

Microwave Journal

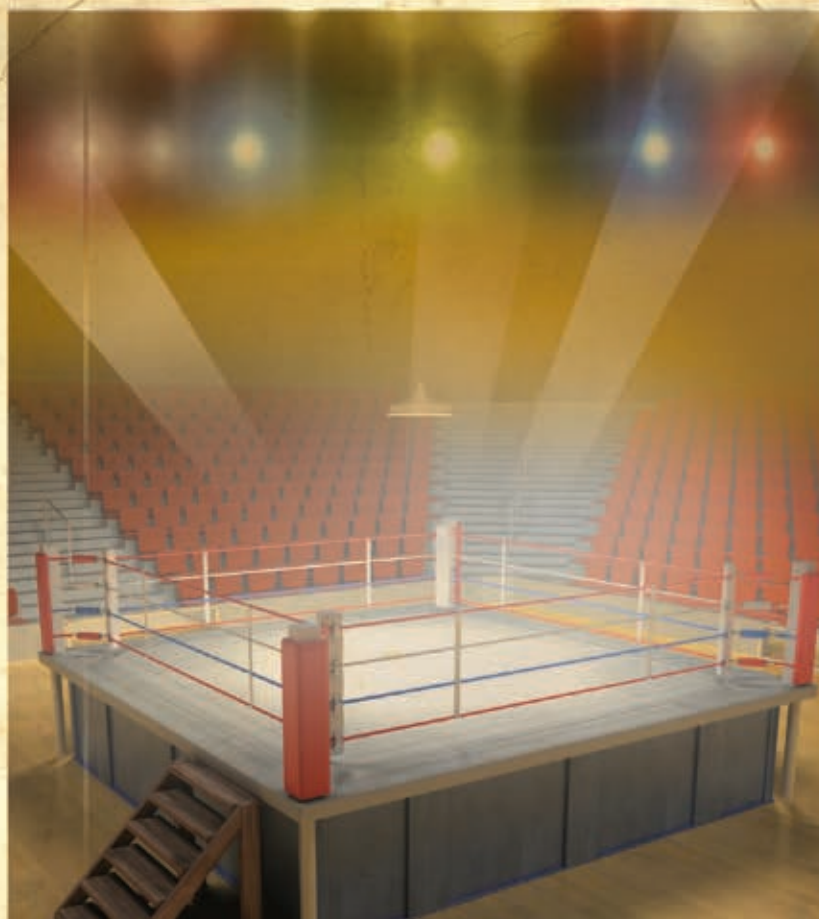
www.mwjjournal.com

Amplifiers and Oscillators

**The III-V vs. Silicon
Battle**

**III-V Heterojunction
Bipolar Transistor
Model**

**LDMOS Ruggedness
Reliability**



**THE III-V vs. SILICON
APRIL BATTLE 2009
POWER AMPLIFIER ARENA**

READY TO DEPLOY TOMORROWS 4G MOBILE SYSTEMS?



WE ARE!

MECA HAS THE ESSENTIAL RF/MICROWAVE COMPONENTS NEEDED TO MESH LTE / WiMAX NETWORKS WITH EXISTING INFRASTRUCTURE.

Since the early days of Series I AUTOPLEX thru recent national deployments of UMTS and E-911, MECA has long been the "backbone" of high performance wired and air-interfaced networks for commercial wireless.

We continue to offer a wide variety of models specifically designed to mesh your next generation networks with existing infrastructure including **Attenuators, Bias Tees, Circulators, DC Blocks, Directional & Hybrid Couplers, Isolators, Power Divider/Combiners** and **RF Loads**.

MECA is one of few component manufacturers to be an approved source



of supply to ALL major US / Canadian service providers because of our uncompromised reputation for delivering rugged and reliable components to the field on-time, every time!

Engineers, Product Managers and Equipment Installer alike trust MECA for critical projects and rely on our superior product performance and extraordinary delivery (**STOCK - 2 weeks ARO**) to stay on schedule.

We proudly offer a 36 month warranty on ALL of our American-made RF / Microwave components.

Are you ready to deploy tomorrows 4G mobile systems? **WE ARE!**

MECA ELECTRONICS, Inc.

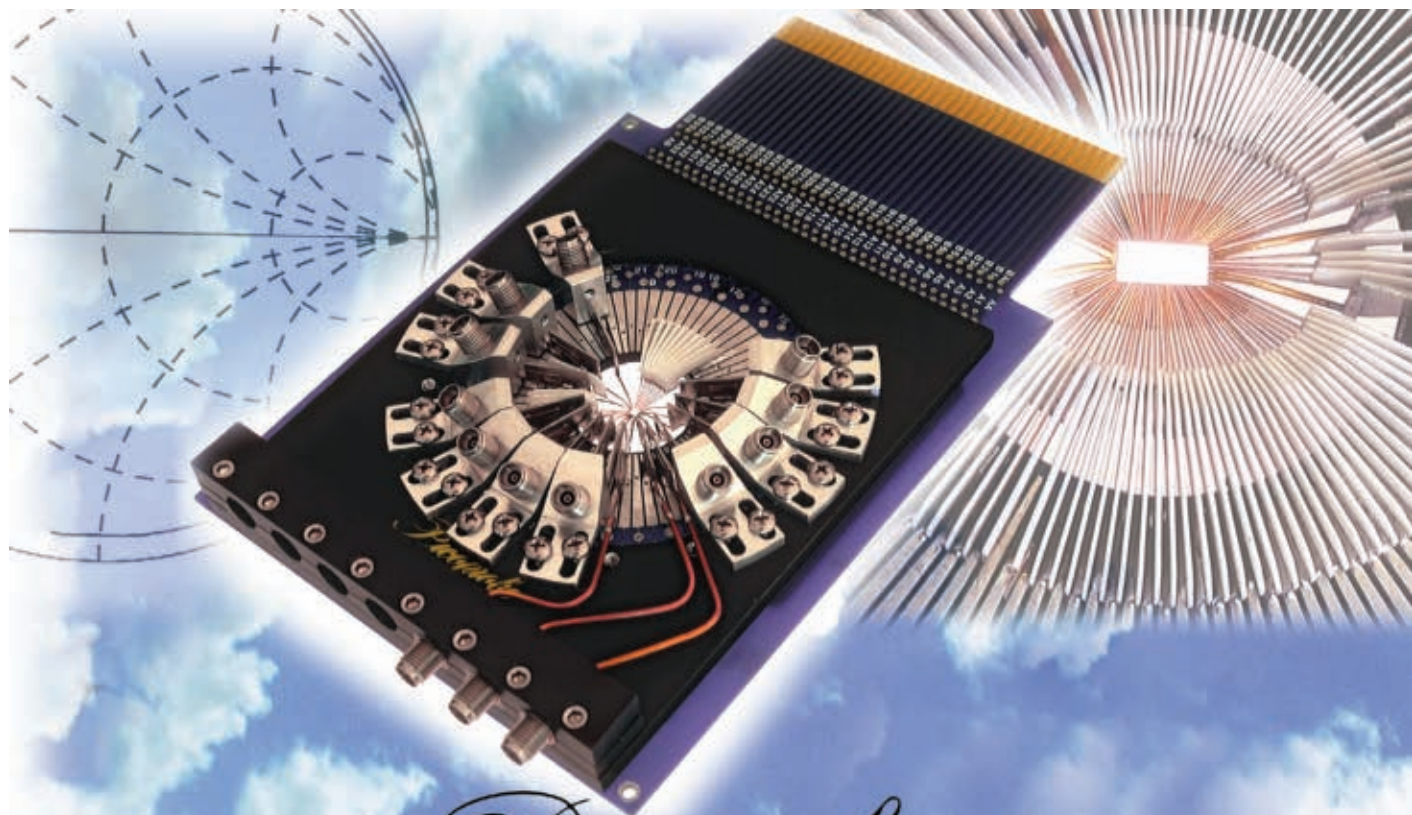
459 East Main Street, Denville, NJ 07834 • 973-625-0661 • Fax: 973-625-9277

866-444-6322 • sales@e-MECA.com • www.e-MECA.com

Since 1961 • Made in USA

THE FASTEST SOLUTIONS TO YOUR RF / MICROWAVE COMPONENT NEEDS

Visit <http://mwj.hotims.com/23284-53> or use RS# 53 at www.mwjjournal.com/info



Picoprobe®

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/23284-33> or use RS# 33 at www.mwjjournal.com/info





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 1 year 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!



 **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



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/23284-61> or use RS# 61 at www.mwjjournal.com/info

Withstand Severe Environmental Conditions



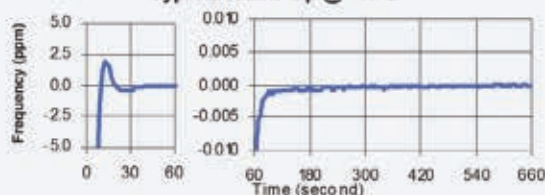
Industry's Smallest High Stability OCXO

Next Generation EX-420 EMXO™ Provides customers advanced stability performance and fast warm-up with low power consumption.

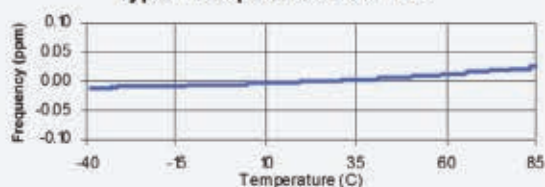
The EX-420 provides exceptionally low aging rates and tight temperature stabilities in an extremely small package over a wide range of environmental conditions. This EMXO™ series bridges the gap between current large, high precision OCXO's and smaller TCXO's. The EX-420 Series becomes the most economical choice where there is a need for spectral purity, short and long term stability, along with small size and dramatically reduced power consumption.



Typical Warm-up @ -40 C



Typical Temperature Slew Test



Additional Features Include

- Temperature Stability to $\pm 75 \times 10^{-9}$ over -20° to $+70^\circ\text{C}$
- Low Power Consumption: $<0.35\text{W}$ @ 25°C , 0.7W @ -40°C
- Fast Warm-up: Two Minutes at 25°C
- Weight: $<3\text{gm}$
- Available in Thru Hole and Surface Mount Package
- 13 mm x 13 mm Half DIP Package

Applications

- SONET/SDH, DWDM, FDM, ATM, 3G
- Test & Measurement Equipment
- Wireless Communication Equipment
- Military Airborne and Mobile Systems

For more information on the new EX-420 or any Vectron products, please contact a customer service representative at 1-88-VECTRON-1 or visit www.vectron.com

OCXO/EMXO

TCXO VCXO VCXO Frequency Translation 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 hybrid 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.

Visit <http://mwj.hotims.com/23284-114> or use RS# 114 at www.mwjjournal.com/info

Helping Customers
Innovate, Improve & Grow



VECTRON
INTERNATIONAL
A DOVER COMPANY



Filter Solutions

Chebyshev and Elliptic Response

Single Filters to Multiplexers

Power Handling from Milliwatts to Several Hundred Watts

Configurations Include Surface Mount, Cables, or Connectors

Small Sizes and Custom Packages



Product Spotlight



Wide Band Notch Filter

The 6IN40-897.5/X265-O/O filter uses elliptic response lumped element design techniques to enhance broadband communications from DC to 765 MHz and 1030 to 3500 MHz, while blocking out wireless communication traffic.

Filter WizardSM

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



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/23284-46> or use RS# 46 at www.mwjournals.com/info



When Capital Budgets Are at Risk...**Trust Narda.**
The Strongest Link to RF & Microwave Solutions in the Business.

From the beginning in 1953...

Narda built both its business model and reputation on manufacturing innovative products which are readily available for commercial and military applications. It prides itself on being a critical and reliable link in the supply chain during these most challenging of economic times – offering standard components from inventory and special products from dedicated production lines.

Even with today's financial instability, Narda, backed by the resources of L-3 Communications, is continuing to **invest** in the inventory and program support needed for your ongoing and upcoming business requirements. We have the **foresight** and **strength** to be able to serve you when you need us... today or in the future.

If your business is in RF & microwaves, your partner is Narda.



- Passive Components • Mechanical and Solid State Switches
- Microwave Integrated Circuits • Fiber Optic Modulator Drivers

narda
microwave-east

The Most Trusted Link to RF & Microwave Solutions.

an  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/23284-80> or use RS# 80 at www.mwjjournal.com/info



Microlab has taken Hybrid Technology to new heights

The Highest performance, the Highest quality...Microlab delivers the Highest value with immediate "off-the-shelf" availability. When system performance is critical, Microlab Hybrid solutions will take your application to the next level...Satisfaction guaranteed!

- Broadest-band
- Highest Isolation
- Lowest Loss
- Superior PIM Performance
- Highest Power
- Multiple Configurations
- "Off-the-Shelf" Availability

For more information visit: www.microlab.fxr.com or call +1 973-386-9696.





Microwave Journal

APRIL 2009 VOL. 52 • NO. 4

FEATURES

COVER FEATURE

22 The III-V vs. Silicon Battle

Darcy Poulin, SiGe Semiconductor Inc.

Introduction to the advantages and disadvantages of the various underlying semiconductor technologies in determining the winner of the III-V versus Silicon battle for power amplifier applications

TECHNICAL FEATURES

60 A Custom III-V Heterojunction Bipolar Transistor Model

Sonja R. Nedeljkovic, John R. McMacken, Paul J. Partyka and Joseph M. Gering, RFMD

Discussion of the features of a custom III-V heterojunction bipolar transistor model and its scaling for cellular power amplifier applications

86 Managing Crystal Oscillator Acceleration Sensitivity in Mobile Applications

Steven Fry, Greenray Industries

Understanding and mitigating the effects of acceleration forces on crystal oscillator performance

96 LDMOS Ruggedness Reliability

S.J.C.H. Theeuwen, J.A.M. de Boet, V.J. Bloem and W.J.A.M. Sneijders, NXP Semiconductors

Description of various ruggedness reliability tests for radio frequency laterally diffused metal-oxide semiconductor transistors

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.



52 Years
of Publishing
Excellence

SENSOR ELECTRONICS:

ANTENNAS & ELECTRONICS FOR YOUR MOST CHALLENGING APPLICATIONS.



We continue to be a world leader in the design, development and production of sophisticated ground, shipboard, and airborne Antennas, Radomes & Advanced Composites, Microwave Components and Integrated Subsystems for Radar, Electronic Warfare and Communication Systems serving the Aerospace and Defense Communities. Our companies include:

- **Atlantic Microwave**
- **Atlantic Positioning Systems**
- **Nurad Technologies, Inc.**
- **Sensor & Antenna Systems - Lansdale**

Together, we are Cobham Sensor Systems – **Sensor Electronics.**



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
COBHAM DEFENSE COMMUNICATIONS Ltd. www.cobhamdcweb.com +44 0 1254 292020 | 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/23284-21> or use RS# 21 at www.mwjjournal.com/info

FEATURES

PRODUCT FEATURES

106 VHF OCXO with Extra-low Noise Floor

Pascall Electronics Ltd.

Introduction to a new series of oven-controlled crystal oscillators combining close-in phase noise performance with lower noise floor and higher output power

114 Millimeter-wave MMICs Deliver Ka-band Power

Mimix Broadband Inc.

Introduction to 4 and 6 W Ka-band power amplifiers

120 Drop-in Industry Replacement Frequency Synthesizers

EM Research Inc.

Development of a series of drop-in frequency synthesizers with models operating from 800 MHz to 3.8 GHz

DEPARTMENTS

- 17 ...Mark Your Calendar
- 18 ...Coming Events
- 43 ...Defense News
- 47 ...International Report
- 51 ...Commercial Market
- 54 ...Around the Circuit
- 124 ...Catalog Update
- 128 ...New Products
- 138 ...The Book End
- 140 ...Career Corner
- 142 ...Ad Index
- 144 ...Sales Reps
- 146 ...MWJ Puzzler

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

WEB SITE PRODUCTION DESIGNER:

MICHAEL O'BRIEN

DTP COORDINATOR: JANICE LEVENSON

GRAPHIC DESIGNER: SACHIKO STIGLITZ

FREELANCE OFFICE SUPPORT SPECIALIST:

SUNDAY O'BRIEN

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

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

"I need LTE test tools so I can meet my deadlines."



Is today soon enough?

Agilent is the only company with LTE test solutions from early design to network deployment. First to market with simulation, signal generation and signal analysis tools for LTE, Agilent has added new protocol test

and network signaling analysis solutions. Now test will never stand in the way of meeting your LTE deadlines. As you take LTE forward, Agilent clears the way.

A sampling of Agilent's LTE test tools:

- Agilent/Anite protocol test solution
- Agilent 89600 VSA software with the Agilent MXA or PSA spectrum analyzers
- Agilent N7624B Signal Studio software for LTE with the Agilent MXG or ESG signal generators
- Agilent J7880A signaling analyzer for LTE



Get FREE LTE poster, application note and more
www.agilent.com/find/ltetest

Order the **NEW** 450 page LTE Book
www.agilent.com/find/LTE-book



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

Go to
www.mwjjournal.com

Free Webinar

MWJ/Besser Associates Webinar Series: SISO to MIMO

This webinar presents the technical considerations behind the multiple antenna (SIMO, MISO and MIMO) and adaptive beamforming techniques that are transforming today's communication systems such as LTE. Design and testing considerations will be among the topics discussed.



Presented by **Besser Associates** and *Microwave Journal*.

Live webcast: 4/21/2009, 11:00 am (EDT)

Sponsored by **Keithley Instruments**

Expert Advice

Mesuro is a spin off from Cardiff University, UK, and its CTO, **Johannes Benedikt**, describes the need for a large-signal measurement system that integrates the measurement of large-signal parameters and an active harmonics source/load pull system to facilitate a first-pass power amplifier design process.



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.mwjjournal.com for details).



MWJ Blog

April is a big conference month. See what happened at the International CTIA Wireless 2009 Convention in Las Vegas, NV, April 1-3 with blog entries from MWJ Technical Editor, Pat Hindle. We'll also check in on WAMICON 2009 and the ARMMS RF & Microwave Society Conference. Visit <http://microwavejournal.blogspot.com/>.

Executive Interview

MWJ asks **Graham Jefferies**, Executive Vice President and COO of **Emrise Corporation** (parent company of Pascall Electronics), about the company's reorganization, product development strategy and strict environmental policy, together with his perspective on operating in the current market conditions.



Online Technical Papers

Super-regenerative Receivers

U.L. Rohde and A.K. Poddar, Synergy Microwave Corp.

SISO to MIMO: Moving Communications from Single-input Single-output to Multiple-input Multiple-output

Mark Elo, Marketing Director of RF Products, Keithley Instruments

Future Technologies and Testing for Fixed Mobile Convergence, SAE and LTE in Cellular Mobile Communications

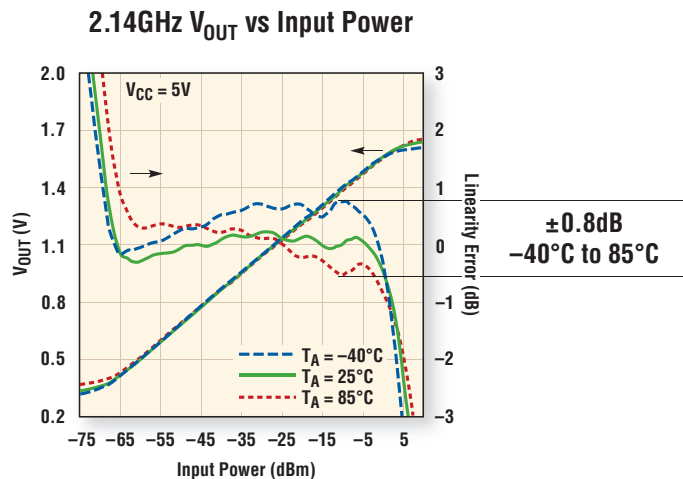
Anritsu

Reinventing the Transmit Chain for Next-generation Multimode Wireless Devices

Richard Harlan, Director of Technical Marketing, ParkerVision

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

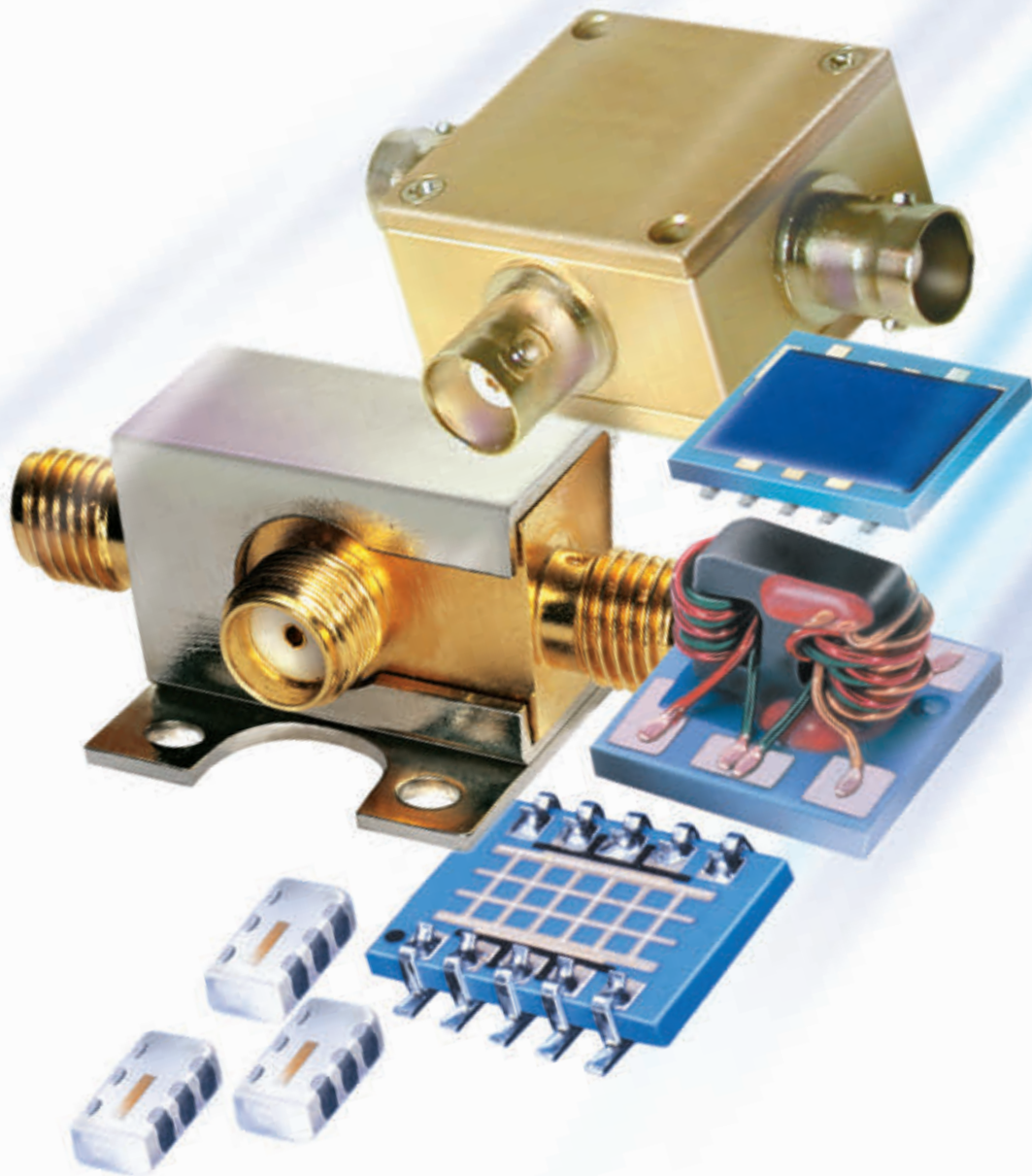
1-800-4-LINEAR



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.





Directional/Bi-Directional **LTCC COUPLER FAMILY**



IN STOCK \$ **169**
From 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



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/23284-62> or use RS# 62 at www.mwjjournal.com/info



MAY 2009						
SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
26	27	28	29	30	1	2
3	4	5	6	7	8	9
		 IEEE Radar Conference Pasadena, CA				
		 PAC 2009 Particle Accelerator Conference Vancouver, Canada				
10	11	12	13	14	15	16
		 Keithley S400 Maintenance Training Course Munich, Germany				
		 CST MICROWAVE STUDIO® Microwave and Antenna Training Nottingham, UK				
17	18	19	20	21	22	23
		 Tektronix Webinar: Next Generation Active Load-pull				
		MWJ/Besser Webinar: Impedance Matching	 Dr. Bob Froelich			
		 16th RF and Microwave Measurement Training Course Middlesex, UK				
24	25	26	27	28	29	30
	 中国微波 CNMW Microwave Industry Exhibition in China National Conference on Microwave and Millimeter Wave in China Xi'an, China		 Ansoft Q3D Extractor Product Training Ann Arbor, MI			
		 TriQuint Webinar: Green Power				
31	1	2	3	4	5	6

Go to: www.mwjjournal.com/events



M/A-COM Technology Solutions RF circulators & isolators

Delivering
performance and
value...now in a
wider range of
standard platforms

Download our complete
circulator & isolator brochure
at www.macom.com/passives



Visit <http://mwj.hotims.com/23284-50>



CALL FOR PAPERS

AMTA 2009
Antenna Measurement Techniques
Association
Deadline: May 8, 2009

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

ONLINE

**ARMMS RF and Microwave Society
Conference**
Post date: April 28, 2009
www.mwjjournal.com/events

APRIL

WAMICON 2009
**IEEE WIRELESS AND MICROWAVE TECHNOLOGY
CONFERENCE**
April 20–21, 2009 • Clearwater, FL
www.wamicon.org

**ARMMS RF and MICROWAVE SOCIETY
CONFERENCE**
April 20–21, 2009 • Oxfordshire, UK
www.armms.org

MAY

IEEE RADAR CONFERENCE
May 4–8, 2009 • Pasadena, CA
www.radarcon09.org

**16TH RF and MICROWAVE MEASUREMENT
TRAINING COURSE**
May 18–22, 2009 • Middlesex, UK
www.theiet.org/microwave-course

MIE 2009
MICROWAVE INDUSTRY EXHIBITION IN CHINA
NCMMW 2009
**NATIONAL CONFERENCE ON MICROWAVE AND
MILLIMETER WAVE IN CHINA**
May 23–26, 2009 • Xi'an, China
www.cnmmw.org

JUNE

**IEEE INTERNATIONAL SYMPOSIUM ON ANTENNAS
AND PROPAGATION**
June 1–5, 2009 • Charleston, SC
www.apsursi2009.org

RFIC 2009
**IEEE RADIO FREQUENCY INTEGRATED CIRCUITS
SYMPOSIUM**
June 7–9, 2009 • Boston, MA
www.rfic2009.org

IMS 2009
**IEEE MTT-S INTERNATIONAL
MICROWAVE SYMPOSIUM**
June 7–12, 2009 • Boston, MA
www.ims2009.org

IMS 2009



COMING EVENTS

**73RD ARFTG MICROWAVE MEASUREMENT
CONFERENCE**
June 12, 2009 • Boston, MA
www.arftg.org

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
**1ST ASIA SYMPOSIUM ON QUALITY ELECTRONIC
DESIGN**
July 15–16, 2009 • Kuala Lumpur, Malaysia
www.isqed-asia.org

AUGUST

EMC 2009
**IEEE INTERNATIONAL SYMPOSIUM ON
ELECTROMAGNETIC COMPATIBILITY**
August 17–21, 2009 • Austin, TX
www.emc2009.org



SEPTEMBER

4G WORLD 2009
September 14–18, 2009 • Chicago, IL
<http://global.wimaxworld.com>

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

46TH ANNUAL AOC
INTERNATIONAL SYMPOSIUM AND CONVENTION
October 18–22, 2009 • Washington, DC
www.crows.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



Packageless surface mount diodes

**Delivering high frequency performance...
with the lowest parasitic capacitance and inductance**

M/A-COM Technology Solutions' Surmount Diodes are the smart choice for broadband, commercial and military applications with surface mount requirements.

- MA4E25 Schottky diode series: Ideal for mixer, limiter and detector applications with wide variety of device configurations
- MA4SPS & MADP PIN diode series: Ideal for switch and attenuator applications with power handling up to 100 watts
- Broad operating frequency range from DC to 26GHz
- Available packages: 0201, 0402, 0502, 0404 and 0603 chip scale package

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



Surmount diode devices are integral to communication systems, such as the manpack tactical radio shown above, that enable our warfighters to communicate on the battlefield.

Photo courtesy of U.S. Army

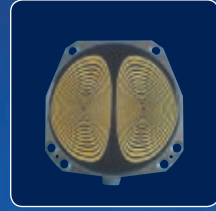
M/A-COM Technology Solutions, Inc.
Lowell, Massachusetts 01851
North America 800.366.2266 • Europe +353.21.244.640
India +91.80.4155721 • China +86.21.2407.1588
www.macom.com
a Cobham company



The whole is far greater than the sum of its parts



Cobham Microwave Systems consists of these groups: Sensor & Antenna Systems, Active Microwave Sub-systems, and Passive Microwave Sub-systems. 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





| 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.cobhamdes.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/23284-22> or use RS# 22 at www.mwjjournal.com/info

THE III-V vs. SILICON BATTLE

Power amplifiers are important components in almost all wireless communication systems. They normally consume large amounts of power, and therefore play a critical role in battery life for mobile devices. As a rough estimate, in a typical WiMAX radio, the baseband and transceiver will consume about 600 mW, whereas the power amplifier will consume about 1.3 W.

When designing a power amplifier, there are a large number of options to be considered. One fundamental choice, however, is whether to use Silicon or III-V technology. This article will point out a number of important issues that affect power amplifier design, and will discuss advantages and disadvantages of the various underlying semiconductor technologies in determining who wins the III-V versus Silicon battle.

In recent years, there have been a number of technological changes that have had an impact on power amplifier designs. Technologies that use OFDM, like WiFi, WiMAX and LTE, are probably the most challenging for a power amplifier; they require a high degree of linearity to meet the required SNR targets, but must also handle a large peak-to-average power ratio associated with OFDM.

In addition, the 802.11-based WiFi and 802.16-based WiMAX standards have become some of the fastest growing technologies in use

today, so it makes sense to focus on the GaAs versus Silicon debate within the context of low power (<1 W), high linearity OFDM power amplifiers.

Having chosen GaAs or Silicon, the power amplifier designer is then confronted with further options within each technology, and each option has its own set of advantages and disadvantages. In GaAs, one can design with GaAs HBT (bipolar-based), GaAs PHEMT (FET-based), or GaAs BiFET (a mixture of both bipolar and FET technologies).

In Silicon, one can design in CMOS (FET-based), or in higher speed SiGe BiCMOS (a mixture of both bipolar and FET technologies). The main workhorses in OFDM power amplifier design today are GaAs HBT and SiGe BiCMOS. However, CMOS as well as GaAs BiFET and PHEMT devices are also all in use.

To deliver high power with OFDM, GaAs has almost always been used due to a better trade-off between transition frequency, F_t , and breakdown voltage. However, over the past 10 years, Silicon technology has developed to the point where it is becoming harder to choose one technology over the other. A few years ago,

DARCY POULIN
SiGe Semiconductor Inc., Ottawa, Canada

SPDT & DPDT WAVEGUIDE SWITCHES

RLC has the standard and custom design solutions you're looking for.

RLC Electronics' electromechanical waveguide switches offer a compact design utilizing a proprietary non-contacting actuator mechanism that requires low current. Precision machined parts insure optimum electrical performance over the entire waveguide band.

- Frequencies from 7.05 to 40 GHz
- Standard Waveguide Sizes
- Low VSWR
- Failsafe, Latching, Manual Override or Manual
- Switching Times As Fast As 25 Milliseconds
- 5, 12 or 28v DC Coil
- Indicator and TTL Options
- High Isolation
- Environmentally Conforms to MIL-DTL-3928
- Low Insertion Loss

For more detailed information on SPDT & DPDT Waveguide Switches, 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

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



Visit <http://mwj.hotims.com/23284-95> or use RS# 95 at www.mwjjournal.com/info

anything above 2 GHz and/or 50 mW would have been designed in GaAs. Today, SiGe BiCMOS power amplifiers can be used at power levels close to 1 W and they have plenty of available gain even at 10 GHz.

If efficiency is important, GaAs technologies still offer the best performance, especially at higher powers. GaAs technology also offers higher breakdown voltage, which translates into greater robustness. However, circuitry has been developed that can protect lower breakdown Silicon devices. Complicating the picture even more, integrated CMOS PAs are now being considered at 2.4 and 5 GHz in applications where lower output powers (less than 15 dBm) and relatively low efficiencies (about 10 percent) can be tolerated.

COEXISTENCE

Today, many wireless communications technologies exist, and they often operate simultaneously. For example, Bluetooth and cellular radios must both operate when using a Bluetooth headset during a voice call. WiMAX and cellular radios will both be active on mobile devices during handovers from one network to the other. Cellular and GPS radios will both be enabled when GPS is used on a cellular phone.

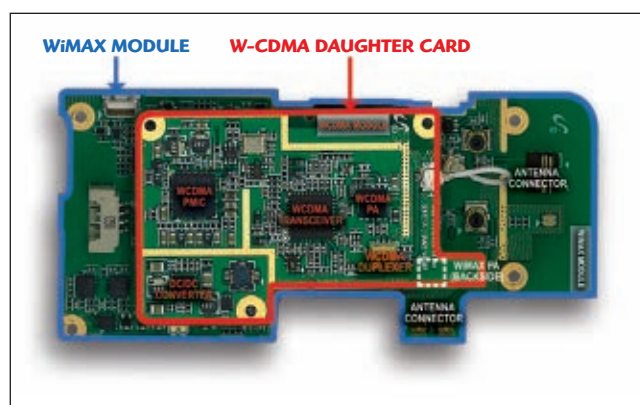
Coexistence refers to the simultaneous operation of multiple radios within a device. **Figure 1** shows a typical example of a dual-mode WiMAX/W-CDMA radio. In this example, a W-CDMA daughter card is placed on top of, and in close proximity to, a WiMAX module. If the WiMAX and W-CDMA radio must operate simultaneously (which would be required during a handover from one network to another), then care must be taken to ensure that the radios do not interfere with one another.

But what does this have to do with power amplifiers? Since W-CDMA and WiMAX radios operate on different frequencies, one might naively expect no issues when both radios are operating at the same time. The problem, of course, is that noise from one radio that is emitted in the passband of the other radio cannot be filtered out at the receiver, and this noise can desensitize the victim receiver. This problem is most severe when two radios are collocated in the same device, as **Figure 1** illustrates, since signals from one radio arrive virtually unattenuated at the receiver of the other radio.

An example is useful to illustrate this problem. Consider a WiMAX radio operating from 2.5 to 2.7 GHz transmitting at 23 dBm, while a victim W-CDMA radio is attempting to receive a signal at 2.17 GHz. The task is to determine what the maximum noise level is that the W-CDMA radio can tolerate so that its sensitivity (i.e. the smallest signal it can detect) is degraded by less than 0.1 dB when the WiMAX radio is operating.

W-CDMA has a 3.84 MHz channel bandwidth and the standard requires a sensitivity of -117 dBm for a coded CDMA signal. Assuming a 21 dB coding gain (128 chip code length), the sensitivity will be -96 dBm/3.84 MHz, or -161.8 dBm/Hz. Based on this, the noise at the W-CDMA antenna would need to be below -170.9 dBm/Hz to result in 0.1 dB degradation in sensitivity (-178.1 dBm + -161.8 dBm results in a net noise of -161.7 dBm).

Of course, the noise power emitted from the WiMAX PA will be reduced as the signal travels from the WiMAX Tx antenna to the W-CDMA Rx antenna. Since the two ra-



▲ **Fig. 1** Dual-mode W-CDMA/WiMAX radio.

dios are located very close together, however, one can only expect approximately 20 dB isolation between the antennas, so the output noise from the WiMAX radio will need to be below -150.9 dBm/Hz.

Now that the output noise target for the WiMAX radio has been calculated, consider the implications on the power amplifier. Suppose that the input noise to the power amplifier is at the noise floor (-174 dBm/Hz), that the PA has a gain of 30 dB at 2.17 GHz, and has a noise figure of 5 dB. Therefore, the net noise from the PA will be $-174 + 30 + 5 = -139$ dBm/Hz, requiring 12 dB additional filtering at 2170 MHz in order to degrade sensitivity of the W-CDMA PA by only 0.1 dB.

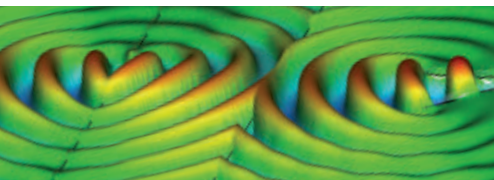
The most obvious place to put the filter is directly after the PA. This is a bad choice, however, since any losses after the PA result in significant additional power consumption, and this power consumption is manifested as heat that must be dissipated. In addition, the effect of the filter loss is worse as output powers increase. For example, assuming that the coexistence filter has 1.5 dB loss and that the PA has 20 percent efficiency, **Table 1** shows the effect of this filter on power consumption and net PA efficiency for different output powers. At an output power of 18 dBm, the 1.5 dB filter loss results in about 130 mW extra DC power consumption. Some of this power is dissipated in the filter

TABLE I				
EFFECT OF POST PA LOSSES ON POWER CONSUMPTION				
Desired output power	18	23	26	dBm
Post PA coexistence filter loss	1.5	1.5	1.5	dBm
PAE	20	20	20	%
Required output power	19.5	24.5	27.5	dBm
PA power consumption assuming no post PA losses	315.5	997.6	1990.5	mW
Actual PA power consumption	445.6	1409.2	2811.7	mW
Additional Power Dissipation	130.1	411.6	821.2	mW
Net PAE	14.2	14.2	14.2	%



Reach the next level

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



→ 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.

Visit <http://mwj.hotims.com/23284-26> or use
RS# 26 at www.mwjjournal.com/info



CHANGING THE STANDARDS

(26 mW), but most of the additional power (104 mW) is dissipated in the PA, which must be made 1.5 dB larger to overcome the filter losses.

When transmitting at 23 dBm, adding the filter increases power consumption by 411 mW. At 26 dBm, the power consumption increases by 821 mW. One can see that putting a filter after the PA can result in a severe energy penalty (especially at higher output powers), and this results in short-

er battery life. In addition, there are resultant cost increases since the PA must be made larger to overcome the filter loss. It is also interesting to note that a 1.5 dB post-PA loss reduces the PA efficiency by the same amount at each output power, from 20 to about 14.2 percent.

In order to reduce power losses, it is preferable to not place the coexistence filter after the PA. However, it should also not be placed in front

of the PA, since most of the noise is generated within the PA. Therefore, the filter is optimally placed between the PA stages, internally on the PA die. The next question then is which technologies are best suited for implementing integrated filters?

At first glance, one might expect GaAs-based semiconductor technology to have an advantage because the passives have higher Q due to lower substrate losses. However, Silicon processes have evolved, and it is now possible to fabricate passive devices on insulating SiO₂, and their performance can be as good as it is on lower-loss GaAs substrates.

There is an additional consideration, however. Modern foundry production tolerances make it very difficult to control the capacitance and inductance of passive devices to the accuracy required for demanding coexistence filters. In order to meet coexistence noise requirements, some form of post-production tuning is required. It is much more convenient to tune devices if one has access to digital control lines. The ability to integrate analog or digital control in tuning sharp filters in SiGe BiCMOS or Si-CMOS technology gives Silicon technology an advantage in this area.

PREDISTORTION

Moore's Law is bringing down the price of digital hardware, and this makes digital adaptive predistortion (DAPD) more attractive every year. In a DAPD system, shown in **Figure 2**, the output from the power amplifier is sampled, downconverted to baseband, and is then compared with the input signal. Phase and amplitude distortion created by the power amplifier are detected, and the baseband signal is adjusted to exactly counteract these distortions. This technique can be used to improve the overall PA efficiency.

Predistortion comes at a cost, however. Additional power is required to downconvert the RF output signal and to carry out the appropriate signal processing. One must always ensure that the improvement in efficiency outweighs the cost of implementing the additional functionality. However, DAPD overhead is typically fairly low, since updates to the lookup table can occur quite infrequently and the DAPD blocks are powered off most of the time.



Secure your PCB void free.
RF AccuBond™.

Void free fused metal PCB-to-pallet bonding. Planar, multilevel, two sided and in cavity designs. Reduce or eliminate associated RF tuning to lower total cost for critical designs. To learn more about advanced fabrication of printed circuit boards call 319-295-3673 or email: cpcsales@rockwellcollins.com

**Rockwell
Collins**

www.rockwellcollins.com/flash

Building trust every day

Visit <http://mwj.hotims.com/23284-96>

MICROWAVE JOURNAL ■ APRIL 2009

DC to 8 GHz MMIC Amplifiers




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



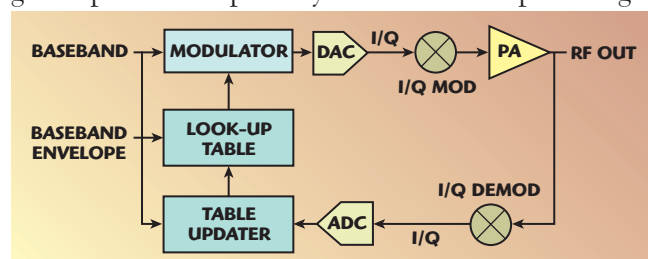
The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

RF/IF MICROWAVE COMPONENTS

346 rev N

Visit <http://mwj.hotims.com/23284-63> or use RS# 63 at www.mwjjournal.com/info

Where does DAPD have the biggest impact? It will probably have the biggest impact when used with PAs developed in highly nonlinear processes.



▲ Fig. 2 Block diagram of a digital adaptive predistortion system.

It also has the most significant impact on larger amplifiers, where the power required by the predistorter is dwarfed by the power used by the amplifier.

For example, integrated CMOS PAs

are now being seen in low power WiFi handset devices. These CMOS PAs have very low F_t , and would need to operate at very high current densities to achieve the linearity required to meet WiFi EVM specifications.

When these devices are operated at lower current levels, they become very nonlinear and DAPD is a necessity for WiFi devices that use integrated CMOS PAs. Even with predistortion, the efficiency of integrated CMOS PAs is quite low, typically less than 10 percent. However, since these devices are operating at relatively low output powers (typically less than 40 mW), the efficiency is not that critical, and DAPD is used to ensure adequate linearity.

In contrast to CMOS only devices, the linearity of GaAs and SiGe transistors reduces the need for predistortion. However, predistortion can be used to improve performance, as it can improve both EVM and spectral mask.

For optimal performance with DAPD, it is best to use a PA that has been designed for maximum efficiency and not maximum linearity. In addition, by optimizing the feedback, one can tune the predistortion to apply more correction to EVM or mask. This can be important. For example, as output power increases, WiFi PAs become significantly mask limited because the out-of-band emissions limits specify a maximum absolute emission level. However, other systems like Japan's new xgPHS system employ 256QAM modulation, and one would want to optimize the DAPD for EVM correction.

There is not really a preferred technology for DAPD. Predistortion is not a necessity for GaAs or BiCMOS PAs, but it can certainly help, and will improve efficiency, especially at higher output powers. For CMOS PAs, predistortion is a requirement due to the relatively low efficiency of this technology.

