS# 74 at www.mwjournal.com/info

Now: Shaping the Future of Microwave Engineering Jobs, Shaping the Future Economy

The RF/microwave engineering community is relatively safe these days. Demand for skilled RF engineers far exceeds the supply and people's jobs are safe... for now.

Looking at the big picture, it is inevitable to realize that the short supply of microwave engineers endangers the existence of those vacant positions and also of those currently staffed. RF engineering and other science jobs can disappear in an offshoring process, as has occurred with production, service and software jobs. Those fields allow cheap labor, R&D and science centers to migrate to wherever technology talent is available. Every microwave engineer job not filled in this country will eventually be filled somewhere else. Every lost engineering job takes away from demand for other positions as well. Unlike the past millennium, the United States is not self-sufficient anymore. It pays hard cash for foreign labor through import of products and services, which it cannot produce domestically. When science and research centers migrate offshore as well, this country will have nothing to base its economy on.

Microwave engineering is core technology and is already essential infrastructure in many industry sectors (communications, defense, medical, automotive, transportation, retail, etc.). We are now in the midst of a race for next generation technologies laying microwave infrastructure in all those markets and more. Extensive R&D efforts occurring now across the globe are also drawing a new map of global technology powers.

Losing technology leadership in the international arena will result in a long-term impact on the country's economy and hence security and stability.

The goal is to ensure the availability of science and engineering resources needed to sustain leadership in technology and innovation. Microwave engineering is our agenda. The same approach should be adopted in other science and technology sectors in order to protect all strategic technology and education assets while we still have them.

Isaac Mendelson
ElectroMagneticCareers.com
Isaac@ElectroMagneticCareers.com

RF/Microwave Candidate Pool

The shameful state of the RF/microwave candidate pool has again raised its ugly head. This reminds me of the recession from the early 1970s when we had very few universities, colleges and trade schools turning out graduates with skills in the electromagnetic field.

Our industry suffers when corporations are not supporting the educational systems to ensure a healthy crop of new technologists every year.

Now that we are in a recession, we still have thousands of career opportunities that we have no candidates to apply. The result is that contracts are late on delivery and our future through innovation is stalled.

It is up to industry and the educational system to keep the RF/microwave industry strong; they have to work together to support studies in this sector.

In the '70s, corporations like Raytheon, M/A-COM and many others supported several universities to develop microwave/RF studies. That solved the problem for a few years, but now we are back to square one.

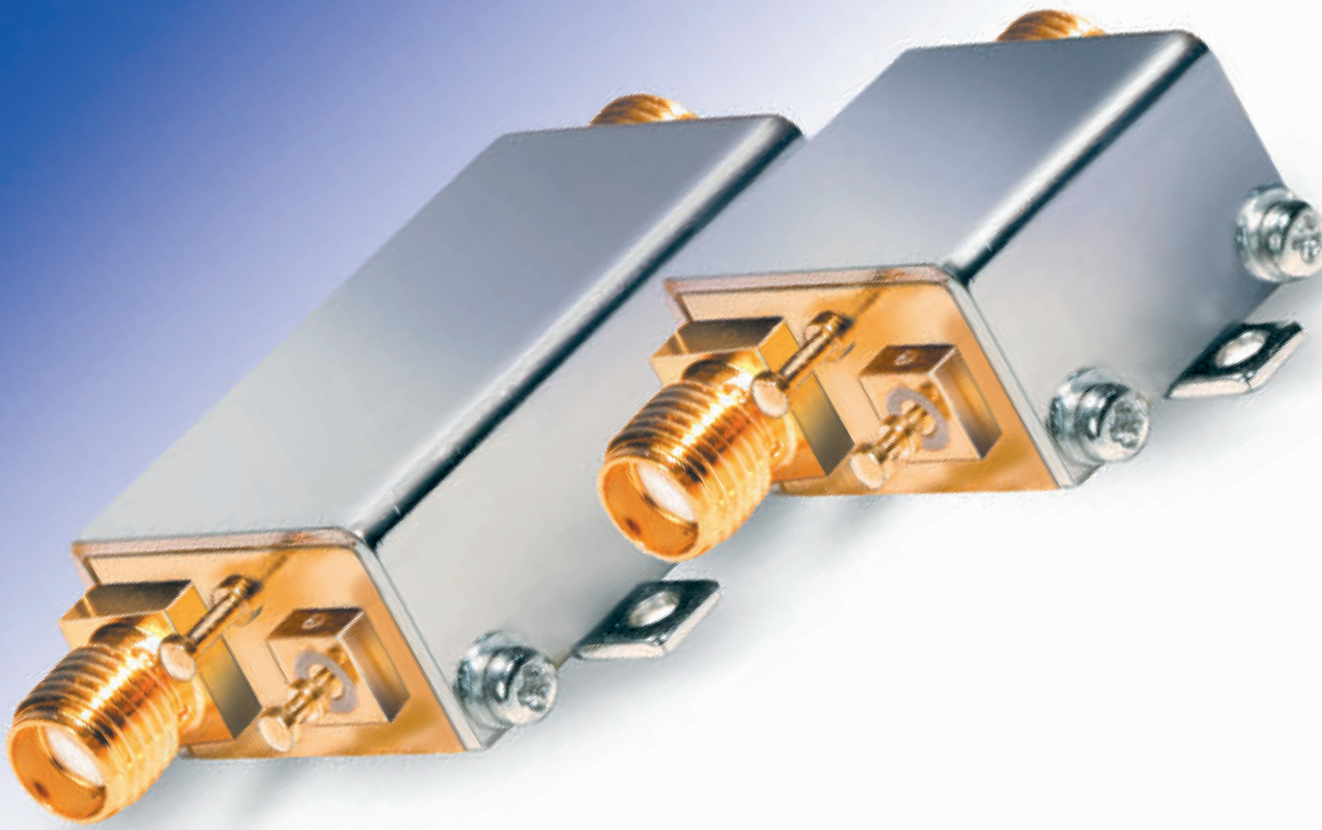
If you are working with a company in this sector speak with your management and speak with your university, college, or trade school to promote education in the RF/microwave field.

I've seen similar times of shortage in engineering power and there is much to learn from what was done then.

Dave Germond
Founder, Cleared Executive Search
dave@clearedsearch.com
(813) 425-3100

300 kHz to 14 GHz

AMPLIFIERS



ZX SERIES

from $49.95 ea. qty. 1-9 IN STOCK

Mini-Circuits ZX60 family of compact coaxial amplifiers serve a broad range of applications from 300 kHz to 14 GHz. ZX60 models offer many combinations of gain (as high as 38 dB), noise figure, output power, and linearity (IP3 performance) over wide bandwidths, allowing designers, for example, to optimize system dynamic range through a wide choice of noise-figure performance levels (as low as 0.4 dB at 1.4 GHz) and high IP3 performance (as high as +45 dBm at 2.4 GHz). ZX60 amplifiers are small in size and low in cost, and still deliver excellent active directivity (isolation-gain) and outstanding unit-to-unit performance repeatability. All models feature Mini-Circuits exclusive Unibody housing (protected by US Patent No. 6,790,049) for reliability. And when these ready-to-ship standard models won't do, Mini-Circuits technical team is ready to quickly meet your most demanding requirements with effective custom solutions.

Mini-Circuits...we're redefining what VALUE is all about!

Model	Freq. (GHz)	Gain (dB) Typ.	NF (dB) Typ.	IP3 (dBm) Typ.	P_{out} @ 1dB Comp. (dBm) Typ.	DC Volts (V)	Current (mA) Max.	Price $ ea. (1-9)
Length: 0.74" x (W) 1.18" x (H) 0.46"								
ZX60-2510M	0.5-2.5	12.9	5.4	+28.8	17.1	5.0	95	59.95
ZX60-2514M	0.5-2.5	16.4	4.8	+30.3	16.5	5.0	90	59.95
ZX60-2522M	0.5-2.5	23.5	3.0	+30.6	18.0	5.0	95	59.95
ZX60-3011	0.4-3.0	12.5	1.7	+31.0	21.0	12.0	120	139.95
ZX60-3018G	0.02-3.0	20.0	2.7	+25.0	11.8	12.0	45	49.95
ZX60-4016E	0.02-4.0	18.0	3.9	+30.0	16.5	12.0	75	49.95
ZX60-5916M	1.5-5.9	17.0	6.4	+28.3	14.4	5.0	96	59.95
ZX60-6013E	0.02-6.0	14.0	3.3	+28.7	10.3	12.0	50	49.95
ZX60-8008E	0.02-8.0	9.0	4.1	+24.0	9.3	12.0	50	49.95
ZX60-14012L	0.0003-14.0	12.0	5.5	+20.0	11.0	12.0	68	172.95
ZX60-33LN	0.05-3.0	17.6	1.1	+30.0	17.5	5.0	80	79.95
Length: 1.20" x (W) 1.18" x (H) 0.46"								
ZX60-1215LN	0.8-1.4	15.5	0.4	+27.5	12.5	12.0	50	149.95
ZX60-1614LN	1.217-1.620	14.0	0.5	+30.0	13.5	12.0	50	149.95
ZX60-2411BM	0.8-2.4	11.5	3.5	45.0	24.0	5.0	360	119.95
ZX60-2531M	0.5-2.5	35.0	3.5	+26.1	16.1	5.0	130	64.95
ZX60-2534M	0.5-2.5	38.0	3.1	+30.0	17.2	5.0	185	64.95
ZX60-3800LN	3.3-3.8	23.0	0.9	+36.0	18.0	5.0	110	119.95