QUIESCENT CURRENT

Most often, power amplifiers are specified in terms of current consumption at their rated output power, and power added efficiency (PAE) is normally specified at full power. When the output power is reduced, the current drawn by the PA is reduced. However, the current drawn is not linear with output power. For example, if the output power drops

ULTRA LOW PHASE NOISE Multiplied Crystal Oscillator (MXO) Series 200 MHz to 12 GHz

Features

- Highly Integrated Industry Leading ULN Oscillators & Multipliers
- Exceptional Phase Noise
- Excellent Spectral Purity
- High Output Power Option Available
- Phase Lock Option Available

Model	Frequency ¹	Output Level ²	Typical Phase Noise (dBc/Hz)				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	-98	-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 +171 dBm on some models.
3. +12 VDC supply voltage options available on some models.



RF Systems & Synthesizers



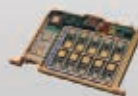
Blue Tops RF Modules



Sub-Assemblies



Ultra Low Noise Crystal Oscillators



Integrated Microwave Assemblies (IMA)



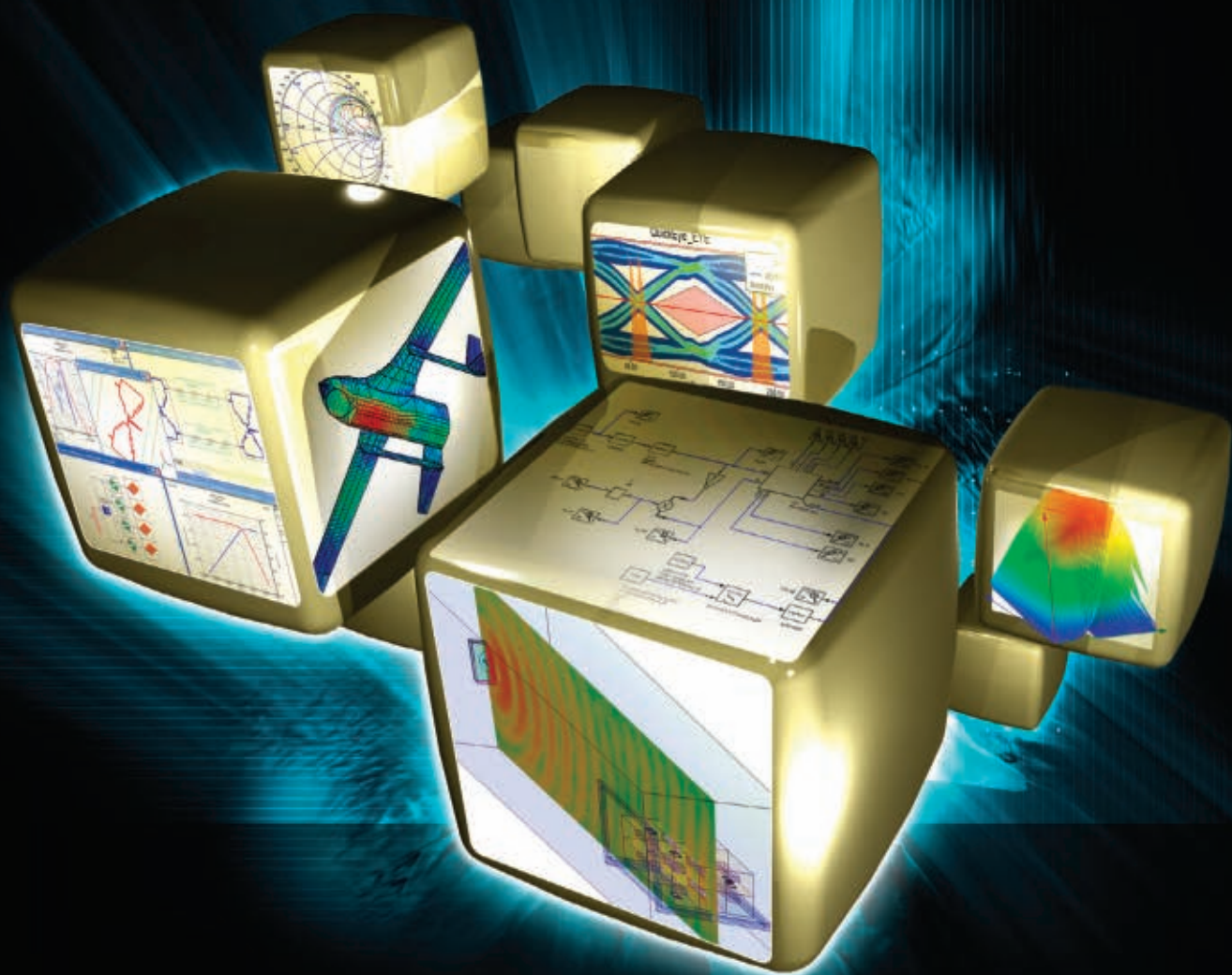
Wenzel Associates, Inc.

2215 Kramer Lane - Austin, Texas - 512-835-2038 - www.wenzel.com - sales@wenzel.com



CROWN CRYSTALS
Wenzel International, Inc.

905-668-3324 - www.crowncrystals.com - crownsales@crowncrystals.com



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



A subsidiary of ANSYS, Inc.

by 50 percent (3 dB), the current typically drops by only about 20 percent. In addition, when output power is backed off so that it approaches zero, the current does not drop to zero, but instead saturates at the PA quiescent current, I_{cq} , due to the bias currents drawn by the PA.

In many applications, quiescent current is of no concern at all. For example, if a power amplifier will be operating at close to maximum power

whenever it is transmitting, the power it consumes when backed off is unimportant, and I_{cq} is irrelevant. This is typically the case for 802.11 Wi-Fi power amplifiers: When data is being transmitted, the PA is on and always operating at maximum power; between transmit bursts it is disabled and consumes only leakage current.

If a PA must be used over a wide range of transmit powers, then power consumption at backed off power lev-

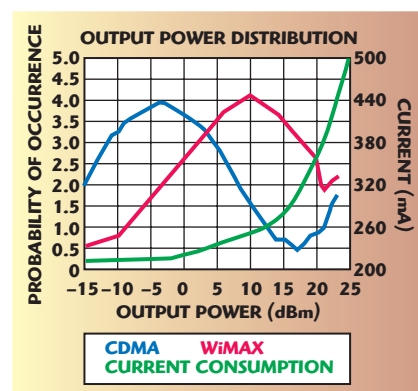
els becomes important, and I_{cq} is important. A good example of this occurs in either CDMA or WiMAX power amplifiers. WiMAX, for example, requires a minimum of 45 dB transmit dynamic range, since power control is intrinsic to the overall network.

Figure 3 shows the expected transmit power distribution for a mobile device in both a CDMA and WiMAX network. For CDMA, one can see that the handset most often transmits at -4 dBm, and it transmits at maximum power relatively infrequently. For WiMAX, handsets will most often transmit at approximately 10 dBm, and again, devices will transmit at maximum power only infrequently.

Also overlaid on this graph is current consumption versus output power for a typical power amplifier. Because the PA is often transmitting at low powers, one can see that it is important to minimize current consumption at lower output powers in order to maximize battery life.

There is probably little advantage of one technology over another in terms of getting good efficiency at backed off powers; they are all equally bad. For example, typical WiMAX PAs have 100 mA I_{cq} . Assuming that the PA draws I_{cq} when delivering 0 dBm, the PA consumes 330 mW and has an efficiency of only 0.3 percent at 0 dBm output power versus an efficiency of about 20 percent at full rated power.

There are a number of techniques that can be used to reduce power consumption at low output powers. A common technique is to bypass the output stage at low output powers, routing the RF energy around the final stage. This drops the gain, and significantly reduces current draw, since the output stage draws no current when it is bypassed.



▲ Fig. 3 Transmit power distribution for devices in CDMA and WiMAX networks.

Serving the mm-wave industry for over 30 years.

SPACE LABS INC.

Millimeter-Wave Amplifiers

- ▶ 18 to 110 GHz
- ▶ Noise figure as low as 2 dB
- ▶ Output power in excess of 1 Watt
- ▶ W-band power amplifiers
- ▶ Active multipliers to 110 GHz
- ▶ DC bias +8 to +15 volts
- ▶ Coax or waveguide ports

At Space Labs, our newly expanded millimeter-wave amplifier lab produces both custom and standard designs. These designs include low-noise, high-power and general purpose amplifiers. Modular construction allows a large variety of configurations to meet specific customer requirements.

The tables below are a small sample of the units available. Narrower bandwidth amplifiers with lower noise figure or higher output power than shown below are achievable. Be sure to check out our wide selection of active multipliers and amplifiers in our catalog or on the internet. Call us with your specific needs.

Low-Noise Amplifiers

RF Freq (GHz)	N. F. typ/max	Gain (dB) (min)	P-1dB (dBm) (typ)	VSWR in/out (typ)	Bias mA/VDC	Model
18 - 32	2.5/3.5	20	+8	2:1	75 mA/+8 to +15	SL2514-20-3
26.5 - 40	3/4.5	35	+17	2:1	375 mA/+8 to +15	SLKa-35-3
50 - 75	4/5	18 (typ)	-8	3:1	50 mA/+8 to +11	SLV-20-4
75-110	4.5/5.5	18 (typ)	-10	2.5:1	50 mA/+8 to +11	SLW-15-5

Q-Band Low Noise Amplifier SLQ-20-3

U-Band Low Noise Amplifier SLU-18-3

Power Amplifiers

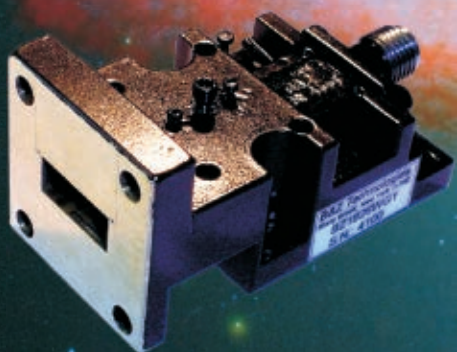
RF Freq (GHz)	P-1dB (dBm) (typ)	Gain (dB) (min)	VSWR in/out (typ)	Bias mA/VDC	Model
18 - 26.5	30	35	2:1	1250 mA/+9 to +12	SP228-35-30
28 - 32	29	35	2:1	950 mA/+8 to +12	SP304-35-29
33 - 35	31	35	2:1	1800 mA/+8 to +12	SP342-35-31
37 - 40	31	30	2:1	1800 mA/+8 to +12	SP383-30-31
75-110	14 (P _{sat})	18	2.5:1	250 mA/+8 to +12	SPW-18-14

SPACE LABS INC.

212 East Gutierrez Street, Santa Barbara, California 93101
(805) 564-4404 Fax 966-3249 E-mail: sales@spaceklabs.com www.spaceklabs.com



Custom Designed Amplifiers



Features:

5 kHz to 70 Ghz

Noise Figures
from 0.35 dB @ 23°C
from 10K @ Cryogenic

P1 dB >+30 dBm

Excellent Group Delay

Phase Matching <5°

Gain Matching <0.5 dB

Up To 50 dB Gain

Cryogenic

Waveguides

High Power

*Off the shelf
prices!*

www.bnztech.com

Visit <http://mwj.hotims.com/23284-17> or
use RS# 17 at www.mwjjournal.com/info

B&Z Technologies, LLC
25 Health Sciences Drive
Stony Brook, New York 11790
USA

Ph: +1 (631) 444-8827
Fax: +1 (631) 444-8825
E-Mail: info@bnztech.com

This technique is effective since the output stage is the largest stage, and draws the most current.

Typically, output stage bypass is done with switches. This favors technologies that have FET switches, since FET switches have much lower loss and are more linear. Therefore, PHEMT or GaAs BiFET processes are good choices.

A SiGe BiCMOS process, at first glance, might not seem to be a great

choice since the technology makes it difficult to produce high quality, low loss switches due to substrate coupling effects. However, Silicon-on-Insulator (SOI) technology has been developed in recent years, and SOI switches are now becoming available with performance rivaling GaAs switches. Therefore, a SiGe BiCMOS process is also suitable for developing low quiescent current devices.

It is much more difficult to fabricate efficient switches with GaAs HBT or CMOS technology, so these technologies are not suitable for output stage bypass commonly used to achieve ultra low quiescent current.

LEAKAGE CURRENT

In all wireless systems, if there is no data to transmit, the PA is disabled and ideally it consumes no power at all. However, unless a switch is placed in series with the supply voltage driving the PA (which is not attractive because of cost, size and power consumption), the power amplifier will always have a supply voltage applied to the collector (bipolar devices) or drain (FET devices).

While the PA can be 'turned off', in practice there is always a small amount of leakage current that flows even when the PA is disabled. This leakage current is a parasitic battery drain, and reduces standby times for mobile devices. Low leakage is often specified as a firm requirement in devices like handsets where standby time is important.

The requirement for low leakage is met with most technologies. GaAs HBT, SiGe HBT and CMOS power amplifiers can all be manufactured with low leakage currents, typically under 10 A. The one technology that may have a problem with leakage current is PHEMT. These devices typically have leakage currents an order of magnitude larger than those manufactured with other technologies. The high leakage current seen with PHEMT PAs is intrinsic to this technology.

Technically speaking, a PHEMT gate looks like a diode, so the threshold voltage needs to be quite low (significantly less than a diode drop). As a result, with 0 V applied to the gate there can be appreciable leakage. Other technologies have insulated gates so threshold voltages are higher and leakage currents are much smaller.

The high leakage current of PHEMT devices is often cited as a reason not to use PHEMT technology for mobile devices. A PHEMT PA turned off and consuming a 100 A leakage current would deplete a typical 1,000 mA-hr battery in 10,000 hours (417 days), and will have a minor impact on the mobile device's standby time.

Narda's In-Stock Attenuators

Available in the most common configurations, including miniature, fixed, medium and high power, variable and step.

- Frequencies from DC to 40GHz
- Values from 0 to 69 db
- Power ratings from 0.5 to 150 watts

Shown here are the 745-69 Step & 779-10 Fixed Attenuators



narda
microwave-east

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/east

The Most Trusted Link to RF & Microwave Solutions.

New mid and high power switches offer highest performance, ease of design

MEDIUM/HIGH POWER SURFACE-MOUNT PIN DIODE SWITCHES

Part #	Freq. Range (GHz max)	Input Power (W max)	Typical Performance @ 2.7 GHz (dB)			Package	Config.
			IL	IRL	Iso		
MSWSE-040-10	3	40	0.25	20	11	0805P	Series
MSWSS-020-40	6	20	0.30	21	50	2012	Series/shunt
MSWSH-020-30	6	20	0.25	19	31	2012	Shunt
MSWSH-100-30	6	100	0.15	22	31	CM22	Shunt
MSWSHB-020-30	10	20	0.40*	30*	32*	2012	Shunt
MSWSSB-020-30	10	20	0.60*	20*	35*	2012	Series/shunt

All specs at ambient temperature * denotes 10 GHz

AEROFLEX
METELICS

APPLICATIONS

- WiMax, Wibro, TD-SCDMA, and other wireless telecommunications
- Test instruments

FEATURES

- Excellent broadband performance up to 10 GHz.
- Easier to design with general purpose diode elements
- Cost-effective solution for assembly

Unlike standard MMIC switches that can't handle high power, Aeroflex / Metelics' new no-driver switch family provides medium to high power levels from 20 to 40W max. with low harmonic distortion. If higher RF power is required, we can support up to 100W max. Need specified information? Contact our application engineers to discuss your requirements.

888-641-7364

www.aeroflex.com/metelics

AEROFLEX
A passion for performance.

While this seems to be a very small contributor, there are a large number of parasitic drains on the battery that all reduce standby time, and phone manufacturers wish to minimize each contributor.

So, for leakage current, the loser appears to be GaAs PHEMT. This is a factor in devices like mobile phones where standby time is important, but will be much less important in devices like laptops.

FRONT-END ICs

As Smartphones incorporating dual-band WiFi, multi-band cellular, GPS, FM and Bluetooth radios grow in popularity, it becomes increasingly difficult to fit everything into the required form factor. The RF front-end, comprising all components between the transceiver and antenna, can contribute significantly to the overall footprint. RF front-end vendors have re-

sponded, and the size of RF front-end components in communications devices has been continually shrinking.

Figure 4 shows a timeline giving an example of the degree to which integration has been applied to RF front-ends for WiFi, and one can see that integration has significantly reduced their footprint. In 2002, front-ends comprised unmatched PAs with many discrete devices, and the RF front-end had a size of about 16 x 18 mm. By 2005, front-end laminate-based modules were available incorporating discrete surface-mount components for matching, and the size had been reduced to about 8 x 7 mm. In 2007, many of these discrete matching components had been replaced by integrated passive devices, and one could now achieve the same functionality in a 4 x 4 mm module without the need for a laminate.

The next logical step in this integration process is to develop a front-end integrated circuit (FEIC), shown in the last photo in Figure 4, achieving a 3 x 3 mm form factor. FEICs offer the possibility of much greater levels of integration by integrating PAs, LNAs, switches and filters onto a single chip. Of course, the pattern of progressive integration has been repeated numerous times in the history of Silicon IC development. GaAs PHEMT and BiFET technologies are well suited for FEICs as they can be used to make excellent LNAs, PAs and switches.

As has been discussed, the SiGe BiCMOS process, at first glance, might not seem to be a great choice, since it is difficult to produce high quality, low loss switches with this technology. However, SOI switches are now available with performance rivaling GaAs switches. As a result, a SiGe BiCMOS process is also a highly suitable platform for FEIC development and one would expect significant growth in this area. In fact, the SiGe BiCMOS platform is even more compelling when considering the possible integration of battery management circuits onto the same die.

To summarize, for front-end IC development, CMOS and GaAs HBTs will not be suitable. GaAs PHEMT and BiFET processes, as well as SiGe BiCMOS processes incorporating SOI technology, are all good choices.



VCOs and PLLs from Crystek Microwave

Choose Crystek when you need truly innovative frequency control technology. Our VCOs and PLL Synthesizers offer the broadest mix of frequency ranges, standard packaging, and custom design options from a single supplier. Plus, with Crystek, you get unsurpassed achievements in engineering and manufacturing, coupled with outstanding support and customer service. Choose Crystek for VCOs that perform.

Low Phase Noise | Micro-Strip and Coaxial Designs | Octave Tuning

ISO 9001:2000 Registered
Certificate #: IMS-0004
10/20/2000



CRYSTEK CORPORATION
Tel: 800.237.3061 • 239.561.3311
www.crystek.com





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/23284-19> or
use RS# 19 at www.mwjjournal.com/info

POWER AMPLIFIERS WITH SERIAL INTERFACES

Historically, PAs have been stand-alone, independent components. Even today, most PAs are controlled with only a single analog enable signal, often requiring precision regulators. In RF front-end modules where power amplifiers, low noise amplifiers and switches are all integrated into a single packaged device, routing the control signals from the baseband chip to the

RF module can be very challenging, especially with the advent of multi-band and multi-PA MIMO technologies. For example, an 802.11a/b/g MIMO radio will require two 5 GHz PAs, two 5 GHz LNAs, two 2.4 GHz PAs, two 2.4 GHz LNAs, filters and Rx/Tx switches, each of which must be controlled separately.

A new trend that is emerging is to use a serial interface to control the PA and/or components within the RF

front-end module. A serial-interface-controlled PA has the potential to revolutionize PA operation, bringing

The Perfect Balance of Performance and Price

Wilkinson Power Dividers



**AEROFLEX
INMET**
An ISO 9001 Certified Company

Aeroflex / Inmet is proud to introduce the first in a series of new Wilkinson power dividers to complement our current offering of resistive divider models.

These 2-way SMA octave and multi-octave designs cover the popular bands of 0.5-1, 0.8-2.5, 1-2 and 2-4 GHz and are now available from stock.

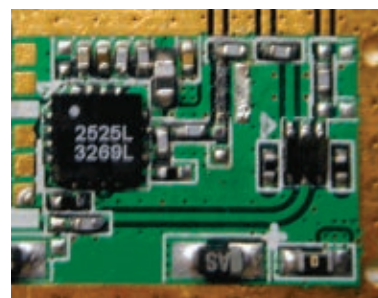
For a quote, please send inquiries by e-mail to dividers@aeroflex.com.

Aeroflex / Inmet also manufactures attenuators, terminations, DC blocks, and adapters for use in test and measurement applications as well as OEM equipment.

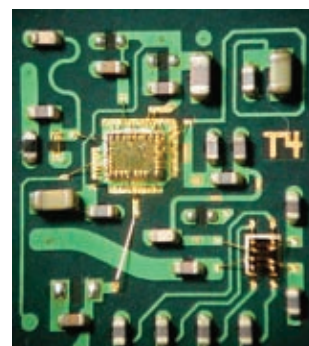
Aeroflex / Inmet
Ann Arbor, Michigan

Call 734-426-5553 or
dividers@aeroflex.com
www.aeroflex-inmet.com

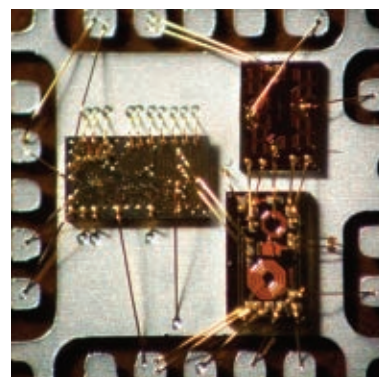
AEROFLEX
A passion for performance.



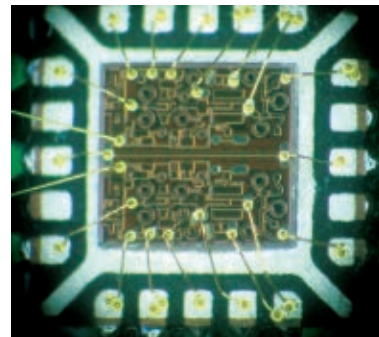
(a) 2002 UNMATCHED PA 18 x 16 mm



(b) 2005 FRONT-END MODULE 8 x 7 mm



(c) 2007 FRONT-END MODULE 4 x 4 mm



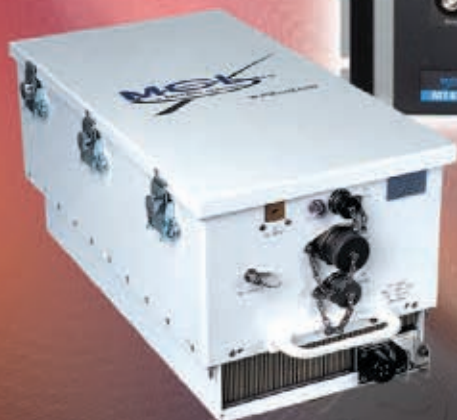
(d) 2008 FRONT-END IC 3 x 3 mm

▲ Fig. 4 Evolution of RF front-end sizes for WiFi radios.

TWT Broadband Power Amplifiers

Ideal For: Radar, EW & EMI/EMC Testing

2.5 – 7.5 GHz 500W
2.0 – 8.0 GHz 370W
6.0 – 18.0 GHz 250W
7.5 – 18.0 GHz 250W
18.0 – 26.5 GHz 45W
26.5 – 40.0 GHz 35W



Features Include:

- ***Compact Size***
- ***Forced Air Cooling***
- ***Quiet Operation***
- ***Extensive Diagnostic With Ethernet Interface***
- ***Advanced Thermal Design***

Indoor & Outdoor Applications

For additional information, please contact:
MCL Sales Department at (630) 759-9500 or sales@mcl.com
MITEQ's Component Sales Department at (631) 439-9220 or components@miteq.com



100 Davids Drive
Hauppauge, NY 11788
TEL.: (631) 436-7400 • FAX: (631) 436-7430
www.miteq.com



501 South Woodcreek Drive
Bolingbrook, IL 60440-4999
TEL.: (630) 759-9500 • FAX: (630) 759-5018
www.mcl.com

the digital interface one step closer to the antenna. In the context of complex front-end modules, the serial interface can reduce or eliminate control lines, greatly simplifying routing from the baseband chip. One could also use the serial interface to report temperature and detector voltages directly over the serial bus, thereby reducing pin-count and eliminating the need for A/D converters on the baseband chip.

Serial interfaces favor Silicon processes like CMOS and SiGe BiCMOS. Most GaAs processes lack complementary devices (pFET or PNP transistors). As a result, it is not possible to implement significant logic or logic control like a truth table on a GaAs die. Therefore, HBT, BiFET, or PHEMT-based devices would all require an external CMOS logic die to properly implement a serial interface. Consequently, if serial interface

control of PAs or RF front-ends is important, the logical choice is CMOS or SiGe BiCMOS.

CONCLUSION

There have been a number of important issues that have impacted the design of power amplifiers in recent years. This article has summarized several new issues, and has looked at how each affects the choice of technology for the power amplifier, particularly for PAs used with OFDM modulations. CMOS PAs are suitable for lower output powers, and require the use of digital adaptive predistortion to achieve linearity required for operation.

While GaAs HBT technology has traditionally been used for high power and high frequency power amplifiers, high performance SiGe BiCMOS power amplifiers are now competing very effectively with them. SiGe BiCMOS power amplifiers can be preferred to GaAs HBT PAs based on the availability of digital logic for serial interface control, as well as for the high levels of integration possible for front-end IC development. Consequently, GaAs HBT and GaAs PHEMT PAs will be used at progressively higher power levels and in more specialized applications. Slowly but surely, Silicon is progressing in the III-V versus Silicon battle on the power amplifier front. ■



Darcy Poulin holds a BS degree with honors in engineering physics from Queen's University at Kingston, and a PhD degree in applied physics from McMaster University in Hamilton, Ontario, Canada. He brings to SiGe Semiconductor more than 15 years of experience in RF engineering and IC design. He is currently principal engineer, RF Systems and Technical Marketing, and is responsible for RF systems work, standards development, and technical marketing activities for Wi-Fi, WiMAX and LTE.

PEAK PERFORMANCE VCOs

New Ultra Wideband VCOs cover 3-20 GHz in just 4 units with phase noise -90 dBc/Hz @ 100 kHz

These new ultra wide band voltage controlled oscillators feature an improved integrated voltage regulator making them even more resistant to external power variations.

By using the latest MMIC technology it has been possible to design a very small and light unit and also enhance uniform performance.

The oscillators can be ordered in two versions, as "drop in" (the V03280 series) or in SMA box (the V04280 series).

SIVERSIMA

www.siversima.com | info@siversima.com

**Have a different opinion?
We'd like to hear from
you. Send us your
comments at
mwj@mwjournal.com.**

Broadband Amplifiers by AML Communications

To Order Call: (805)388-1345 ext. 203

Model	Frequency (GHz)	Gain (dB)	Flatness (dB) max	NF (dB) max	P1dB (dBm) min	VSWR (In/Out)	DC Current @ +12/+15VDC
Broadband Low Noise Amplifiers							
AML016L2802	0.1 – 6.0	28	±1.25	1.3*	+7	2.0:1	190
AML48L3001	4.0 – 8.0	30	±1.0	1.2	+10	1.8:1	150
AML412L3002	4.0 – 12.0	30	±1.5	1.5	+10	1.8:1	150
AML218L0901	2.0 – 18.0	9	±1.0	2.2	+5	2.5:1	60
AML0518L1601-LN	0.5 – 18.0	16	±1.0	2.7	+8	2.2:1	100
AML0126L2202	0.1 – 26.5	22	±2.25	3.5*	+8	2.2:1	170
AML1226L3301	12.0 – 26.5	33	±2.0	2.8	+8	2.5:1	200

Broadband Medium Power Amplifiers

AML0016P2001	0.01 – 6.0	21	±1.25	3.2*	+23*	2.0:1	480
AML26P3001-2W	2.0 – 6.0	28	±2.5	6	+33	1.8:1	1500
AML28L3002-2W	2.0 – 8.0	30	±2.0	5.5	+33	2.0:1	2000
AML218P3203	2.0 – 18.0	32	±2.5	4	+25	2.0:1	450
AML618P3502-2W	6.0 – 18.0	35	±2.5	4	+33	2.0:1	1850

Narrow Band Low Noise Amplifiers

AML23L2801	2.8 – 3.1	28	±0.75	0.7	+10	1.8:1	150
AML1414L2401	14.0 – 14.5	24	±0.75	1.5	+10	1.5:1	130
AML1718L2401	17.0 – 18.0	24	±0.75	1.6	+10	1.8:1	150

Low Phase Noise Amplifiers

Part Number	Frequency (GHz)	Gain (dB)	Output Power (dBm)	100Hz	1KHz	10KHz	100KHz
Phase noise (dBc/Hz) at offset							
AML811PN0908	8.5 – 11.0	9	17	-154	-159	-167	-170
AML811PN1808	8.5 – 11.0	18	18	-152.5	-157.5	-165.5	-168
AML811PN1508	8.5 – 11.0	15	28	-145.5	-153.5	-158.5	-164.5
AML26PN0904	2.0 – 6.0	9	20	-150	-165	-165	-178
AML26PN1201	2.0 – 6.0	11	15	-155	-160	-160	-175

High Dynamic Range Amplifiers

Part Number	Frequency (MHz)	Gain (dB)	P1dB (dBm)	OIP3 (dBm)	DC
AR01003251X	2 – 32	21	32	52	+28V @ 470mA
AML30040125	50 – 500	23	28	53	+28V @ 700mA
BP60070024X	20 – 2000	32	30	43	+15V @ 1100mA

*Above 500MHz.



Communications

Camarillo, CA (805)388-1345 ext. 203

Over 1000+ amplifiers at

www.amlj.com

Visit <http://mwj.hotims.com/23284-10> or use RS# 10 at www.mwjournal.com/info

Power Amplifiers by Microwave Power

To Order Call: (408)727-6666 ext. 42

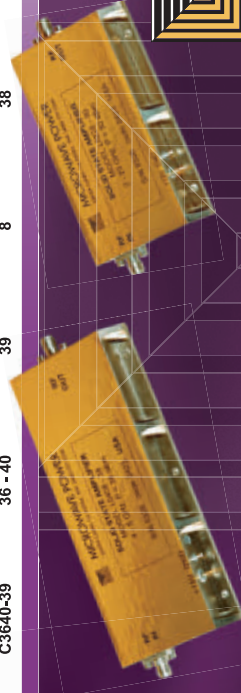
Model	Frequency (GHz)	Psat (dBm)	Psat (W)	P1dB (dBm)	Gain (dB)	DC Current(A) @ +12V or +15V
Broadband Microwave Power Amplifiers						
L0104-43	1 - 4	42.5	17.8	41.5	45	14
L0204-44	2 - 4	44	25	42.5	45	14
L0206-40	2 - 6	40	10	38.5	40	8.5
L0208-41	2 - 8	41	12	40	40	17
L0218-32	2 - 18	32	1.4	31	35	5
L0408-43	4 - 8	43	20	41.5	45	17
L0618-43	6 - 18	43	20	41.5	45	22
L0812-46	8 - 12	46	40	45	45	28

Millimeter-Wave Power Amplifiers

L1826-34	18 - 26	34	2.5	33	35	4
L1840-27	18 - 40	27	0.5	26	30	2
L2240-28	22 - 40	28.5	0.7	27	30	3
L2630-39	26 - 30	39	8.0	38	40	15
L2632-37	26 - 32	37	5.0	36	38	10
L2640-31	26 - 40	31	1.2	30	30	5
L3040-33	30 - 40	33	2.0	32	33	9
L3337-36	33 - 37	36	4.0	35	40	12
L3640-36	36 - 40	36	4.0	35	40	10

High-Power Rack Mount Amplifiers

Model	Frequency (GHz)	Psat (dBm)	Psat (W)	P1dB (dBm)	Pac (kW)	Height (in)
C071077-52	7.1 - 7.7	52.5	170	51.5	1.8	10.25
C090105-50	9 - 10.5	50	100	49	1	8.75
C140145-50	14 - 14.5	50.5	110	49.5	2	10.25
C1416-46	14 - 16	46	40	45	0.35	5.25
C1820-43	18 - 20	43	20	41.5	0.25	5.25
C2326-40	23 - 26	40	10	39	0.25	5.25
C2630-45	26 - 30	45	30	44	0.45	5.25
C3236-40	32 - 36	40	10	39	0.25	5.25
C3640-39	36 - 40	39	8	38	0.24	5.25



Microwave Power

An AML Communications Company

Santa Clara, CA (408)727-6666 ext. 42

www.microwavepower.com

Look for some serious power at

Need High Linearity for 3G?



TriQuint simplifies your 3G RF design with one of the industry's largest selections of high linearity GaAs products for base station transceiver and amplifier designs. TriQuint devices are already at work across the globe in 3G wireless network base stations. Our 3G / 4G products have the linear yet high-efficiency performance needed for WCDMA, CDMA2000, TD-SCDMA, WiMAX and LTE designs.

Your Technical Connection

PACKAGED PERFORMANCE... One Way TriQuint Simplifies RF Connectivity

"TriQuint supports every major 3G standard. Our small signal devices can be designed easily into 3G and 4G line-ups – a great fit with our RF power and BTS SAW products."

— Oleh, Design Engineering Manager
— Craig, Senior Member Technical Staff



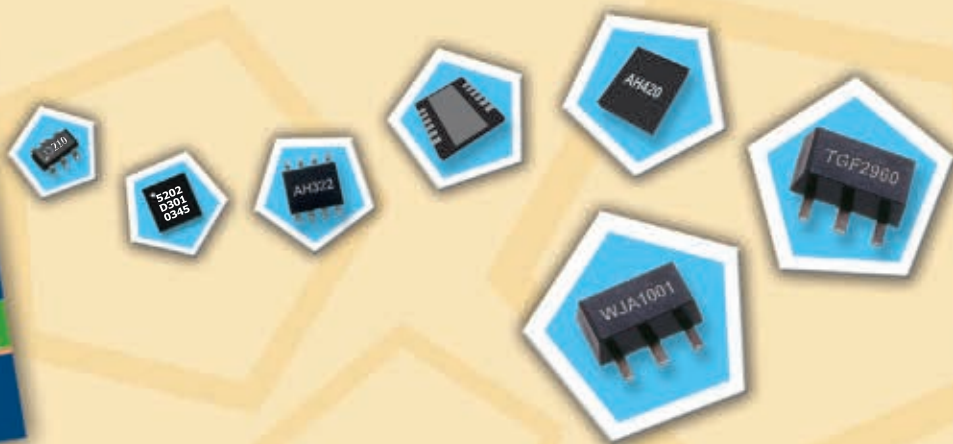
Find out how TriQuint base station innovations can improve your designs:

www.triquint.com/tech-connect/bts

Connecting the Digital World to the Global Network®

© 4-09 TriQuint Semiconductor, Inc.

www.triquint.com



3G Base Station Devices

+5V High Linearity Driver Amplifiers

Frequency Range (MHz)	Gain (dB)	P1dB (dBm)	OIP3 (dBm)	Vcc (V)	Icc (mA)	Package Type	Part Number
60 - 3500	16.5	25.5	42	5	115	SOT-89	AH128-89*
400 - 2700	15.5	28.5	45	5	160	SOT-89	AH125-89*
1800 - 2400	24.5	29.5	46	5	400	SOIC-8	AH212-S8
1800 - 2400	25.5	30.5	46	5	400	QFN	AH212-E
400 - 2700	15	31.5	49	5	300	SOIC-8	AH225-S8*
400 - 2700	13.5	33.5	50	5	500	SOIC-8	AH322-S8*
400 - 2700	14	35.7	50	5	800	QFN	AH420-E*

NOTES: * Newly released. All data shown at 2140 MHz.

+5V High Linearity RF Gain Blocks

Frequency Range (MHz)	Gain (dB)	P1dB (dBm)	OIP3 (dBm)	Vcc (V)	Icc (mA)	Package Type	Part Number
60 - 3000	14	18	36	5	70	SOT-89	AG102
60 - 3000	14	18	39	5	78	SOT-89	AM1
50 - 4000	14	22	42	5	150	SOT-89	AH1
50 - 4000	14.5	19.3	37	5	80	SOT-89	WJA1030
50 - 4000	18.5	20	40	5	90	SOT-89	WJA1021
50 - 3000	18.5	20	44	5	100	SOT-89	WJA1001

+5V High Linearity IF Gain Blocks

Frequency Range (MHz)	Gain (dB)	P1dB (dBm)	OIP3 (dBm)	Vcc (V)	Icc (mA)	Package Type	Part Number
50 - 1000	19	19	36.5	5	65	SOT-89	WJA1505
50 - 1000	14	19	38.5	5	70	SOT-89	WJA1515
50 - 1000	19.5	20.5	44	5	95	SOT-89	WJA1500
50 - 1000	14	20	47	5	95	SOT-89	WJA1510

High Linearity HFET Transistors

Frequency Range (MHz)	Gain (dB)	P1dB (dBm)	OIP3 (dBm)	Vdd (V)	Idd (mA)	Package Type	Part Number
50 - 4000	20.5	27.5	40	8	125	SOT-89	FP1189
50 - 6000	19	27	40	8	100	SOT-89	TGF2960-SD
50 - 4000	18.5	30	43	8	250	SOT-89	FP2189
50 - 6000	18	30	44	8	200	SOT-89	TGF2961-SD

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/23284-111> or use RS# 111 at www.mwjjournal.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

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, Inc. 4000 Via Pescador, Camarillo, CA 93012

Tel (805) 389-3224 Fax (805) 389-3629 sales@ciaowireless.com

Visit <http://mwj.hotims.com/23284-20> or use RS# 20 at www.mwjjournal.com/info





Northrop Grumman Selected to Develop Wireless Spacecraft Technology

Radios are wireless. Telephones are wireless. Computers are wireless. And in the next step forward in space systems, satellite equipment could become wireless too. Northrop Grumman Corp. is developing a robust, radiation-hardened, wireless spacecraft bus under a \$4.1 M, 21-month, first

phase contract from the US Air Force Research Laboratory (AFRL). A spacecraft data bus serves as the electrical interface between the spacecraft's equipment and payloads.

"The innovative program will redefine spacecraft of the future," said John Brock, Director of Mission Technology Futures for Northrop Grumman Aerospace Systems. "Wireless technology will allow us to build faster, lower cost and lighter weight spacecraft by reducing the extensive touch labor, risks and complexities associated with integrating heavy, copper wire harnesses." Under the contract, Northrop Grumman will develop a wireless data bus interface that enhances AFRL's innovative electronics architecture for spacecraft called Space Plug-n-Play Avionics or SPA. These electronics have modern features of automatic device recognition and fault detection, much like commercial computer interfaces, to enable addition and removal of equipment without any software or database changes.

The development challenge is to create hardware elements for managing messages and directing communication traffic in an RF-rich micro-environment with hundreds of wireless devices. The initial phase will conclude with a wireless standard, such as Bluetooth, and will establish protocols, design implementation guidelines, and address spacecraft unique features such as security, reliability and electromagnetic emissions management.

Called SPA—Wireless, the interface communication system will upgrade commercial wireless technology for internal spacecraft use. Upgraded space wireless devices will allow new capabilities for spacecraft to:

- Locate and track parts through assembly, integration and rework;
- Detect when tools and assembly aids are inside the spacecraft;
- Automatically assess the connectivity health of a delivered component; and
- Ease reconfiguration and self-examination using commercial off-the-shelf wireless equipment.

"Many functions in a spacecraft that currently need a wire harness are used only once, or only intermittently over the life of a satellite," Brock explained, adding that the company is continuously exploring the use of new technologies to reduce the cost of spacecraft. "These functions, such as deployment limit switches, temperature measurements, and status switches are excellent candidates for wireless."

Lockheed Martin Awarded Contract to Expand Submarine Communications

Lockheed Martin has been awarded a \$35.8 M contract by the US Navy to design and produce antenna buoy systems that will significantly expand the communications capabilities of submarines while they are submerged. The Navy's Communications at Speed and Depth (CSD) program will use expendable subma-

rine and air-launched communications buoys to enable submarines operating below periscope depth and at tactical speeds to communicate with surface ships and land-based assets via satellite networks. All classes of US Navy submarines will be equipped with this capability.

Under the contract, a Lockheed Martin-led industry team will develop three types of expendable communications buoys: two submarine-launched tethered buoys that provide real-time chat, data transfer and e-mail capabilities via either Iridium or UHF satellites; and an untethered, acoustic-to-radio frequency gateway buoy that can be launched from a submarine or maritime patrol aircraft to enable two-way data transfer between a submerged submarine and surface assets. The contract also includes production of associated shore and onboard equipment needed to support the systems. If all options are exercised, the cumulative value of the contract is estimated at \$177.9 M.

The Lockheed Martin-led team, which includes Ultra Electronics Ocean Systems and ERAPSCO, collectively has more than 50 years of experience in the design and development of expendable devices. Ultra Electronics Ocean Systems Inc., headquartered in Braintree, MA, is a world-leading developer and provider of special purpose expendable devices for US Navy submarines and surface ships as well as major allied navies. ERAPSCO, a joint venture between Sparton Electronics Florida Inc., DeLeon Springs, FL and Ultra Electronics – USSI, Columbia City, IN, is a designer and manufacturer of expendable underwater transducer and sensor products for the US Navy and its allies.

"Having the ability to communicate at speed and depth will truly transform submarine communications," said Captain Dean Richter, Program Manager – PEO C4I / Submarine Integration Program Office (PMW 770). "With this capability, submarines become a fully-integrated fleet asset with on-demand access to the Global Information Grid."

"Delivering this capability eliminates a traditional limitation of submarines by giving them the ability to communicate with maximum tactical flexibility and maneuverability," said Joe Rappisi, Vice President and General Manager of Lockheed Martin's Marion-based business. "We are partnered with the industry's best to give submarines the same access to communication networks as the rest of the US Navy's fleet."



Harris Corp. Demonstrates Highband Networking Radio Systems

Harris Corp.'s new Highband Networking Radio™ (HNR) provided interoperable, long-range backbone communications for stationary, on-the-move and airborne platforms, including the Boeing A160T "Hummingbird" Unmanned Aerial System, at the US Army's C4ISR On-the-Move Event at Fort

Dix, NJ. The radio was co-developed with BAE Systems. The event was held last summer and marked the Army's largest-ever Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) and networking technology demonstration.

The airborne communications layer provided by the A160T Hummingbird unmanned aerial system allowed Harris to demonstrate the system's ability to bridge air/ground communications between two geographically dispersed networks. The Army exercise also demonstrated that the Harris system could operate in both C-band and Ku-band simultaneously within a single, integrated network, thereby providing Brigade-and-above echelon commands with robust communications for tactical operations. During the exercise, 11 C-band and Ku-band HNR sys-

tems were demonstrated. Harris intends to support and participate in C4ISR OTM E09 and continue to leverage its relevant environment to further develop and accelerate features and capabilities in the HNR system.

"The performance achieved by the Highband Networking Radio in the C4ISR OTM event was an important milestone in the production of this product and provides continued validation of the capabilities of the Harris-developed Highband Networking Waveform™ in a variety of applications," said Wes Covell, President of Defense Programs for Harris Government Communications Systems.

The Highband Networking Radio integrates directive-beam technology with mobile, ad hoc mesh networking, and achieves burst data rates of up to 54 Mbps. It has been implemented on a variety of fixed-wing rotary-wing and airship platforms, including piloted aircraft and unmanned aircraft systems. Applications of the Highband Networking Waveform and HNR extend to numerous scenarios, including terrestrial tactical communications augmented by air-to-ground and air-to-air nodes, as well as air-and-missile defense missions. The waveform and radio also can be used to extend the battlespace network into the maritime force contingent, connecting expeditionary forces with near-shore support and blue-water platforms. HNR was recently deployed to the US Army 101st Airborne Assault Division's 2nd Brigade Combat Team in Baghdad, Iraq. ■

A Clean Sweep

The DDS Synthesizer lineup from ITT offers the cleanest phase noise performance and superior switching speeds. From our budget-conscious WaveCor SLO to several standard WaveCor rack mount models, including cost saving duals, no one offers you better digital signal generation options. And if your application requires a custom design, we can put over 20 years of DDS experience to work in building the perfect solution.