U.S.Patent # 6,790,049

Mini-Circuits®
ISO 9001 ISO 14001 CERTIFIED

ALL NEW minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending *The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com*

IF/RF MICROWAVE COMPONENTS

411 Rev D

Visit http://mwj.hotims.com/23286-75 or use RS# 75 at www.mwjournal.com/info

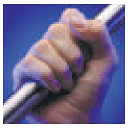
Advertising Index

RS No.	Advertiser	Page No.	Phone	Fax	Web Address
1	Advanced Control Components Inc.	89	732-460-0212	732-460-0214	http://mwj.hotims.com/23286-1
2	Advanced Switch Technology	144	613-384-3939	613-384-5026	http://mwj.hotims.com/23286-2
3	Aeroflex	35	614-888-2700		http://mwj.hotims.com/23286-3
4	Aeroflex / KDI-Integrated Products	121	973-887-5700	973-884-0445	http://mwj.hotims.com/23286-4
5	Aeroflex / Metelics, Inc.	109	888-641-7364	408-733-7645	http://mwj.hotims.com/23286-5
6	Aeroflex / Weinschel, Inc.	61	800-638-2048	301-846-9116	http://mwj.hotims.com/23286-6
7	Aeroflex Plainview	85	800-645-8862		http://mwj.hotims.com/23286-7
8	Agilent Technologies, Inc.	55	800-829-4444	415-857-5518	http://mwj.hotims.com/23286-8
9	AML Communications Inc.	41	805-388-1345	805-484-2191	http://mwj.hotims.com/23286-9
10	Anaren Microwave	83	800-411-6596	315-432-9121	http://mwj.hotims.com/23286-10
11	Anatech Electronics, Inc.	84	973-772-4242	973-772-4646	http://mwj.hotims.com/23286-11
12	Ansoft Corporation	27	412-261-3200	412-471-9427	http://mwj.hotims.com/23286-12
13	Antenna Magus - Magus (Pty) Ltd	107	+27 21 880 1880	+27 21 880 1833	http://mwj.hotims.com/23286-13
14	Applied Radar, Inc.	144	401-295-0062	401-667-2912†	http://mwj.hotims.com/23286-14
15	AR Europe	39	215-723-8181		http://mwj.hotims.com/23286-15
15	AR Modular RF	39	215-723-8181		http://mwj.hotims.com/23286-15
15	AR Receiver Systems	39	215-723-8181		http://mwj.hotims.com/23286-15
15,16	AR RF/Microwave Instrumentation	39,117	215-723-8181		http://mwj.hotims.com/23286-15
17,18	Artech House	106,138	800-225-9977	781-769-6334	http://mwj.hotims.com/23286-17
19	AWR	13	310-726-3000		http://mwj.hotims.com/23286-19
20	Bonding Source	81	603-595-9600		http://mwj.hotims.com/23286-20
21	Boonton Electronics (a Wireless Telecom Group Company)	33	973-386-9696	973-386-9191	http://mwj.hotims.com/23286-21
22	Ciao Wireless, Inc.	44	805-389-3224	805-389-3629	http://mwj.hotims.com/23286-22
23,24	Cobham Defense Electronic Systems	11,20-21	215-996-2000		http://mwj.hotims.com/23286-23
25	COMSOL, Inc.	95	781-273-3322	781-273-6603	http://mwj.hotims.com/23286-25
26	CPI Beverly Microwave Division	30	978-922-6000	978-922-2736	http://mwj.hotims.com/23286-26
27	CST of America, Inc.	25	508-665-4400	781-576-5702	http://mwj.hotims.com/23286-27
28,29	Ducommun Technologies	40,54	310-513-7214	310-513-7298	http://mwj.hotims.com/23286-28
30	Eastern Wireless TeleComm, Inc.	99	410-749-3800	410-749-4852	http://mwj.hotims.com/23286-30
31	Electro Magnetic Careers	148			http://mwj.hotims.com/23286-31