Visit our website to download data sheets.



ITT

Microwave Systems


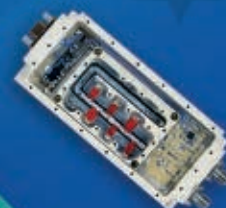
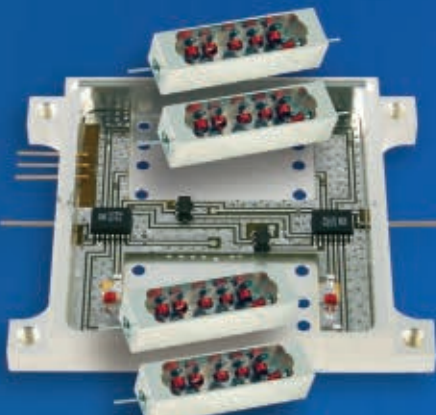
Engineered for life

978-441-0200

ittmicrowave.com



Visit <http://mwj.hotims.com/23284-43> or use RS# 43 at www.mwjjournal.com/info



RF & Microwave Filters
for the most advanced

Integrated Assemblies

LORCH
MICROWAVE

Salisbury, Maryland 21802 · USA
800.780.2169 · 410.860.5100

Brackenholme Y08 6EL. UK
Tel/Fax +44 (0) 1757 633 755

www.lorch.com

**LORCH delivers custom solutions
for demanding applications**

- high-level integration capabilities
- latest component technology
- optimized for performance and value
- all hardware designed, manufactured and assembled in-house
- time-tested baseline designs ready for customization

smiths
bringing technology to life

Visit <http://mwj.hotims.com/23284-49> or use RS# 49 at www.mwjjournal.com/info

2009 MTT-S Series

BOSTON MA



Thinking About This year's Big Series?



Choosing your allegiance in the time-honored baseball rivalry between **New York** and **Boston** is complicated.

However, choosing Reactel as your RF & Microwave filter supplier is like child's play.

Visit Reactel at booth #1504 for your chance to win tickets to cheer on **New York** or **Boston** at Fenway Park on the nights of June 9th, 10th, & 11th. Enter your name for a drawing to win a pair of tickets to each game. The drawing will be held on Tuesday, Wednesday and Thursday during the show in Reactel's booth. You must be present to win. Full details can be found in the booth during the show, or by visiting www.reactel.com/mtts-series.



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.

Visit <http://mwj.hotims.com/23284-88> or use RS# 88 at www.mwjjournal.com/info





EU Keeps Embedded System Developers Interested

The INTERoperable Embedded Systems Tool chain for Enhanced rapid Design, prototyping and code generation (INTERESTED) project has been launched. This new initiative is funded under the European Union's 7th Framework Programme.

INTERESTED is focused on the creation of the first-ever European-wide, integrated and open reference tool chain covering the full spectrum of embedded systems and software development. Its aim is to realise a reference tool chain that is highly dependable, safe and efficient while also reducing the cost of deployment and maintenance by 50 per cent. Delivery of the complete, integrated reference tool chain is expected by the end of 2010.

The project brings together the leading European embedded tool vendors, whose tools form the basis for the integrated reference tool chain, with major European embedded tool users from a variety of industries who will validate the reference tool chain against real-world design requirements and applications. As well as creating a reference tool chain that draws on leading European embedded systems and software tools, the project will also provide interoperability with Commercial Off-the-Shelf (COTS), open source and in-house embedded design solutions.

Using standards-based integration and interoperability solutions, the INTERESTED tool chain will assimilate embedded tools into three distinct design domains—system and software design, networking and execution platform, and timing and code analysis. These design domains cover the full scope of embedded systems and software engineering from system and application software design modelling, verification and code generation through networking and RTOS execution platforms to hardware-dependent software verification and code generation as well as timing analysis and code execution verification.

The INTERESTED reference tool chain is intended primarily for use by companies operating within stringent quality control requirements on the development of complex safety and mission-critical embedded systems. Such companies must generally comply with formal certification processes such as DO-178B for aerospace, IEC 61508 for industry, EN 50128 for railways, IEC 60880 for energy power plants and DEF STD 00-56 for military requirements as well as the forthcoming ISO 26262 automotive safety standard.

NGMN Releases ITDD Document

The Next Generation Mobile Network (NGMN) Alliance has launched the Initial Terminal Device Definition (ITDD) document, which

provides the generic definitions required for next generation devices and demonstrates the Alliance's commitment to providing support across the entire next generation marketplace including devices and networks.

A major objective of the NGMN Alliance is to ensure that next generation devices are available when the network is commercially available in 2010. The industry requires complete synchronicity of next generation devices, networks and services for a successful launch. The ITDD project was initiated to determine the requirements for user equipment for delivery in 2010. It defined devices that are enabled to serve common requirements while at the same time providing enough customisation to be regionally useful.

This document has initiated a sequence of Executive Workshops on Devices where all NGMN partners are committed to participate and the alliance continues to put a major focus in its work plan on the critical success factors in the device area including early device availability and capabilities, certification, test cases and IPR matters. The ITDD document can be downloaded at www.bbngmn.org.

C4AS and EADS DS Create Joint Venture

C4 Advanced Solutions (C4AS), a wholly owned subsidiary of the Emirates Advanced Investments group, and EADS Defence & Security (DS) have created a joint venture company in Abu Dhabi to develop and market high-tech solutions in the field of defence and security applications.

This joint venture company will open a long-term relationship between EADS DS and the EAI group and will be dedicated to bringing advanced solutions to its customers. Those solutions will be jointly developed by the two partner companies through the new JV company in close cooperation with customers and end users, thus maximising operational value.

This partnership is also a clear cornerstone of EADS DS and EAI strategy to address efficiently the key importance of transfer of technology to the UAE, as a successful medium for the development and implementation of strategic and nationally sensitive defence and security systems.

Next Generation Backhaul Network for Morocco

North African operator, Wana, has selected Cambridge Broadband Networks' VectaStar Next Generation point-to-multi-point microwave backhaul solution to increase the per-



formance of its backhaul network and support the introduction of mobile broadband services in Morocco. The backhaul solution provides operators with investment protection by enabling them to build cost-effective backhaul networks today with the capacity for their next generation networks tomorrow.

Wana is one of Cambridge Broadband Networks' longest standing customers. It built its first VectaStar network in 2006, which was subsequently extended in 2008 using 10.5 GHz equipment. The new equipment purchased operates at 26 GHz, exceeding the performance and flexibility levels Wana needs to build a cost-effective mobile broadband backhaul network for the future.

Such future-proofing was a key factor in the selection of the solution as Karim ZAZ, CEO of Wana, explained, "VectaStar has served Wana well as a backhaul and access product. The improved performance of VectaStar Next Generation, along with its unique simultaneous IP and TDM support, makes it the ideal technology to backhaul our mixed service mobile broadband network. Its architecture also shortens network deployment time, helping us speed network upgrades to our customers. We see it as an essential element to ensure the continued profitability of Wana."

Thales Wins ESA Contract for LTAS

Thales Alenia Space España has won a €3.8 M contract from the Directorate of Technical and Quality Management of the European Space Agency (ESA) for the development and qualification of an avionics kit to provide Launcher Telemetry Acquisition via Satellite (LTAS). This kit will be used on future missions by Ariane

5, Vega and other European launchers, and is capable of communicating via relay satellites such as the American TDRSS constellation and/or the European Artemis satellite.

As prime contractor, Thales Alenia Space España will be responsible for the design and production of an engineering model, followed by a ground compatibility test using the Artemis satellite. An in-orbit demonstration test currently planned on the second Vega flight, VERTA-1, will follow, with deliveries scheduled for 2010.

The LTAS kit is designed to be installed on a launcher to handle the mission's telemetry transmissions via satellite. The kit will encode the telemetry data from the launcher's avionics, then amplify and transmit this data via the antennas.

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

TINY TOUGHEST MIXERS UNDER THE SUN

NOW
UP TO 20 GHz!



Rugged, tiny ceramic SIM mixers from ^{\$4⁹⁵} ~~4~~ ea. qty. 1000 offer unprecedented wide band, high frequency performance while maintaining low conversion loss, high isolation, and high IP3.

Over 21 models IN STOCK are available to operate from an LO level of your choice, +7, +10, +13, and +17 dBm. So regardless of the specific frequency band of your applications, narrow or wide band, there is a tiny SIM RoHS compliant mixer to select from 100 kHz to 20 GHz. Built to operate in tough



0.2" x 0.18"

environments, including high ESD levels, the SIM mixers are competitively priced for military, industrial, and commercial applications. Visit our website to view comprehensive performance data, performance curves, data sheets, pcb layouts, 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!

U.S. Patent # 7,027,795  RoHS compliant

 **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



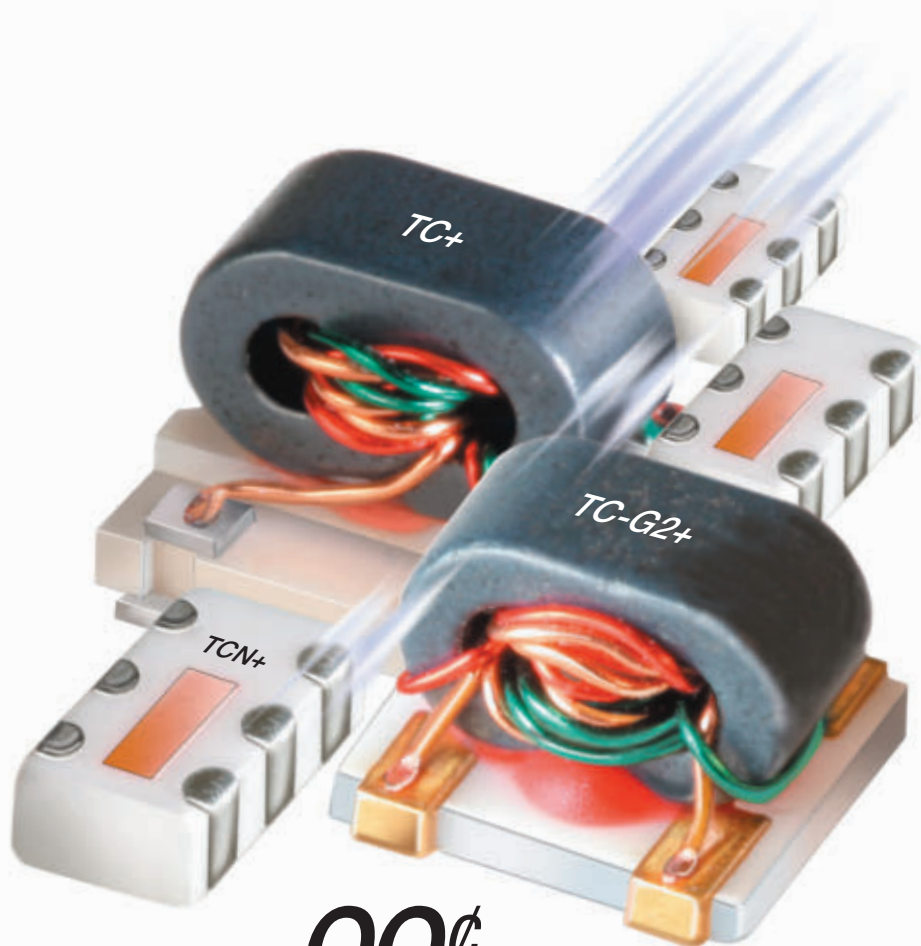
The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

IF/RF MICROWAVE COMPONENTS

428 Rev A

Visit <http://mwj.hotims.com/23284-64> or use RS# 64 at www.mwjjournal.com/info

TINY RF & MICROWAVE TRANSFORMERS



.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.



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



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

RF/IF MICROWAVE COMPONENTS

377 Rev L

Visit <http://mwj.hotims.com/23284-65> or use RS# 65 at www.mwjjournal.com/info



Semiconductor End-use Segments Will Suffer Due to Recession

The current global economic slump will be felt broadly across all semiconductor end-use market segments, reports In-Stat. This slump is unlike the 2001 downturn that was demand-driven and more strongly felt in some segments than in others.

"The automotive segment is expected to experience a 22.7 percent revenue decline in 2009 because of the price sensitivity of consumers and the lack of available credit for many potential buyers," says Jim McGregor, In-Stat analyst. "The consumer segment is also expected to lag the overall semiconductor market in 2009 as consumers cut spending, but the consumer segment should recover relatively quickly due to declining prices and consumers' willingness to spend a few hundred dollars for communications and entertainment devices while still deferring larger-priced purchases. Beginning in 2010, the consumer segment should begin growing as an overall percentage of the semiconductor market once again, reaching 21.4 in 2013."

Recent research by In-Stat found the following:

- Long term, the computer segment will lose share while the consumer and automotive segments gain share.
- The computer segment will remain the largest well beyond 2013 at 40.7 percent of total semiconductor revenue.
- Total semiconductor revenue is expected to drop by 19.6 percent in 2009, but should eclipse 2008 revenue at \$265.9 B in 2012.

The research, "Global Semiconductor End-use Forecast: Is Anyone Buying?," covers the worldwide market for semiconductors. It includes:

- Worldwide semiconductor unit, average selling price (ASP) and revenue forecasts
- Worldwide semiconductor revenue forecasts by end-use market segments broken out by region and by major WSTS product category
- Regional semiconductor revenue forecasts broken out by major end-use category
- Semiconductor major product category forecasts broken out by end-use market segments

WiMAX Subscriber Revenue Will Grow in 2009

Any reader who believed all the recent headlines would feel confident that the WiMAX market is being crushed by LTE. Nortel has left the WiMAX market and Alcatel-Lucent has "backed off" from WiMAX; these developments supposedly dealt a blow to Clearwire, which had so far chosen neither as an infrastructure

vendor. But that is not quite the whole story.

Nortel exited the mobile WiMAX market because it failed to become competitive and win any significant business. Nortel is staying in the fixed WiMAX market. Alcatel-Lucent did not really back away from mobile WiMAX, but rather views it more as a wireless broadband solution than a fully mobile wireless solution. Alcatel-Lucent moved R&D spending from WiMAX to LTE since WiMAX is productized while LTE is just starting to develop. The lines are very blurred between fixed/portable use of mobile WiMAX and fixed/portable/mobile use of mobile WiMAX. Many deployments will start with fixed and portable services first and may evolve to fully mobile use later.

"Contrary to the popular view, Alcatel-Lucent is still quite involved with mobile WiMAX," says ABI Research principal analyst Philip Solis. "The company has had its 3.5 GHz products certified by the WiMAX Forum; its 'ng Connect' program includes mobile WiMAX; and it is working with Intel on an interoperability program for mobile WiMAX devices. In addition, Alcatel-Lucent ranks first in 2008 market share for mobile WiMAX base station deployments, followed by Alvarion, Motorola and Samsung." WiMAX has many growth opportunities beyond traditional mobile operator networks, including data-centric deployments in both developed and developing regions. "To ignore a growth market in a down economy would be a mistake," adds Solis. Growth will be more modest for WiMAX base stations by themselves for 2009, but 2010 will see healthy expansion.

800,000 Alternative Energy-powered Base Stations in 2009

No one can deny that green and clean agendas are rising to the surface in the mobile communications market. ABI Research forecasts that in 2009 over 800,000 base stations will utilize alternative energy solutions such as wind or solar energy, and that nearly 70 million mobile devices will be ethically disposed of or will be recycled in 2009.

To meet the growing need for detailed market information about these green initiatives, ABI Research has launched a new Clean Telecoms Research Service.

Vice President and Chief Research Officer Stuart Carlaw says, "One only has to look at the splash of solar powered mobile devices at Mobile World Congress 2009 to see that environmentally friendly solutions are becoming increasingly important to mobile consumers, service providers, application developers and OEMs alike. Renewable energy will be a critical aspect in connecting the next two billion subscribers in off-grid and brown power areas. Not only is it environmentally friendly, but it is also extremely cost effective."

The new ABI Research Clean Telecoms Research Service covers important aspects such as energy consumption, renewable energy penetration, manufacturing and materials usage, corporate responsibility, regulatory issues, recy-



cling, and product end-of-life management in the key areas of radio access and core networks, devices and services.

US Consumers Could Drop Spending on Mobile, Broadband and Pay TV Services

In-Stat's recent survey reveals that broadband service is among the most integral parts of consumers' lives. Over 66 million consumers across demographic categories are using the Internet while camped out on their sofas watching TV.

"Some male age groups had 40 to 50 percent of respondents using a PC while watching TV, and about 30 percent of females under the age of 40 are also using a PC while watching TV," says Gerry Kaufhold, In-Stat analyst. "New approaches using online web portals synchronized to a TV program will continue to develop, because they pres-

US consumer spending on Subscription-TV, Broadband and Mobile Services will be "about the same" for most consumers, but about 15 percent intend to cut back. As a result, In-Stat estimates that consumer spending across these three segments could see nearly a \$5 B decrease during the next 12 months. Yet

ent no new costs. Cable TV operators also face increasing competition from lightweight services that deliver popular cable programming, supplemented by content delivered via broadband."

Recent research by In-Stat found the following:

- Consumer multitasking while watching TV varies significantly depending on demographic characteristics.
- Several companies are identifying new opportunities to "marry" TV to people simultaneously viewing a related website, and transform the World Wide Web into a "lean back" experience.
- Low-cost Netbook PCs could represent a \$2.4 B opportunity.
- The biggest decrease in spending on mobile, broadband and subscription TV services will come from households with income below \$35 K.

The research, "US TV Viewers Response to Economic Turmoil," covers TV viewing habits in the US. It includes:

- Analysis of impact of current economic downturn on consumer behavior regarding TV viewing, broadband use, and spending across mobile, broadband and subscription TV.
- Results and analysis of a late 2008 US consumer survey on TV viewing, Internet usage habits and multitasking while watching TV.
- Examination of consumers' interest in Internet TV services.

Need Oscillator Performance that's Off the Charts?



T1177 TCXO
9 x14 mm Pkg.,
Frequency to 800 MHz



T124 TCXO *New Product!*
V. Low Freq., Tight Stability
Compact, Rugged Pkg.



YH1420 OCXO *New Product!*
Very Tight Stability
to ± 0.1 ppm



T1300 TCXO
Ultra-low g-Sensitivity
Low Power & Superior
Phase Noise performance



T77 TCXO
Rugged 5x7 mm Pkg.,
1mA Draw typical,
Stability to ± 0.5 ppm

You need Greenray.

Greenray oscillators offer Frequency Stability of 1 ppm or less in a variety of packages and are available from 1 Hz to 1 GHz.

With excellent vibration, shock and acceleration sensitivity for use in mobile and airborne applications, our oscillators also deliver optimum stability and phase noise characteristics. The stability performance of several of our TCXOs matches that of an OCXO, but without the excessive power draw and warm-up time.

With over 45 years of experience, we utilize leading edge design and innovative manufacturing techniques to produce oscillators for the military, communications, SATCOM, GPS, and instrumentation markets, as well as for emerging technologies like WiMAX.

For more information and to receive our latest product catalog call today, e-mail, or visit us online.



**T77 TCXO Shown
Actual Size**



www.greenrayindustries.com

TEL 717-766-0223 FAX 717-790-9509 sales@greenrayindustries.com





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.

Advancing the
wireless revolution™

Visit <http://mwj.hotims.com/23284-16> or use RS# 16 at www.mwjjournal.com/info

AXIEM
3D PLANAR EM



INDUSTRY NEWS

■ **IEEE**, the world's largest technical professional society, signed a merger agreement with the honor society **Eta Kappa Nu** (HKN), a nonprofit, public-service organization comprising nearly 200 university chapters. The merger, which will go into effect by mid-2009 pending final approval, will make HKN the official honor society of IEEE, recognizing scholarship and academic excellence and identifying student leaders, young professionals and eminent scholars in the IEEE's technical fields of interest. Under the agreement, HKN will become an organizational unit of IEEE, governed by the new IEEE-HKN Board of Governors. A restricted endowment will be created in the IEEE Foundation to support HKN's educational, societal and recognition activities. In addition to holding HKN's current assets, the new endowment will receive an initial donation of US\$1.2 M from IEEE.

■ **The Vitec Group**, a worldwide provider of a wide range of equipment and services to the broadcasting, entertainment and photographic industries, announced the establishment of **RF Extreme LLC**, a new business unit within the company that comprises leading digital and analog video microwave brands, Nucomm, RF Central and Microwave Service Co. (MSC).

■ The **Lumexis** Fiber To The Screen (FTTSTTM) system is airborne with the assistance of **Tyco Electronics**. This new system brings weight savings and unprecedented capability to the commercial airline industry as demonstrated during the maiden flight of the US Airways A320 launched February 3, 2009. The products supplied by Tyco Electronics aided a problem-free installation for the first US Airways A320 aircraft in Rome, NY. As an example of its commitment to customer satisfaction, Tyco Electronics closely assisted in the installation process, contributing to the successful delivery.

■ Based upon the success of the recent Tech Tours held in Bangalore and Chennai, India, **ETS-Lindgren** and **Agilent Technologies** announced plans to add three new cities in India to the Tech TourTM schedule for 2009. Newly added locations include Delhi, Pune and Hyderabad—all coming in June, 2009.

■ **AWR**, an innovation leader in high frequency electronic design automation (EDA), and **Anritsu Co.**, a global provider of test and measurement solutions, announced AWR ConnectedTM for Anritsu, which makes Microwave Office high frequency design software a standard component of Anritsu's new VectorStar MS4640A vector network analyzer (VNA). AWR Connected for Anritsu makes the MS4640A the first microwave instrument to physically integrate a full suite of design tools within its firmware. Microwave Office software provides all the tools necessary for high frequency IC, printed circuit board, and module design, including linear circuit simulators, electromagnetic (EM) analysis tools, and integrated schematic and layout, without leaving the measurement environment.

AROUND THE CIRCUIT

■ **Visible Assets Inc.** announced that the Institute of Electrical and Electronics Engineers (IEEE) has approved RuBee®, a long-wavelength, packet-based, magnetic transceiver protocol, as a new international standard designated IEEE 1902.1. Visible Assets and **Seiko Epson Corp.** sponsored creation of the standard and the workgroup and are responsible for its development.

■ **Freescale Semiconductor**, a supplier of 802.15.4 chipsets, announced it has shipped more than seven million IEEE® 802.15.4 and ZigBee® units in 2008 for the wireless sensor networks used in smart energy, industrial control and home entertainment applications.

■ **VXI Technology Inc.** announced that it has changed its name to **VTI Instruments Corp.** to more completely represent the applications and markets that it serves. VTI Instruments develops precision instrumentation for electronic signal distribution, data acquisition and monitoring on several open architecture platforms, including VXI, VME and LXI, which the company co-founded in 2004.

■ **Elcoteq SE**, an electronics manufacturing services (EMS) company in the communications technology industry, marks the 10-year anniversaries of its Dongguan high volume manufacturing plant and its Hong Kong management support office in China. Elcoteq was one of the first EMS companies to recognize Chinese customer demand for local manufacturing and support services, establishing Elcoteq Dongguan and Elcoteq Asia Ltd. in 1999. Elcoteq factories in China manufacture communications technology products such as wireless communications terminal products, home communications products and network equipment.

■ **L-com Global Connectivity Inc.** has announced that its Boca Raton, FL facility has been ISO 9001-2008 certified. This location houses engineering, sales and manufacturing for L-com's HyperLink brand wireless products.

■ **Laird Technologies Inc.**, a global leader in the design and supply of customized, performance-critical components and systems for advanced electronics and wireless products, was chosen in a global selection as one of the Top 100 M2M companies for 2009 by *M2M Magazine*.

CONTRACTS

■ **Herley Industries Inc.** announced that it has received an option award exceeding \$4.7 M to supply Tactical Instrument Landing Systems (TILS) for both the F/A-18E/F/G and E-2D Naval aircraft. The AN/ARA-63 TILS is a microwave landing system that provides precise elevation and azimuth guidance information necessary for critical aircraft carrier landings.

■ **Elcom Technologies Inc.** announced receipt of orders totaling \$2.4 M for Elcom's UFS and IBS lines of frequency synthesizers. The orders reflect Elcom's growing market share in threat simulation and antenna test, respectively.

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

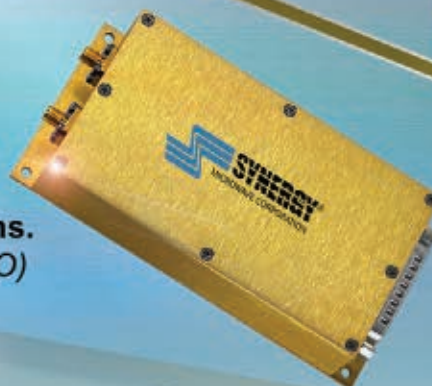
Programming Interface:

- 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

- Low phase noise option
- Low phase noise option



Coming Soon!

4 to 8 GHz

Available Frequencies Ranging Up To 8000 MHz



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@synergymw.com
Visit <http://mwj.hotims.com/23284-106> or use RS# 106 at www.mwjjournal.com/info
Visit Our Website At WWW.SYNERGYMWAVE.COM

Elcom believes the orders reflect an increasing need by defense contractors and defense departments around the world to more accurately emulate aggressor capabilities as combat aircraft are exposed to increasingly sophisticated hostile environments. Elcom was selected due to its leading fast switching speed capabilities, low phase noise, high frequency agility, fine frequency resolution and flexible modulation & attenuation.

■ **RF Industries Ltd.** announced that its **RadioMobile** division has received a \$76,000 follow-on purchase order to provide IQ Mobile systems to a major California County Fire Agency.

■ **RF Micro Devices Inc.** (RFMD), a designer and manufacturer of high performance semiconductor components, announced the company's RF7168 dual-band GSM/GPRS transmit module (TxM) has been selected to support multiple **MediaTek** GSM/GPRS handset platforms based on MediaTek's MT6139 and Othello®-G transceivers. MediaTek is a provider of GSM/GPRS cellular platforms and accounts for the majority of GSM/GPRS handsets produced by handset manufacturers in China.

■ The US Air Force recently announced that it has selected **KOR Electronics** to design, build and deliver three of its latest generation Radio Frequency Target Generators (RFTG). Designed specifically to handle a broad spectrum of radar, RF and target generation applications, the RFTG designs will integrate highly sophisticated software and state-of-the-art microwave components to orchestrate solutions to overcome some of the most challenging problems in high fidelity RF signal generation.

■ **TriQuint Semiconductor**, an RF product manufacturer and foundry services provider, announced that it has fulfilled initial production orders from **Northrop Grumman Corp.** to support the F-35 Lightning II fire control radar system. The F-35, also referred to as the Joint Strike Fighter (JSF), is being developed by Lockheed Martin Corp. with primary partners Northrop Grumman and BAE Systems. The program is forecast to deliver several thousand aircraft by the mid-2030s.

FINANCIAL NEWS

■ **Exalt Communications**, a provider of high performance licensed and license-exempt microwave radio systems for wireless backhaul applications, announced that it has raised \$15 M in Series C funding. InterWest Partners led the financing, joining existing investors Velocity Interactive Group and Trinity Ventures, who were full participants in the round, on the company's board of directors. Exalt will use the funds to accelerate international growth, expand marketing and sales to carriers, governments and enterprises, strengthen its presence in North America and continue expanding its product portfolio.

■ **Wavesat Inc.**, a supplier of broadband wireless semiconductor solutions, announced the company has secured its latest round of funding, raising \$11.7 M CAD. Existing

investors led by BDR Capital, BDC Capital and Multiple Capital participated in the round. Proceeds will be used to further strengthen the company's leadership position in the 4G Broadband market.

NEW MARKET ENTRIES

■ **RF Connections**, a woman owned small business, is a new concept in business representation and technical consulting. President and founder of RF Connections, Ruth Fawson, worked alongside some of the pioneers of the RF connector industry for more than 40 years and has extensive experience with RF connector and cable assembly design. Fawson represented her former company's interests at military and industry connector meetings and spearheaded QPL programs as project manager and design engineer. RF Connections offers manufacturer representation at key military accounts. Technical consulting includes creation and implementation of custom training modules, research reports applicable to the defense market and technical design services. RF Connections is also an independent woman owned, small business distributor of custom and difficult to find microwave product. For more information, visit www.rf-connections.com.

■ **DKN Research**, a research and engineering firm in Haverhill, MA, and **NY Industries**, a circuit board manufacturer in Ohtsu, Japan, launched a prototype and engineering service for Printable Electronics. The firms utilize state-of-the-art facilities and offer a broad range of experience with printing technologies for microelectronics and packaging. For more information, visit www.dknresearch.com.

PERSONNEL

■ **Yoichiro Kega** has been appointed president for ALPS Electric Europe GmbH. Based at the European headquarters in Düsseldorf, Germany, he will be responsible for further strategic developments and the successful implementation of the company's products in the European market. Kega has worked for ALPS for almost 25 years in different positions including European sales manager and domestic sales senior manager at the headquarters in Japan and as business planning manager at ALPS Peripheral Division.



▲ Yoichiro Kega

■ Crane Aerospace & Electronics, a segment of Crane Co., has announced the appointment of **Charles "Bud" Jewett** as business development director for the Electronics Group. Jewett will be responsible for strategic business relationships, partnerships and new business development. He will be based in Annapolis, MD. Prior to joining Crane, Jewett worked in business development with Harris Government Communications Systems where his focus included US Naval communications, data links and networking solutions. Jewett is a retired US Navy Captain with 30 years of experience as a Naval Flight Officer and a leader in acquisition and systems engineering at the Naval Air Systems Command.

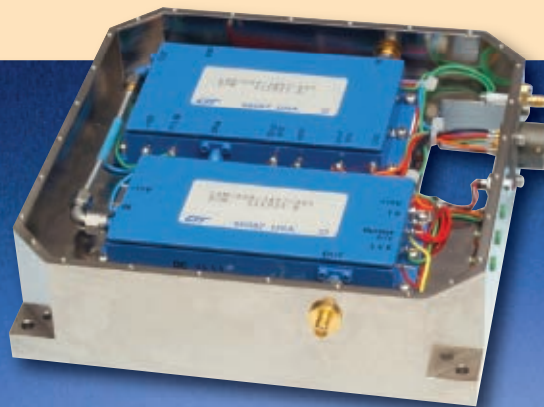


▲ Charles "Bud" Jewett

UAVs: Force Multipliers

CTT: CDL-Compatible Solutions

Ground ❖ Air ❖ Space



The DoD's Roadmap forecasts the inventory of UAVs to quadruple by the year 2010. Capabilities of UAVs require CDL (common data link)-compatible formats for LOS (line-of-site) and BLOS (beyond-line-of-site) communication. CTT, Inc. has developed a family of GaAs-based solid-state amplifier products and subassemblies designed to accommodate these requirements.

CTT's UAV experience includes participation in data and video communication links on programs including Hunter, Predator, Pioneer, Global Hawk and others.

Building on this experience, CTT is well positioned to offer engineering and production technology solutions — including high-rel manufacturing — in support of your UAV data link requirements.

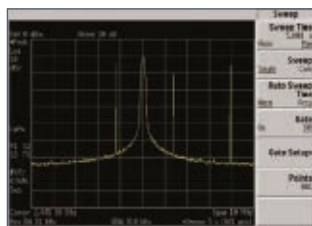
More than twenty years ago CTT, Inc. made a strong commitment to serve the defense electronics market with a simple goal: quality, performance, reliability, service and on-time delivery of our products.

Give us a call to find out how our commitment can support your success. It's that simple.

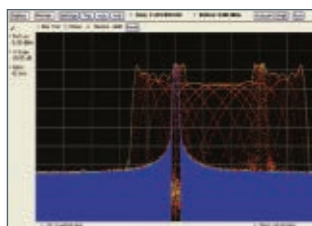
- ❖ **Up Converters and Transceivers**
 - C thru Ka-Band
 - Compact, Space-Saving Designs
- ❖ **High Data Rate and Video Amplifiers**
 - Ultra-Wideband
 - Up to 40 GB/Sec
- ❖ **Up and Down Link Amplifiers**
 - C thru Ku-Band
 - Up to 25 Watts
- ❖ **Surface Terminal Amplifiers**
 - C thru Ku-Band
 - Up to 100 Watts
- ❖ **CDL (Common Data Link) Subassemblies**
 - IF and RF
 - Digitally Controlled

Visit <http://mwj.hotims.com/23284-27> or use RS# 27 at www.mwjjournal.com/info

241 East Java Drive • Sunnyvale • California 94089
Phone: 408-541-0596 • Fax: 408-541-0794 • www.cttinc.com • E-mail: sales@cttinc.com



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.

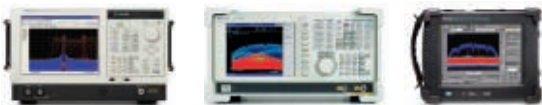
Tektronix DPX Technology—See What You've Been Missing.

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.

■ Lark Engineering announced the appointment of **Paul Courville**, Design Engineering Operations, whose responsibilities include R&D, designing and implementing into production new multi-function microwave designs. Previously, Courville worked for REMEC Defense & Space, 147th Combat Communication Squadron and Cohu Electronics.

■ Sabritec, a custom connecting devices manufacturer, announced the addition of **Robert Fake** to its sales and



▲ Robert Fake

marketing staff as western regional sales manager. Fake brings a great deal of insight and experience into the company's organization working for over 20 years in OEM sales and product marketing management primarily within the engineering interconnect industry. Most recently, Fake was the business development manager with a major military cable solution provider. His

knowledge in a wide variety of connector products will provide the necessary support to all of the company's product lines in support of its rapidly growing business. Fake will be based out of Orange County, CA, and be focused on business development, market expansion, sales rep and major account management for the western region of the US.

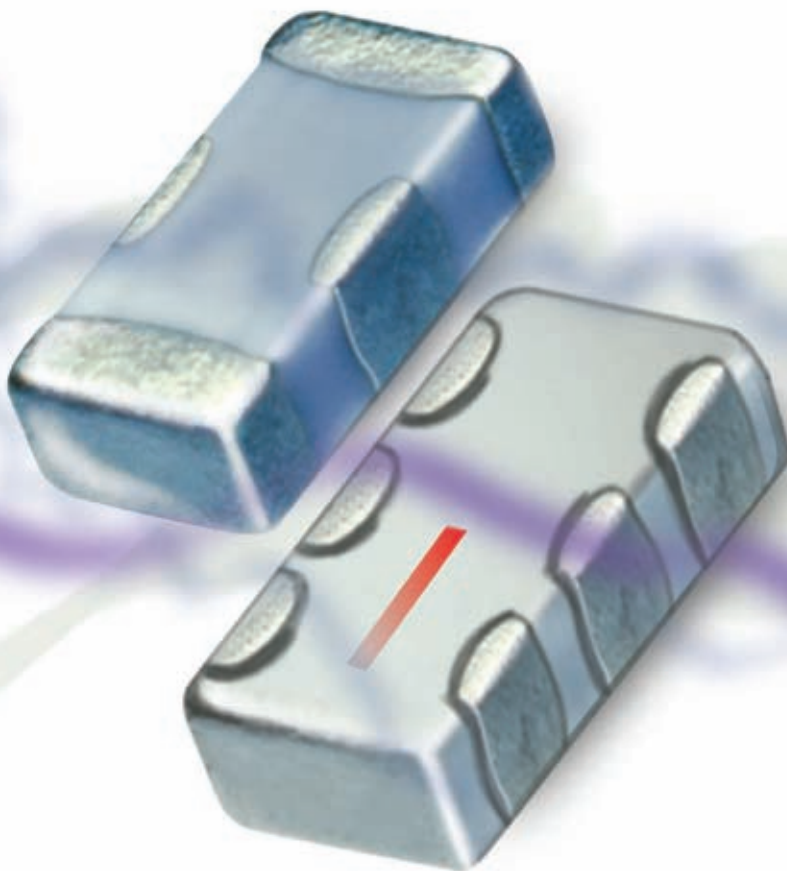
REP APPOINTMENTS

■ **San-tron Inc.**, a manufacturer of RF coaxial connectors and cable assemblies, has announced the hiring of a new field sales representative to handle customer relationships in Istanbul, Turkey. **IMCA Elektronik** is a knowledge-based marketing company specializing in generating demand in the electronic components and semiconductors industry. Located in Istanbul, Turkey, IMCA will be servicing accounts for customers throughout the country. They can be reached by phone at +90 212 483 39 12, e-mail info@imca.com.tr, or on the web at www.imca.com.tr.

■ **Modelithics Inc.** announced that **ICON Design Automation Pvt. Ltd.** will be the company's representative in India. Modelithics and ICON Design Automation have signed a comprehensive agreement designed to support India's market for high accuracy RF and microwave simulation models and characterization services.

■ **Mouser Electronics Inc.** announced it reached a worldwide distribution agreement with **Vectron International**, an industry leader in precision frequency control products. Mouser's stock includes Vectron's crystal oscillators and surface acoustic wave (SAW) products.

■ **XMA** welcomes **NW Sales LP** as the company's manufacturer representative for the TX, AR, OK, LA territory. Established in 1972, NW Sales is a well-respected manufacturers' representative firm serving the leading OEMs in the commercial, defense and petrochemical markets in the four-state territory of Texas, Oklahoma, Louisiana and Arkansas.



CERAMIC FILTERS

LOW PASS AND HIGH PASS



*Value Packed
Recession Busters!*

from **99¢** ea. qty. 1000

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.

Over 120 models...80 MHz to 13 GHz

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 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!

Wild Card KWC-LHP LTCC Filter Kits only \$98

Choose any 8, LFCN, HFCN models.

Receive 5 of ea. model, for a total of 40 filters.

Order your KWC-LHP FILTER KIT TODAY!



 **RoHS compliant** U.S. Patent 6,943,646

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



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

IF/RF MICROWAVE COMPONENTS

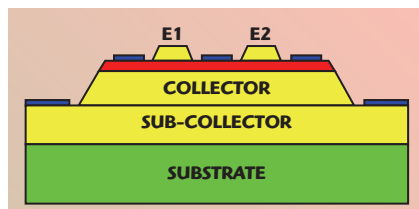
432 Rev D

Visit <http://mwj.hotims.com/23284-66> or use RS# 66 at www.mwjjournal.com/info

A CUSTOM III-V HETEROJUNCTION BIPOLAR TRANSISTOR MODEL

Communication systems today comprise the major use of GaAs technology with the highest volumes found in the cellular handset front-end. Here, heterojunction bipolar transistor (HBT) power amplifiers (PA) and Pseudomorphic High Electron Mobility Transistor (PHEMT) switches enjoy a comfortable market share. In this environment, the demands of production design require a robust CAD system with accurate and verified compact models for both active and passive devices. In this paper, we will outline some of the work done at RFMD® to develop and support scalable HBT models suitable for handset power amplifier design.

In the first section, a brief outline is given of the evolution of a custom HBT model from a basic Gummel-Poon formulation to one encompassing more GaAs physics. It is written in Verilog-A and runs in multiple environments. In the second section, a model of a single device is shown that can be scaled to simulate the behavior of large output arrays. This will include both electrical and thermal aspects. Finally, we will present validation data to illustrate the performance of the model.



▲ Fig. 1 Cross-section of two-finger HBT (not to scale).

A cross-section of a simple two-finger HBT is shown in **Figure 1**. In these devices, the emitter is made of a wider bandgap material such as AlGaAs or InGaP while the base has a narrower bandgap, typically GaAs. In a single-heterojunction device, the base, collector and sub-collector will all be of the same material, while in a double-heterojunction bipolar transistor (DHBT) the collector will use a wider material. The energy band diagram for the more general DHBT is shown in **Figure 2**. In these systems, the potential barrier seen by base holes in the valence band is higher than that seen by emitter electrons in the conduction band. This results in higher emitter injection efficiency, leading to higher gain. In a conventional homojunction bipolar junction transistor (BJT), high injection efficiency requires a highly doped emitter and a thicker, lower doped base, increasing the base resistance and base transit time. The theory behind this dates back to the early days of the transistor.¹

SONJA R. NEDELJKOVIC, JOHN R. McMACKEN, PAUL J. PARTYKA AND JOSEPH M. GERING
RFMD, Greensboro, NC

Massachusetts Bay Technologies, Inc. (MBT)

specializes in the design, manufacture, and distribution of RF/Microwave semiconductor diodes. MBT is committed to the continuance of innovations in service to its customers, improvement of design, product performance, and quality control.

MBT's product frequencies range from 100Hz up to and including millimeter wave; our quality devices are used in various industry applications such as university and laboratory research, consumer products, telecommunications, aerospace and military.

MBT's consistent objective is to provide a superior product with unsurpassed customer service to our clients. Our engineers are available to discuss your specific design and application requirements that is both cost and time effective. We look forward to providing you component expertise and a quality product.

MBT's product line includes the following RF/Microwave devices:

- Abrupt Tuning Varactors Diodes
- Hyperabrupt Tuning Varactors Diodes
- Step Recovery/Multiplier Diodes
- PIN/Beam Lead PIN/Limiter Diodes
- Point Contact Diodes
- Schottky Diodes
- MIS Chip Capacitors
- Custom Designed Components

Are you looking for a discontinued Alpha Industries, Frequency Sources, Hewlett Packard, M/A-Com, Microwave Associates, MEDL, Motorola, NEC, Philips, Parametric Industries, Siemens, Thomson CSF, Toshiba, or Varian part? MBT will cross reference and manufacture your discrete, obsolete, or custom RF/Microwave application.



Visit <http://mwj.hotims.com/23284-52> or use RS# 52 at www.mwjjournal.com/info

MASSACHUSETTS BAY TECHNOLOGIES

RF/MICROWAVE SEMICONDUCTORS

Motivated By Performance, Focused on Reliability®

Massachusetts Bay Technologies, Inc 378 Page Street Stoughton, MA 02072 • Tele: 781-344-8809 • Fax: 781-341-8177

• Website: www.massbaytech.com • Email: sales@massbaytech.com

© 2009 Massachusetts Bay Technologies, Inc. All trademarks of Massachusetts Bay Technologies

THE HBT MODEL

DC Operation

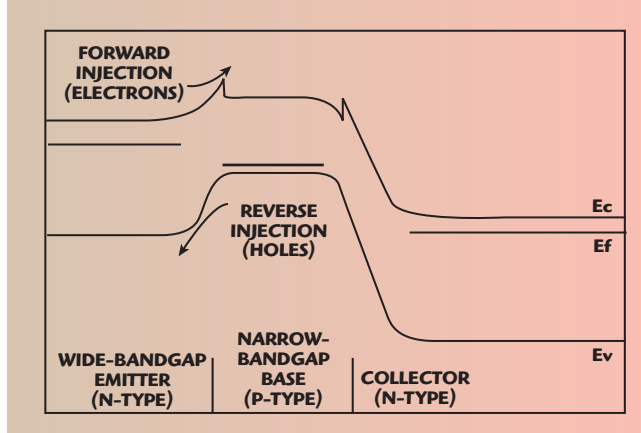
The large-signal equivalent circuit used in the model is shown in **Figure 3**. In typical fashion, we divide the device into intrinsic and extrinsic sections. To characterize the DC behavior, we need to develop expressions for the emitter-collector transport current (I_{CE}) and the two base diodes that create it (I_{BE} , I_{BCi}). We begin with the Gummel-Poon formulation for the forward current² (due to injection across the base-emitter junction).

$$I_{CF} = \frac{I_{SF}}{q_B} \left[e^{\frac{V_{BE}}{N_F V_T}} - 1 \right] \quad (1)$$

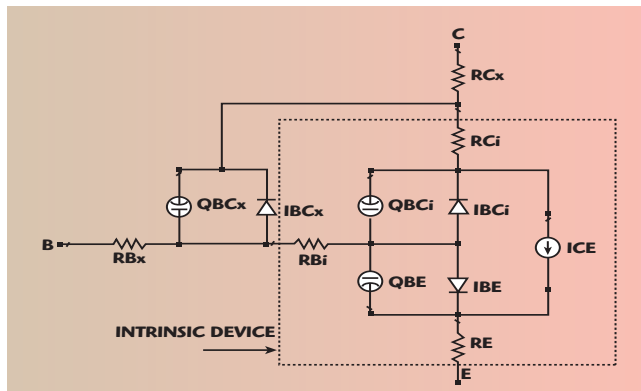
Here, q_B is the hole charge in the base normalized to its equilibrium value (i.e., $q_B = Q_B/Q_{B0}$). Thus, at zero bias $q_B=1$. Similarly, the reverse transport current is written as

$$I_{CR} = \frac{I_{SR}}{q_B} \left[e^{\frac{V_{BC}}{N_R V_T}} - 1 \right] \quad (2)$$

and the total current is simply the difference between the two: $I_{CE}=I_{CF}-I_{CR}$. Note that we have used separate saturation currents (I_{SF} , I_{SR}) and ideality factors (N_F , N_R) for forward and reverse operation. In conventional silicon homojunction devices this is not necessary since the reciprocity principle ensures that both currents are equal for equal bias. In HBTs, however, the presence of conduction band spikes at the junctions can give rise to additional trans-



▲ Fig. 2 Energy band diagram of a HBT.

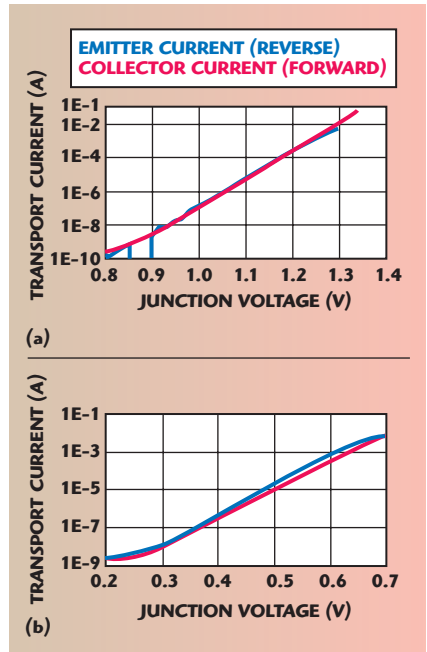


▲ Fig. 3 Large-signal equivalent circuit for RFMD HBT model.

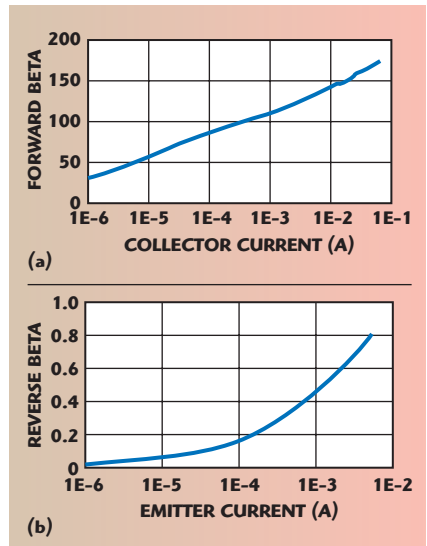
port mechanisms such as thermionic emission and tunneling. If these are significant, we need the flexibility of the additional parameters. To illustrate this, consider the forward and reverse Gummel plot for a single-heterojunction AlGaAs/GaAs device, as shown in **Figure 4 (a)**. In this technology, the emitter/base interface was graded to minimize the conduction band spike. The slope and intercept of the “ideal” part of the current is the same and could be modeled using one I_S and N . **Figure 4 (b)**, on the other hand, shows the same measurements for an InP DHBT. With conduction band spikes at both the emitter-base and base-collector junctions, the additional parameters are necessary.

Similar flexibility is required in modeling the base current. The DC current gain of an HBT is non-linear and cannot be written as the transport current divided by some beta parameter. Consider the plots of DC beta (forward and reverse) versus current shown in **Figures 5 (a)** and **(b)**. Not only is there a large variation in gain, but the forward and reverse beta differs by two orders of magnitude. Thus, we use separate saturation currents and ideality factors for both ideal and leakage components:

$$I_{BE} = I_{SH} \left[e^{\frac{V_{BE}}{N_H V_T}} - 1 \right] + I_{SE} \left[e^{\frac{V_{BE}}{N_E V_T}} - 1 \right] \quad (3)$$



▲ Fig. 4 Forward and reverse collector-emitter current for a graded AlGaAs/GaAs single heterojunction (a) and an InP double heterojunction (b) transistor.



▲ Fig. 5 Forward beta- I_C/I_B (a) and reverse beta- I_E/I_B (b) for an AlGaAs HBT.

Aethercomm salutes our armed forces!

Another industry first from Aethercomm:
a 20 MHz to 6000 MHz 10 Watt
RF amplifier in a single module!



**Aethercomm thanks the
U.S. Military for a job well done.**

We design & manufacture RF amplifiers and systems
used for Force Protection and other life saving missions.
Aethercomm products are combat proven and operate in the
harshest environments on the earth.

Featured Product : SSPA 0.02-6.00-10

- GaN technology
- 20 MHz to 6000 MHz bandwidth
- 10 Watts PSat output power typical
- 50 dB small signal gain typical
- 28 Vdc operation
- +/- 3 dB gain flatness typical
- -40C to +85C base plate operation
- 2.5" (w) x 6.4" (l) x 1.0" (h)

Applications:

- EW Jamming
- Broadband Communications
- Test and Measurement

Contact Aethercomm with your RF amplifier requirements.

Visit <http://mwj.hotims.com/23284-6> or use RS# 6 at www.mwjjournal.com/info



Tel 760.598.4340

Fax 760.598.4342

sales@aethercomm.com

www.aethercomm.com



$$I_{BC} = I_{SRH} \left[e^{\frac{V_{BC}}{N_{RH} V_T}} - 1 \right] + I_{SC} \left[e^{\frac{V_{BC}}{N_C V_T}} - 1 \right] \quad (4)$$

Next we consider the normalized hole charge q_B . In the standard Gummel-Poon method, two effects are normally considered that will change the hole charge from its equilibrium value. The first is the Early effect³ in which the width of the un-depleted base changes with bias (Equation 6). The second is the high-current Kirk effect⁴ in which the base region can push out into the collector (Equation 7). The two effects are combined into Equation 5.

$$q_B = \frac{q_1}{2} + \sqrt{\frac{q_1^2}{4} + q_2} \quad (5)$$

where

$$q_1 = 1 + \frac{V_{BE}}{V_R} + \frac{V_{BC}}{V_F}, \text{ and} \quad (6)$$

$$q_2 = \frac{I_S}{I_{KF}} \left[e^{\frac{V_{BE}}{V_T}} - 1 \right] + \frac{I_S}{I_{KR}} \left[e^{\frac{V_{BC}}{V_T}} - 1 \right]$$

In HBTs with their highly-doped bases, the Early effect is not significant but we have left the parameters in mainly for nostalgia. There are, however, a variety of high-current

effects. Using this formulation, the high current limit of I_{CE} tends to

$$I_{CE} \approx \sqrt{I_S I_{KF}} e^{\frac{V_{BE}}{2V_T}} \quad (7)$$

(i.e., a fixed ideality factor of 2.0). For HBTs we need more flexibility and thus we add an additional expression to q_B , similar to the one used in the Agilent HBT model.⁵

$$q_B = \frac{q_1}{2} + \sqrt{\frac{q_1^2}{4} + q_2} + \frac{I_S}{I_{SA}} e^{\frac{V_{BE}}{N_A V_T}} + \frac{I_S}{I_{SB}} e^{\frac{V_{BC}}{N_B V_T}} \quad (8)$$

TEMPERATURE MODELING

The most common approach to temperature modeling is to make some subset of the parameters functions of either a ratio or difference of the junction temperature to some reference temperature, e.g., $X(T) = f(T/T_{NOM})$ or $X(T) = f(T - T_{NOM})$. Some can be physics-based while others are purely phenomenological expressions. For example, the variation of saturation current is usually modeled as

$$I_s(T) = I_s(T_{nom}) \left(\frac{T}{T_{nom}} \right)^{XTI} e^{\left[\frac{E_g(T_{nom})}{kT_{nom}} - \frac{E_g(T)}{kT} \right]} \quad (9)$$

This equation can be derived from the power law temperature variation of the conduction and valence band effective density of states. In contrast, the ideality factors are written simply as



When They're **Counting on You**, You Can **Count on Us**.



Products

- Coaxial Switches
- Pin Diode Switches
- Switch Matrices
- Couplers
- Ferrite Products

Applications

- Avionics
- Defense
- Industrial
- Medical
- Telecommunications

Ducommun Technologies

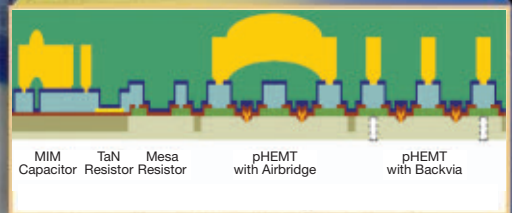
- RF/Microwave Products since 1969
- Heritage includes: Dynatech, DB Products & WiseWave
- Customer Focused
- Engineered Solutions

Request a Free copy of our NEW Coaxial Switch Catalog at
www.ducommun.com/mwj or phone: 310-513-7214.





M²



K band optical gate technology

MilliMeter Wave pHEMT Technology @ WIN=M²W

Parameter	Value
Small Signal Gain	14 dB
Ft	60 GHz
Vp	-1.2 V
Idss	360 mA/mm
Idmax	490 mA/mm
Vdg Breakdown	17.5 V
Ron	1.2 Ohm-mm
P1dB*	750 mW/mm
PAE (peak)*	51%
Gm (peak)	400 mS/mm

* f=10 GHz, Vdg=7 V, Ids=160 mA/mm

High performance microwave and millimeter wave technology is ready for your high volume applications.

www.winfoundry.com



Visit <http://mwj.hotims.com/23284-118> or use RS# 118 at www.mwjjournal.com/info

$$N_X(T) = N_X + TN_X(T - T_{NOM}) \quad (10)$$

And parasitic resistances is written as

$$R_X(T) = R_X \left(\frac{T}{T_{NOM}} \right)^{TR_X} \quad (11)$$

CHARGE EXPRESSIONS - Q_{BE}

All capacitances in our model are written as charge expressions and implemented using the Verilog-A ddt() operator. The base-emitter junction has three terms associated with it: The depletion region junction capacitance, a diffusion capacitance associated with the base transit time and a charge to account for the high-current Kirk effect.

The junction capacitance is modeled using the usual expression

$$C_{BE} = \frac{C_{BEO}}{(1 - V_{BE} / V_{JBE})^{M_{JBE}}} \quad (12)$$

where the corresponding charge is just the integral over voltage.

$$Q_{JBE} = C_{BEO} \frac{V_{JBE} - V_{BE}}{(m-1) \left[1 - V_{BE} / V_{JBE} \right]^{M_{JBE}}} \quad (13)$$

The narrow, highly doped base of an HBT allows us to model the diffusion charge simply as a constant transit time multiplied by the forward transport current:

$$Q_B = T_B \cdot I_{CF} \quad (14)$$

Finally, the Kirk effect is modeling using a power-law-based transit time

$$Q_{TK} = T_{TK} \left[\frac{I_{CF}}{I_{TK}} \right]^{G_{TK}} I_{CF} \quad (15)$$

The resulting base-emitter charge term is simply the sum of all three effects

$$Q_{BE} = Q_{JBE} + Q_B + Q_{TK} \quad (16)$$

CHARGE EXPRESSIONS - Q_{BC}

In the base-collection junction, the reverse-bias depletion capacitance is limited by the width of the collector, as the depletion region width will not change significantly once it reaches the sub-collector. To account for this effect, Equation 12 needs to be modified in some way. In our work, we have adopted the approach used in HICUM Level 0, as it is simple to implement and simple to extract.⁶

The time constant associated with the collector delay has a forward current dependence that is modeled with a hyperbolic tangent function after Iwamoto⁷

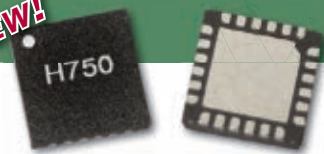
$$T_f = \frac{1}{2} TFC0 \left(1 + \tanh \left(\frac{ITC \left(1 - \frac{V_{BC}}{VTC} \right) - I_{cf}}{ITC2 \left(1 - \frac{V_{BC}}{VTC2} \right)} \right) \right) \quad (17)$$

LIMITING AMPLIFIER

FOR SHORT, INTERMEDIATE & LONG REACH FIBER OPTIC APPLICATIONS!

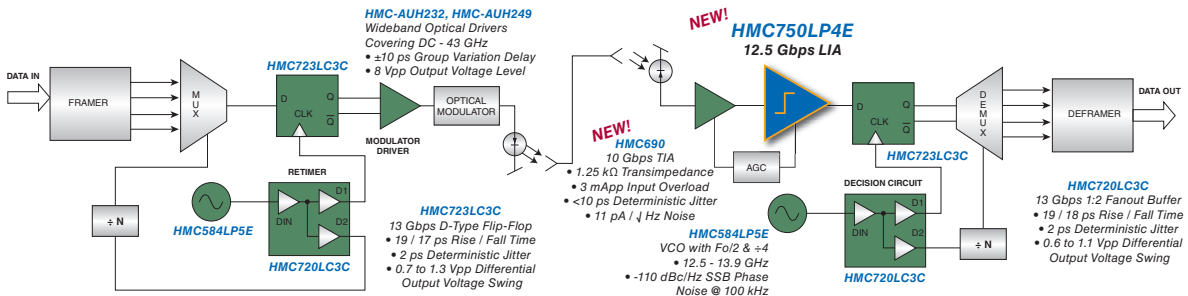
Analog & Mixed-Signal ICs, Modules, Subsystems & Instrumentation

NEW!



HMC750LP4E, 12.5 Gbps Limiting Amplifier

- ◆ 44 dB Differential Gain
- ◆ 2 mVpp Input Sensitivity
- ◆ 5 ps Deterministic Jitter
- ◆ 11 GHz Small Signal Bandwidth
- ◆ Integrated DC Offset Correction
- ◆ Adjustable Differential Output Voltage Swing up to 880 mV



Ideal for SONET OC-192 & SDH STM-64 Transponder, 10 Gbps Ethernet, Broadband Instrumentation and Optical Receiver Modules



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"

Low Noise AmplIFIERS

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



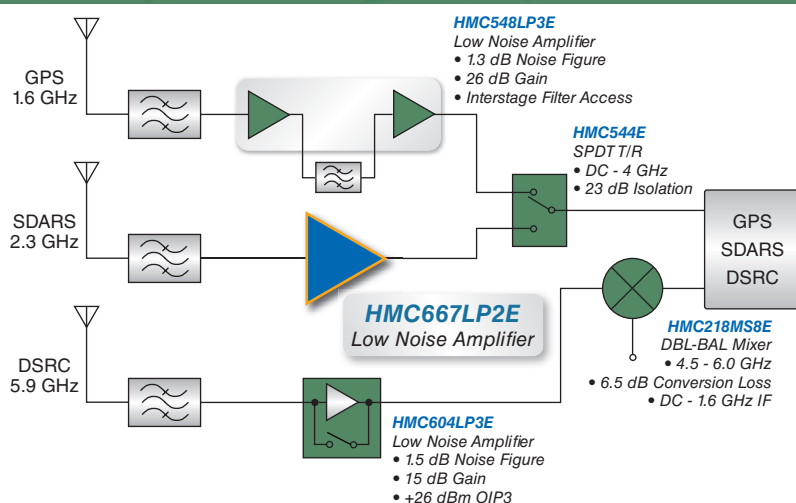
Analog & Mixed-Signal ICs, Modules, Subsystems & Instrumentation



GPS, SDARS & DSRC
RF Front-End for Telematics

HMC667LP2E
High IP3 LNA, 2.3 - 2.7 GHz

- ◆ 0.75 dB Noise Figure
- ◆ 19 dB Gain
- ◆ +29.5 dBm OIP3
- ◆ +16.5 dBm P1dB
- ◆ +3V or +5V Single Supply



A SELECTION OF IN-STOCK LNAs INCLUDING 4 NEW PRODUCTS

Frequency (GHz)	Function	Gain (dB)	OIP3 (dBm)	NF (dB)	P1dB (dBm)	Bias Supply	Package	Part Number
0.05 - 0.96	Low Noise, 75 Ohm	14	39	2.2	19	+5V @ 120 mA	ST89	HMC599ST89E
0.175 - 0.66	Low Noise	24	37	0.5	19	+5V @ 90mA	LP3	HMC616LP3E
NEW! 0.175 - 0.66	Low Noise, Dual Channel	24	37	0.5	19	+5V @ 93mA	LP4	HMC816LP4E
0.2 - 4.0	Low Noise, High IP3	13	38	2.3	22	+5V @ 110mA	ST89	HMC639ST89E
0.2 - 4.0	Low Noise, High IP3	13	40	2.2	22	+5V @ 155mA	ST89	HMC636ST89E
0.35 - 0.55	Low Noise	17	38	1	21	+5V @ 104mA	LP3	HMC356LP3E
0.55 - 1.2	Low Noise	16	37	0.5	21	+5V @ 88mA	LP3	HMC617LP3E
NEW! 0.55 - 1.2	Low Noise, Dual Channel	16	37	0.5	21	+5V @ 88mA	LP4	HMC817LP4E
0.7 - 1.2	Low Noise, Failsafe Bypass	16	33	0.9	13	+5V @ 57mA	LP3	HMC668LP3E
NEW! 0.7 - 2.2	Low Noise	22	36	1.7	24	+5V @ 227mA	LP3	HMC758LP3E
1.7 - 2.2	Low Noise, Failsafe Bypass	17	29	1.4	12	+5V @ 86mA	LP3	HMC669LP3E
1.7 - 2.2	Low Noise	19	36	0.75	20	+5V @ 117mA	LP3	HMC618LP3E
NEW! 2.1 - 2.9	Low Noise	19	33	0.9	19	+5V @ 95mA	LP3	HMC715LP3E
2.3 - 2.7	Low Noise	19	29.5	0.75	16.5	+5V @ 59mA	LP2	HMC667LP2E
2.3 - 2.7	Low Noise w/ Bypass	20	31	1.1	17	+5V @ 74mA	LP3	HMC605LP3E
NEW! 3.1 - 3.9	Low Noise	18	33	1	19	+5V @ 65mA	LP3	HMC716LP3E
3.3 - 3.8	Low Noise w/ Bypass	19	29	1.2	16	+5V @ 40mA	LP3	HMC593LP3E
4.8 - 6.0	Low Noise w/ Bypass	15	26	1.5	14	+5V @ 42mA	LP3	HMC604LP3E
NEW! 4.8 - 6.0	Low Noise	16.5	31.5	1.1	18.5	+5V @ 73mA	LP3	HMC717LP3E

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



Hittite Microwave Corporation
Corporate Headquarters
HMC Europe, Ltd.
HMC Deutschland GmbH
Northern Europe - HMC Europe, Ltd.
HMC Asia Co., Ltd.
HMC Co., Ltd. Shanghai
Hittite KK

Ph 978-250-3343
Ph +44-870-766-4355
Ph +49-8031-97654
Ph +44-870-766-4355
Ph +82-2-559-0638
Ph +86-21-6209-8809
Ph +81-3-6853-6854

sales@hittite.com
europe@hittite.com
germany@hittite.com
nordic@hittite.com
korea@hittite.com
china@hittite.com
japan@hittite.com

Order On-Line
www.hittite.com



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

Visit <http://mwj.hotims.com/23284-37> or use RS# 37 at www.mwjjournal.com/info

A base diffusion capacitance is also incorporated due to the reverse transport current and writes the base-collector charge as a sum of these terms:

$$Q_{BC} = Q_{JBC} + T_f I_{CF} + T_r I_{CR} \quad (18)$$

HBT SELF-HEATING

HBTs used in PA applications are run at relatively high power densities. Thus, the Joule heating in the device can lead to a significant temperature rise. This is illustrated in **Figure 6**. The DC beta of an AlGaAs/GaAs device decreases at higher temperatures, and this drop can be seen in the forward IV curve, especially in the regions where power dissipation is high. We model this effect in the most common way, which is to approximate the various thermal time constants in the structure by a two-pole lumped element circuit driven by a current source. The value of the current is set equal to the power dissipated in the device (usually dominated by the drop across the base-collector junction). The voltage developed across the current source is equal to the device temperature rise that is fed back into the temperature model to solve for the device current in a consistent manner until the electrical simulation converges. We provide external pins for both sides of the thermal circuit. The "bottom" pin can be connected to an external thermal network that represents a package while the upper node can be attached to another network to simulate thermal coupling. The resulting five-terminal equivalent circuit

is shown in **Figure 7**. In the thermal network of **Figure 7**, C_{th} , R_{th2} and C_{th2} are constant parameters of the model, while the R_{th} element is temperature dependent.

In early works, **Fig. 6** Forward I-V measurement of an AlGaAs/GaAs HBT showing the effects of self-heating.

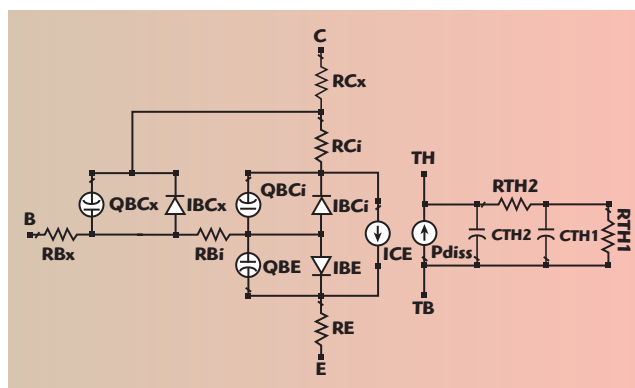
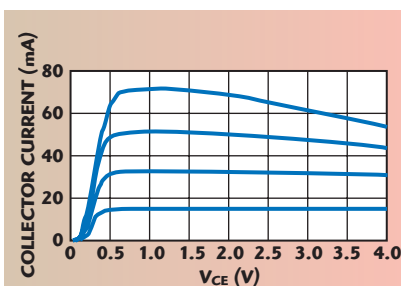


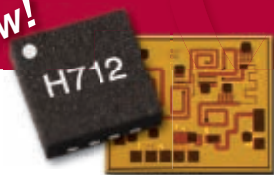
Fig. 7 Five-terminal large-signal equivalent circuit incorporating two-pole self-heating.

WIDE RANGE VVAs

VOLTAGE VARIABLE ATTENUATORS TO 86 GHz!

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

NEW!



HMC712 & HMC712LP3CE 5 - 30 GHz Voltage Variable Attenuators

- ◆ Wide Bandwidth: 5 - 30 GHz
- ◆ Excellent Linearity: +28 dBm Input P1dB
- ◆ Wide Attenuation Range: 30 dB
- ◆ Absorptive Topology: 12 dB Input Return Loss, 10 dB Output Return Loss
- ◆ Low Insertion Loss: 2.5 dB

A SELECTION OF IN-STOCK VOLTAGE VARIABLE ATTENUATORS

Frequency (GHz)	Function	Insertion Loss (dB)	Attenuation Range (dB)	IIP3 (dBm)	Control Input (Vdc)	Package	Part Number
DC - 14	Analog VVA	2	0 to 30	10	0 to -3V	LP3	HMC346LP3E
DC - 20	Analog VVA	2.2	0 to 25	10	0 to -3V	Chip	HMC346
0.45 - 2.2	Analog VVA	1.9	0 to 48	20	0 to +3V	MS8	HMC473MS8E
1.5 - 2.3	Analog VVA	3.3	0 to 40	15	0 to +2.5V	MS8	HMC210MS8E
NEW! 5 - 30	Analog VVA	2.5	0 to 30	32	0 to -3V	Chip	HMC712
NEW! 5 - 26.5	Analog VVA	3.5	0 to 28	32	0 to -3V	LP3C	HMC712LP3CE
17 - 27	Analog VVA	1.5	0 to 22	17	-4 / +4	Chip	HMC-VVD102
36 - 50	Analog VVA	1.5	0 to 22	17	0 to +4V	Chip	HMC-VVD106
70 - 86	Analog VVA	2	0 to 14	-	-5 / +5	Chip	HMC-VVD104

Ideal for Microwave Radio, Military, Space & Test Equipment Applications



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

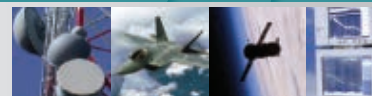
Order On-Line at: www.hittite.com
Receive the latest product releases - click on "My Subscription"

DUAL CHANNEL DETECTOR

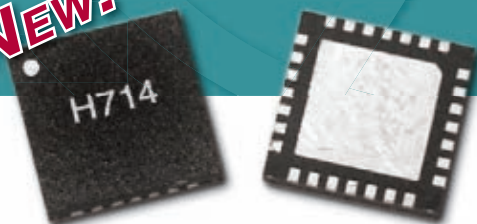
FOR FIXED WIRELESS, WiMAX, & CELLULAR INFRASTRUCTURE!



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



NEW!

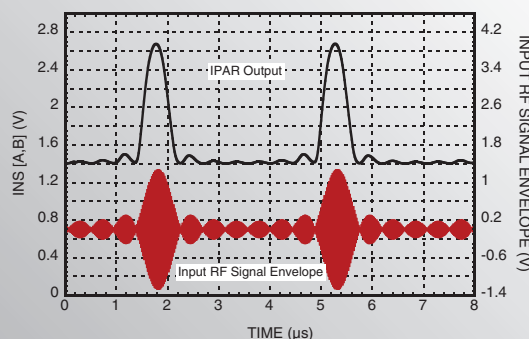


5x5mm SMT

HMC714LP5E Dual Channel RMS Power Detector, 100 MHz to 3.9 GHz

- ◆ Each Channel Provides RMS Power & Crest Factor Measurement
- ◆ Excellent Matching Channel-to-Channel
- ◆ ± 1 dB Detection Accuracy to 3.9 GHz
- ◆ Input Dynamic Range: -55 dBm to +15 dBm
- ◆ Excellent Temperature Stability

iPAR Output & Input RF Signal Envelope vs. Time for an Input Crest Factor of 12.04 dB @ 1900 MHz



RF Input Power @ -20 dBm

IN-STOCK POWER DETECTORS: LOG, RMS (Dual) / PAR & SDLVA

Frequency (GHz)	Function	Dynamic Range (dB)	RSSI Slope (mV / dB)	RF Threshold Level (dBm)	Bias Supply	Package	Part Number
50 Hz - 3.0	Log Detector / Controller	74 \pm 3	+19	-66	+3.3V @ 29mA	LP4	HMC612LP4E
0.001 - 8.0	Log Detector / Controller	70 \pm 3	-25	-61	+5V @ 113mA	LP4	HMC602LP4E
0.001 - 10.0	Log Detector / Controller	69 \pm 3	-25	-65	+5V @ 103mA	Chip	HMC611
0.001 - 10.0	Log Detector / Controller	69 \pm 3	-25	-65	+5V @ 106mA	LP4	HMC611LP4E
0.01 - 4.0	Log Detector / Controller	70 \pm 3	19	-68	+3.3V @ 30mA	LP4	HMC601LP4E
0.05 - 4.0	Log Detector / Controller	70 \pm 3	19	-69	+3.3V @ 29mA	LP4	HMC600LP4E
NEW! 0.1 - 2.7	Log Detector / Controller	54 \pm 1	17.5	-52	+5V @ 17mA	MS8	HMC713MS8E
DC - 3.9	RMS Power Detector	69 \pm 1	37	-60	+5V @ 65mA	LP4	HMC610LP4E
NEW! 0.1 - 3.9	Dual RMS / PAR Power Detector	71 \pm 1	37	-56	+5V @ 138mA	LP5	HMC714LP5E
NEW! 0.1 - 3.9	RMS / PAR Power Detector	69 \pm 1	37	-57	+5V @ 65mA	LP4	HMC614LP4E
0.1 - 20	SDLVA	59	14	-54	+3.3V @ 83mA	LC4B	HMC613LC4B

Connectorized Power Detector Modules

NEW! 0.01 - 2.0	RMS Power Detector	70 \pm 1	37	-58	+12V @ 95mA	C-6 / SMA	HMC-C054
NEW! 1 - 20	SDLVA	59	14	-67	+12V @ 86mA	C-10 / SMA	HMC-C052

See www.hittite.com For Our Complete Power Detector Product Line!



Hittite Microwave Corporation
Corporate Headquarters
HMC Europe, Ltd.
HMC Deutschland GmbH
Northern Europe - HMC Europe, Ltd.
HMC Asia Co., Ltd.
HMC Co., Ltd. Shanghai
Hittite KK

Ph 978-250-3343
Ph +44-870-766-4355
Ph +49-8031-97654
Ph +44-870-766-4355
Ph +82-2-559-0638
Ph +86-21-6209-8809
Ph +81-3-6853-6854
sales@hittite.com
europe@hittite.com
germany@hittite.com
nordic@hittite.com
korea@hittite.com
china@hittite.com
japan@hittite.com

Order On-Line
www.hittite.com



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

Visit <http://mwj.hotims.com/23284-39> or use RS# 39 at www.mwjjournal.com/info

was constant and most commonly extracted with Dawson's procedure.¹⁰ Yeats¹¹ provided a more rigorous expression for thermal resistance as a function of ambient temperature and dissipated power. This approach is necessary to account for the temperature-dependent thermal conductivity of GaAs; however, there was a concern over potential numerical issues as Yeats' parameter n is close to 1, and $(n-1)$ is in a denominator. Yeats' parameter n comes from the expression for the temperature dependence of thermal conductivity.

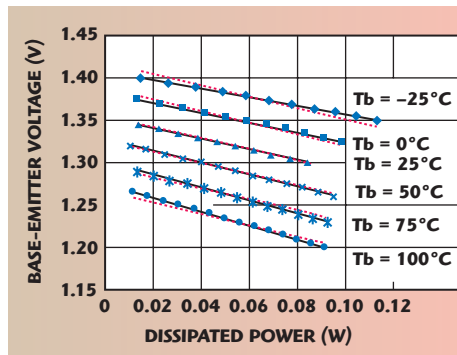
$$\kappa(T) = \kappa_{300K} \left(\frac{300K}{T} \right)^n \quad (19)$$

Since n is typically close to 1, this implies that the thermal resistivity is approximately linear in temperature. Therefore, we adopted a linear-temperature dependence in the expression for thermal resistance.

$$R_{th} = R_{th0} + R_{th1}(T_j - T_{nom}) + R_{th1}(T_{base} - T_{nom}) \quad (20)$$

The model parameters are R_{th0} and R_{th1} ; T_j , T_{base} and T_{nom} are the junction, device-base and nominal-model temperatures, respectively. The formula in Equation 20 makes the thermal resistance in effect dependent on the thermal gradient from the junction to the base of the transistor (node TB in Figure 7). It is worth noting that we investigated separate parameters for the T_j and T_{base} contributions in Equation 20, but found that it had no practical benefit.

Akin to the approaches in References 10 and 11, the thermal resistance parameters are determined by



▲ Fig. 8 Measured (symbols), modeled per this article (solid lines) and modeled with constant thermal resistance value (dashed lines) base-emitter voltage vs. dissipated power for a single-cell HBT (32 mA).

fitting the base-emitter voltage versus dissipated power at a constant emitter current, Equation 20 coupled with the following:

$$V_{be} = V_{b0} + V_{b1}(T_j - T_{nom}) \quad (21)$$

$$T_j = T_{base} + R_{th} P_{diss} \quad (22)$$

Figure 8 shows the fit of the thermal resistance model to measurements on a standard transistor cell. This same data set was fitted to Yeats' thermal resistance equation in Reference 11. Figure 9 compares the thermal resistance of our model to that of Yeats' formula versus junction temperature with a 25°C base temperature. The agreement is quite good over the junction temperature range expected in normal operation (in this case less than 100°C) and shows that the simplification of the model provides sufficient accuracy while avoiding potential stability or convergence problems. Lastly, it should be noted that some other models do have temperature-dependent thermal resistances.^{8,9} Unfortunately, these models only take into account the junction temperature, thus ignoring the effect of any thermal gradient in the device substrate.

Returning to the four elements of the thermal circuit (R_{th2} , C_{th2} , R_{th} and C_{th}), typically R_{th2} and C_{th2} are set to small, negligible values. R_{th} and C_{th} are extracted based on the methods presented in References 10 and 12 and the discussion of the previous paragraph. The thermal resistance extraction methods assume that if a constant emitter current (high enough to observe significant power dissipation) is forced through the device then the variation in base-emitter voltage is only due to the variation in junction temperature. Measurements are conducted over a wide range of temperatures to account for the temperature dependence of thermal resistance. The thermal capacitance is extracted from pulsed I-V measurements using the normalized difference unit (NDU) method.¹² The method is based on the comparison of pulsed I-V measurements of different pulse lengths to static I-V measurements. The thermal time constant is defined as the time after a step in P_{diss} when 63.2

percent of the resulting change in the junction temperature has occurred. From the NDU versus pulse length plot, the thermal time constant (τ) is extracted (see Figure 10) and the thermal capacitance is calculated as

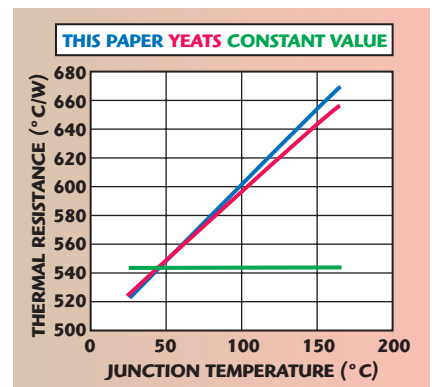
$$C_{th} = \tau / R_{th} \quad (23)$$

Unlike the thermal resistance, the thermal capacitance is assumed to be temperature independent.

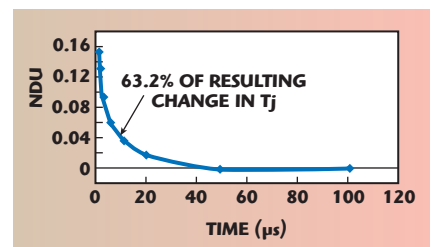
Single Cell Model Validation

Once extracted, a transistor model should be validated in multiple ways. Our HBT model is fully checked against DC measurements and S-parameter measurements over a wide range of biases and temperatures. This verifies that the model plays back the types of measurements used in the model extraction. Once the extracted model shows good agreement with this first-step validation, a second level of validation is performed with on-wafer large-signal measurements such as 50 Ω power sweeps,¹³ source/load-pull measurements and waveform measurements.

The 50 Ω power sweep is performed with a commercial vector network analyzer (VNA), which is calibrated to measure vector S_{11} and S_{21} as well as the power at second and



▲ Fig. 9 Calculated thermal resistance vs. junction temperature for various models.



▲ Fig. 10 Extraction of the thermal time constant from the NDU vs. pulse length.

What's your hot button?



A 90° hybrid
coupler with
100% attention
to quality.

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. Unit after unit, reel after reel, nothing beats our full line of miniature 90° hybrids. Whether your priority is loss, return loss, and isolation. Quality control and RF testing. RoHS compliance. Or unfailing on-time delivery to your dock.

To see for yourself why we are, and continue to be, the category leader – email xinger2@anaren.com or contact one of our world-class stocking distributors.



Reliable service require reliable components:

Why take chances on untested 'knock-off' couplers, when Xinger-II brand couplers stay on spec – from the very first product samples you see right on through to full-scale production.

Part Number	Frequency (GHz)	Power (W)
XC0450E-03	0.46–0.47	100
XC0450L-03	0.41–0.48	200
C0810J5003A00*	0.80–1.0	4
XC0900P-03	0.80–1.0	25
XC0900E-03	0.80–1.0	75
XC0900A-03	0.811–1.0	225
XC0900L-03	0.8–1.0	225
XC1400P-03S	1.2–1.6	30
C1720J5003A00*	1.7–2.0	4
1P503	1.7–2.0	30
XC1900E-03	1.7–2.0	120
XC1900A-03	1.7–2.0	225

Part Number	Frequency (GHz)	Power (W)
C2023J5003A00*	2.0–2.3	4
JP503	2.0–2.3	25
XC2100E-03	2.0–2.3	100
XC2100A-03	2.0–2.3	145
C2327J5003A00*	2.3–2.7	4
1P603	2.3–2.7	25
XC2500E-03	2.3–2.7	80
XC2500A-03	2.3–2.7	150
C3337J5003A00*	3.3–3.7	4
XC3500P-03	3.3–3.8	55
XC3500M-03	3.3–3.8	70
1M803	5.0–6.0	20

*This part available exclusively from Richardson Electronics.

Visit <http://mwj.hotims.com/23284-11> or use RS# 11 at www.mwjjournal.com/info

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)



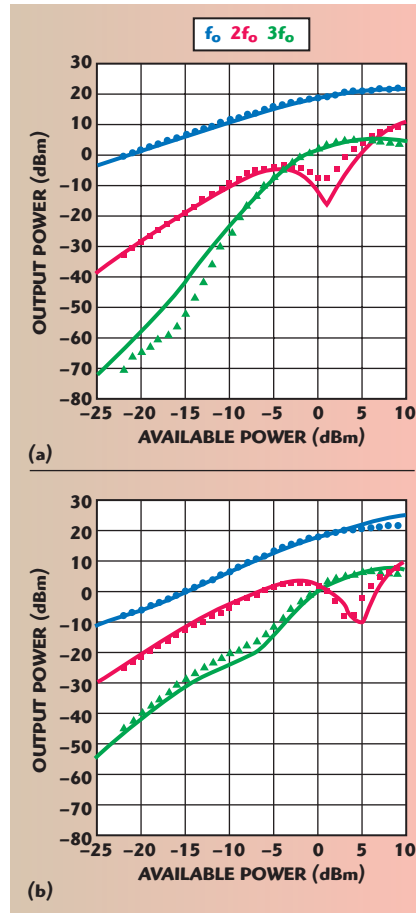
third harmonics. Measurements in the 50 Ω power sweep setup are done over bias and temperature. Even though the load-line for this measurement is 50 Ω , through a combination of biases and power levels, the device is effectively exercised over its full I-V plane. Since this measurement can be easily integrated into the same measurement stand that performs on-wafer, DC and S-parameter measurements, it is a valuable first-step in large-signal validation. **Figures 11 (a) and (b)** show a comparison of the measured and simulated output power at the fundamental, second harmonic and third harmonic from 50 Ω power sweeps at a Class A and Class AB bias point, respectively. Because of the flexibility to cover multiple test conditions with the 50 Ω power sweep, we have devised a metric (discussed in Reference 13) that gauges the relative error between the simulation and the measurement. This metric has been very helpful in judging the improvements in the model as it evolved to its present form.

Waveform measurements are also performed on-wafer at ambient temperature, and for this measurement we use a commercial large-signal network analyzer (LSNA). The spectral components of the base and collector voltages and currents are measured at the transistor reference plane, and the time domain waveforms are calculated. The system is configured to vary bias and RF drive power as well as the input and output impedances using mechanical tuners. **Figures 12 (a) and (b)** show the base and collector waveforms at a Class AB bias point for nominal 50 Ω source and load terminations.

MULTI-CELL ARRAY MODELING

In PA applications, scaling the model from a single device to large arrays is necessary. Using a simple multiplication factor is not sufficient, as the parasitic interconnect and thermal behavior of an array will be quite different from the single cell transistor used to extract the model.

Our approach for multi-cell array modeling involves a combination of EM simulations of the interconnect manifolds and scaling of the thermal impedances¹⁴ to account for the increase in operating temperature due to the proximity of devices in the array. While the manifold modeling is



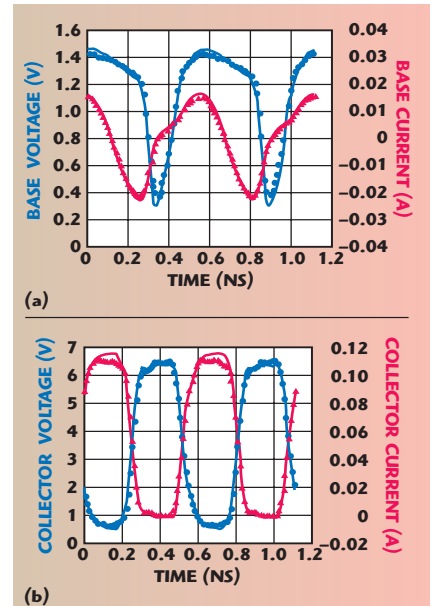
▲ Fig. 11 Measured (symbols) and simulated (solid lines) output powers at f_0 , $2f_0$ and $3f_0$ from a 50 Ω power sweep on a single HBT at $V_c = 3.5$ V and $I_{cq} = 20$ mA (a) and $I_{cq} = 2$ mA (b).

handled using EM simulation,¹⁴ thermal modeling of the arrays is implemented in two different ways:

- Deriving a custom thermal impedance scaling equation in the Verilog-A code that is capable of predicting the average junction temperature for various array layouts, and
- Adding thermal coupling networks between the thermal nodes (utilizing the TH and TB pins of Figure 5 (b)) of neighboring devices without altering the internal thermal resistance.

A custom thermal scaling equation or a thermal coupling network can be generated in many different ways;¹⁵⁻²⁰ for example, by using a finite-difference numerical thermal simulation,^{21,22} by using a 3-D finite-element steady-state thermal solver^{23,24} or by optimizing to achieve a best fit with measured data (I-V curves).^{15,17}

For the first approach where it is necessary to derive a thermal scaling equation that provides an average



▲ Fig. 12 Measured (symbols) and simulated (solid line) base (a) and collector (b) voltage and current waveforms with nominal 50 Ω loading ($V_c = 3.5$ V, $I_{cq} = 2$ mA and $P_{avs} = 5$ dBm).

temperature for a variety of layouts, we started from electrical measurements extracting effective, average thermal resistances for arrays with different numbers of cells and cell-to-cell separations. The equation consists of the thermal resistance of a single cell and a correction function to account for the number of cells and the cell-to-cell separation.

$$R_{th_cell} = R_{th_nom} * f(N, y) \quad (24)$$

R_{th_nom} is the thermal resistance of a single cell device, N is the number of cells and y is the device pitch. The function, $f(N, y)$, simply modifies the thermal resistance function of an isolated device, scaling it by an array-specific factor. The unit-cell thermal resistance in Equation 24 is already temperature-dependent and is separately scalable with respect to within-cell geometry. The function, $f(N, y)$, is derived empirically for arrays of selected unit cells by curve-fitting to the measured DC data until the best fit to the overall array I-V characteristics is achieved. The thermal scaling equation is then validated against TCAD simulations at low- and medium-power dissipations (see **Figure 13**).