32	ET Industries	125	973-394-1719	973-394-1710	http://mwj.hotims.com/23286-32
33,34	EuMW 2009	126,127	+ 44 20 7596 8742	+ 44 20 7596 8749	http://mwj.hotims.com/23286-33
35	GGB Industries, Inc.	3	239-643-4400	239-643-4403	http://mwj.hotims.com/23286-35
36	HARTING North America	38	847-717-9316	847-717-9420	http://mwj.hotims.com/23286-36
37	Herotek, Inc.	70	408-941-8399	408-941-8388	http://mwj.hotims.com/23286-37
38,39,40,41,42	Hittite Microwave Corporation	76,77,78,79	978-250-3343	978-250-3373	http://mwj.hotims.com/23286-38
43	Huber + Suhner AG	91	+41 71 353 41 11	+41 71 353 44 44	http://mwj.hotims.com/23286-43
44	JQL Electronics Inc.	72	888-236-9828	630-823-2902	http://mwj.hotims.com/23286-44
45	K&L Microwave, Inc.	7	410-749-2424	443-260-2268	http://mwj.hotims.com/23286-45
46	KR Electronics, Inc.	144	732-636-1900	732-636-1982	http://mwj.hotims.com/23286-46
47	Linear Technology Corporation	15	800-454-6327		http://mwj.hotims.com/23286-47
48	Lorch Microwave	47	800-780-2169	410-860-1949	http://mwj.hotims.com/23286-48
49	LPKF Laser & Electronics	32	800-345-LPKF	503-682-7151	http://mwj.hotims.com/23286-49
50,51	M/A-COM Technology Solutions	18,19	800-366-2266		http://mwj.hotims.com/23286-50
52	Maury Microwave Corporation	9	909-987-4715	909-987-1112	http://mwj.hotims.com/23286-52
53	MECA Electronics, Inc.	COV 2	973-625-0661	973-625-9277	http://mwj.hotims.com/23286-53
54	Microsemi	59	541-382-8028		http://mwj.hotims.com/23286-54
	Microwave Journal	90,110,134,136,140,142	800-225-9977	781-769-5037	www.mwjournal.com
55	Mimix Broadband, Inc.	COV 3	281-988-4600	281-988-4615	http://mwj.hotims.com/23286-55
56,57,58,59, 60,61,62,63, 64,65,66,67, 68,69,70,71, 72,73,74,75,76	Mini-Circuits	4-5,16,51,52, 63,73,87,97, 105,111,119,129, 135,137,139,141, 143,145,147,149,151	718-934-4500	718-332-4661	http://mwj.hotims.com/23286-56
77,78,79	MITEQ Inc.	31,103,131	631-436-7400	631-436-7430	http://mwj.hotims.com/23286-77
80,81	Modco, Inc.	144	775-331-2442	775-331-6266	http://mwj.hotims.com/23286-80
82	Modular Components National, Inc.	115	410-879-6553	410-638-7356	http://mwj.hotims.com/23286-82
83,84	Narda Microwave-East, an L3 Communications Co.	8,36	631-231-1700	631-231-1711	http://mwj.hotims.com/23286-83
85	National Association of Tower Erectors	133	605-882-5865	605-886-5184	http://mwj.hotims.com/23286-85
86	OML Inc.	113	408-779-2698	408-778-0491	http://mwj.hotims.com/23286-86
87	Pascall Electronics Limited	50	+44(0) 1983 817300	+44(0) 1983 564708	http://mwj.hotims.com/23286-87
88,89	R&K Company Limited	116	+81-545-31-2600	+81-545-31-1600	http://mwj.hotims.com/23286-88
	Radar System Analysis, Design and Simulation	132	781-769-9750 x4030		www.ArtechHouse.com
90	Reactel, Incorporated	48	301-519-3660	301-519-2447	http://mwj.hotims.com/23286-90
91	Renaissance Electronics Corporation	88	978-772-7774	978-772-7775	http://mwj.hotims.com/23286-91
92	RF & Hyper	153	+33 (0) 1 44 31 82 57	+33 (0) 1 44 31 83 42	http://mwj.hotims.com/23286-92

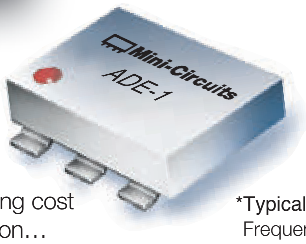
0.5 to 2000 MHz MIXERS

$1.69

(ea. qty. 1000)



Value Packed Recession Busters!



In today's tough economic times there is no choice, reducing cost while improving value is a must. Mini-Circuits has the solution… pay less and get more for your purchases with our patented frequency mixers ADE-1, ADE-2, and ADE-11X. Total solutions for high performance, reliability, and value…and they cost only $1.69 each (quantity 1000), with prices even lower at higher quantities!
Right from the start, we've embedded premium advantages into these level 7 mixers such as broad bandwidths, low conversion loss, excellent L-R isolation, and IP3 as high as +20 dBm. These units also feature our low profile surface mount package with open cover to allow high reliability water wash, tin plated leads for excellent solderability and RoHs compliance, and all-welded connections which reduce parasitic inductance and improve reliability. In fact, these units are so reliable that they are backed by our exclusive ***2 year guarantee***.

actual size

Mini-Circuits…we're redefining what VALUE is all about!

*Typical Specifications:	ADE-1	ADE-2	ADE-11X
Frequency LO/RF (MHz)	0.5-500	5-1000	10-2000
Frequency LO/IF (MHz)	DC-500	DC-1000	5-1000
LO Level (dBm)	7	7	7
IP3 (dBm)	15	20	9
Conv. Loss (dB)	5.0	6.67	7.1
L-R Isolation (dB)	55	47	36
L-I Isolation (dB)	40	45	37
Dimensions: L.310"xW.220"xH	.162"	.112"	.112"

*Specified midband unless otherwise noted.

Price $ea. (Qty. 25)	*2.49*	*2.49*	*2.49*

Protected by U.S. patent 6133525.

RoHS compliant

Mini-Circuits®
ISO 9001 ISO 14001 AS 9100 CERTIFIED

minicircuits.com

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For detailed performance specs & shopping online see Mini-Circuits web site

YONI2™ Patent Pending ***The Design Engineers Search Engine*** *Provides ACTUAL Data Instantly From MINI-CIRCUITS At:* ***www.minicircuits.com***

IF/RF MICROWAVE COMPONENTS

348 Rev B

Visit http://mwj.hotims.com/23286-76 or use RS# 76 at www.mwjournal.com/info

Advertising Index

***Visit* Microwave Journal *on the Web at* www.mwjournal.com**

Visit mwjournal.com/info and enter RS# to request information from our advertisers

Microwave Journal

July 2009 Issue

How Design Software Changed the World

Modified Dual-mode Filter

Dual-band Planar Dipole Antenna

Sales Representatives

microwave journal

Carl Sheffres, Publisher

Ed Kiessling, Traffic Manager

Eastern and Central Time Zones
Chuck Boyd
Northeast Reg. Sales Mgr.
(New England, Upstate NY, Eastern Canada)
685 Canton Street
Norwood, MA 02062
Tel: (781) 769-9750
FAX: (781) 769-5037
cboyd@mwjournal.com

Michael Hallman
Eastern Reg. Sales Mgr.
(Mid-Atlantic, Southeast, Midwest)
4 Valley View Court
Middletown, MD 21769
Tel: (301) 371-8830
FAX: (301) 371-8832
mhallman@mwjournal.com

Pacific and Mountain Time Zones
Wynn Cook
Western Reg. Sales Mgr.
PO Box 23200
San Jose, CA 95153
Tel: (408) 224-9060
FAX: (408) 224-6106
wcook@mwjournal.com

International Sales
Richard Vaughan
International Sales Manager
16 Sussex Street
London SW1V 4RW, England
Tel: +44 207 596 8742
FAX: +44 207 596 8749
rvaughan@horizonhouse.co.uk

Germany, Austria, and Switzerland (German-speaking)
Brigitte Beranek
Wissling Marketing Services
Riedstrasse 5
72813 St. Johann-Wuertingen
Germany
Tel: +49 7122 828140
FAX: +49 7122 828145
bberanek@horizonhouse.com

Israel
Oreet Ben Yaacov
Oreet International Media
15 Kineret Street
51201 Bene-Berak, Israel
Tel: +972 3 570 6527
FAX: +972 3 570 6526
obenyaacov@horizonhouse.com

Korea
Young-Seoh Chinn
JES Media International
2nd Floor, ANA Bldg.
257-1, Myungil-Dong
Kangdong-Gu
Seoul, 134-070 Korea
Tel: +82 2 481-3411
FAX: +82 2 481-3414
yschinn@horizonhouse.com

Japan
Katsuhiro Ishii
Ace Media Service Inc.
12-6, 4-Chome,
Nishiiko, Adachi-Ku
Tokyo 121-0824, Japan
Tel: +81 3 5691 3335
FAX: +81 3 5691 3336
amskatsu@dream.com

China
Michael Tsui
ACT International
Tel: 86-755-25988571
Tel: 86-21-62511200
FAX: 86-10-58607751
michaelT@actintl.com.hk

Hong Kong
Mark Mak
ACT International
Tel: 852-28386298
markm@actintl.com.hk

RF&HYPER EUROPE

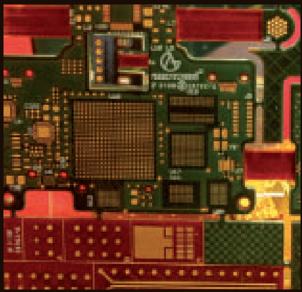
October 6, 7 and 8, 2009
PARIS-NORD VILLEPINTE
FRANCE - HALLS 1 & 2