To extend the scaling equation to arrays of a larger variety of unit cells, TCAD simulations were employed. TCAD simulations of array temperatures provide a low-cost, efficient



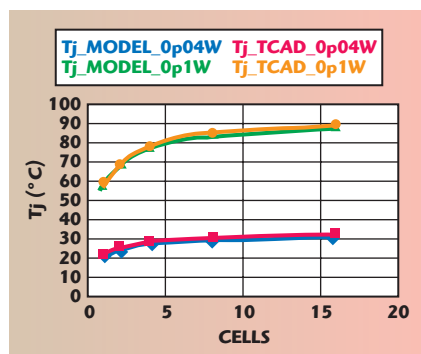
SPUMA 400-FR

Features

- Very low loss, flexible communication cable
- Non-halogen (non-toxic) low smoke, flame resistant
- UL recognised AWM product, according standard 758, style 1354

Benefits

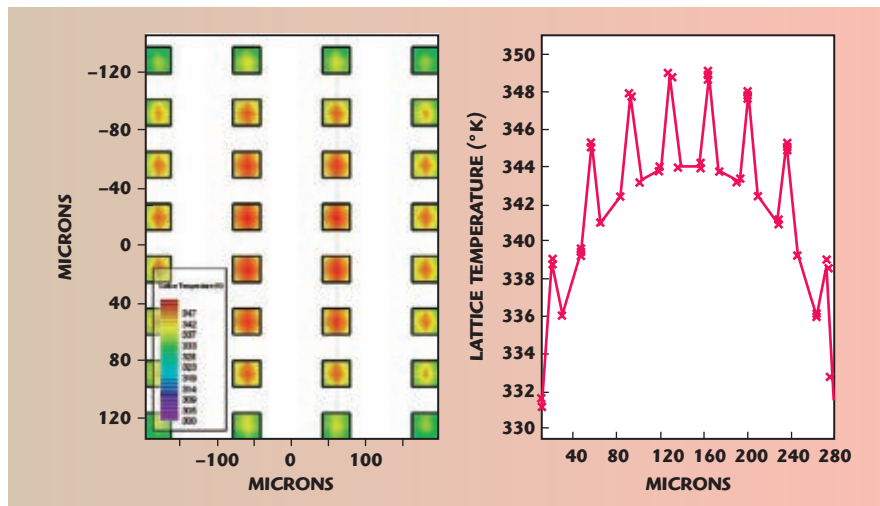
- Less attenuation
- Less price
- Excellent return loss (VSWR)



▲ Fig. 13 Comparison of modeled and TCAD-simulated T_j as a function of cell number ($P_{diss} = 0.04$ and 0.1 w/cell).

alternative to generating data from electrical measurements on real arrays. After the initial calibration of the simulation to measured results, TCAD is used to generate a large set of thermal data from which we derive the scaling function for each unit cell type. Because the TCAD input decks are typically text files, it is straightforward to write a script that automatically generates input decks for arbitrary arrays of unit-cell power sources arranged in a regular grid. This automated deck generation along with the short TCAD simulation times allowed for the efficient creation of large sets of thermal data (see **Figure 14**).

In this first implementation of Rth modification for arrays, the array is represented as a collection of identical parallel HBTs where each device has an “average” thermal resistance that yields the effective array temperature



▲ Fig. 14 Layout generated TCAD with temperature imbalance in an array.

at a given power dissipation. Thus, there is no temperature or electrical variation from cell to cell within the array. Instead, each device has a modified thermal resistance that effectively increases the device temperature at a given P_{diss} compared to an isolated device running at the same P_{diss} . Since this approach provides an average junction temperature, it cannot be used to analyze the “hot spots” in the array caused by any thermal imbalance. Although this approach does not provide information about the temperature distribution in the array, in many cases it is desirable to use this simplification as it results in shorter simulation times and improved robustness due to fewer electrical nodes without impact-

ing simulation accuracy.

The second approach for the thermal modeling of multi-cell arrays is based on creating a network of thermal resistances connecting adjacent devices. This allows devices within an array to have distinct temperatures, thus giving a more accurate prediction of the temperature distribution in the array at the expense of simulation time and complexity. Thermal resistors are used to connect the thermal nodes of the five-terminal model for adjacent devices, as shown in **Figure 15**. The heat paths represented by the resistive network are shown in **Figure 16**.

In our approach, we adopt a simplified pi-network where the resistances are extracted using a test structure,

-151dBc/Hz = ULTRA LOW PHASE NOISE

Single & Multi-Channel RF Synthesizers

FREQ. RANGE	MODEL	CH's	PHASE NOISE (dBc/Hz) at 10kHz offset				
			100MHz	300MHz	1GHz	2GHz	3GHz
8MHz to 300MHz	HS0301A	1	-151	-141			
	HS0304A	4	-151	-141			
	HS0308A	8	-151	-141			
8MHz to 1GHz	HS1001C	1	-151	-141	-131		
	HS1004A	4	-151	-141	-131		
	HS1008A	8	-151	-141	-131		
8MHz to 2GHz	HS2001A	1	-151	-141	-131	-125	
	HS2004A	4	-151	-141	-131	-125	
	HS2008A	8	-151	-141	-131	-125	
8MHz to 3GHz	HS3001A	1	-151	-141	-131	-125	-121
	HS3004A	4	-151	-141	-131	-125	-121
	HS3008A	8	-151	-141	-131	-125	-121

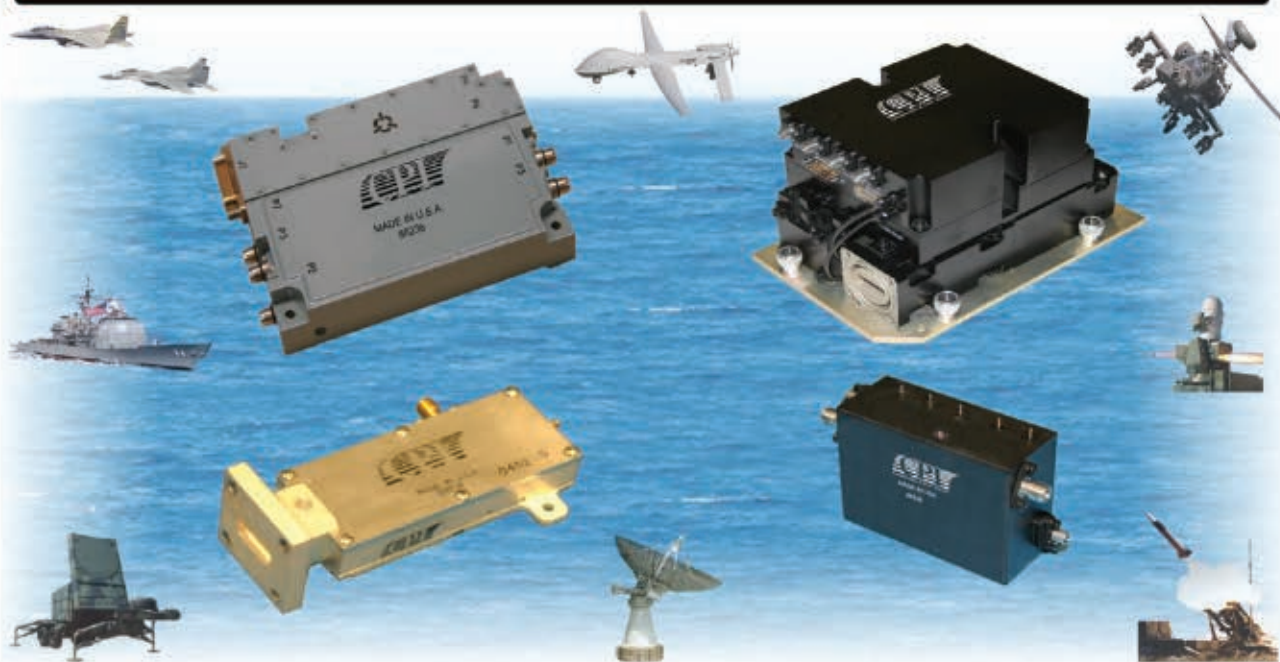
- Frequency Tuning Resolution: 0.001Hz
- Output Power: -110dBm to +15dBm (0.1dB Resolution)
- PHASE COHERENT, 360° Phase Offset (0.1° Resolution)



holzworth
instrumentation
www.holzworth.com

Boulder - CO - USA
ph: +1.303.325.3473

Integrated Microwave Assemblies



Advanced Technology - Extensive Experience - Superior Performance



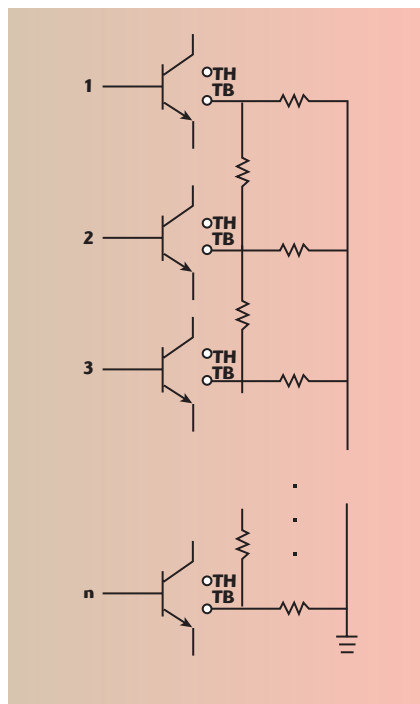
Communications & Power Industries' Beverly Microwave Division (BMD) offers product technology that includes Integrated Microwave Assemblies and Control Components. BMD's broad experience and extensive capabilities in the areas of high power microwave component design for military and non-military radar, satellite, communications, and EW systems makes it uniquely suited to design and manufacture a wide range of components and multi-function assemblies in small, lightweight packages. Coupling that with our experience in other transmission lines and technologies gives us a technical capability that is unparalleled in the microwave industry.

- * Multi-function components
- * RF front ends
- * Switches & attenuators
- * High level assemblies & modules
- * Design capability up to 40 GHz
- * Power handling to 1 MW+ peak
- * Integral driver & associated electronics
- * The industry's most extensive high power test facility

**Communications & Power Industries
Beverly Microwave Division**

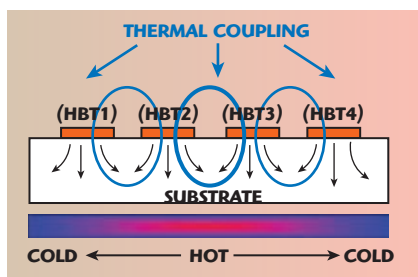
150 Sohier Road
Beverly, MA 01915
Phone: (978) 922-6000
Fax: (978) 922-2736

marketing@bmd.cpii.com
www.cpii.com/bmd



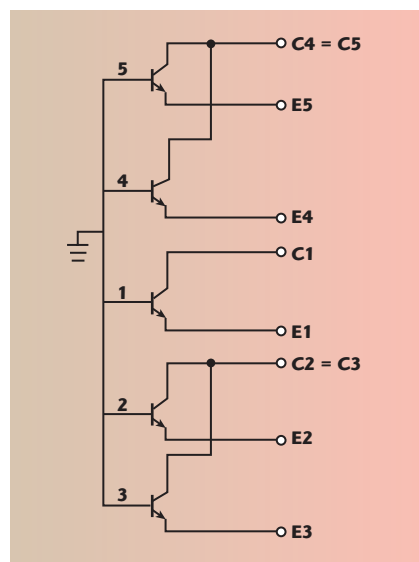
▲ Fig. 15 Thermal coupling network to account for thermal imbalance in an array.

as shown in **Figure 17**. The values of the thermal resistors used to connect adjacent devices can be derived from electrical measurements that represent a change in an individual device's temperature as its neighbor devices are individually powered on (see **Figure 18**). This is again based on the V_{be} thermometer method, inferring a temperature rise in a given device as a neighbor heats it from the change in V_{be} needed to produce a constant emitter current. Test data shows that



▲ Fig. 16 Heat dissipation in multi-cell device.

the temperature rise due to thermal coupling is proportional to the power dissipated in the neighboring transistors and depends on the proximity of the neighbor transistors with the device under test. Results were validated by comparing the electrical simulation of a two-cell through five-cell array with thermal coupling networks to TCAD simulation (see **Figure 19**). Utilizing the results from this test, we were able to generate thermal coupling networks for larger arrays using the principle of superposition, where the thermal resistors are calculated from a device's temperature rise attributed to power dissipated by its nearest neighbors. The approach was tested for a variety of device spacing, array configurations and cell numbers. It is important to note that the thermal coupling networks are extracted from measurements done at room temperature, relying on the fact that intrinsic thermal resistance is temperature-dependent. If higher accuracy is desired over a wide temperature



▲ Fig. 17 Test structure used to evaluate neighbor heating for the thermal coupling network.

range, it would be necessary to assign temperature-dependence to the elements in the thermal network.

For the full validation of a multi-cell array model, we consider a more practical example, a typical 32-cell array. While either approach for the thermal modeling can be used, the first approach described above has been used for this example. The results are shown in **Figures 20** and **21**, where the measured data is marked by circles with the simulation by a solid line. **Figure 21 (a)** and **(b)** indicate a reasonable match to Γ_{IN} with the power gain within 0.7 dB over 6 dB

Not all synthesizers are created equal.

Broadband, Fast Tuning Mini Synthesizer

- Model No. SMS-B120
- 1 to 20 GHz, Single Output
- <50 μ sec Tuning Speed
- -60 dBc Spurious
- Only 4.5W Power Consumption
- Internal 1.0ppm 10 MHz Reference
- Smallest 3" x 3" x 0.7" Package



At Spinnaker Microwave, our products are designed with one thing in mind – your specifications.

We pride ourselves on delivering quality signal sources custom tailored to your unique application – military, industrial or commercial.

Direct Digital Up-Converter Synthesizer

- Model No. SMS-DU1020
- Up to 500 MHz DDS 'Chirp' Modulation
- 10 to 20 GHz, Single Output
- 50 dBc Spurious
- 50 nS Tuning Speed (In-Band)
- Low-Cost Integrated Module
- Small 4.5" x 4.5" x 1.2" Package



Contact Spinnaker Microwave today for the high-performance microwave sources you can count on.



3281 Kifer Rd, Santa Clara, CA 95051 • Tel: 408-732-9828 • Fax: 408-732-9793 • www.spinnakermicrowave.com

Now! **MULTIPLY UP TO 20 GHz**



Frequency Multipliers from **\$5⁹⁵** 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



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/23284-67> or use RS# 67 at www.mwjjournal.com/info

Advanced technology:

Surface Mount Connectors

RF Surface Mount Coaxial Connectors (SMCC) from Rosenberger are available in various standard interfaces:

- coaxial series, e.g. SMP, Mini-SMP, MCX, SMA, or QMA
- FAKRA-RF automotive connectors
- high-precision test-&-measurement connectors

Our SMCC products convert signals from coaxial to planar waveguide mode inside the connector via an innovative miniature transition.

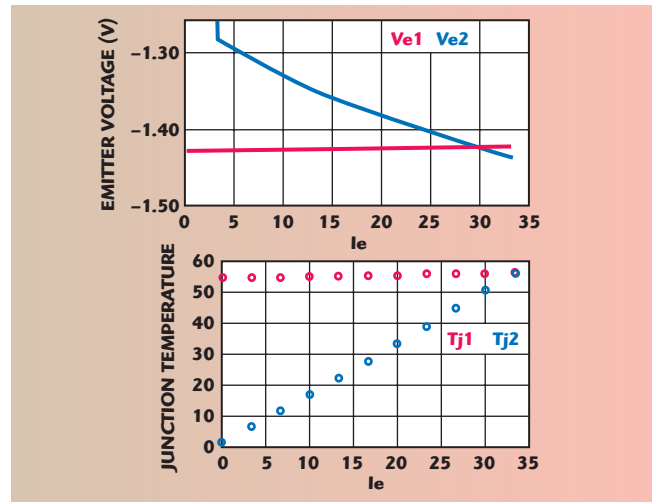
This innovative design leads to excellent return loss, isolation performance, a low dispersion transmission characteristic and optimized performance – e.g. for MCX connectors to 12 GHz, although specified to 6 GHz.

Exploring new directions

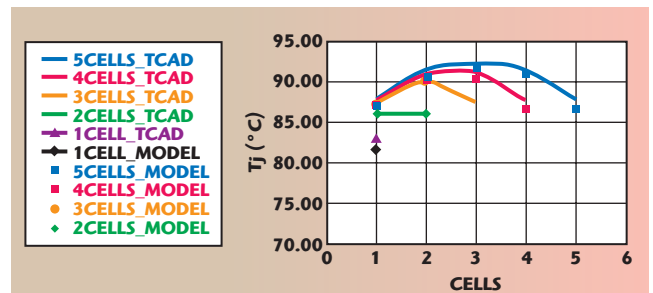
Ask us for more information:

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/23284-97>



▲ Fig. 18 Modeled (symbols) and measured (solid lines) emitter voltage and junction temperature of a two-cell device (device 1 is turned on while device 2 emitter current is swept).

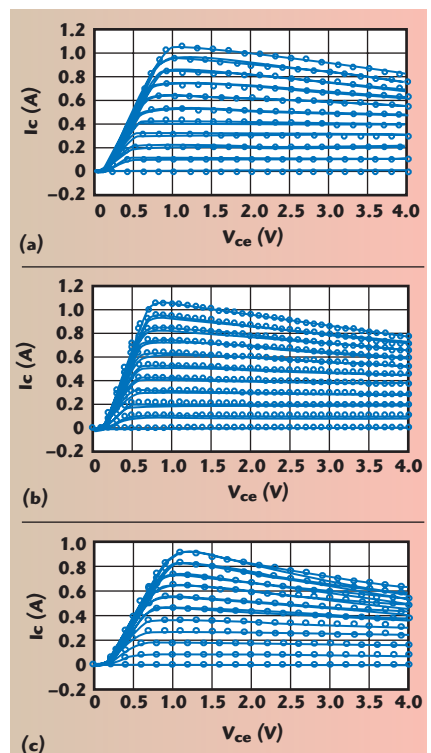


▲ Fig. 19 TCAD (lines) and model (symbols) simulations of Tj ($P_{diss} = 0.1 \text{ W/cell}$, $T_{amb} = 25^\circ\text{C}$).

into compression. **Figure 21 (c)** shows the power added efficiency (PAE) with less than 5 percent error. Finally, the measured versus simulated dynamic load line is shown in **Figure 21 (d)**.

CONCLUSION

We have discussed the salient features of a custom III-V HBT model and its scaling for cellular PA applications. While this custom model is similar in basic accuracy at the unit-cell level to some commercially available models, we have found the



▲ Fig. 20 I-V curves for large arrays generated using a principal of superposition at -25°C (a), 25°C (b) and 85°C (c).

THE MILITARY AND AEROSPACE INDUSTRIES RELY ON ACC ADVANCED SWITCH TECHNOLOGY.



Our complete line of switch products include:

- PIN Diode and GaAs FET Design
- "Unlimited" Number of Throws
- Frequency capability up to 40GHz
- Switching Speed under 10 nSec available
 - Up to 120db isolation

- ***High power models available to 150W CW and beyond***

PACKAGING

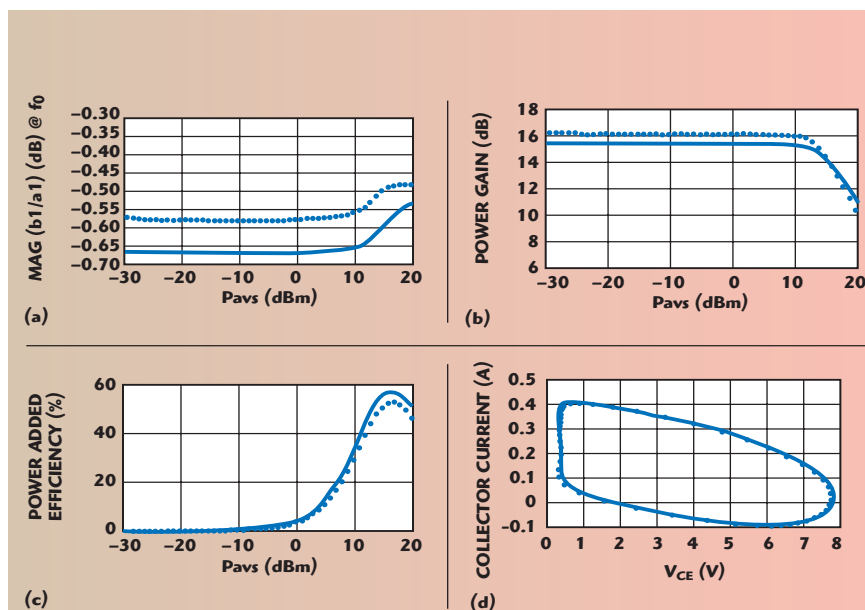
- Connectorized • Drop-in
- Surface mount

ALSO AVAILABLE:

Custom Switches, Switch Matrices and Switch Filters

 **Advanced Control Components**
Inc.

611 Industrial Way West, Eatontown, NJ 07724 • Tel 732 460-0212 • Fax 732 460-0214
www.advanced-control.com



▲ Fig. 21 Thirty-two-cell model validation: Input Gamma vs. available power (a), power gain vs. available power (b), PAE vs. available power (c) and dynamic load line (d).

flexibility to tailor a custom model to an application space beneficial to scaling the model to multi-cell arrays used in product designs without degrading array-level accuracy or simulation time.

ACKNOWLEDGMENTS

We wish to thank F. Kharabi, B. Clausen, S. Parker, P. Li, T. Dinh, E. Davis and D. Halchin for many varied and helpful discussions. Also, we wish to thank L. Hill, D. Wernsing, G. Lyons, C. Lineberry, H. Randall, T. Howle, A. Harman and S. Dorn for support with the measurements and keeping our feet on the ground. Lastly, we wish to thank A.J. Nadler for reviewing our manuscript and RFMD for supporting this effort. ■

References

1. H. Kroemer, "Theory of a Wide-gap Emitter for Transistors," *Proceedings of the IRE*, Vol. 45, No. 11, 1957, pp. 1535-1537.
2. H.K. Gummel and H.C. Poon, "An Integral Charge Control Model of Bipolar Transistors," *Bell System Technical Journal*, Vol. 49, 1970, p. 827.
3. J.M. Early, "Effects of Space-charge Layer Widening in Junction Transistors," *Proceedings of the IRE*, v40, 1952, p. 1401.
4. C.T. Kirk, "A Theory of Transistor Cutoff Frequency

Is AMC In Your Easter Basket This Year?

"In Pursuit Of Excellence Through Engineering"



AMERICAN MICROWAVE CORPORATION

7311-G Grove Road, Frederick, MD 21704

Phone: 301-662-4700 · Fax: 301-662-4938

Email: sales@americanmicrowavcorp.com

Web: www.americanmicrowavcorp.com

Visit <http://mwj.hotims.com/23284-9> or
use RS# 9 at www.mwjjournal.com/info



Turnkey Timing Solutions

Low Jitter, Multi-Function, Simple Implementation

Valpey Fisher Corporation offers a comprehensive line of integrated clock/PLL timing solutions for Ethernet synchronization, clock and data recovery, and jitter attenuation.

In addition, the OCXO line has the lowest power consumption, smallest package, and is the most eco-friendly green product in the industry.

Valpey Fisher also provides an array of Precision Oscillators (TCXOs, VCXOs, XOs) and Hi-Rel/COTs products.

Timing Modules



VFJA910

15.0mm x 13.0mm

- Dual LVCMOS Outputs
- Ultra Low Jitter <0.25ps RMS
- Jitter Attenuator for Sync-E



VFJA434

19.5mm x 15.5mm

- 4 Selectable Inputs, Quad Outputs
- Ultra Low Jitter <0.18ps RMS
- Jitter Attenuator for Sync-E, SONET/SDH, Wireless



VFTX210

20.0mm x 20.0mm

- Ultra Low Jitter and Phase Noise: -121 dBc/Hz @ 1 KHz offset for $F_c = 1$ GHz
- < 1ppm Frequency Stability
- +8 dBm Sine Wave output



VFCG-HD1

24.0mm x 24.0mm

- 30 selectable Input Video Formats
- NTSC, PAL, SMPTE274, SMPTE296 outputs of 148.5MHz & 148.3516MHz or 74.25MHz & 74.1758MHz
- Synchronous Audio Clk 12.288MHz (optional)
- For Video Converter, Video Distribution, Video Formatting



VFOV400

15.1mm x 15.1mm

- Lowest power consumption OCXO <0.12W
- Telecom Reference, Portable devices, Guidance Systems



VFOV110

25.4mm x 22mm

- Ultra Low Phase Noise: -170 dBc/Hz @ 100KHz
- Point to Point Radio, Satellite Base Station, Synthesizer Reference



VFOV300

36.1mm x 27.2mm Europack

- ± 0.1 ppb temperature stability
- Ultra Low Jitter & Phase Noise
- STRATUM II compliant, Rubidium Replacement for GPS holdover



VFOV100

Multiple Package Options

- Low Phase Noise: -155 dBc/Hz @ 1KHz offset -168 dBc/Hz floor
- Telecom Reference, GPS holdover, Microwave Communications /RADAR signal source, Instrumentation



Valpey Fisher Corporation

High Frequency, Low Phase Noise Timing Solutions

800-982-5737 • www.valpeyfisher.com • sales@valpeyfisher.com

Visit <http://mwj.hotims.com/23284-113> or use RS# 113 at www.mwjjournal.com/info

- (fT) Falloff at High Current Densities," *IRE Transactions on Electron Devices*, v9, n2, 1962, pp. 164-174.
5. Agilent Heterojunction Bipolar Transistor Model, Agilent Advanced Design System Documentation 2008, Nonlinear Devices Chapter 2, pp. 4-33.
 6. M. Schroter, S. Lehmann, H. Jiang and S. Komarow, "HICUM/Level0 – A Simplified Compact Bipolar Transistor Model," *IEEE Proceedings of the 2002 Bipolar/BiCMOS Circuits and Technology Meeting*, 2002, pp. 112-115.
 7. M. Iwamoto, D.E. Root, J.B. Scott, A. Cognata, P.M. Asbeck, B. Hughes and D.C. D'Avanzo, "Large-signal HBT Model with Improved Collector Transit Time Formulation for GaAs and InP Technologies," *IEEE International Microwave Symposium Digest*, 2003, pp. 635-638.
 8. Agilent Heterojunction Bipolar Transistor Model, Non-Linear Devices, Agilent ADS Documentation v2005A, Chapter 2, 2005, pp. 4-42.
 9. UCSD HBT Model, <http://hbt.ucsd.edu>.
 10. D.E. Dawson, A.K. Gupta and M.L. Salib, "CW Measurement of HBT Thermal Resistance," *IEEE Transactions on Electron Devices*, Vol. 39, No. 10, October 1992, pp. 2235-2239.
 11. B. Yeats, "Inclusion of Topside Heat Spreading in the Determination of HBT Temperatures by Electrical and Geometrical Methods," *21st Annual Gallium Arsenide Integrated Circuit Symposium Digest*, October 1999, pp. 59-62.
 12. C. Baylis, L. Dunleavy and J. Daniel, "Direct Measurement of Thermal Circuit Parameters Using Pulsed IV and Normalized Difference Unit," *Microwave Symposium Digest, 2004 IEEE MTT-S International, Volume 2*, June 2004, pp. 1233-1236.
 13. J. Gering, S. Nedeljkovic, F. Kharabi, J. McMacken and D. Halchin, "Transistor Model Validation through 50 Ohm, Vector Network Analyzer Power Sweeps," *70th ARFTG Conference*.
 14. S. Nedeljkovic, J. McMacken, J. Gering and D. Halchin, "A Scalable Compact Model for III-V Heterojunction Bipolar Transistors," *Microwave Symposium Digest, 2008 IEEE MTT-S International*, June 2008, pp. 479-482.
 15. H. Beckrich, S. Ortolland, D. Pache, D. Celi, D. Gloria and T. Zimmer, "Impact of Neighbor Components Heating on Power Transistor Electrical Behavior," *Microelectronic Test Structures, 2006 IEEE International Conference*, March 2006, pp. 205-210.
 16. D. Walkey, T.J. Smy, D. Celo, T.W. MacElwee and

RF & Microwave components, assemblies and subsystem



A LEADING
RF & Microwave
PRODUCT PROVIDER FROM ASIA PACIFIC



■ **components**
■ **assemblies**
■ **subsystem**



Product Line

Ultra Low Noise Amplifiers
LNAs
Power Amplifiers
DLVAs
VCOs, DROs and PDROs
Frequency Synthesizers
Switches & Attenuators
Filters & Power dividers
Integrated Assemblies
OEM & ODM welcomed

Applications

Radar/ EW Systems
Aircraft, Missile and Space
Satellite & Communications
GPS/Navigation Systems
Testing and Measurement

Feature

Frequency 0.5-40GHz
Thin-film Technology
Integrated Technology
MIL Qualified Standard
Superior Performance



Ultra Low Noise Amplifiers

MODEL	Freq. Range (GHz)	GAIN (dB) TYP	FLAT-NESS (±dB) MAX	Noise Figure (dB) MAX	P1dB (dBm) MIN
XKLA0520N3010	0.5~2	30	±1.0	1.0	10
XKLA1020N3010	1~2	30	±1.0	0.8	10
XKLA2040N3010	2~4	30	±1.0	0.8	10
XKLA2080N3010	2~8	30	±1.5	1.3	10
XKLA4080N3010	4~8	30	±1.2	1.1	10
XKLA8012N3210	8~12	30	±1.5	1.5	10
XKLA2018N3010	2~18	30	±2.0	2.5	10

DLVAs

MODEL	Freq. Range (GHz)	TSS (dBm) Typ	Linearity (±dB) MAX	Dynamic Range (dBm)	Log Linearity (±dB) MAX	VSWR Max.
XKDA2060D72NS	2~6	-72	2	-70~+5	1.0	2.2:1
XKDA2080D72NS	2~8	-72	2	-70~+5	1.0	2.2:1
XKDA4080D72NS	4~8	-72	2	-70~+5	1.0	2.2:1
XKDA60180D72NS	6~18	-72	2	-70~+2	1.0	2.2:1

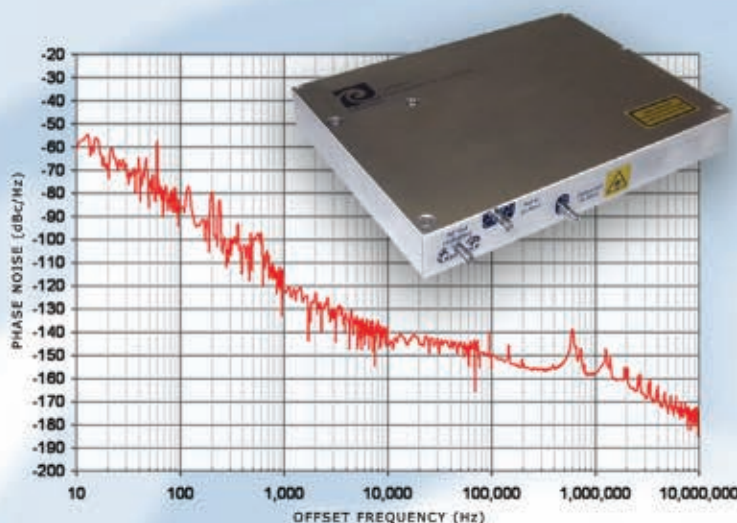
Multi-function Integrated Assemblies

- LNA Assemblies
- Front ends
- T/R Assemblies
- Switching Filter
- Up/down Converter
- Frequency Assemblies
- Radar Simulators
- Testing Instruments

<http://www.seekonrf.com>

TEL: 0086-28-81705322 Fax: 0086-28-81700845 E-mail: sales@seekonrf.com

Ultra-Low Phase Noise Microwave Oscillator **AND** Homodyne Phase Noise Measurement System: Higher Performance at a Lower Cost



Phase Noise at 10 GHz

Based on patented opto-electronic oscillator (OEO) technology.

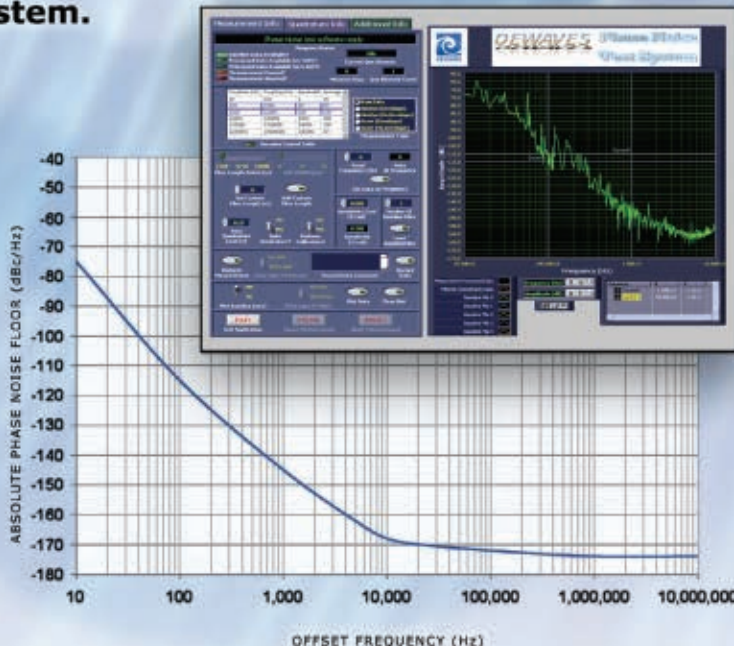
FEATURES

- -145 dBc/Hz at 10 kHz offset at 10 GHz
- Compact 4.5" x 5.9" x 0.79" package
- Low spurious content
- Low vibration/acceleration sensitivity
- External phase locking option
- Pulsed optical output option
- EMI tolerant

The fully automated connect and click microwave phase noise/jitter measurement system.

FEATURES

- No reference source required
- No down converter or PLL required
- -174 dBc/Hz **absolute** phase noise measurement capability
- Frequency range option up to 40 GHz
- RMS and P-P jitter measurement option
- Unique microwave-photonic system taking seconds to operate
- Various performance level, feature, and future upgrade options



Absolute Phase Noise Floor at 10 GHz

PLEASE CONTACT US
FOR CUSTOM FEATURES



626.449.5000
www.oewaves.com

- M.C. Maliepaard, "Compact, Netlist-based Representation of Thermal Transient Coupling Using Controlled Sources," *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*, Vol. 23, No. 11, November 2004, pp. 1593-1596.
17. P. Dai, P. Zampardi, K. Kwok, C. Cismaru and R. Ramanathan, "Study of Thermal Coupling Effect in GaAs Heterojunction Bipolar Transistor by Using Simple Mirror Circuit," *GaAs ManTech 2005*.
 18. D. Walkey, T.J. Smy and D. Celo, "Prediction of Maximum Temperature Rise in Multi-finger Transistor Structures Using Normalization," *GaAs ManTech 2002*.
 19. P. Baurelis, "Electrothermal Modeling of Multi-emitter Heterojunction Bipolar Transistors (HBT)," *Integrated Nonlinear Microwave and Millimeter-wave Circuits Third International Workshop*, October 1994, pp. 145-148.
 20. M. Schubler, V. Krozer, J.G. de la Fuente and H.L. Hartnagel, "Thermal Coupling in Multi-finger Heterojunction Bipolar Devices," *27th European Microwave Conference and Exhibition*, September 1997, pp. 104-108.
 21. D. Denis, C.M. Snowden and I.C. Hunter, "Coupled Electrothermal, Electromagnetic and Physical Modeling of Microwave Power FETs," *Microwave Theory and Techniques, IEEE Transactions*, Vol. 54, No. 6, June 2006, pp. 2465-2470.
 22. M. Rudolph, F. Schnieder and W. Heinrich, "Investigation of Thermal Crunching Effects in Fishbone-type Layout Power GaAs-HBTs," *Gallium Arsenide Applications Symposium GaAs 2004*, October 2004, Amsterdam, The Netherlands.
 23. H. Beckrich, T. Schwartzmann, D. Celif and T. Zimmer, "A Spice Model for Predicting Static Thermal Coupling Between Bipolar Transistors," *Research in Microelectronics and Electronics*, 2005 PhD, Vol. 2, July 2005, pp. 75-78.
 24. D. Lopez, R. Sommet and R. Quéré, "Spice Thermal Subcircuit of Multi-finger HBT Derived from Ritz Vector Reduction Technique of 3D Thermal Simulation for Electrothermal Modeling," *Gallium Arsenide Applications Symposium GaAs 2001*, 24-28 September 2001, London, England.
 25. A. Cidronali, G. Collodi, C. Accillaro, C. Toccafondi, G. Vannini, A. Santarelli and G. Manes, "A Scalable PHEMT Model Taking into Account Electromagnetic and Electro-thermal Effects," *Gallium Arsenide Applications Symposium GaAs 2003*, 6-10 October 2003, Munich, Germany.



When They're **Counting on You**, You Can **Count on Us**.



Products

- Amplifiers
- Mixers
- Oscillators
- Passive Waveguide Components
- Integrated Assemblies

Applications

- Law Enforcement Radar
- Surveillance Radars
- Missile Guidance
- Level Sensing Radars
- Communications Systems

Ducommun Technologies

- Design & manufacture of Millimeter Wave Products
- Heritage includes WiseWave, acquired in 2006
- Lean Manufacturing Implemented
- AS9100 Registered
- Customer Focused - Engineered Solutions



Email mwj@ducommun.com to request a FREE copy of our Sensor Brochure.



RF Multipin Connectors SQ-, TQ-, IQ-, and RQ-Series

*Order your personal copy
of this 52 pages catalog today*



Spectrum
Elektrotechnik GmbH

when Quality is needed

P.O. Box: 450533

80905 Munich, Germany

Telephone: +49-89-3548-040 Facsimile: +49-89-3548-0490

Email: Sales@Spectrum-et.com WWW.Spectrum-et.com

Visit <http://mwj.hotims.com/23284-104> or use RS# 104 at www.mwjjournal.com/info

Push&TQ&RMCatalog1

MANAGING CRYSTAL OSCILLATOR ACCELERATION SENSITIVITY IN MOBILE APPLICATIONS

All quartz crystal oscillators are affected by acceleration. While for many applications the effects are negligible, in those where frequency stability is critical and the environment is physically demanding (high shock or vibration), the effects can be significant. Even devices that are operated in relatively benign locations are under the influence of gravity and possibly low level vibration. If they are rotated or moved, a small shift in the operating frequency will occur. **Figure 1** shows a precision quartz resonator mounted in a four-point holder.

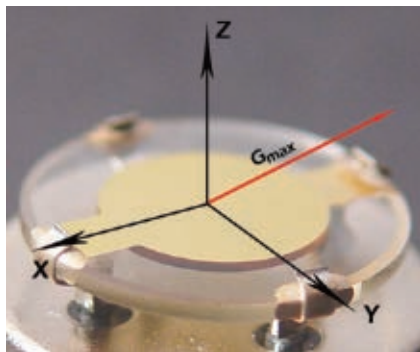
The acceleration sensitivity characteristic of a quartz crystal, commonly referred to as Gamma ($\vec{\Gamma}$), is vectorial in nature. The frequency shift that will be exhibited by a crystal experiencing an acceleration is therefore dependent on the direction and magnitude of the applied force as well as the magnitude and orientation of the inherent acceleration or “g-sensitivity” vector.¹ The fractional frequency change $\frac{\Delta f}{f_0}$ of the oscillator under an acceleration \vec{a} is given by the inner product of $\vec{\Gamma}$ and \vec{a} , that is

$$\frac{\Delta f}{f_0} = \vec{\Gamma} \cdot \vec{a} \quad (1)$$

The acceleration sensitivity vector $\vec{\Gamma}$ can be determined by measuring the frequency change under acceleration in three linearly independent directions (e.g. three orthogonal directions) that are aligned with the faces of the oscillator or crystal package. A frame of reference is therefore defined. The magnitude $|\vec{\Gamma}|$ of $\vec{\Gamma}$ is given by the square-root of the sum of the squares of its components ($\Gamma_x, \Gamma_y, \Gamma_z$)

$$|\vec{\Gamma}| = \sqrt{\Gamma_x^2 + \Gamma_y^2 + \Gamma_z^2} \quad (2)$$

It can be seen that the fractional frequency change is maximally positive when \vec{a} is parallel to $\vec{\Gamma}$; it is maximally negative when \vec{a} is antiparallel to $\vec{\Gamma}$, and approaches zero when \vec{a} is perpendicular to $\vec{\Gamma}$. This relationship is illustrated in **Figure 2**. The direction of $\vec{\Gamma}$ relative to the measurement frame as shown in **Figure 3** may then be determined.⁴



▲ Fig. 1 Four-point mount crystal blank.

STEVEN FRY
Greenray Industries, Mechanicsburg, PA

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



Model	Frequency Range	Type	Typical Phase Noise						Output Frequency	Output Power (dBm, Min.)
			10	100	1K	10K	100K	1M		
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



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

www.miteq.com

LTE / WiMAX 4G Components

Ultra Low Phase Noise PLL guarantee low EVM, hence prevent signal drop or loss, which is suitable for data intensive applications such as LTE/WiMAX.

Part Number	Freq. (MHz)	Pout. (dBm)	Phase noise [1K / 10KHz] (dBc/Hz)
PLF800F	800	5	-95 / -105
PLF1960F	1960	4	-93 / -103
PLF2150F	2150	3	-92 / -101
PLF2500F	2500	2	-92 / -100
PLF5100F	5100	2	-90 / -94

Above products are PLF series which includes ROM, and is a fixed frequency PLL synthesizer module. Different frequency designs available. Variable PLL (PLV series) and TCXO inclusive PLL (PLA series) are available.



Just the right NF and IP3 to have minimum data error rate

Part Number	Freq. (MHz)	N.F. (dB)	OIP3 (dBm)	Max Input Power (dBm)
CL2102D-L*	1750 ~ 2600	0.7	33	30
CL3102D-L*	3100 ~ 3500	0.9	33	30
CL2701-L	2300 ~ 2700	0.9	28	25
CL2702-L	2300 ~ 2700	0.8	33	25
CL3501-L	3400 ~ 3600	0.9	32	25
CL3502-L	3300 ~ 3600	1	36	25

* Limiter inclusive design to protect LNA. Custom design available at no added cost.

With much experience on Hybrid and Pallet PA design, custom solution can be provided within a week just for you. Listed products are just a few of our capability, so contact us now for custom PLL & LNA products at no added cost.

RFHIC
www.rfhic.com

Tel) 82-31-250-5011 / Fax) 82-31-250-5088
E-mail) rfhsales@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.

MTT-S Booth# 738

$$\Phi = \cos^{-1} \left(\frac{\Gamma_x}{\sqrt{\Gamma_x^2 + \Gamma_y^2}} \right) \quad (3)$$

$$\theta = \sin^{-1} \left(\frac{\Gamma_z}{\Gamma} \right) \quad (4)$$

Normally the dominant source of the oscillator's acceleration sensitivity is the quartz crystal resonator. Depending on the construction, a given group of crystals may exhibit substantial variation in both the direction and magnitude of $\vec{\Gamma}$. It is therefore necessary to measure each crystal in order to be assured of its individual characteristic.

The acceleration sensitivity of a quartz crystal is caused primarily by non-uniform stresses induced within the active area of the quartz blank by the acceleration. The active area of a crystal resonator is in the center of the blank, between the plated electrodes. Conventional crystals are typically mounted at two points in a flat holder such as an HC-43 or HC-45. Round holders such as the HC-35 or HC-37 (TO-05 or TO-08 size) mount the crystal horizontally at three or four points. The resonant frequency of any mechanical body is inherently sensitive to stresses and strains that cause the resonant frequency to change. An applied acceleration in any direction will impart a stress to the quartz that is non-uniform in some manner due to the mounts. Typical crystal acceleration sensitivities will range from about 1×10^{-10} per g for specially constructed precision SC-cut and AT-cut resonators to the order of 10^{-7} per g for tuning fork resonators.²

With the drive to continually reduce the package size of crystal oscillators for new systems and applications, improvements have been made in the performance of miniature strip crystals. These resonators use small rectangular quartz blanks instead of the round wafers found in conventional holders, as shown in **Figure 4**.⁵ Although these crystals have been used for some time in low cost oscillators, recent advances in their design and processing have provided resonators for some precision applications

TECHNICAL FEATURE

that are just as good or even better in some respects than the much larger conventional holders. The blanks are mounted at one end and suspended in a cantilever fashion. The low mass of the quartz and the isolation of the active area from the stress of the mount can provide a design with low acceleration sensitivity with some being better than 1×10^{-9} per g.

ENVIRONMENTAL EFFECTS

The type of acceleration that the crystal is exposed to will determine how the frequency will respond. It is common for an oscillator to experience mechanical shocks due to routine handling of equipment or movements in the vicinity of the oscillator. These types of shocks will cause a

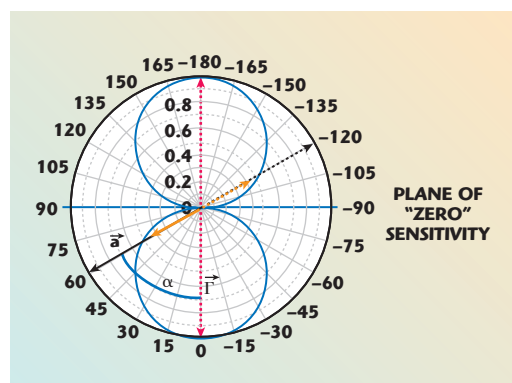


Fig. 2 Relative frequency shift as a result of applied acceleration.

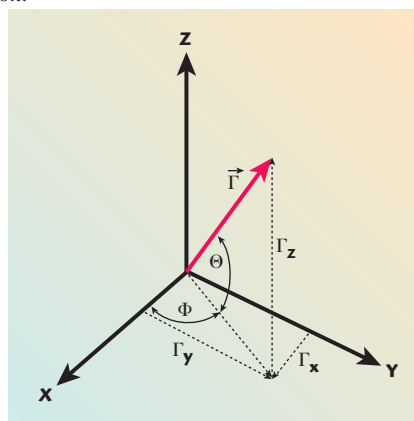


Fig. 3 Gamma vector measurement frame.

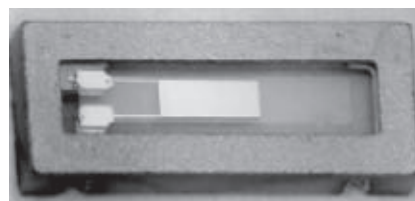
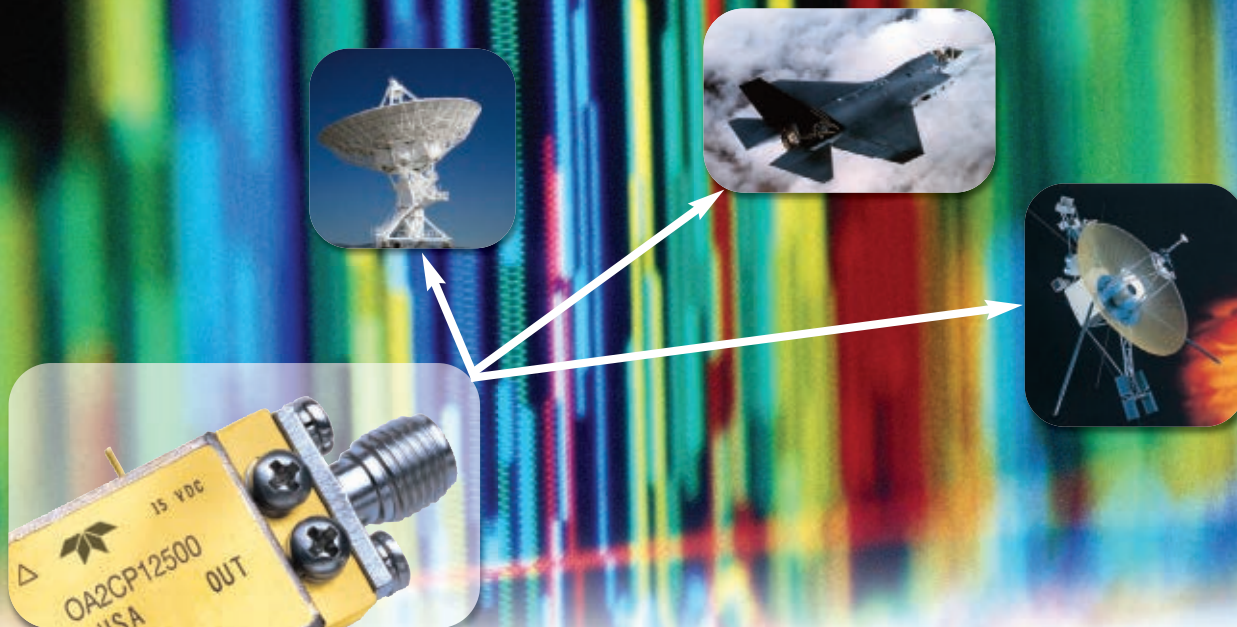


Fig. 4 Internal view of crystal strip mount.



VCO Performance and Dependability

85 MHz to 18 GHz

	Freq. Range	Tuning Voltage Range	Output Power/ Variation	Typical Phase Noise Offset at 10kHz/100kHz (dBc/Hz)	Nominal Modulation Sensitivity Min.-Max.	Typical Harmonic Suppression	D.C. Bias	
Model	(MHz)	(Volts)	(dBm/ ±dB)		(MHz/V)	(dBc)	Voltage (Volts)	Current (mA)
Oscillator with internal MMIC amplifier available in SMT0-8 or CougarPak™								
OAS5100	4300-5100	0-15	13.0/2.0	-84/-108	50-85	-22	5.0	94
OAS7700	5700-7700	0-15	10.0/2.0	-75/-100	70-250	-30	5.0	95
OAS8900	6900-8900	0-15	10.0/2.0	-70/-95	100-270	-30	5.0	95
Oscillator available in SMT0-8 or CougarPak™								
OS6700	5400-6700	0-15	0/2.0	-75/-100	80-180	-17	5.0	25
OS7700	5700-7700	0-15	2.0/2.0	-75/-100	70-250	-17	5.0	25
OS8900	6900-8900	0-15	1.0/2.0	-70/-95	100-270	-25	5.0	24
Oscillator available in TO-8, SMT0-8 or CougarPak™								
OC1000	500-1000	0-20	10.0/2.0	-90/-105	15-55	-10	15.0	35
OC3400	2700-3400	0-15	10.0/2.0	-80/-105	75-115	-12	15.0	60
OC4500	3500-4500	0-15	8.0/2.0	-75/-100	50-150	-10	15.0	60
Oscillator, Amp, Filter and Voltage Regulator in 2- and 3-Stage CougarPak™								
OA2CP2001	1000-2000	0-(-15)	15.0/2.0	-70/-100	50-150	-15	15.0	250
OA2CP12500	9000-12500	0-(-12)	15.0/2.0	-65/-95	150-450	-25	15.0	250
OA3CP18001	12000-18000	0-(-12)	15.0/2.0	-55/-85	150-750	-15	15.0	350

Typical and guaranteed specifications vary versus frequency; see detailed data sheets for specification variations.

QUALITY • PERFORMANCE • ON TIME



TELEDYNE COUGAR

A Teledyne Technologies Company

ISO 9001:2000 • AS9100 • MIL-PRF-38534 • Class H & Class K Certified

408-522-3838 • Fax 408-522-3839

www.teledyne-cougar.com • email: cougar@teledyne.com

Visit <http://mwj.hotims.com/23284-110> or use RS# 110 at www.mwjjournal.com/info

GaN Wideband Amplifiers



Great IP2 Performance

Part Number	Freq. (MHz)	Gain (dB)	P3dB (dBm)	OIP3 (dBm)
RFW2500H10-28	20~2500	13	36	41
RWP05020-10	20~1000	35	43	50
RWP05040-10	20~1000	38	45	50
RWP06020-10	450~880	39	44	49
RWP06040-10	450~880	33	46	51

Custom design available.

Other Wideband Amplifiers

Part Number	Freq. (MHz)	Gain (dB)	Psat (W)	PKG
RFC092	800~1000	23	1	DP-27
RFC1G22-24	20~1000	22	1	DP-27
RFC1G18H4-24	20~1000	18	4	DP-27
RFC1G18H4-24S	20~1000	18	4	SOT-115J
RUP15010-10	500~2500	14	10	
RUP15010-11	500~2500	57	10	
RUP15020-10	500~2500	15	20	
RUP15020-11	500~2500	57	20	
RUP15030-10	500~2500	14	30	
RUP15050-10	500~2500	11	50	

With much experience on Hybrid and Pallet PA design, custom solution can be provided within a week just for you. Listed products are just a few of our capability, so contact us now for wider bandwidth power amplifiers.

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
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.

MTT-S Booth# 738

temporary perturbation in the frequency that could disturb the operation of circuitry such as narrowband phase-locked loops. Reducing these effects requires either attenuation of the applied shock or improving the acceleration sensitivity of the oscillator.

Oscillators that are deployed in a mobile environment such as a vehicular application may experience significant levels of vibration. Through the acceleration sensitivity of the oscillator, this vibration modulates the output frequency. Random vibration on some airborne platforms can reach extremely high levels. This wideband mechanical vibration leads to wideband phase noise degradation in the oscillator. Periodic vibrations from an engine, rotating machinery or even a cooling fan can induce discrete sidebands on the output signal. The levels of the sidebands will be determined by the magnitude and frequency of the vibration as well as the acceleration sensitivity component of the crystal in the direction of the force.¹

Another influence that affects all oscillators is the constant acceleration due to gravity. All bodies at rest on the surface of the earth experience an acceleration \vec{a} of 1 g directed upward. Rotating an oscillator around a horizontal axis will change the angle between $\vec{\Gamma}$ and \vec{a} . Through Equation 1 it can be seen that a frequency change will occur. For many applications this change is negligible, but for those requiring stability on the order of 1 ppb or better, this amount of frequency shift can be significant.

ACCELERATION SENSITIVITY MEASUREMENT METHODS

There are several methods that can be used to measure the acceleration sensitivity $\vec{\Gamma}$ of an oscillator. Here we discuss the simple 2-g tipover test and the vibration induced sideband methods.

A technique that uses the constant gravitational acceleration of the earth to cause a measurable frequency shift in an oscillator is known as the "2-g tipover test". A set of orthogonal axes relative to the oscillator case is defined. The oscillator is oriented so that one axis (\hat{x}) points upwards and the frequency is measured. The oscillator is then rotated 180° so that this axis points downwards and the frequency is measured in this orientation. From the point of view of the oscillator, this is as

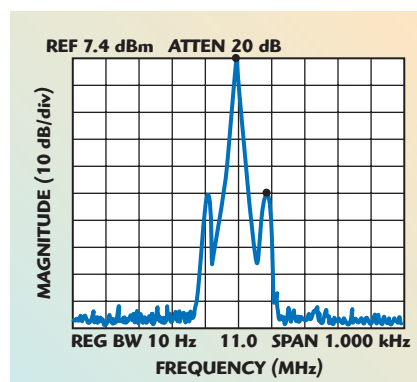
though the acceleration changed from $\vec{a} = (1g)\hat{x}$ to $\vec{a} = -(1g)\hat{x}$

so the resultant frequency difference between the two configurations would be given by

$$\frac{\Delta f}{f_0} = \Gamma_x(1g) - \Gamma_x(-1g) = \Gamma_x(2g) \quad (5)$$

There is a net 2 g change in the acceleration so $\vec{\Gamma}_x$ is one half of the fractional frequency change (in units per g). Repeating this for the other two axes gives all three components of $\vec{\Gamma}$ and hence $\vec{\Gamma}$ is defined. This method requires a relatively stable oscillator in order to see the gravitational induced shifts above the short-term noise and thermal drift of the oscillator. Several cycles may be needed to separate the g sensitivity from these effects.

An accurate method for measuring the acceleration sensitivity of any oscillator uses mechanical vibration to modulate the output frequency of the oscillator through the acceleration sensitivity effect (see **Figure 5**). The effect on the output signal can then be observed with a spectrum analyzer. Sinusoidal vibrations are used to characterize the sensitivity at a specific frequency. Under sinusoidal vibration, discrete sidebands will be induced on the oscillator output signal offset from the carrier f_0 by the vibration frequency f_v . Since the sinusoidal vibration essentially FM modulates the carrier, the level of the sidebands will be predicted by FM modulation theory. For a signal whose frequency has a peak change of Δf at a modulating frequency f_m , the measured sideband levels at frequency $f_0 \pm f_m$ will have good approximation to the modulation index formula for a small index of <0.1 .²



▲ Fig. 5 Oscillator spectrum under sine vibration.



Where Performance Counts



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

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.

**Military • Commercial
Wireless • Space**



www.ewtfilters.com

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

Dare to Compare!

QUIET!

Now
Delivering

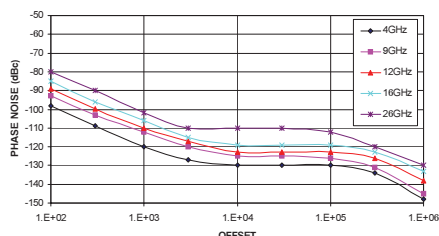
and PRECISE

OCXO, PLXO

Phase Locked & FR DROs

New Products! Details on website

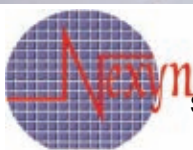
TYPICAL PHASE NOISE OF NEXYN PLDRO



Phase Noise at 14 GHz

100 Hz	- 88 dBc/Hz
1 KHz	-109 dBc/Hz
10 KHz	-119 dBc/Hz
100 KHz	-120 dBc/Hz
1 MHz	-135 dBc/Hz

- Reliable and Rugged Design
- Extremely Low Microphonics
- 5-500 MHz External Reference
- Frequency: 3 to 30 GHz
- Power output: +15 dBm
- Spurious: < -80 dBc
- -55 to +85 C (temp range)
- Int. Ref. Stability to +/- 0.05 ppm
- Now offering PLO .3 to 3 GHz
- Low Noise crystal reference
- Dual Loop Output Frequency to nearest KHz w/ Ext. 10 MHz Ref



Nexyn Corporation

1089 Memorex Dr.
Santa Clara, CA 95050

Tel: (408) 982-9339

Fax: (408) 982-9275

Visit our website at www.nexyn.com

Excellent Technical Support
Guaranteed Performance and
Competitive Pricing

TECHNICAL FEATURE

$$\text{Sideband Level(dBc)} = 20 \log \left(\frac{\Delta f}{2f_m} \right) \quad (6)$$

The amount of frequency shift is given by $\Delta f = |\vec{\Gamma} \cdot \vec{a}| f_0$ and the modulation frequency is the frequency of the sinusoidal vibration f_v , so that the formula for the level of the vibration induced sidebands becomes:

$$L(f_v) = 20 \log \left(\frac{|\vec{\Gamma} \cdot \vec{a}| f_0}{2f_v} \right) \quad (7)$$

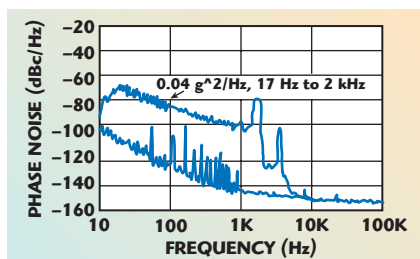
By rearranging the formula, the measured sideband level in dBc can be converted to the corresponding g-sensitivity in the direction being vibrated, d , given the known vibration g-level α_d and nominal frequency f_o .

$$|\vec{\Gamma}_d| = \frac{2f_v}{\alpha_d \cdot f_o} \cdot 10^{\frac{SB(dB)}{20}} \quad (8)$$

The acceleration sensitivity is fairly constant with frequency as long as the vibration frequency is below the lowest mechanical mode of the resonator. This could be as high as two or three kHz for a strip crystal or a stiff four-point mount or as low as 100 Hz for a large crystal using a spring type mount. The frequency shift is also linearly proportional to the applied g level up to about 50 g's. For screening purposes a vibration frequency and acceleration level are chosen that give easily measurable sidebands.

EFFECTS OF RANDOM VIBRATION

Under random vibrations the oscillator will experience accelerations over a wide range of frequencies and various magnitudes. Even a moderate amount of random vibration can cause a significant degradation of an oscillator's phase noise performance (see **Figure 6**). Similar modulation index arguments are used to calculate the



▲ Fig. 6 Phase noise degradation due to random vibration.

vibration induced noise at a frequency offset, f_r . These random motions are characterized by the power spectral density of the vibration profile. The formula for approximating the induced noise at offset f_r becomes:

$$L(f_r) = 20 \log \left(\frac{|\vec{\Gamma} \cdot \vec{f}_0| \cdot \sqrt{2\text{PSD}}}{2f_r} \right) \quad (9)$$

When the phase noise of the oscillator is measured while vibrating, it is then possible to calculate the g-sensitivity at any frequency within the spectrum. Care must be taken to ensure that fixture resonances and cable sensitivities are accounted for when evaluating the results.

SCREENING FOR ACCELERATION SENSITIVITY

There are some applications where the performance of the crystal oscillator under vibration or shock is a critical parameter that must be guaranteed 100 percent to a stringent level. Although robust crystal designs and well controlled production processes can produce crystals with high yields, screening is still necessary to ensure some specifications. A typical screening system would consist of a vibration table and controller, fixturing for securing the crystals in an oscillator and a narrow-band spectrum analyzer or other instrument for evaluating the levels of vibration induced sidebands. A vibration level and frequency are selected that will produce measureable sideband levels, but are convenient to work with. A level of 10 g's at a frequency of 90 Hz is a typical choice. **Figure 7** shows the results of screening a group of 20 MHz TCXOs that use AT strip crystals.

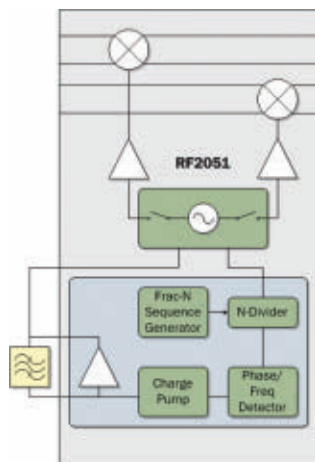
METHODS FOR REDUCING SENSITIVITY

There are methods and techniques that can be employed to improve the acceleration performance of a crystal oscillator. For example, if the acceleration sensitivity vector $\vec{\Gamma}$ is reasonably consistent in direction and if the accelerations occur primarily in one direction, then aligning the oscillator so that the accelerations are perpendicular to $\vec{\Gamma}$ can result in as much as a 10-fold reduction in frequency changes compared to a worst case alignment.

Active acceleration compensation may be implemented by utilizing an

RFMD® Integrated RF Synthesizer and VCO with Mixers

Family of Integrated Configurable Components for RF Front Ends



Designed to reduce development time, risk, and size of RF front end circuits in modern radios, the RF205x family of products from RFMD® provides engineers with a highly integrated, yet flexible solution. These devices use a unique system partitioning—a vertical slice through an RF section—that combines a high-performance fractional-N PLL, low phase noise VCOs, LO buffers, and high-linearity RF mixers. The components generate a low noise LO signal of between 300 MHz to 2400 MHz, and have built-in wideband RF mixers that operate from 50 MHz up to 2500 MHz. All RF205x devices are contained in a standard plastic 32 pin, 5 x 5 mm package.

205x SERIES SPECIFICATIONS

	Units	RF2051	RF2052	RF2053
Fractional-N PLL		Yes	Yes	Yes
On-chip VCOs		Yes	Yes	No
RF mixers		2	1	1
DC Parameters				
Supply voltage	V	3.0	3.0	3.0
Supply current (low-current setting)	mA	55	55	55
VCO and Synthesizer				
Input reference frequency	MHz	10 to 104		
LO frequency	MHz	300 to 2400	300 to 2400	-
Open loop VCO phase noise at 500 MHz LO frequency	dBc/Hz	-140	-140	-
RF Mixer				
RF and IF port frequency range	MHz	50 to 2500		
Noise figure (low-current setting)	dB	-	9.5	-
Input IP3 (high-linearity setting)	dBm	-	20	-

FEATURES

- 2.7 V to 3.6 V operation
- Fractional-N synthesizer—1.5 Hz resolution
- Integrated LO buffers, high-linearity RF mixers, and low phase noise VCOs
- Programmable linearity mixers for power saving
- Three-wire serial control interface

For complete specifications and free evaluation samples, email RF205x@rfmd.com

RFMD® is a trademark of RFMD, LLC. All other trade names, trademarks and registered trademarks are the property of their respective owners.
©2008 RFMD.



rfmd.com/RF205x

Visit <http://mwj.hotims.com/23284-94> or use RS# 94 at www.mwjjournal.com/info



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

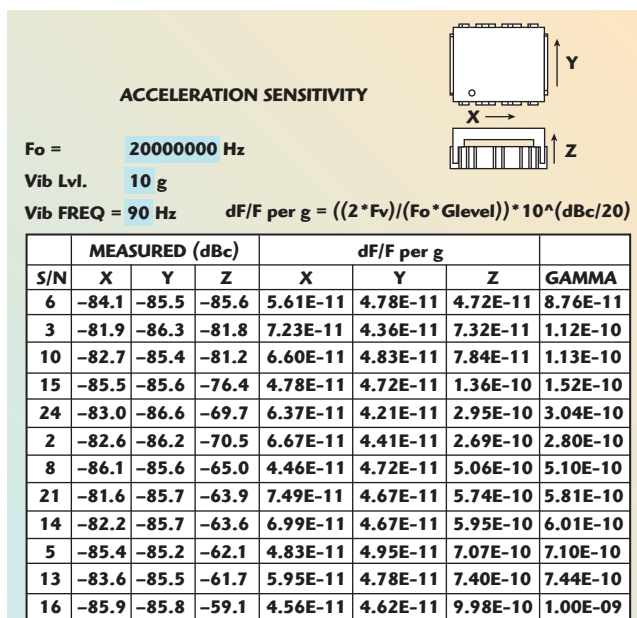
5702-D General Washington Drive
Alexandria, Virginia 22312 USA
Tel: (703) 642-6332, Fax: (703) 642-2568
Email: sales@umcc11.com

www.umcc11.com

accelerometer with feedback to the oscillator circuit. This closed loop system is then accurately calibrated to offset the frequency of the oscillator proportional to the sensed acceleration and cancel out the frequency shifts caused by the acceleration. This technique can work well at lower frequencies up through a few hundred Hz, but it requires a relatively complex circuit to sense acceleration in all three axes, scale the correction signal properly and account for frequency dependent phase shifts in the circuitry. Close attention to the mechanical details of the design is also required.

Another type of compensation involves using multiple crystals with their acceleration sensitivity vectors aligned so that they are pointing in opposite directions in an anti-parallel arrangement.³ The crystals are then connected to the oscillator circuit either in a parallel or series configuration where the composite combination operates as a single crystal with modified motional parameters. The two $\vec{\Gamma}$ vectors then essentially cancel the effect of each other. This method can be quite effective if the crystals are similar and are characterized and aligned properly in the assembly. With a solid mechanical design, cancellation will occur up through several kHz and can provide a significant improvement in phase noise performance during random vibration.

Some systems designed for severe environments or very sensitive installations can effectively use vibration and shock isolators to mechanically attenuate the force that is transmitted to the oscillator. Vibration isolators are only effective in reducing levels above the natural resonant frequency of the system. Obtaining a low resonant frequency below a few hundred Hz is difficult with a small, light component such as a miniature oscillator and it may be necessary to add weight to



▲ Fig. 7 Screening results for a group of 20 MHz TCXOs.

the assembly depending on the stiffness of the isolator. There is a region near the resonant frequency where the force is actually amplified by some amount depending on the damping characteristics of the materials. Care must be taken to ensure sufficient sway room to allow for movement of the assembly, especially if excited near the resonant frequency. An isolation system that is not properly designed can make the overall performance worse rather than better.

While acceleration forces are unavoidable, by understanding their effects on oscillator performance and the methods that may be used to mitigate these effects, acceptable performance can be achieved in most application environments. Advancements in crystal technology continue, but the "zero g-sensitivity" oscillator is not yet a reality so dealing with the effects of acceleration will be necessary for the foreseeable future. ■

References

1. R.L. Filler, "The Acceleration Sensitivity of Quartz Crystal Oscillators: A Review," *IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control*, Vol. 35, No. 3, May 1988, pp. 297-305.
2. J.R. Vig, "Quartz Crystal Resonators and Oscillators for Frequency Control and Timing Applications: A Tutorial," Rev. 8.5.3.0, February, 2005, AD-M001251(revised).
3. R.L. Filler, "Acceleration Resistant Crystal Resonator," U.S. Patent No. 4,410,822, 1983.
4. J.M. Przyjemski, "Improvement in System Performance Using a Crystal Oscillator Compensated for Acceleration Sensitivity," *Proc. 32nd Annual Frequency Control Symposium*, pp. 426-431, 1978.
5. Statek Corp., Technical Note 28, "An Ultra-miniature Low Profile at Quartz Resonator."



SUPER ULTRA WIDEBAND AMPLIFIERS

+24 dBm output... 0.7 to 21GHz 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
Note: Alternative heat-sink must be provided to limit maximum base plate temperature.					
ZVA-183+	0.7-18	26	+24	3.0	895.00
ZVA-213+	0.8-21	26	+24	3.0	995.00

All models IN STOCK!

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



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

IF/RF MICROWAVE COMPONENTS

440 Rev A

Visit <http://mwj.hotims.com/23284-68> or use RS# 68 at www.mwjjournal.com/info

LDMOS RUGGEDNESS RELIABILITY

An overview of the 28-42-50 V LDMOS technologies is given and the ruggedness reliability is discussed, in addition to the RF performance. Various ruggedness tests are presented such as pulsed snapback measurements, VSWR and video bandwidth tests.

RF power amplifiers are key components in base stations, broadcast transmitters, ISM applications and microwave applications. They can handle a wide range of signal types such as GSM, EDGE, W-CDMA, WiMAX and DVB-T. RF laterally diffused MOS (LDMOS) transistors have been the technology of choice for these power amplifiers for more than a decade, because of their excellent power capabilities, gain, efficiency, cost and reliability.

Ruggedness is one of the most important reliability parameters for RF power transistors. Ruggedness is the ability to withstand a stress condition without degradation or failure. One way to characterize ruggedness is by measuring the voltage standing wave ratio (VSWR) in an RF test fixture with a defined mismatch at the output. The design of the test fixture and the matching of the transistor are critical for the result of the VSWR test. LDMOS transistors are optimized to withstand a certain power and voltage, and the process is engineered for the best trade-off between RF performance and ruggedness.

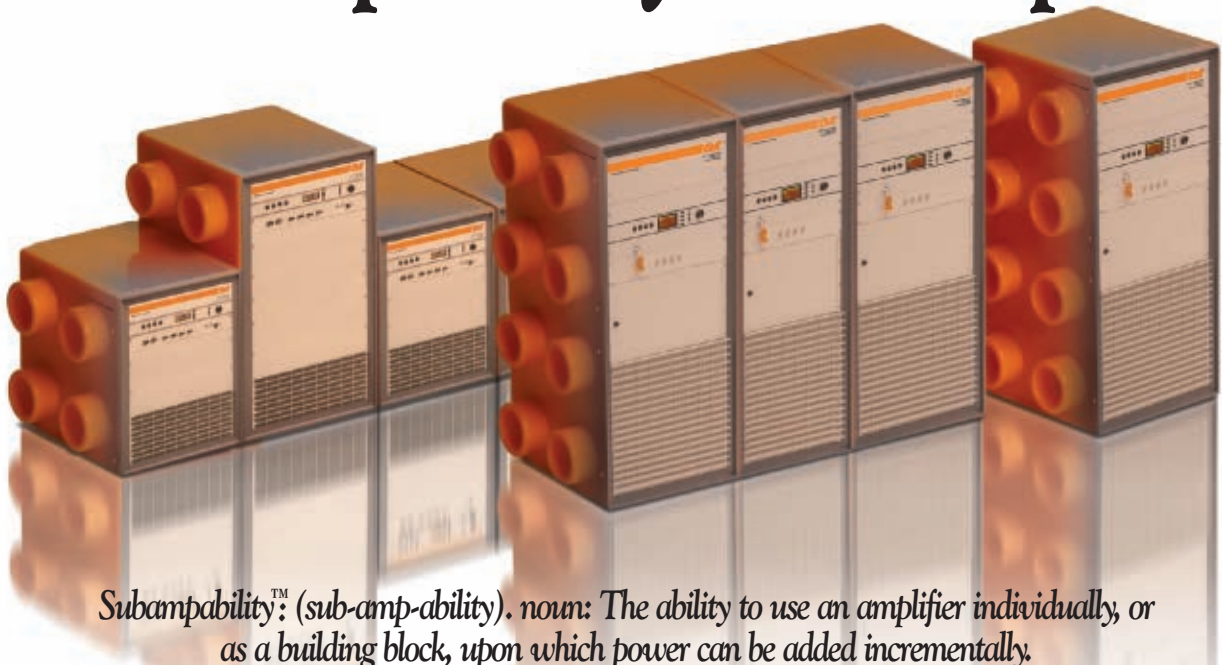
In this article, RF LDMOS devices are shown, which combine very good ruggedness with state-of-the-art RF performance. Ruggedness tests, which have been developed to meet today's product ruggedness criteria, will be described.

RF LDMOS TECHNOLOGIES (28-42-50 V)

NXP Semiconductors has developed a base station RF LDMOS technology^{1,2} and high voltage RF LDMOS technologies.³ The base station technology operates at supply voltages of approximately 28 V, while the high voltage technology can be used at 42 and 50 V. Both LDMOS types are processed in an 8-inch CMOS-fabrication environment, capable of lithography down to 0.14 μm , where the LDMOS process is derived from the C075 CMOS (0.35 μm gate) process with LOCOS isolation. Additions to this C075 process are the source sinker to the substrate, CoSi_2 gate silicidation, tungsten shield and mushroom-type drain structure with thick multi-layer AlCu metallization. A schematic

S.J.C.H. THEEUWEN, J.A.M. DE
BOET, V.J. BLOEM AND W.J.A.M.
SNEIJERS
NXP Semiconductors
Nijmegen, The Netherlands

Here's The Idea Behind Our Subampability™ Concepts!



Subampability™: (sub-amp-ability). noun: The ability to use an amplifier individually, or as a building block, upon which power can be added incrementally.

Grow as you go. One small step at a time. Building on what's already there.

AR has applied this age-old idea to amplifiers used for EMC testing. When you need a more powerful amplifier, now you can add the power, instead of tossing out the old amp and starting all over again.

Add Power To Existing Amps.

With test specs constantly changing, it's an idea whose time has come. Many amplifiers within our "S" and "W" Series are designed so that the power can be expanded with a relatively simple upgrade. Of course, the amplifiers can still be used individually when needed.

The latest examples are Models 10S4G11A (10 watts, 4-10.6 GHz) and 15S4G8A (15 watts, 4-8 GHz). A fairly simple upgrade performed by AR expands the 10S4G11A to a 20S4G11A (20 watts, 4-10.6 GHz) ... and the 15S4G8A to a 35S4G8A (35 watts, 4-8 GHz).

Once this initial upgrade is performed, the sky's the limit. The 20S4G11A and the 35S4G8A are like building blocks that can easily be expanded by adding sub amps and controller/combiner units.

At AR, we're always thinking ahead. And we know you are, too. That's why you'll appreciate our Subampability concept ... and the fact that all AR products are backed by the strongest, most comprehensive warranty in the industry, and a global support system that's second to none.

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

40 years
AR
And Still Going Strong

See Application Note #40 Expandable Power for further details.

ISO 9001:2000
Certified



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/23284-14> or use RS# 14 at www.mwjjournal.com/info

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

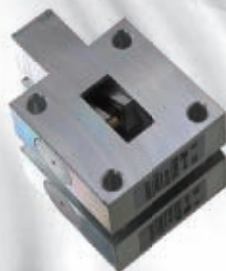
- Isolator/Circulator
- Waveguide
- Combiner
- Directional Coupler
- Power Divider
- Ceramic Filter

DROP-IN SERIES



COAXIAL SERIES

WAVEGUIDE SERIES



SURFACE MOUNT SERIES

JQL ELECTRONICS INC.

Tel: (888) 236-9828 (US & Canada)
(630) 930-9917 (International)
Fax: (630) 823-2902 / (630) 756-0017
Email: sales@jqlelectronics.com

www.jqlelectronics.com

Designed and Created by Garfield-Loves-Fish™ Studio

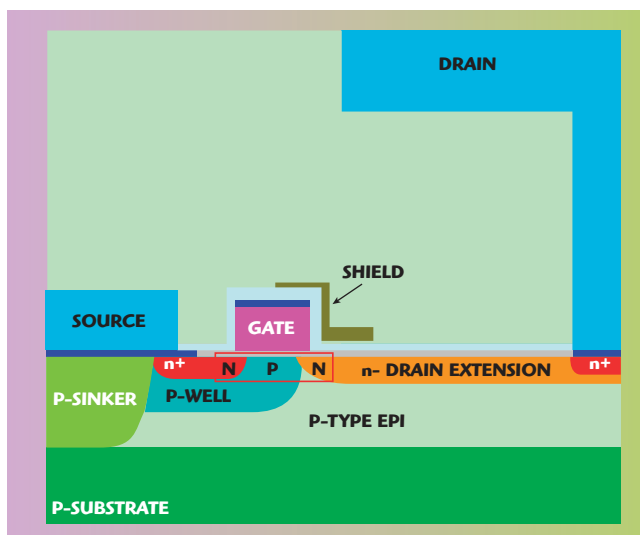
picture of the LDMOS is shown in **Figure 1**, where the inherently present NPN parasitic bipolar transistor is indicated by the red rectangle.

The RF performance of the base station LDMOS is state-of-the-art and is used in a wide range of applications like GSM, W-CDMA and WiMAX.¹ Recently, high voltage (42 to 50 V) LDMOS technologies³ have been developed for high power devices at frequencies below 1 GHz. Typical RF performance of the high voltage technology at 470 to 860 MHz (UHF) and 225 MHz (VHF) is shown in **Figures 2** and **3**, respectively. The UHF device delivers 75 to 110 Wavg at 42 and 50 V, respectively. The broadband gain is 19 dB and the efficiency is 30 to 32 percent with a Complementary Cumulative Distribution Function (CCDF) of 8 dB. The VHF device delivers 1300 W power (P1dB) at 50 V with a peak efficiency of over 70 percent and a gain of 24 dB.

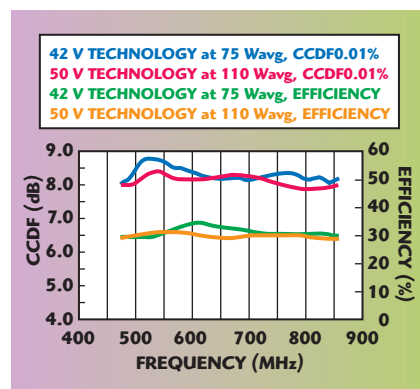
Both devices have been tested to be very rugged and capable of handling high voltage and high power over a wide band of extreme mismatch conditions. In general, at low frequencies, more ruggedness is required of devices. This is partly due to the higher harmonic content at frequencies much lower than the cut-off frequency. Also, the signal type is important for ruggedness, sharply varying pulse signals with a steep rise time being more severe for ruggedness. For this reason, LDMOS technologies have been hardened under the most stringent ruggedness tests during development, and in particular the 50 V high voltage technology.

PARASITIC BIPOLAR TRANSISTOR

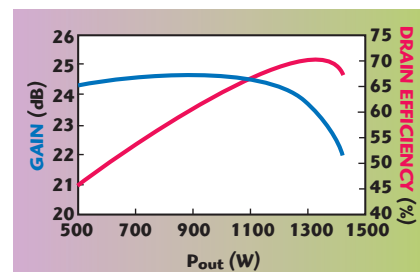
Inherent to the LDMOS device is the presence of a parasitic bipolar transistor. This NPN bipolar transistor is indicated in the schematic picture of the device. The corresponding electrical schematic is given in **Figure 4**, showing, in addition to the LDMOS,



▲ Fig. 1 Schematic picture of LDMOS technology.



▲ Fig. 2 RF performance of the 42 V and 50 V LDMOS technology devices at 470 to 860 MHz for an 8k DVB-T signal.



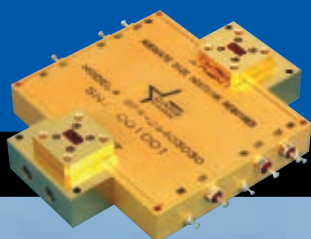
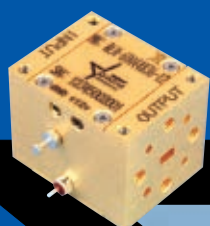
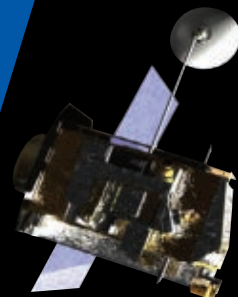
▲ Fig. 3 RF performance of a 50 V LDMOS device (BLF-578) at 225 MHz.

the presence of the parasitic NPN bipolar transistor and the drain-substrate diode. The drain-source diode clamps the voltage across the LDMOS and the parasitic bipolar and sinks the excess current to the substrate. For large sink currents, however, the drain-source voltage exceeds the diode breakdown voltage and the parasitic bipolar transistor can be triggered.

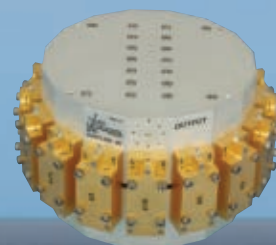
This triggering of the parasitic bipolar transistor is essential for the occurrence of a ruggedness failure. To



COMPLETE MILLIMETER-WAVE FRONT END SOLUTIONS FOR YOUR SYSTEMS



Standard and Application-Specific
Amplifiers and Oscillators



Millimeter-Wave Products 18-220 GHz

- ★ Components including antennas, amplifiers, oscillators, converters, control devices and passive components
- ★ Subsystems and integrated modules
- ★ Custom products and engineering services

QUINSTAR TECHNOLOGY, INC.

24085 Garnier Street, Torrance, CA 90505
Tel 310-320-1111 • Fax 310-320-9968

sales@quinstar.com

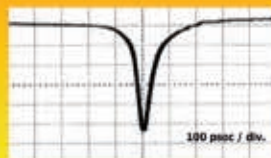
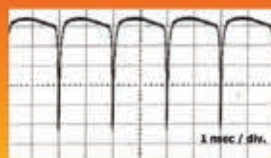
www.quinstar.com



Impulse Generators 100 - 2000 MHz

Application:

- > Clock Reference
- > Sampling Circuit
- > Sharp Biasing or Triggering Source
- > Optical Modulator Driving



MODEL	INPUT (DRIVING) FREQ. (MHz)	TYPICAL OUTPUT VOLTAGE (V)	TYPICAL IMPULSE PULSE WIDTH (P SEC)
GIM100A	100	-12	100
GIM200A	200	-18	90
GIM250A	250	-18	80
GIM500A	500	-15	60
GIM1000A	1000	-10	50
GIM1500A	1500	-8	45
GIM2000A	2000	-7	35

Your Source for the Most Complete Line of Comb & Impulse Generators

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



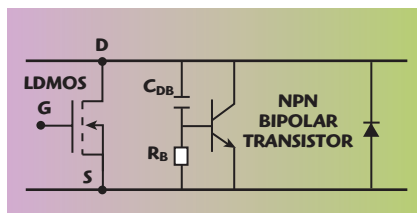
The Microwave Products Source

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



TECHNICAL FEATURE



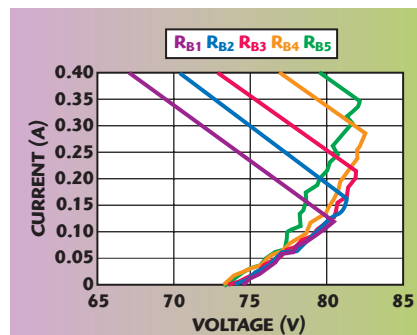
▲ Fig. 4 Electrical representation of the LDMOS and the inherently present parasitic bipolar transistor and drain-substrate diode.

make the bipolar transistor robust for a triggering event, the bipolar of the LDMOS has been characterized and optimized. Important transistor parameters for triggering are the base resistance (R_B), the gain of the bipolar and the amplitude of the base current. As a characterization tool for the triggering of this bipolar, a short pulse (50 to 200 ns) is used in the measurement of the current-voltage characteristics. An impedance transmission line is used as a pulse source to create a rectangular pulse. The desired voltage is applied via a DC power supply and then quickly discharged with a low inductance switch. The current and voltage are measured with a memory scope during the discharge. The snapback in the I-V curve is measured, which gives insight in the device properties of the DUT. The characterization is done on a wafer with small (test) devices in a 50 Ω commercially available set-up. Power RF devices cannot be used, since the setup is not able to generate enough current. This is a fast and adequate evaluation of device and process changes on ruggedness without the influence of test circuits and matching conditions.

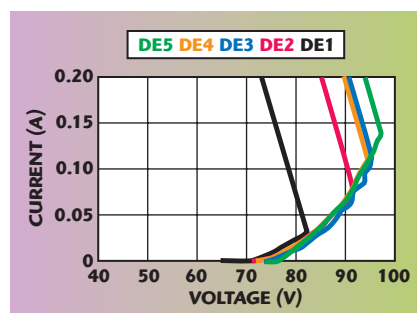
RUGGEDNESS CHARACTERIZATION

During the development of RF-LDMOS processes, the intrinsic ruggedness of the parasitic bipolar transistor of the RF power LDMOS devices has been continuously improved.

The base resistance is important for ruggedness as can be seen from the electrical representation of the LDMOS. In the processing, the base resistance of the parasitic bipolar transistor has been varied to lower the voltage drop between base and emitter. In **Figure 5**, the pulsed current-voltage characteristic of base station RF LDMOS devices is shown for different base resistances. Around the (diode) breakdown voltage of the transistor



▲ Fig. 5 Pulsed current voltage characterization of several devices with different base resistance.



▲ Fig. 6 Characterization of devices with different drain engineering variants at $V_{gs} = 0$ V.