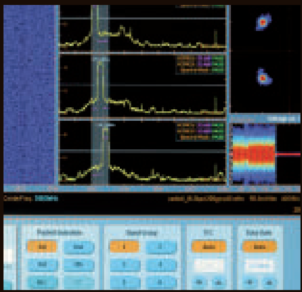
The Trade show dedicated to **Radiofrequencies**, **Microwaves**, **Wireless**, **Optical Fibres** and their **Applications**

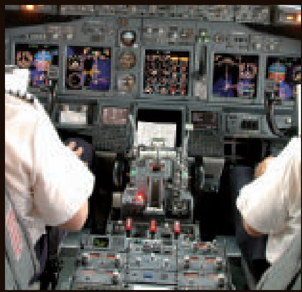
Optimize your time!
Find innovative solutions to achieve your projects

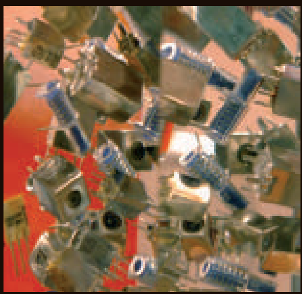
Same place, same dates

- FORUM DE L'ÉLECTRONIQUE
- FORUM RADIOCOMS
- MESUREXPO
- OPTO
- VISION-SHOW
- ESPACE LASER PARIS









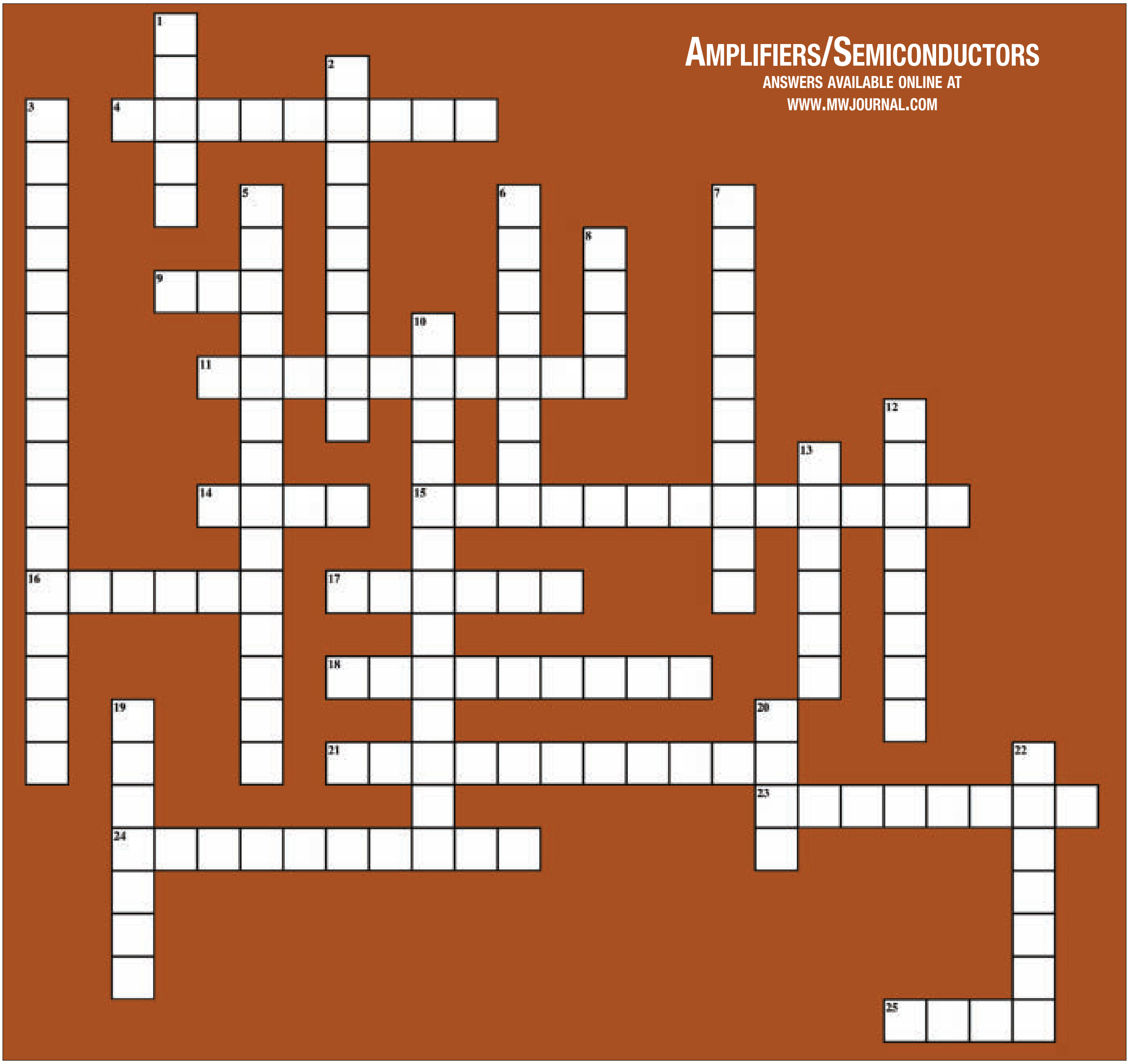
GL events

FREE BADGE
www.forum4S.com

RF&HYPER EUROPE
VISITOR

Password: PUB

Visit http://mwj.hotims.com/23286-92 or use RS# 92 at www.mwjournal.com/info



ACROSS

4 The vector ratio of voltage to current, the reciprocal of admittance

9 Wideband gap III-V material used to produce broadband, high power amplifiers

11 Undesired changes in a waveform that result in spurious content of the signal

14 A device or impedance that terminates the output of a device

15 Loss of signal resulting from the insertion of a device in a transmission line (2 words)

16 Material typically used to produce high frequency, broadband PIN diodes

17 PA return loss under actual output drive levels (2 words)

18 Energy at integral multiples of the frequency of the fundamental signal

21 The ratio of the input signal to noise ratio to the output signal to noise ratio for a circuit or system (2 words)

23 The process of varying the impedance seen by the output of an active device to other than 50 ohms in order to measure performance parameters (2 words)

24 Measure of how much of the input power is usefully applied to the amplifier's output

25 The amount of power at which the amplitude of the output of a device or circuit is reduced by 1 dB from the expected small-signal gain

DOWN

1 Laterally diffused metal oxide semiconductor

2 Range of frequencies for which the amplifier gives "satisfactory performance"

3 The amount of electrical power converted to heat by a device (2 words)

5 The state of operation in which there is no interruption of the presence of a signal (2 words)

6 Undesired signals present at the output of a device under test that are neither harmonics nor intermodulation products

7 At a given point in a transmission system, the difference between the incident and reflected power (2 words)

8 The ratio between the amplitude of the output signal of a device or circuit compared to the amplitude of the input signal

10 Technique used to improve the linearity of amplifiers