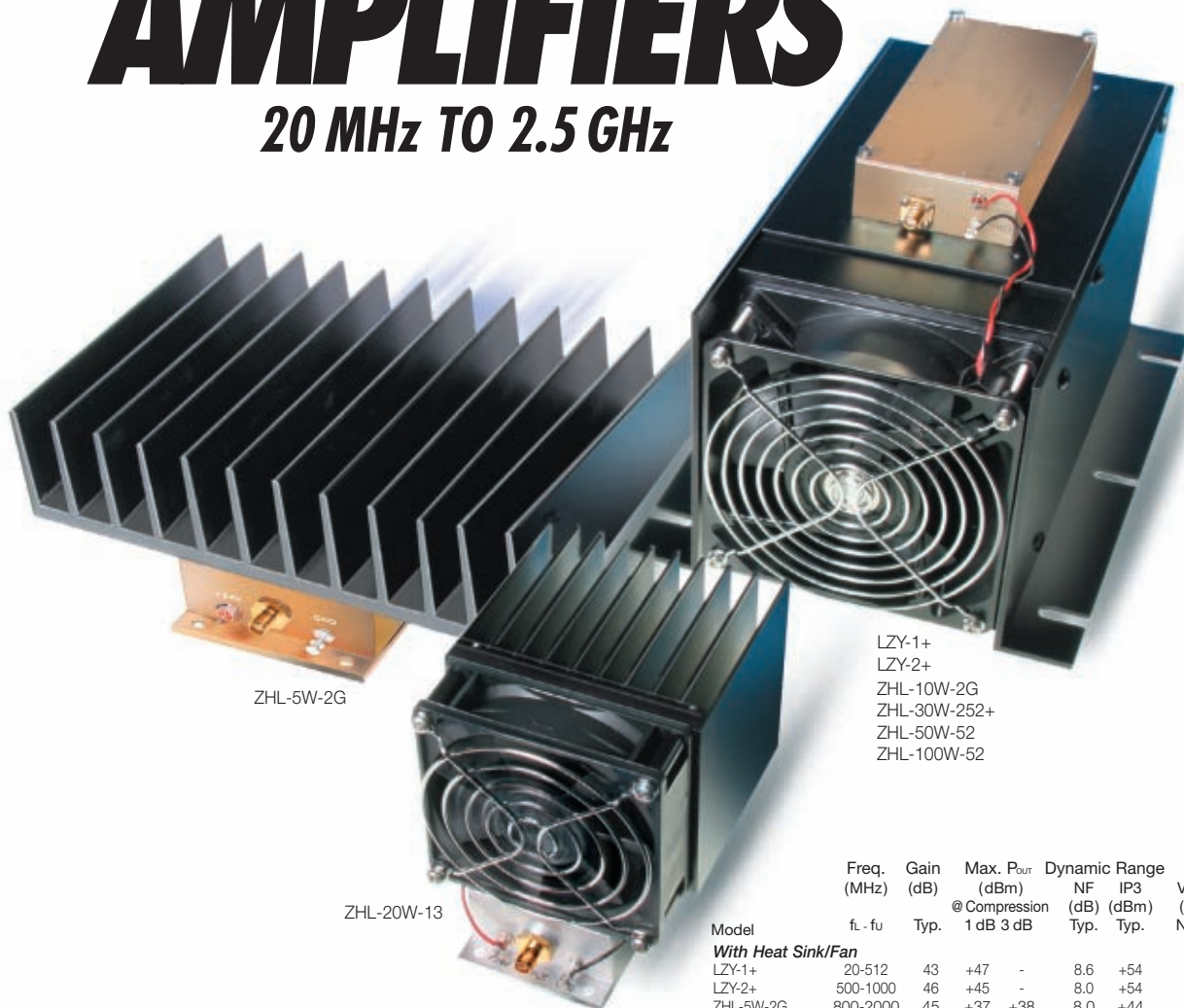
(in this example at approximately 73 V), the drain current starts to increase and at 82 V a snapback occurs. This snapback voltage and snapback current are the two parameters that are a measure for the intrinsic RF ruggedness. By process optimizing the base resistance, the snapback current has been successfully doubled, resulting in a better VSWR of the corresponding power devices.

Furthermore, the capacitance between the base of the bipolar and the drain (C_{DB}) has been optimized by engineering the drain extension of the LDMOS. **Figure 6** shows measurements for different drain engineering (DE) variants. At 83 to 98 V, the parasitic bipolar of the device is triggered, causing a snapback in the curve. This snapback is improved by DE variation, resulting in a more rugged device. This is confirmed by VSWR measurements done on power devices. The best devices can tolerate a 10 V higher supply voltage for the same power level and a VSWR of 10:1.

From this rugged base station LDMOS technology, a super-rugged high voltage (42 to 50 V) RF LDMOS technology has been derived for broadcast applications up to 1 GHz and for VHF and ISM applications, where the most stringent reliability criteria are

UP TO 100 Watt AMPLIFIERS

20 MHz TO 2.5 GHz



ZHL-5W-2G

ZHL-20W-13

LZY-1+
LZY-2+
ZHL-10W-2G
ZHL-30W-252+
ZHL-50W-52
ZHL-100W-52

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

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!

Model	Freq. (MHz)	Gain (dB)	Max. P _{out} (dBm)	Dynamic Range (dB)	DC Pwr. (V)	Price \$ea.
	f _L - f _H	Typ.	@ Compression 1 dB 3 dB	NF (dB) Typ.	Volt Current (V) (A) Nom. Max.	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.



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



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/23284-69> or use RS# 69 at www.mwjjournal.com/info

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 :

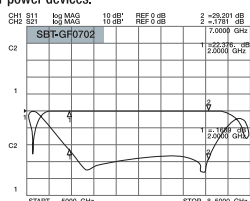
SPECIFICATION

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

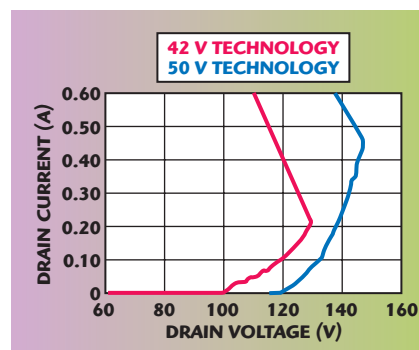
demanded. **Figure 7** shows that the breakdown voltage of these high voltage technologies is increased, compared to the 28 V base station technology. More importantly, the snapback voltage is also significantly larger, resulting in values of 130 and 150 V. Simultaneously, the snapback current is more than doubled compared to the base station technology, shown previously. High voltage power devices have been measured for a VSWR of 10:1 at the nominal supply voltage of 42 to 50 V, but they can even withstand values up to 60 to 70 V, as expected from the figure. This ruggedness has been achieved by engineering of the drain extension, epi layer thickness and shield construction.

From the snapback current and voltage, the maximum dissipated power before failure is calculated. This power is an indication for the quality of the ruggedness of a power device, as shown in **Figure 8** for 42 V development devices. The power at which a power device fails (applying a VSWR of 10:1 with a DVB-T signal) is plotted versus the power at which an on-wafer test device fails (pulsed current voltage sweep). A linear relation is found between the power and on-wafer test device, which indicates this on-wafer test is a good predictor for the ruggedness of a power device. For large powers, there is a deviation from the linear trend. It is speculated that this is due to thermal aspects and circuitry matching.

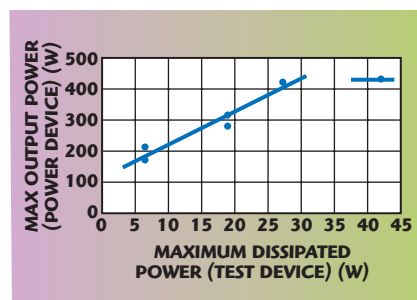
RUGGEDNESS SAFE OPERATION AREA

In the application, not only a drain voltage is applied but also a gate voltage. If the applied gate voltage is above the threshold voltage, a current will flow in the transistor and in the base. This base current in combination with a high drain voltage will more easily trigger the parasitic bipolar transistor. The failures of devices have been measured for a wide range of current-voltage settings to construct a parasitic bipolar safe operation area (PB-SOA). The constructed PB-SOA curve is shown in **Figure 9**.

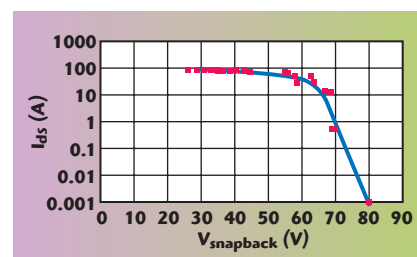
This PB-SOA curve resembles the theoretical safe operation area curve (see **Figure 10**), as is known for CMOS devices for instance. A few I-V characteristics and the class AB load line have been added.



▲ Fig. 7 Pulsed current-voltage measurements of the high-voltage broadcast LDMOS for different epi thickness.



▲ Fig. 8 Correlation between the peak power at which a power device fails (VSWR = 10:1, 8k DVB-T, 9.5 dB PAR) and the power dissipated at snapback of a corresponding test device.



▲ Fig. 9 Constructed safe operation area of the parasitic bipolar transistor as derived from on-wafer pulsed I-V measurements for NXP base station RF LDMOS.

The load line approached the edge of the SOA at its two extremes: at high drain current and at high drain voltage. For high current, the triggering of the bipolar is thermally induced, while at high drain voltage the triggering is electrically induced. By engineering the snapback characteristic, the LDMOS devices are optimized to prevent the occurrence of the electrically induced triggering, since this mechanism is the most frequent cause for ruggedness failures, as determined from the occurrence of a random damage pattern. Also, the thermal behavior of LDMOS is part of the continuous improvement.

"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

Handheld RF Testers:

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

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.

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



COMPEX

The Single Layer Specialists

ISO 9001 : 2000
Delivery in Days • Since 1976

Single Layer Capacitors

- Broadest variety available
- Gold, Tin, or Silver Terminations
- 100pF X7R from 10 x 10 mils
- 1,000pF X7R from 30 x 30 mils



Mounting Shorts

- Instant bonding pads
- Height matching reduces lead length
- Any size available



Submounts

- Alumina, Aluminum Nitride, Quartz, Kovar
- Custom patterns
- Thickness from 3 to 60 mils and beyond

New RPS

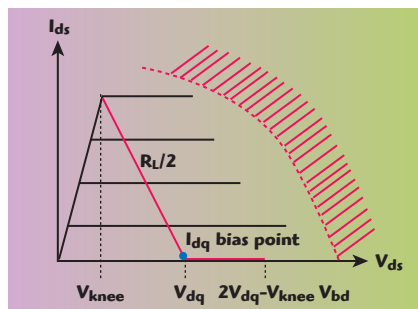
Rapid Prototyping System for Thin Film Substrates and Copper Laminate Boards

- Direct patterns, no mask required
- 48-hour delivery
- Single prototype to full production



COMPEX CORP
Electronic Components

West Berlin, NJ 08091
e-mail: sales@compexcorp.com
856/335-2277 • fax: 856/335-7223
web: www.compexcorp.com



▲ Fig. 10 Schematic picture of the safe operation area.

TABLE I

VBW MEASUREMENT AT VARIOUS SUPPLY VOLTAGES AROUND A CENTER FREQUENCY OF 2 GHz FOR A TONE SPACING OF 80 MHz. P_{OUT} IS THE POWER FOR A SINGLE TONE.

P _{out} (dBm)	32 V	V _d 33 V	35 V
41.5	Pass	Pass	Pass
42.0	Pass	Pass	Pass
42.5	Pass	Pass	Pass
43.0	Pass	Pass	Pass

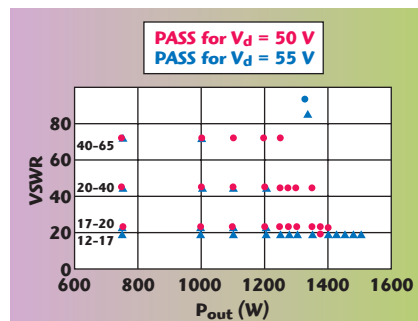
RUGGEDNESS IN APPLICATIONS

After the on-wafer pulsed current voltage ruggedness measurements, several ruggedness tests are performed in the application circuitry, the most common one being a measurement of the VSWR. In data sheets, a VSWR of 10:1 is typically specified under nominal power conditions.

A wider bandwidth operation is required for more complex signals like W-CDMA. This puts heavier constraints to the broadband decoupling of circuits. The LDMOS device has to withstand signal deformations due to a non-ideal decoupling. To test the wideband ruggedness, a video bandwidth (VBW) measurement is performed. In a VBW test, a signal with 2 tones in compression is applied, with a tone spacing of Δf . The tone spacing is increased until the device fails. Such a VBW test is shown in **Table 1** for the base station LDMOS technology with a Δf of 80 MHz. This is a typical bandwidth for multi-slot W-CDMA amplifiers. Usually the LDMOS is operated at 32 V, but the devices pass up to 35 V supply voltage with this 80 MHz tone spacing as shown in the table.

Extremely rugged devices are in the high voltage technology families. These devices operate at 42 to 50 V at UHF or VHF frequencies, low frequencies where the most rugged-

TECHNICAL FEATURE



▲ Fig. 11 VSWR ruggedness measurement at various output power for a pulsed CW (with 20% duty cycle) signal at 225 MHz.

ness demands exist. In **Figure 11**, the VSWR versus output power is plotted for drain supplies of 50 and 55 V applied to a BLF578 device for a signal at 225 MHz with a 20 percent duty cycle. As predicted by the on-wafer tests (discussed in the ruggedness characterization section), the device can easily tolerate 55 V drain voltage in combination with a VSWR of 20 and a power of 1.4 kW, values far above the nominal operation settings.

CONCLUSION

Various ruggedness reliability tests have been described for RF power transistors. Pulsed on-wafer snapback measurements during the development and VSWR and video bandwidth tests in the application circuitry are used to optimize the ruggedness of 28-42-50 V LDMOS technologies. Extremely rugged devices have been developed in combination with state-of-the-art RF performance. ■

ACKNOWLEDGMENTS

The authors wish to acknowledge J. Gajadharsing, B. Merkus, H. Mollee, P. Hammes, T. Bakker, K. Vennema, J. Klappe and M. Murphy for all discussions and support during the development.

References

1. F. van Rijs and S.J.C.H. Theeuwens, "Efficiency Improvement of LDMOS Transistors for Base Stations: Towards the Theoretical Limit," 2006 International Electron Devices Meeting Digest, pp. 205-208.
2. S.J.C.H. Theeuwens and H. Mollee, "LDMOS Transistors in Power Microwave Applications," December 2008 White Paper at Microwave Journal website, http://www.mwjjournal.com/search/article.asp?HH_ID=AR_6871.
3. S.J.C.H. Theeuwens, W.J.A.M. Sneijders, J.G.E. Klappe and J.A.M. de Boet, "High Voltage RF LDMOS Technology for Broadcast Applications," Proceedings of the Third European Microwave Integrated Circuits Conference, 2008, EuMIC02-2, pp. 24-27.

10 MHz to 65GHz COMPONENTS



Directional Couplers



QPSK Modulators



90°/180° Hybrids



Power Dividers



Antenna Beamformers



Visit <http://mwj.hotims.com/23284-31>
or use RS# 31 at www.mwjjournal.com/info

50 Intervale Road, Boonton, NJ 07005 U.S.A. : Tel 973-394-1719 : Fax. 973-394-1710

www.etiworld.com



VHF OCXO WITH EXTRA-LOW NOISE FLOOR

EXECUTIVE INTERVIEW SERIES

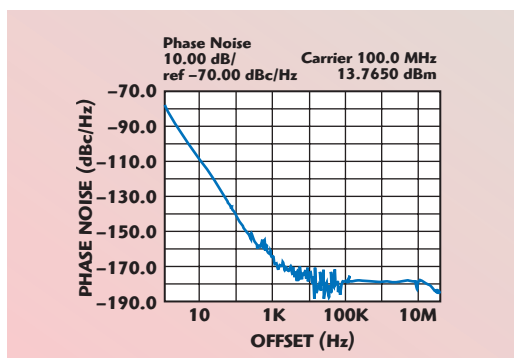
MWJ SPEAKS WITH GRAHAM JEFFERIES, EXECUTIVE VICE PRESIDENT AND COO OF EMRISE CORPORATION (PARENT COMPANY OF PASCALL ELECTRONICS).

VISIT WWW.MWJOURNAL.COM TO READ THIS IN-DEPTH INTERVIEW.

Over the past 50 years crystal oscillators have become ubiquitous wherever a stable reference is needed in RF systems. Oven-controlled Crystal Oscillators (OCXO) in the 5 to 10 MHz range are typically used to provide very stable frequency references, or where ultra-low phase noise is required very close to carrier, at offsets up to about 10 Hz. Also, the high Q of the crystal (typically

$>10^6$ for 3rd-overtone SC-cut) exerts extremely tight control over the oscillator circuit, and crystals with very low phase noise are available.

Applications such as phase noise measurement systems, high performance radars and frequency synthesizers generally need low phase noise floors at offsets in the tens to hundreds of kHz region. It is not possible to achieve the required performance by direct multiplication or PLL synthesis from 10 MHz OCXOs because of the $20\log(N)$ relationship which applies when a frequency is multiplied by N. For example, deriving a 1.6 GHz signal from 10 MHz will increase the phase noise by 44 dB. Even if the 10 MHz oscillator has a very low phase noise floor of -175 dBc/Hz, for example, the lowest possible floor at 1.6 GHz is -131 dBc/Hz, even before the noise added by the multiplier or PLL is taken into account.



▲ Fig. 1 Standard Pascall 100 MHz OCXO phase noise.

PASCALL ELECTRONICS LTD.
Isle of Wight, UK

Millimeter Wave Vector Analysis Modules 33 GHz to 500 GHz



OML VNA products extend

- ☒ ***Agilent PNA-X, PNA and 8510 systems***
- ☒ ***Anritsu Vector Star, Lightning and Panorama systems***

- ☒ Two T/R modules—"S" parameters measurement
- ☒ One T/R and one T module—1 path 2 port ("S11" and "S21") measurement
- ☒ One T/R or S and one T module—antenna and materials characterization
- ☒ One T/R or S and one T2 module—antenna polarization testing
- ☒ All OML VNA 2 modules can be upgraded to a higher configuration
- ☒ OML offers a complete line of waveguide VNA calibration kits

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/23284-84> or use RS# 84 at www.mwjjournal.com/info

MICROWAVE SOLUTIONS, INC.

We provide more than just AMPLIFIERS!
We provide "Microwave Solutions"

LOW NOISE AMPLIFIERS

Model Number	Freq. GHz	Gain dB, min	P1dB dBm, min	N.F. dB, max
MSH-2651202	1.0-2.0	40.0	10.0	2.0
MSD-3800206	2.2-2.3	44.0	10.0	0.5
MSH-4311304-DI	3.4-4.2	23.0	13.0	1.5
MSH-4421303-DI	4.4-5.0	27.0	15.0	1.1
MSH-5422102-DI	6.4-7.2	25.0	8.0	1.5
MSH-6331301-DI	8.0-9.5	23.0	12.0	2.0
MSH-6411703	9.1-10.5	30.0	32.0	1.8
MSH-7301201-DI	12.7-13.2	20.0	10.0	2.0
MSH-7321201	16.0-18.0	20.0	10.0	2.0

BROADBAND AMPLIFIERS

Model Number	Freq. GHz	Gain dB, min	P1dB dBm, min	N.F. dB, max
MSD-3498602	.02-3.0	30.0	30.0	10.0
MSH-4384301-DI	1.0-4.0	22.0	15.0	5.0
MSH-4572502-DI	2.0-6.0	33.0	23.0	2.8
MSH-5452304	4.0-8.0	29.0	15.0	3.0
MSH-7486403	6.0-18.0	29.0	20.0	6.0
MSH-7464401	8.0-18.0	25.0	18.0	5.0
MSH-9344202	18.0-26.5	20.0	7.0	5.0

HIGH POWER AMPLIFIERS

Model Number	Freq. GHz	Gain dB, min	P1dB dBm, max	Amps @12VDC
MSD-2597601	.02-3.0	33.0	30.0	.90
MSD-3488601	.05-3.0	30.0	30.0	1.0
MSD-2654601	1.0-2.0	40.0	30.0	.80
MSH-4426602	3.7-4.2	25.0	30.0	1.0
MSH-5556603	4.0-8.0	35.0	30.0	1.0
MSH-6543603	8.0-12.0	34.0	30.0	1.1
MSH-7406601	12.7-13.2	30.0	30.0	1.2
MSH-4525701	3.7-4.2	35.0	33.0	2.0
MSH-5555701	4.0-8.0	32.0	33.0	2.0
MSH-5515701	5.9-6.4	35.0	33.0	2.0
MSH-6545701	8.0-12.0	33.0	33.0	2.0
MSH-4327702	3.7-4.2	24.0	34.7	2.0
MSH-4527702	5.3-5.9	34.0	34.7	2.0
MSH-6317701	7.7-8.5	24.0	34.7	1.8
MSH-6517702	9.0-10.0	34.0	34.7	2.0
MSH-4528704	5.3-5.9	33.0	37.0	3.2
MSH-5617801	5.9-6.4	38.0	37.0	3.6
MSH-6617801	7.7-8.5	39.0	37.0	3.6
MSH-6417802	9.0-10.0	29.0	37.0	4.4
MSH-7407801	12.7-13.5	30.0	37.0	4.8
MSH-4427902	3.7-4.2	30.0	40.0	7.0
MSH-4627903	5.2-5.8	26.0	40.0	7.0
MSH-5617902	5.9-6.4	40.0	40.0	7.0
MSH-6607801	9.5-10.5	38.0	40.0	10.0
MSH-7507902	12.7-13.2	35.0	40.0	10.5

More Models Available
Give us a call with your specs!

Available Options:
Detector Output
Limiting Amps
Hermetic Packages
I/O Waveguide
Temp. Compensation
AGC & TTL
Bias-T Output

Features:
High-Reliability
Military
Industrial
Reverse Polarity
Protection

With over 25 years as a world provider of high performance amplifiers, Microwave Solutions, can deliver and satisfy your requirements. MSI will give you a competitive advantage and enhance your position in today's global market. Give us a call, fax your requirements or visit our web site:

www.microwavesolutions.com

Microwave Solutions, Inc.

National City, CA 91950

1-800-9MSI-AMP

T: (619) 474-7500 F: (619) 474-4600

sales@microwavesolutions.com

ISO 9001:2000 Certified

PRODUCT FEATURE

VHF OCOs can provide low close-to-carrier phase noise at the same time as offering an improvement of 20 dB or more in noise floor when used as a reference for multipliers or synthesizers. The standard Pascall OCO offers best-in-class close-in phase noise combined with a very low noise floor. **Figure 1** shows a phase noise plot of a 100 MHz level E OCO, which has a guaranteed specification of -137 dBc/Hz at 100 Hz offset.

However, enquiries from customers, together with a desire to enhance the performance of Pascall's synthesizer products, suggested that there would be useful benefits for the most demanding applications if the OCO's noise floor could be reduced. This prompted the development of the new F-series OCO, which has a lower noise floor while preserving the good close-to-carrier phase noise of the original oscillator.

DEVELOPMENT CONSIDERATIONS

When developing the F-series OCO it was important to understand and take into account the many mechanisms that can make an oscillator unexpectedly noisy and some of them are extremely subtle. For instance, put simply, a tuned oscillator is a feedback system in which the phase shift round the loop is a whole number of cycles at the operating frequency. The primary frequency control mechanism involves a tuned circuit or resonator. At low offsets this acts as a frequency discriminator, converting frequency variation into phase shift. The oscillator operates at a frequency at which the resonator's phase shift compensates for that of the maintaining circuit.

Also, in addition to the phase shift criterion, the magnitude of the loop gain must be unity. This is generally achieved either by limiting within the oscillator circuit or by an ALC loop.

Because the combined phase shift of the resonator and the maintaining circuit is a whole number of cycles at the operating frequency, any phase perturbation originating within the maintaining circuit requires a compensatory phase change in the resonator. This results in a corresponding frequency shift. In this way, when an amplifier with flat phase noise is used

in an oscillator, it will produce a signal with flat FM noise. As Φ M sideband amplitude is proportional to phase modulation and phase is the integral of frequency with respect to time, this leads to the characteristic 20 dB/decade slope seen round the carrier frequency.

Higher-Q resonators give more phase shift for a given change in frequency. In an oscillator this mechanism is used in reverse, so less frequency change is incurred for a given phase perturbation, leading to lower phase noise. This applies equally whether the phase disturbance originates from within the oscillator circuit or externally, from load variation or power supply noise. Hence, high Q is a good thing.

At lower offsets, various mechanisms cause the maintaining circuit to produce flicker phase modulation which the oscillator loop converts to flicker FM noise, giving a 30 dB/decade slope close to carrier.

The phase noise floor depends on both the signal level within the oscillator and the way the output is extracted from it. Compromises often have to be reached between load pulling, noise floor and close-in phase noise.

This description doesn't cover AM noise, though. In a well-designed oscillator, however, it is generally much lower than the phase noise close to carrier, and typically falls to a similar floor at large offsets, so it isn't normally a significant problem.

On the other hand crystal oscillators generally have much worse phase noise than would be predicted from the circuit noise and the resonator Q. This is because the crystals themselves exhibit $1/f$ FM noise, which translates to $1/f^3$ phase noise. In low noise oscillator designs, the close-to-carrier noise is generally dominated by the crystal's noise rather than its loaded Q or the circuit noise. Therefore, crystal selection is essential if low phase noise is important, as there can be more than 20 dB variation even within a single batch of crystals.

High Q is still important, as it reduces the oscillator circuit's contribution to close-in noise, and minimizes supply pushing and load pulling. At frequencies around 100 MHz, 5th-overtone SC-cut crystals offer the best combination of low noise and high Q,

Gallium Nitride, 2 to 6 GHz Amplifier Range



- ✓ Easily extends current 2 GHz capability
- ✓ Minimum linear power levels of 30W, 50W and 100W available
- ✓ Designed with 21st century transistor technology
- ✓ Ease of power upgrade within the range

Continuing amplifier innovation From MILMEGA

Designed to bring the intrinsic benefits of Gallium Nitride transistor technology to the lab environment while extending current lab capability with the minimum of fuss. The new range of innovative microwave amplifiers from MILMEGA delivers exceptional reliability, embedded intelligence and portability in a 21st century response to the challenge of microwave power provision.

With the flexibility and ease of use that you would expect from a MILMEGA product, the new 2 to 6 GHz range further enhances our reputation for going the extra mile to deliver what customers want, with the quality and reliability competitors aspire to.

Find out more at www.milmega.co.uk/AS0206

Designers and Manufacturers of High
Power Microwave and RF Amplifiers



MILMEGA Limited Ryde Business Park, Nicholson Road, Ryde, Isle of Wight, PO33 1BQ United Kingdom
Tel. +44 (0) 1983 618004 Fax. +44 (0) 1983 811521 sales@milmega.co.uk www.milmega.co.uk

Visit <http://mwj.hotims.com/23284-59> or use RS# 59 at www.mwjjournal.com/info

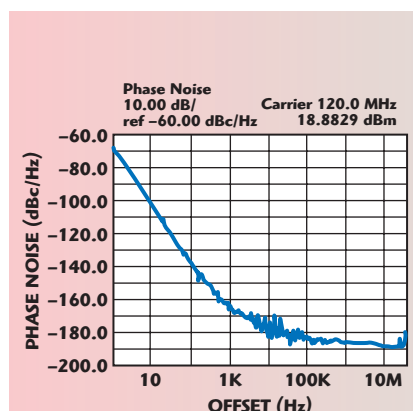
together with a flat frequency/temperature characteristic at their turnover point, typically about 80°C.

DESIGN CONSIDERATIONS

All of these factors are of importance, but practical oscillator design almost always involves compromises and trade-offs. The F-series OCXO aims to provide the lowest possible phase noise within a relatively compact 2 x 2 x 0.75 inch package.

The OCXO incorporates a low noise regulator followed by further filtering to maximize rejection of external supply noise and ripple. In particular, careful attention is paid to ground paths, in order to prevent oven current noise affecting the oscillator's performance. The oscillator is based very closely on the company's standard OCXO design, with the active devices operated linearly because nonlinear operation generally increases the transistors' flicker noise and also increases modulation of the signal by power supply noise and ripple. The degree of degradation tends to vary with factors such as crystal motional resistance, temperature, etc. Linear operation also gives more predictable RF operating conditions, which helps when tuning the oscillator on either side of the crystal's series resonance.

The extra-low noise floor of the F-



▲ Fig. 2 Pascall F-series 120 MHz phase noise.

series OCXO is achieved by maintaining high signal levels within the output amplifier. The signal is taken from the oscillator in a way that maximizes the power into the amplifier while using the resonator to reduce far-from-carrier noise.

PERFORMANCE

The F-series has the same close-in phase noise as the standard Pascall OCXO, together with improved noise floor and higher output power. **Table 1** summarizes the performance offered at 100 MHz. Note that the phase noise is guaranteed minimum performance, not typical figures.

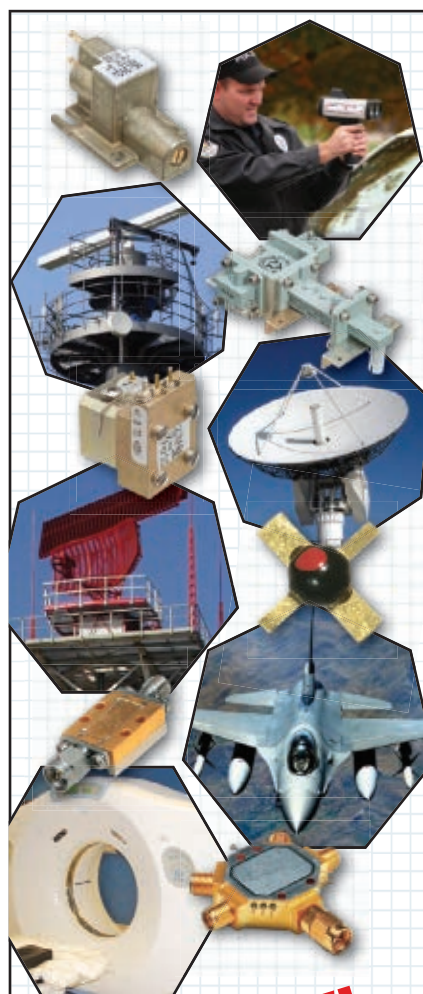
The first application for the new OCXO design was at 120 MHz. **Figure 2** shows a phase noise plot. The phase noise of crystals rises fairly rapidly with increasing frequency, so it is not possible to achieve the same close-in performance at 120 MHz as at 100 MHz. However, the plot clearly shows the improved phase noise floor.

Measurement of very low phase noise floor presents a serious challenge, and needs cross-correlation to push the test system's added noise below that of the DUT. In this instance, the indicated performance in the 10 to 70 kHz range is probably limited by the test set.

APPLICATIONS

With its exceptionally low phase noise floor, the F-series OCXO is ideally suited for driving ultra-low-noise frequency multipliers, phase detectors and mixers. Its high output power means that an additional drive am-

TABLE 1 F-SERIES OCXO PERFORMANCE AT 100 MHz	
Parameter	Value
Tuning range	$\pm 6 \times 10^{-6}$
Tune voltage	0 to +10 V; positive slope
Temperature stability	$\pm 2 \times 10^{-7}$ w. r. t. 25°C; -30 to +70°C
Output power	18 dBm \pm 2 dB
Harmonics	≤ -30 dBc
Phase noise (guaranteed)	
10 Hz offset	≤ -102 dBc/Hz
100 Hz offset	≤ -137 dBc/Hz
1 kHz offset	≤ -164 dBc/Hz
10 kHz offset	≤ -178 dBc/Hz
≥ 100 kHz offset	≤ -182 dBc/Hz
Supply voltage	+12 V \pm 0.5%
Warm-up power	≤ 6 W
Steady-state power	≤ 3.5 W at 25°C



NEW!

Find all our latest products in the newly expanded Microwave & RF product directory at

www.microsemi.com

See us at
MTT-S
Booth 1925



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

NEW 2 to 18GHz 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

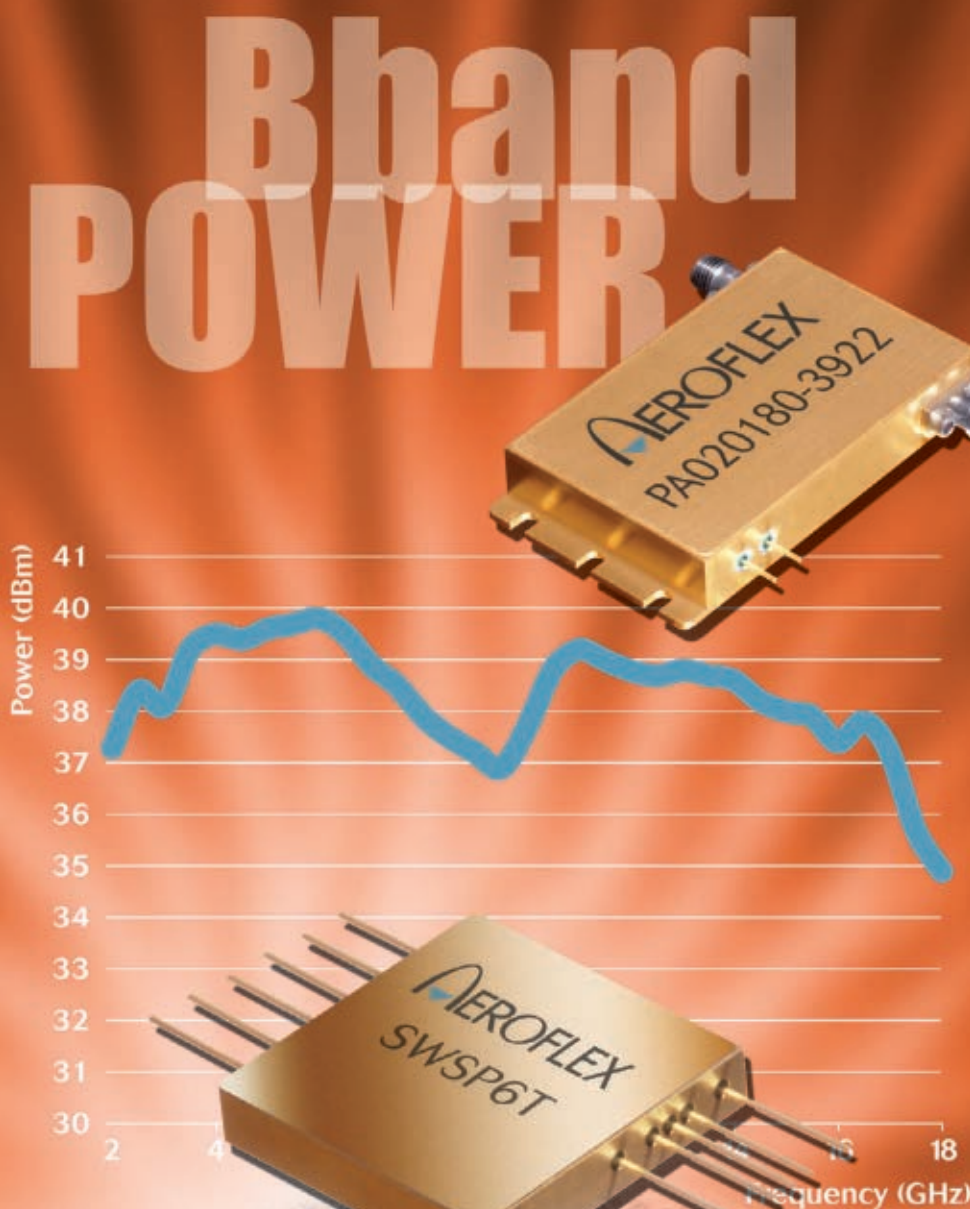
Broadband power amps

- 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



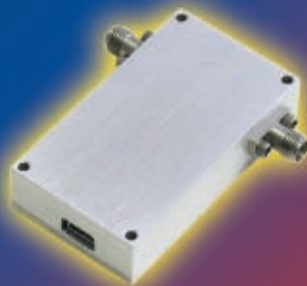
AEROFLEX
A passion for performance.

Square Peg, Round Hole?

Not anymore. WA's new
DA Series Programmable
Attenuators offer a **USB**
interface and software drivers
for **plug-and-play** convenience.

DA Series Attenuators

- Broadband Coverage: DC - 13 GHz
- 30, 60 and 90 dB units with 0.5 dB steps
- USB-2.0 interface for power and control
- Software driver/application included.
Custom software solutions available
- High accuracy: ± 0.5 dB typical
- Fast switching speed: <100ns
- Rugged Construction
- Applications: Base Station, Broadband Telecommunications,
Microwave & VSAT Radios and Military



A Tradition of Quality / A Commitment to Customer Service

www.WeinschelAssociates.com



19212 Orbit Drive
Gaithersburg, MD 20879
Voice: 877.948.8342
Fax: 301.963.8640
RF@WeinschelAssociates.com

Visit <http://mwj.hotims.com/23284-115>



Are you getting nowhere
with your RF project?
Looking endlessly for
a good source for your
RF & Microwave Filters?



Be right on target!

visit us at

www.anatechelectronics.com

For our custom designs

www.anatechmicrowave.com

For our standard designs

www.amcrf.com

For our webstore

A
R
E
L
I
A
B
L
E
S
O
U
R
C
E



Anatech Electronics, Inc.

Manufacturer of RF and Microwave Filters and Products

Tel: 973-772-4242 E-Mail: sales@anatechelectronics.com
www.anatechelectronics.com

Visit <http://mwj.hotims.com/23284-12>

plifier will not normally be needed,
thereby eliminating another source of
noise.

For applications that do not require
such a low noise floor, the standard
OCXO may be a more appropriate
choice as it has lower power consump-
tion but still offers the same close-to-
carrier performance. However, the
extra-low far-from-carrier noise of the
F-series can help designers to achieve
real performance improvements in
state-of-the-art systems such as high
performance radars, ultra-low noise
frequency synthesizers and phase
noise test systems.

CONCLUSION

The new F-series OCXO combines
the close-in phase noise performance
of the company's standard OCXO with
an even lower noise floor and higher
output power, offering designers a
new tool to improve system perfor-
mance in the most demanding appli-
cations. The oscillator has an ample
electrical tuning range of $\pm 6 \times 10^{-6}$,
with mechanical tuning available as an
alternative, and is in a standard 2 x 2 x
0.75 inch package size.

Pascall Electronics Ltd.,
Ryde, Isle of Wight, UK,
Tel: +44 (0) 1983 817300,
Fax: +44 (0) 1983 564708,
enquiries@pascall.co.uk,
www.pascall.co.uk.

RS No. 300

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.mwjjournal.com/](http://www.mwjjournal.com/IMS2009)
IMS2009
starting in June.

WORLD'S WIDEST SELECTION

VCOs



10 to 6740 MHz from **\$11⁹⁵** 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 YON!z Search Engine" at the Mini-Circuits web site.

Just enter your specifications into YON!z...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

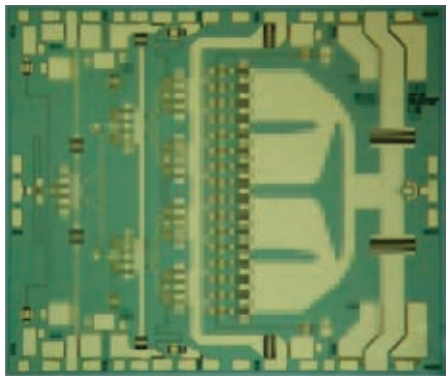


The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

IF/RF & MICROWAVE COMPONENTS

359 Rev J

Visit <http://mwj.hotims.com/23284-70> or use RS# 70 at www.mwjjournal.com/info



MILLIMETER-WAVE MMICs DELIVER KA-BAND POWER

High speed MMICs were historically developed for the United States military and included systems for high data rate network-centric communications, anti-jamming and low detection/interception warfare communications. The millimeter-wave frequency range provides benefits such as broader bandwidth, smaller antennas and greater security. Recently, military millimeter-wave activity has been overshadowed by the growth of commercial sector applications, such as point-to-point and point-to-multipoint radios, VSAT terminals, automotive radar, high speed digital communication networks, sensors and direct broadcast satellite television applications. With this shift, however, still comes a need for high volume Ka-band transmitters to address emerging and traditional military applications.

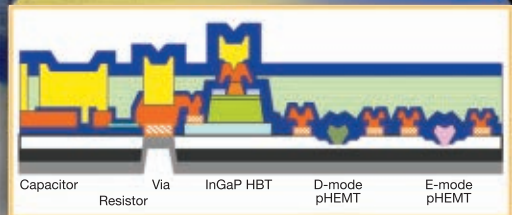
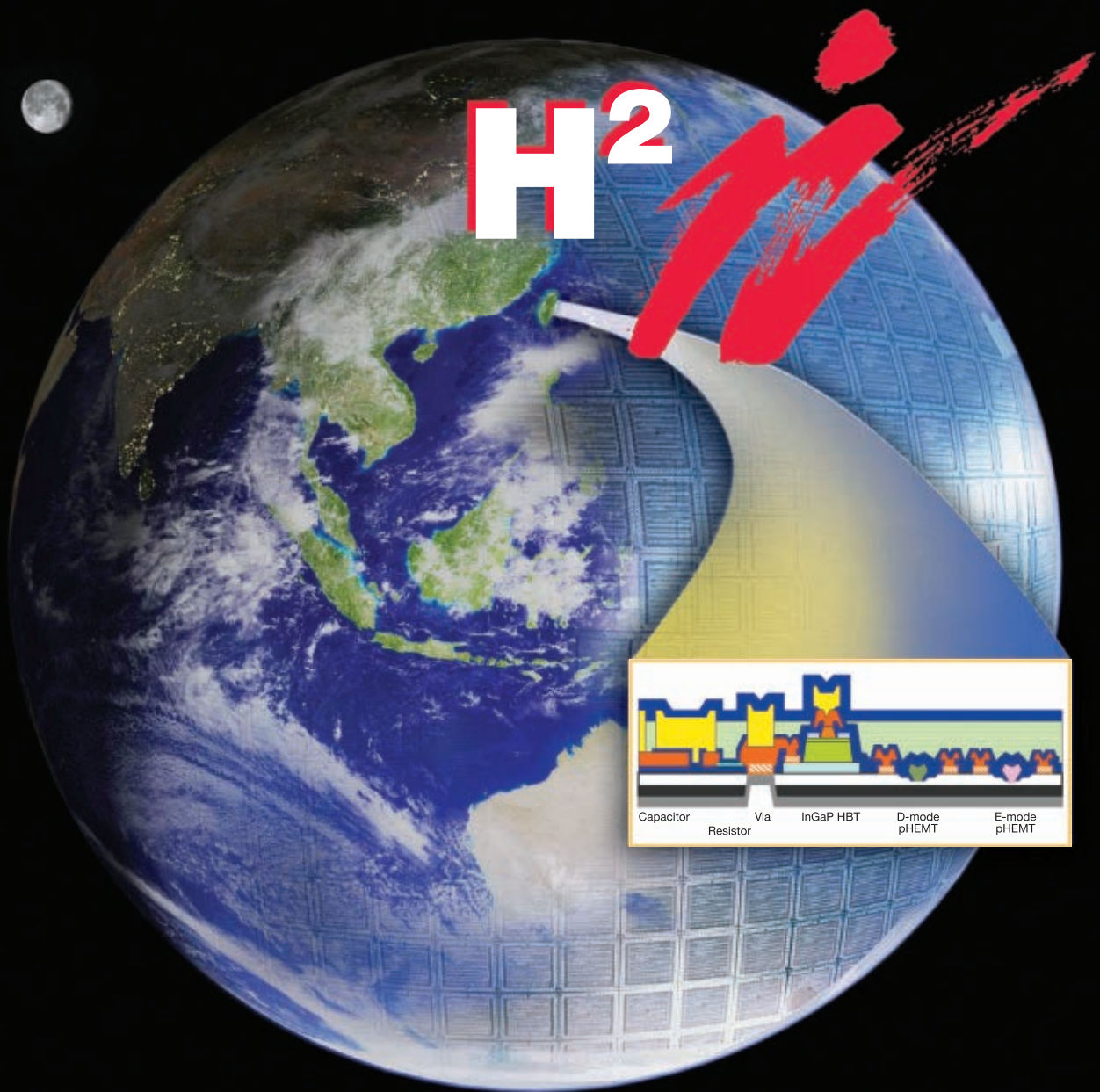
Mimix Broadband has developed two power amplifiers based on a new four-stage 34 to 37 GHz MMIC design. These power amplifiers utilize the company's GaAs PHEMT device technology and electron beam lithography to ensure the highest level of repeatability and

uniformity needed for both commercial and military applications. Robust thermal performance and standard 4 mil die thickness also make the device useful in both manual and automated assembly operations. The XP1072-BD multi-stage amplifier, **Figure 1a**, delivers over 35 dBm of pulsed saturated output power and 22 dB small-signal gain (see **Figure 2a**). The XP1073-BD device, **Figure 1b**, is a balanced amplifier version that provides over 37 dBm of pulsed saturated output power and 22 dB small-signal gain (see **Figure 2b**).