12 The degree to which the impedance of a component differs from the transmission line or component to which it is connected

13 Amplifier class where the output filter blocks all harmonics to achieve very high efficiencies (2 words)

19 Amplifier configuration where the carrier amplifier is biased to operate in Class AB mode and the peaking amplifier is biased to operate in Class C mode to achieve higher efficiency

20 Metal Electrode Leadless Face package used for PIN diodes

22 Amplifier class widely used in SSB linear amplifier applications where low-distortion and high power-efficiency tend to both be very important (2 words)

CELEBRATING 2009: THE YEAR OF MMIX

2009 translates in Roman numerals to "MMIX." It only happens once, so Mimix Broadband is celebrating by declaring 2009... **the Year of MMIX**. During the year, we'll highlight key advances in our product portfolio, as well as pay tribute to other engineering feats – specifically the Seven Wonders of the Modern World as chosen by the American Society of Civil Engineers.

Toronto's CN Tower is a communications and tourist tower standing 553.33 meters (1,815.39 feet) tall. It is the tallest freestanding structure in the Americas and, amazingly, varies from true vertical accuracy by only 29 millimeters (1.1 inches) over the entire height of the tower. The CN Tower is a powerful communications tower for numerous radio and cellular media.

Here at Mimix, we have engineered an impressive range of power amplifiers (PAs) that tower above industry averages! Our PAs offer high power, excellent performance and efficiency, and are available in a selection of bare die and packaged versions.

MIMIX POWER AMPLIFIERS...TOWERING ABOVE INDUSTRY AVERAGES!

Description	Device	Frequency (GHz)	Gain (dB)	Gain Flatness (dB)	Output P1dB (dBm)	OIP3 (dBm)	Bias (mA @V)	Package (mm)
Power Amplifier	XP9003	1.6	38.0	+/-0.5	+43.0	-	2.9 A @ 9.0	40x36
Power Amplifier (QFN)	XP1035-QH	5.9-9.5	26.0	+/-1.0	+29.0	+39.0	500 @ 6.0	4x4
Power Amplifier (QFN)	XP1050-QJ	7.0-9.0	15.0	+/-0.5	+34.5 Psat	+48.0	1.2 A @ 8.0	6x6
Power Amplifier (QFN)	XP1042-QT	12.0-16.0	21.0	+/-1.0	+25.0	+38.0	500 @ 5.0	3x3
Power Amplifier (QFN)	XP1043-QH	12.0-16.0	21.5	+/-1.0	+30.0	+41.0	700 @ 7.0	4x4
Power Amplifier	XP1057-BD	13.5-16.0	17.0	+/-1.0	+39.0	+48.0	3.7 A @ 7.5	DIE
Power Amplifier	XP1058-BD	14.5-16.0	27.0	+/-1.0	+36.0	+44.0	2.2 A @ 8.0	DIE
Power Amplifier	XP1072-BD	34.0-37.0	22.0	+/-2.0	+35.0 Psat	-	2.4 A @ 5.5	DIE
Power Amplifier	XP1073-BD	34.0-37.0	22.0	+/-2.0	+37.0 Psat	-	4.8 A @ 5.5	DIE

Explore our wide range of power amplifiers and download complete datasheets for all products at www.mimixbroadband.com.

Celebrate the Year of MMIX with us by visiting www.mimixbroadband.com/year-of-MMIX

Visit http://mwj.hotims.com/23286-55 or use RS# 55 at www.mwjournal.com/info

Mimix BROADBAND™

providing optimal semiconductor solutions worldwide

Mimix Broadband, Inc., 10795 Rockley Rd., Houston, TX 77099 U.S. 281.988.4600 mimixbroadband.com

© 2009 All rights reserved. Mimix Broadband, Inc. Mimix Broadband is a registered trademark of Mimix Broadband, Inc. Any rights not expressly granted herein are reserved.

Wide bandwidth,
HIGH POWER DEVICES

Unsurpassed quality + on-time delivery, is the Werlatone promise

QUADRATURES COUPLERS DIVIDERS HYBRIDS

WERLATONE

Breaking all the Rules

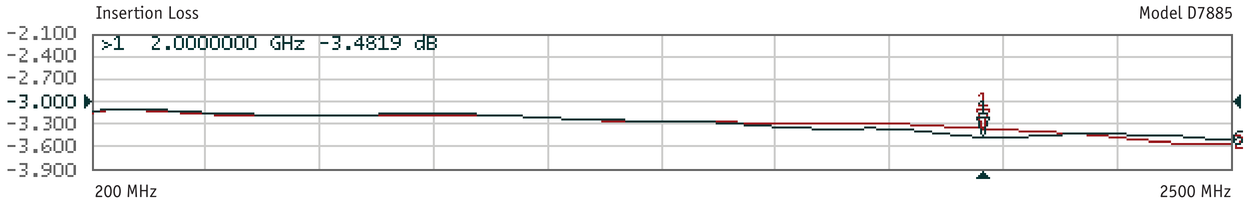
High Power Combiners

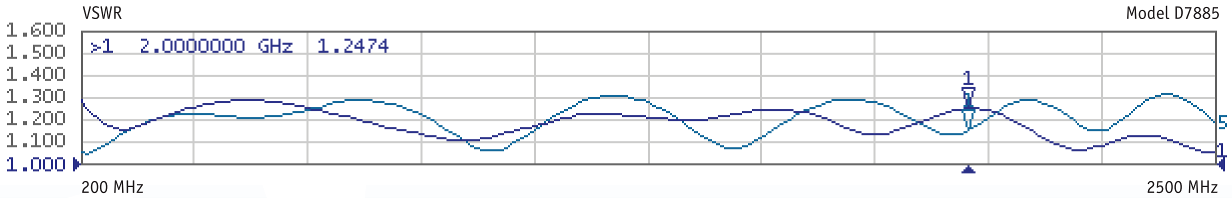
- **10:1 + Bandwidth**
- **Full Input Failure Protection**
- **Capable of Non-Coherent Combining**

COMBINERS

**Multi-Section Power Dividers, first described by Seymour Cohn, employ a large number of floating, high value resistors, resulting in excessive high frequency roll-off and low unbalanced power capability.

Werlatone's, Patent Pending **"Collapsed Cohn" design requires only one or two, low value, high power resistors to provide the same port-to-port isolation and higher unbalanced power protection, while eliminating high frequency roll-off.





www.werlatone.com

Model	Type	Frequency (MHz)	Power (W CW)	Insertion Loss (dB)	VSWR	Isolation (dB)	Size (Inches)
D7885	2-Way	200-2500	200	0.65	1.40:1	15	7.7 x 1.6 x 1.1
D7823	2-Way	500-2500	200	0.4	1.35:1	15	4.7 x 2.0 x 0.8
D7630	2-Way	800-3000	200	0.4	1.35:1	15	3.7 x 1.9 x 0.87
D7539	4-Way	800-2800	200	0.6	1.35:1	17	5.5 x 4.1 x 1.1
D7695	4-Way	900-1300	100	0.4	1.30:1	20	4.0 x 3.3 x 0.8

Visit http://mwj.hotims.com/23286-115 or use RS# 115 at www.mwjournal.com/info