PERFORMANCE

The XP1072-BD operates on a recommended drain voltage of 5.5 V DC and a nominal -0.7 V DC on the gates. Separate biasing of the stages within the amplifier is recommended if the amplifier is to be used in a linear application or at high levels of saturation, where gate rectification will alter the effective

MIMIX BROADBAND INC.
Houston, TX



Innovative GaAs integration technology

HBT + pHEMT @ WIN = H²W

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

www.winfoundry.com



Visit <http://mwj.hotims.com/23284-119> or use RS# 119 at www.mwjjournal.com/info

RF Microwave Filters & Components *Standard & Custom Designs Available to meet your Specifications*



**Microwave Filter
Company, Inc.**



800-448-1666

315-438-4700

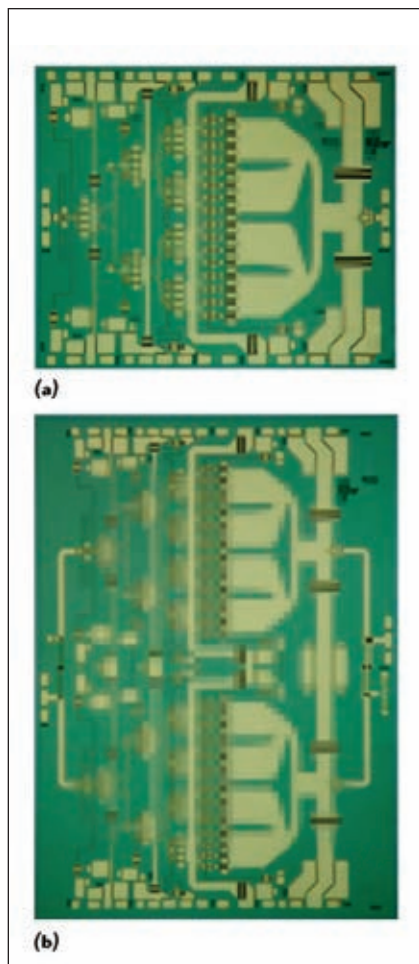
E-mail: mfcsales@microwavefilter.com

Web: www.microwavefilter.com



Made in the USA

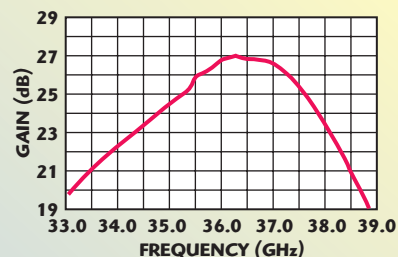
ISO 9000:2001 Registered Company



▲ Fig. 1 Photo of XP1072-BD (a) and XP1073-BD (b).

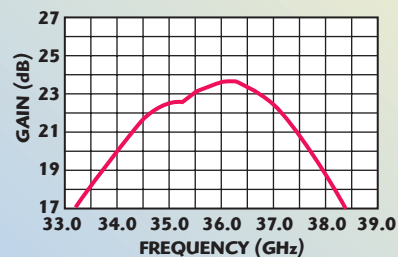
gate control voltage. For non-critical applications it is possible to parallel all stages and adjust the common gate voltage for a total drain current I_d (total) = 2400 mA (maximum 3.0 amps). The power added efficiency for the single die version is 25 percent and 24 percent for the balanced version. The rated operating temperature of the device is between -55° and $+85^\circ\text{C}$.

For applications such as radar, where the amplifier RF output power is saturated, the optimum drain current will vary with RF drive and each amplifier stage is best operated at a constant gate voltage. Significant gate currents will flow at saturation and bias circuitry must allow for drain current growth under this condition to achieve the best RF output power and power added efficiency. Additionally, if the input RF power level varies significantly, a more negative gate voltage will result in less die heating at lower RF input drive levels where



XP1072-BD, $V_d = 5.5\text{ V}$, $V_g = -0.7\text{ V}$,
 $I_{d1} = 126\text{ mA}$, $I_{d2} = 271\text{ mA}$,
 $I_{d3} = 502\text{ mA}$, $I_{d4} = 932\text{ mA}$

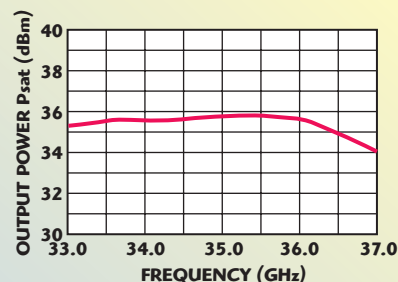
(a)



XP1073-BD, $V_d = 5.5\text{ V}$, $V_g = -0.7\text{ V}$,
 $I_{d1} = 267\text{ mA}$, $I_{d2} = 528\text{ mA}$,
 $I_{d3} = 910\text{ mA}$, $I_{d4} = 1719\text{ mA}$

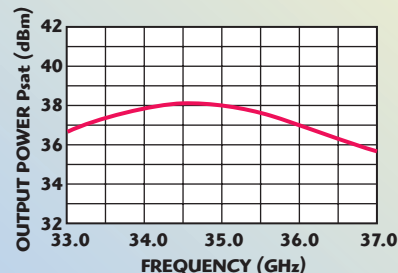
(b)

▲ Fig. 2 XP1072-BD (a) and XP1073-BD (b) measured on-wafer gain.



XP1072-BD, $V_d = 6.0\text{ V}$, $V_g = -0.7\text{ V}$,
PULSED

(a)



XP1073-BD, $V_d = 6.0\text{ V}$, $V_g = -0.7\text{ V}$,
PULSED, OPT Load for P_{out}

(b)

▲ Fig. 3 XP1072-BD (a) and XP1073-BD (b) output power.

the absence of RF cooling becomes significant. Note under this bias condition, gain will then vary with RF

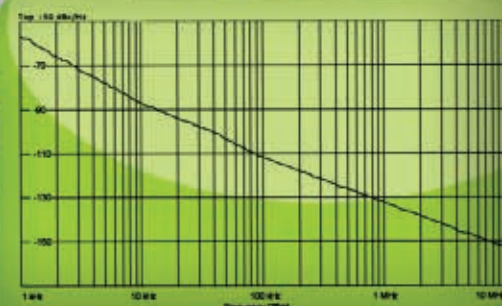
Model	Frequency Range (MHz)	Tuning Voltage (VDC)	DC Bias VDC @ I [Typ.]	Phase Noise @ 10 kHz (dBc/Hz) [Typ.]	Size (Inch)
DCO Series					
DCO1198-8	1198.4 - 1198.7	0.5 - 7.5	+8 @ 30 mA	-116	
DCO170340-5	1700 - 3400	0.5 - 24	+5 @ 24 mA	-90	
DCO200400-5	2000 - 4000	0.5 - 18	+5 @ 35 mA	-90	
DCO200400-3	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

New!
Wideband Models

Patented Technology

Features

- Exceptional Phase Noise
- Miniature Footprint: 0.3" x 0.3" x 0.1"
- Excellent Tuning Linearity
- Models Available from 4 to 11 GHz
- Optimized Bandwidth (Approx. 1 GHz)
- High Immunity To Phase Hits
- Lead Free RoHS Compliant



Visit <http://mwj.hotims.com/23284-107> or use
RS# 107 at www.mwjjournal.com/info

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

Visit Our Website At WWW.SYNERGYMWAVE.COM

NAB Show Las Vegas
April 20-23, 2009

DSEI London
September 8-11, 2009

Milipol Paris
November 17-20, 2009

Surveillance Skills Outperforming Nature

IZT R3000 Digital Wideband Receiver Series

- World-class RF performance and advanced signal processing
- Automatic signal detection
- Search, intercept and emitter location
- Threat recognition
- Measurement



www.izt-labs.de

Innovationszentrum
Telekommunikations-
technik GmbH

Visit <http://mwj.hotims.com/23284-44>

PRODUCT FEATURE

drive. Output power as a function of frequency is shown for both devices in **Figure 3**, demonstrating the amplifier's performance.

For linear applications where optimum IM3 (Third-Order Intermod) performance is required at more than 5 dB below P1dB, active gate biasing can be implemented to keep the drain currents constant as the RF power and temperature vary. Active biasing of the gates gives the best performance and most reproducible results. Depending on the supply voltage available and the power dissipation constraints, the bias circuit may be a single transistor or a low power operational amplifier, with a low value resistor in series with the drain supply used to sense the current. The gate voltage of the PHEMT is controlled to maintain the desired drain current and provides an indirect form of temperature compensation.

APPLICATIONS

These amplifiers focus on serving market applications where performance (saturated power and PAE), compact size and extreme ruggedness are primary drivers. While new applications are emerging, RADAR is probably the most closely targeted application, using FMCW on missiles and munitions. Another likely defense application is Ka-band for battlefield resource tracking and management. Airborne applications include landing systems for commercial fixed wing aircraft and precision altimeters for rotary craft on the military side. In many cases, these parts will reside behind small antenna elements or arrays on small platforms and therefore the devices are offered in die form as preferred by most of the system integrators working at these frequencies and power levels.

While lower power MMIC solutions are currently available, these devices are limited to power levels that in the past required 2 or 4 way combining to achieve the required output power. Due to circuit losses, combining lower power devices leads to diminished performance, hurting overall power and efficiency while increasing the substrate footprint. Conversely, combining with this device raises the ceiling of what was thought possible with solid-state amplifiers. Multiple die combined in an array provide a solid-state solution for RADAR applications. Multiple gain stages eliminate drivers, and the balanced design offers better VSWR and greater power from a single part. Power combining naturally becomes more painful as you go up in frequency. This device eliminates or reduces the need to combine die in many applications. With a reduced part count, using these MMICs to design high power solid-state amplifiers offers the benefits of lower complexity and simpler assembly, leading to higher yield and optimal results.

Mimix Broadband Inc.,
Houston, TX
(281) 988-4600,
www.mimixbroadband.com.

RS No. 301

"The Largest Coax Connector Inventory in North America"



So what?

So RF Connectors can deliver your coax connector needs now – that's what. We have delivered RF connector solutions to satisfied customers for over 25 years. How about you?



- Connectors and Adapters
- Preparation and Installation Tools
- Test and Measurement Kits

www.rfindustries.com, (800) 233-1728, (858) 549-6340, and fine distributors

Our warehouse today. Your hands tomorrow.



Celebrating 125 Years
of Engineering the Future



IEEE COMCAS 2009

The International IEEE Conference on Microwaves,
Communications, Antennas and Electronic Systems

David Intercontinental Hotel, Tel Aviv, Israel, November 9-11, 2009



Steering Committee

Conference Chairman:

Shmuel Auster

Elta Systems Ltd.

IEEE AP/MTT Chapter Chair, Israel

Technical Program Committee

Co-Chairmen:

Barry S. Perlman

US Army CERDEC, USA

IEEE MTT-S 2009 President

Roger Pollard

University of Leeds, UK

IEEE VP-TAB 2009

Publications Chairman:

Benjamin Epstein

OpCoast LLC, USA

Global Administration:

Charlotte Blair

Sonnet Software Inc., USA

Awards and Sponsorship:

Barry M. Alexia

Rockwell Collins, USA

Exhibition:

Oren Hagai

Interlligent, Israel

Finance:

Yossi Pinhasi

Ariel University Center, Israel

www.comcas.org

Secretariat: (all enquiries)



Ortra Ltd

1 Nirim Street, P. O. Box 9352

Tel-Aviv 61092, Israel

Tel: +972 - 3 - 6384444

Fax: +972 - 3 - 6384455

comcas@ortra.com

Call for Papers

COMCAS 2009 continues the tradition of providing a multidisciplinary forum for the exchange of ideas in the areas of microwaves, antennas, communications, solid state integrated circuits, sensing and electronic systems engineering. The venue will be exciting and enjoyable with many opportunities for networking, candid exchange of ideas and a strong sense of community. This year we will expand the program to include RF and microwave photonics, biomedical technologies, cognitive radios and networks, radar, radio frequency identification, electron devices and photonic means for IC inspection among other topics. A diverse assembly of researchers, engineers and scientists will be invited to present their ideas and discuss new results, providing a unique opportunity for attendees to view a variety of interesting and innovative technologies in one location. Invited papers and tutorial talks from international experts will be presented in key topical areas. So please join us for the 2nd Annual IEEE COMCAS meeting in the exciting and vibrant city of Tel Aviv, Israel from 9-11 November 2009.

Technical Topics:

- Ad Hoc, Sensor and Mesh Networking
- Antennas (components, modeling, phased array, etc.)
- Biomedical Technologies
- Cognitive and Software-Defined Radios and Networks
- Communications Systems, Modeling, Simulation and Analysis
- Computational Electromagnetics and Wave Propagation
- Electromagnetic Compatibility
- Energy Harvesting and Thermal Management
- Hyperspectral Imaging and Remote Sensing
- MEMS (Modeling, Devices, Applications)
- Mixed Signal Analog/RF/Digital Circuits and Systems
- Microwave and MM-wave circuit technologies
- Nanoplasmonics and Metamaterials
- RF/Microwave Photonics
- Power Amplifiers and Electron Devices
- Radar and Electronic Systems
- RFID Devices, Technologies and Systems
- Solid State Devices, RFICs, Circuits and Modeling
- Terahertz Technology & Applications

Regular oral presentations will be 20 min. in length; there will also be Poster sessions.

All submitted papers will be peer reviewed and assessed on key accomplishments, contribution to technology, advancement of the state-of-the-art, originality and interest to the attendees. Accepted papers will be published in the COMCAS 2009 Proceedings which will be available through IEEE Xplore after the conference.

Papers should first be submitted as a 1 to 2 page summary. Please refer to the detailed author instructions provided on the conference web site www.comcas.org.

The official language of the Conference is English.

Deadline for Summary Submission: 15 June 2009. Final manuscripts due 15 Sept. 2009

The technical program will be complemented with a **Technical Exhibition**, which will be held on November 9-10, offering companies and agencies a unique opportunity to visit Israel and present related products and services in display and printed advertisement. **For further details please contact the Conference Secretariat.**



DROP-IN INDUSTRY REPLACEMENT FREQUENCY SYNTHESIZERS

EM Research has developed the ZLX Series of drop-in frequency synthesizers with models operating from 800 MHz to 3.8 GHz that are replacements for many industry standard PLOs and synthesizers.

The ZLX Series is a cost-effective replacement that provides design engineers with improved signal source performance without any need to modify the circuit board or design and can be used in a wide variety of applications.

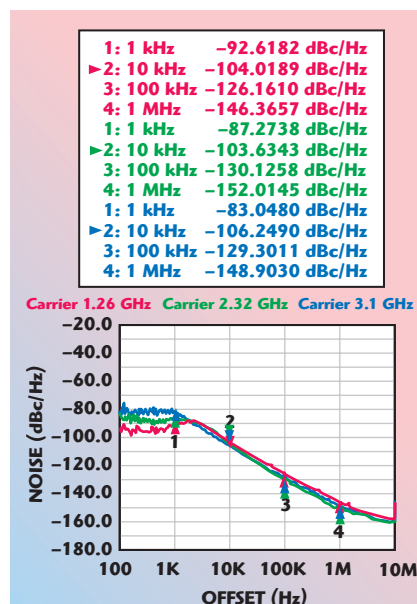
The ZLX can be custom-designed to operate fixed or programmable from less than 800 MHz to over 3.8 GHz and is housed in a standard commercial surface-mount package. The ZLX offers extremely low phase noise; for example, less than -106 dBc/Hz at 10 kHz offset and -129 at dBc/Hz at 100 kHz offset at an output frequency of 3.1 GHz. The ZLX Series also provides low power consumption

of less than 100 mW at +3.3 VDC operating voltage. **Figure 1** shows sample phase noise plots for three different frequencies (1.26, 2.32 and 3.1 GHz).

The bandwidth can be fixed or programmable (serial interface) up to 30 percent bandwidth with output power from 0 to +7 dBm. **Table 1** shows typical performance parameters for various models over the frequency range available. All models are available in the drop-in replacement housing measuring 0.6 x 0.6 x 0.14 inches (15.24 x 15.24 x 3.6 mm). **Figure 2** shows the outline drawing including pin outs.

The ZLX Series is available for high volume production and can be used in a wide variety of applications including commercial wireless, base station and subsystems, mobile radios, SatCom, point-to-point/multi-point radios, WiMAX, 2G and 3G repeaters, CATV and wireless infrastructure. EM Research provides the option of RoHS and non-RoHS designs on all products including the ZLX Series.

EM RESEARCH INC.
Reno, NV



▲ Fig. 1 Phase noise plots for 1.26, 2.32 and 3.1 GHz.

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



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/23284-71> or use RS# 71 at www.mwjjournal.com/info

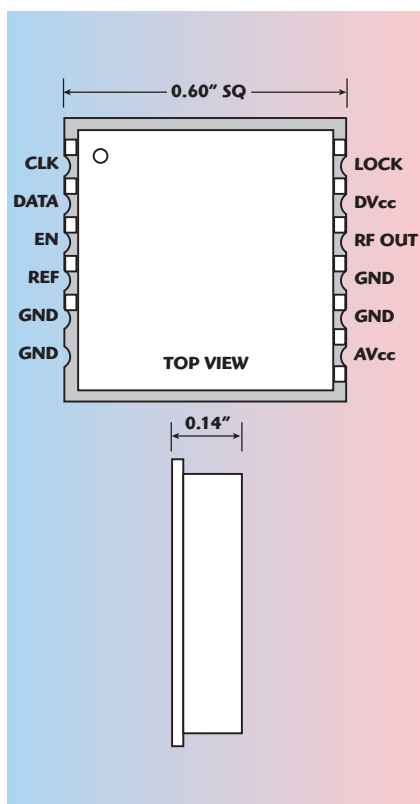


Fig. 2 ZLX package outline and pin-out.

TABLE I								
TYPICAL PERFORMANCE FOR SELECT MODELS								
Model #	Freq. (MHz)	Power Out (dBm)	Harmonics (dBc)	Phase Noise, typ. (dBc/Hz)		Spurious (dBc)	Supply	
				10 kHz	100 kHz		Voltage (Vdc)	Current (mA)
ZLX-800-XX	800	+7	-20	-105	-125	-70	+5	55
ZLX-832-XX	832	+7	-20	-105	-125	-70	+5	55
ZLX-1030-XX	1030	+7	-20	-100	-120	-70	+5	55
ZLX-1090-XX	1090	+7	-20	-100	-120	-70	+5	55
ZLX-1260-XX	1260	+2	-20	-100	-120	-70	+5	40
ZLX-1410-XX	1410	+2	-20	-100	-120	-70	+5	40
ZLX-1620-XX	1620	+2	-20	-100	-120	-70	+5	40
ZLX-1850-XX	1850	+2	-20	-100	-120	-70	+5	40
ZLX-2090-XX	2090	+2	-20	-100	-120	-70	+5	40
ZLX-2320-XX	2320	+2	-20	-100	-120	-70	+5	40
ZLX-2700-XX	2700	+2	-20	-100	-120	-70	+5	40
ZLX-3100-XX	3100	+2	-20	-100	-120	-70	+5	40
ZLX-3200-XX	3200	+7	-20	-98	-118	-70	+5	55
ZLX-3500-XX	3500	+7	-20	-98	-118	-70	+5	55
ZLX-3800-XX	3800	+7	-20	-98	-118	-70	+5	55

As a cost-effective, pin-for-pin footprint-compatible design, the ZLX Series eliminates the need for rework or modification of the printed circuit board, while providing critical performance advantages over the competing products. The ZLX Series is ideal for design engineers looking for a func-

tionally superior, drop-in industry replacement synthesizer.

EM Research Inc.,
Reno, NV (775) 345-2411,
sales@emresearch.com,
www.emresearch.com.

RS No. 302

Precision quartz oscillators for wide range of applications



MV197

- 10 to 20 MHz;
- 5E-9...5E-10 stability vs. temperature;
- Low noise options: up to -133 dBc/Hz at 10 Hz;
- 36x27xH mm case, lowest profile H=10 mm.



MV199

- 10 to 20 MHz;
- 5E-9...1E-9 stability vs. temperature;
- Low noise option -130 dBc/Hz at 10 Hz;
- Ultra miniature package 20x20x12.7 mm.



MV209

- 5 to 10 MHz;
- Ultra precision, up to 2xE-10 stability;
- Low noise option -130 dBc/Hz at 10 Hz;
- Double oven design in 36x27x19 mm case.



MV218

- 48 to 500 MHz;
- Low noise options: up to -167 dBc/Hz at 10 kHz (100 MHz);
- Fast warm-up: < 60 s;
- Small package size 25x25x10 mm.

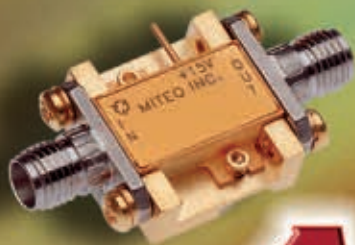
MORION, Inc.

MV200



- 5 to 100 MHz;
- 2E-9...2E-10 stability vs. temperature;
- Low aging: up to 2E-8/year;
- Low noise options: up to -138 dBc/Hz at 10 Hz;
- Low profile option (10 mm).

Contact us for more information: www.morion.com.ru | sale@morion.com.ru | Phone: +7 (812) 350-7572 | St. Petersburg, Russia



AFS SERIES... More Than Just Low Noise

AMPLIFIERS

- OPTIONS:**
- Cryogenic
 - TTL Controlled
 - Detected Output
 - Limiting
 - High Dynamic Range
 - Military Versions
 - Variable Gain
 - Equalized Gain
 - Space Qualified
 - Limiter Input
 - Built-in Test

Model Number	Frequency Range (GHz)	Gain (Min./Max.) (dB)	Gain Flatness (±dB)	Noise Figure (dB, Max.)	VSWR Input (Max.)	VSWR Output (Max.)	Output Power @ 1 dB Comp. (dBm, Min.)	Nom. DC Power (+15 V, mA)
OCTAVE BAND AMPLIFIERS								
AFS3-00120025-09-10P-4	0.12-.25	38	0.50	0.9	2.0:1	2.0:1	+10	125
AFS3-00250050-08-10P-4	0.25-0.5	38	0.50	0.8	2.0:1	2.0:1	+10	125
AFS3-00500100-06-10P-6	0.5-1	38	0.75	0.6	2.0:1	1.5:1	+10	150
AFS3-01000200-05-10P-6	1-2	38	1.00	0.5	2.0:1	2.0:1	+10	150
AFS3-01200240-06-10P-6	1.2-2.4	34	1.00	0.6	2.0:1	2.0:1	+10	150
AFS3-02000400-06-10P-4	2-4	32	1.00	0.6	2.0:1	2.0:1	+10	125
AFS3-02600520-10-10P-4	2.6-5.2	28	1.00	1.0	2.0:1	2.0:1	+10	125
AFS3-04000800-07-10P-4	4-8	32	1.00	0.7	2.0:1	2.0:1	+10	125
AFS3-08001200-09-10P-4	8-12	28	1.00	0.9	2.0:1	2.0:1	+10	125
AFS3-08001600-15-8P-4	8-16	28	1.00	1.5	2.0:1	2.0:1	+8	100
AFS4-12001800-18-10P-4	12-18	28	1.50	1.8	2.0:1	2.0:1	+10	125
AFS4-12002400-30-10P-4	12-24	24	2.00	3.0	2.0:1	2.0:1	+10	85
AFS3-18002650-30-8P-4	18-26.5	18	1.75	3.0	2.2:1	2.2:1	+8	125
MULTIOCTAVE BAND AMPLIFIERS								
AFS3-00300140-09-10P-4	0.3-1.4	38	1.00	0.9	2.0:1	2.0:1	+10	125
AFS2-00400350-12-10P-4	0.4-3.5	22	1.50	1.2	2.0:1	2.0:1	+10	80
AFS3-00500200-08-15P-4	0.5-2	38	1.00	0.8	2.0:1	2.0:1	+15	125
AFS3-01000400-10-10P-4	1-4	30	1.50	1.0	2.0:1	2.0:1	+10	125
AFS3-02000800-09-10P-4	2-8	26	1.00	0.9	2.0:1	2.0:1	+10	125
AFS4-02001800-24-10P-4	2-18	35	2.00	2.4	2.5:1	2.5:1	+10	175
AFS4-06001800-22-10P-4	6-18	25	2.00	2.2	2.0:1	2.0:1	+10	125
AFS4-08001800-22-10P-4	8-18	28	2.00	2.2	2.0:1	2.0:1	+10	125
ULTRA WIDEBAND AMPLIFIERS								
AFS3-00100100-09-10P-4	0.1-1	38	1.00	0.9	2.0:1	2.0:1	+10	125
AFS3-00100200-10-15P-4	0.1-2	38	1.00	1.0	2.0:1	2.0:1	+15	150
AFS1-00040200-12-10P-4	0.04-2	15	1.50	1.2	2.0:1	2.0:1	+10	50
AFS3-00100300-12-10P-4	0.1-3	32	1.00	1.2	2.0:1	2.0:1	+10	125
AFS3-00100400-13-10P-4	0.1-4	30	1.00	1.3	2.0:1	2.0:1	+10	125
AFS3-00100600-13-10P-4	0.1-6	30	1.25	1.3	2.0:1	2.0:1	+10	125
AFS3-00100800-14-10P-4	0.1-8	28	1.50	1.4	2.0:1	2.0:1	+10	125
AFS4-00101200-22-10P-4	0.1-12	34	1.50	2.2	2.0:1	2.0:1	+10	150
AFS4-00101400-23-10P-4	0.1-14	24	2.00	2.3	2.5:1	2.5:1	+10	200
AFS4-00101800-25-S-4	0.1-18	25	2.00	2.5	2.5:1	2.5:1	+10	175
AFS4-00102000-30-10P-4	0.1-20	20	2.50	3.0	2.5:1	2.5:1	+10	125
AFS4-00102650-42-8P-4	0.1-26.5	24	2.50	4.2	2.5:1	2.5:1	+8	135

Note: Noise figure increases below 500 MHz.



This is only a small sample of our extensive list of standard catalog items.

Please contact our Sales Department at (631) 439-9220 or e-mail components@miteq.com for additional information or to discuss your custom requirements.



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

www.miteq.com



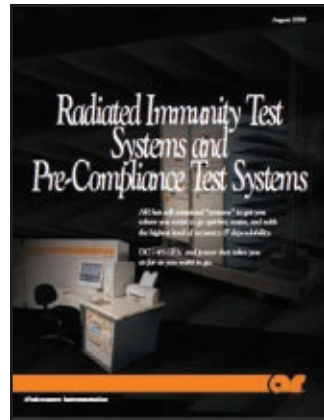
Selection Guide



Agilent's updated Antenna Test Selection Guide now includes the PNA-X measurement receiver that offers a 30 percent faster data acquisition speed than any other antenna receiver on the market. This selection guide helps customers select the hardware necessary to make accurate antenna and radar and cross-section measurements. This guide shows customers how to easily migrate to the PNA-X receiver, understand issues related to antenna equipment selection, and provides insight about interface requirements between components.

Agilent Technologies Inc.,
Santa Clara, CA (800) 829-4444, www.agilent.com.

RS No. 310



AR Systems Brochure



AR RF/Microwave Instrumentation's newest brochure highlights the company's systems' capabilities and ARCell Precompliance Test Systems. AR has the capabilities to customize systems to solve your RF and EMC test problems with the power and frequency you need—from 10 kHz to 45 GHz. The AR-Cell systems are out-of-the-box immunity and emissions test systems that perform precompliance testing to IEC 61000-4-3 requirements as well as other industry specific standards.

AR RF/Microwave Instrumentation,
Souderton, PA (215) 723-8181, www.ar-worldwide.com.

RS No. 311



Interactive Product Catalog

The Empower RF website provides a comprehensive, user-friendly selection of the company's products and functionality to configure and submit quote requests. The site features a parametric search engine and a collection of RF engineer's applets such as a watts-to-dBm converter, gain calculator and links to contact Empower's sales team. There is also a mobile-friendly version accessible from devices such as a RIM Blackberry.

Empower RF Systems Inc.,
Inglewood, CA (310) 412-8100, www.empowerrf.com.

RS No. 312



Designer's Guide



This 14th edition Designer's Guide catalog includes 100 new digital, mixed-signal, RF, microwave and millimeter-wave product data-sheets, as well as quality/reliability, application and packaging/layout information. Full specifications are provided for 730 products across 20 product lines, including: amplifiers, attenuators, data converters, frequency dividers/detectors, frequency multipliers, high speed digital logic, interface, LIAs, mixers, demodulators/modulators, passives, phase shifters, PLLs, power detectors, sensors, switches, synthesizers, TIAs, VGAs and VCOs/PLOs.

Hittite Microwave Corp.,
Chelmsford, MA (978) 250-3343, www.hittite.com.

RS No. 313



Test and Measurement Solutions

The best measurement set-up is only as good as its weakest link and in order to obtain reliable and reproducible measurement results, particular care must be taken in selecting the right components required for the measurement set-up. Therefore, this catalog highlights the company's extensive range of high-quality components that are matched to the various needs of test and measurement applications. The order number of the catalog is: No. 84068138.

HUBER+SUHRNER AG,
Herisau, Switzerland +41 71 353 4111, www.hubersuhner.com.

RS No. 314



Product Catalog

K & L Microwave's 128-page catalog can be used as a desktop reference guide that offers details and specifications to help designers and engineers choose products quickly. Integrated assemblies and a wide assortment of lumped component, cavity, ceramic and suspended substrate filters are among the many types of products featured in this catalog.

K & L Microwave,
Salisbury, MD (410) 749-2424, www.klmicrowave.com,
www.klfilterwizard.com.

RS No. 318



Test and Measurement Product Guide

Keithley's 2009 product guide includes information on the company's latest hardware and software innovations to address challenging test and measurement applications, as well as informative tutorials and selector guides. To request your free copy, visit www.keithley.com/at/556 or call (800) 588-9238.

Keithley Instruments Inc.,
Cleveland, OH (800) 588-9238, www.keithley.com.

RS No. 315



Product Catalog

VENDORVIEW

MECA's latest 104-page catalog (Volume 8) features many new products in the company's extensive line of RF/microwave components with industry leading performance, including fixed attenuators, directional and hybrid couplers, isolators/circulators, power divider/combiners, RF loads, DC blocks and bias tees and cable and adapters. Also included is an extensive RF glossary, frequency allocation charts, application notes, conversion tables, diagrams and microwave formulas.

MECA Electronics Inc.,
Denville, NJ (973) 625-0661, www.e-meca.com.

RS No. 317



Component CD Catalog

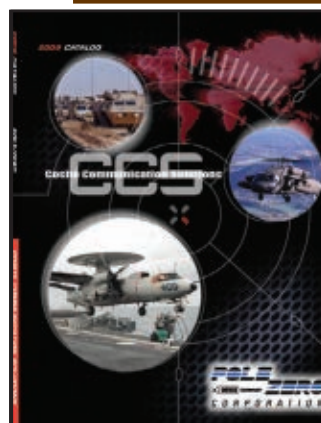
VENDORVIEW

This full-line CD Components Catalog offers a comprehensive display of standard and custom capabilities. The CD includes thousands of pages of product specifications, outline drawings, test data, manufacturing flow diagrams, and a wide assortment of technical ap-

plication notes. MITEQ designs and manufactures state-of-the-art microwave components such as UHF to millimeter-wave low-noise and medium power amplifiers, mixers, multipliers, switches, frequency sources, IF signal processing equipment, fiber optics and integrated microwave subassemblies. Emphasis is on high performance, custom engineering driven applications.

MITEQ Inc.,
Hauppauge, NY (631) 436-7400, www.miteq.com.

RS No. 319

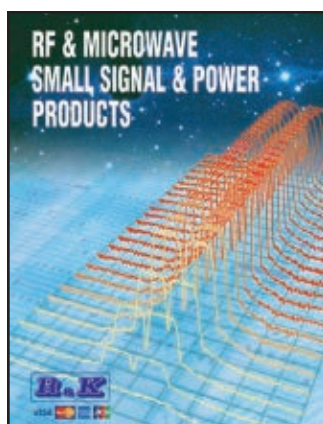


Tunable RF Filter Catalog

Are you looking for tunable RF bandpass and notch filters? Do you need pre/post-selectors, filter/amplifier cascades or LNAs? In the new 2009 catalog, Pole/Zero offers a complete line of tunable cosine filter products in the 1.5 MHz to 2 GHz range. Call or visit the website to get your copy and solve your tunable filter needs today.

Pole/Zero Corp.,
West Chester, OH (513) 870-9060, www.polezero.com.

RS No. 320



RF/Microwave Small Signal & Power Products

This comprehensive 600-page catalog provides full specifications and dimensional information, along with typical plotted performance for over 400 of the company's standard RF and microwave products. These include power amplifiers, low noise amplifiers, mixers, power dividers/combiners, couplers, switches, filters and many more. In particular, there is a section featuring connector and surface-mount modules that cover the DC to 16 GHz frequency range.

R&K Co. Ltd.,
Fuji-city, Shizuoka, Japan +81 545 31 2600,
www.rk-microwave.com.

RS No. 316



Coax Connector Solutions Catalog

The new 156-page RF Connectors Coax Connector Solutions Catalog highlights the company's line of coaxial connectors, adapters, tools and kits. It is available free of charge. The guide provides product specifications, stripping guidelines and photos for over 1200 coaxial products stocked for shipping. Extensive coverage is given to classic connector lines, such as BNC, TNC, N, UHF, Mini-UHF, SMA, SMB, MCX, MMCX, 7-16 DIN, FME, and those compatible with LMR® cables. Available in print, on CD and the company's website.

RF Connectors,
San Diego, CA (858) 549-6340, www.rfindustries.com.

RS No. 321

Featured White Papers

The information you need, from the technology leaders you trust.



Super-Regenerative Receivers

U. L. Rohde and A. K. Poddar,
Synergy Microwave Corporation

KEITHLEY

SISO to MIMO: Moving Communications from Single-Input Single-Output to Multiple-Input Multiple-Output

Mark Elo, Marketing Director of RF Products,
Keithley Instruments



Future Technologies and Testing for Fixed Mobile Convergence, SAE and LTE in Cellular mobile Communications

Anritsu

ParkerVision

Reinventing the Transmit Chain for Next-Generation Multimode Wireless Devices

Richard Harlan, Director of Technical Marketing,
ParkerVision

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.mwjjournal.com/resources)



CATALOG UPDATE



Material Selection Guide VENDORVIEW

This 16-page Material Selection Guide features the company's BISCO® Silicone material. These materials, which are offered in cellular, solid and specialty grades, are used in a wide range of markets, from transportation and communications to electronics and high intensity lighting. Applications include gaskets and seals, high temperature PCB thermal insulation and battery shields, automotive heat shields, and vibration and acoustic mitigation pads. The new BISCO Selection Guide

includes product samples and tips for materials selection based on market applications.

Rogers Corp., Rogers, CT (800) 237-2068, www.rogerscorp.com. RS No. 322

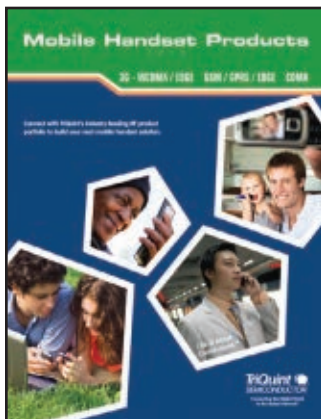


Product Brochure VENDORVIEW

San-tron Inc., a manufacturer of RF coaxial connectors and cable assemblies, has announced the release of its "RF & Microwave Coaxial Connectors and Cable Assemblies" brochure. The brochure outlines the company's entire product offering, categorized by connector types. Connector offerings include, but are not limited to, SMA, N, BNC, TNC, HN and 7/16 connectors. Adapters, cable assemblies and custom specialty connectors are also featured. The brochure is now available at www.santron.com.

San-tron Inc., Ipswich, MA (978) 356-1585, www.santron.com.

RS No. 323



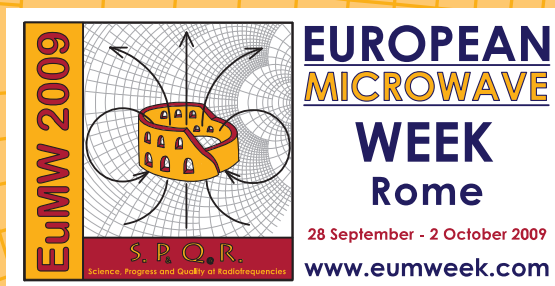
Mobile Handset Brochure

Are you building 3G/W-CDMA, GSM/GPRS/EDGE or CDMA mobile devices? Need an innovative RF solutions partner with high efficiency, high performance products delivered in compact packaging? Download TriQuint's latest Mobile Handset Brochure at www.triquint.com/prodserv/brochures/handset_brochure.pdf and find RF solutions for data-cards and phones ranging from ultra-low cost to data centric.

TriQuint Semiconductor Inc., Hillsboro, OR (503) 615-9000, www.triquint.com.

RS No. 324

Europe's Premier Microwave, RF, Wireless and Radar Event



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:

- 7,000 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:

- European Microwave Integrated Circuits Conference (EuMIC)
 - European Microwave Conference (EuMC)
 - European Wireless Technology Conference (EuWiT)
 - European Radar Conference (EuRAD)
- Plus Workshops and Short Courses

Interested in exhibiting? Book online NOW!

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:



Supported by:



A new institution from the IEE and IET

Endorsed by:



Organised by:



Official Publication:



The 2nd European Wireless Technology Conference



The 6th European Radar Conference



The 4th European Microwave Integrated Circuits Conference

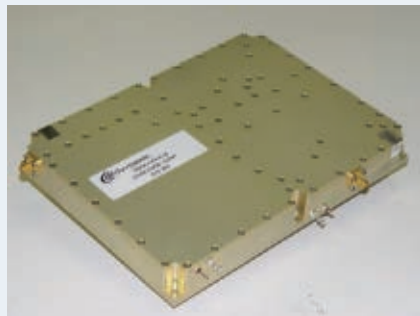
Visit <http://mwj.hotims.com/23284-32> or use RS# 32 at www.mwjjournal.com/info

NEW WAVES: AMPLIFIERS AND OSCILLATORS

FOR MORE NEW PRODUCTS, VISIT WWW.MWJOURNAL.COM/BUYERSGUIDE

FEATURING **VENDORVIEW** STOREFRONTS

Multi-octave Power Amplifier

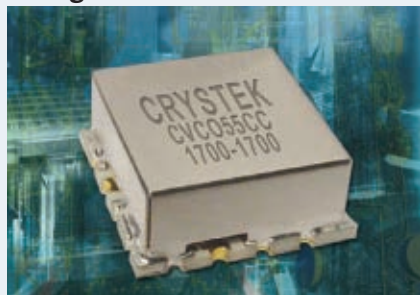


Model number SSPA 4.0-8.0-10 is a high power, broadband, RF amplifier that operates from 2 to 8 GHz. This PA is ideal for broadband military platforms as well as commercial applications because it is robust and offers high power over a multi-octave bandwidth. This amplifier operates with a base plate temperature -20° to +65°C. It is packaged in a modular housing that is approximately 6" by 8" by 1".

Aethercomm Inc., San Marcos, CA
(760) 598-4340, www.aethercomm.com.

RS No. 216

Voltage-controlled Oscillator



Crystek's CVC055CC-1700-1700 voltage-controlled oscillator (VCO) operates at 1700 MHz with a control voltage range of 0.3 to 4.7 V. This VCO features a typical phase noise of -120 dBc/Hz at 10 kHz offset and offers excellent linearity. Output power is typically +2.5 dBm. Engineered and manufactured in the US, the model CVC055CC-1700-1700 is packaged in the industry-standard 0.5" x 0.5" SMD package. Input voltage is 5 V, with a maximum current consumption of 25 mA. Pulling and pushing are minimized to 1 MHz and 0.5 MHz/V, respectively. Second harmonic suppression is -15 dBc typical. Price: \$18.46 each in volume.

Crystek Corp., Fort Myers, FL
(239) 561-3311, www.crystek.com.

RS No. 217

RF Power Transistors



These laterally diffused metal oxide semiconductor (LDMOS) RF power transistors are designed to meet growing demand for reduced power consumption in cellular transmitters. Freescale's eighth generation high voltage (HV8) RF Power LDMOS technology is engineered specifically to meet the stringent demands of high-data rate applications such as W-CDMA and WiMAX, as well as emerging

standards such as LTE and Multicarrier GSM. The portfolio of devices based on HV8 technology is optimized for operation in advanced power amplifier architectures, which includes Doherty used in combination with digital predistortion (DPD). A primary benefit of Freescale's HV8 technology is the increase in operating efficiency that helps reduce total power consumption of a base station system, thereby reducing operating costs.

Freescale Semiconductor, Austin, TX
(800) 521-6274, www.freescale.com.

RS No. 218

Temperature-compensated Crystal Oscillator



The T124 Series of TCXOs is an ultra-low frequency oscillator that is available down to 650 Hz in a low profile, compact SMT package. The T124 Series TCXOs, available from 650 Hz to 1.25 MHz, provide extremely stable, low frequency square-wave output (temperature stability to ± 0.3 ppm over -40° to +85°C). The T124 features 3.3 V input voltage and EFC (electrical frequency control, optional) to adjust for long-term aging. The T124 utilizes a rugged, AT strip crystal to provide superior aging characteristics to 3 ppm over 15 years. With compact size and low power consumption, the T124 Series is ideally suited to low jitter clocking for mobile RF applications.

Greenray Industries Inc., Mechanicsburg, PA (717) 766-0223,
www.greenrayindustries.com.

RS No. 219

Variable Gain Amplifiers



These digital variable gain amplifiers are ideal for automotive, broadband, cellular/3G, WiMAX/4G, military and test & measurement equipment applications between 30 and 1000 MHz. The HMC680LP4(E) is a digitally-controlled variable gain amplifier that operates from 30 to 400 MHz, and can be programmed to provide from -4 to 19 dB of gain, in 1 dB

steps. The HMC681LP5(E) is a digitally-controlled variable gain amplifier that operates from DC to 1 GHz, and can be programmed to provide from 13.5 dB, to 45 dB of gain, in 0.5 dB steps.

Hittite Microwave Corp., Chelmsford, MA
(978) 250-3343, www.hittite.com.

RS No. 220

SATCOM Pre-filter Amplifier



The SATCOM pre-filter amplifier provides 30 dB of transmit band rejection with minimum impact on LNA noise figure. This RF module combines a low-loss input filter with a low noise amplifier, followed by a final clean-up filter. The entire module is housed in a small surface-mount package measuring 4" x 1" x 0.5". Microstrip input and output launches facilitate PCB attachment. Typical noise figure is 1.2 dB with 14 dB gain. The LNA is set for 14 dB gain, but can be set as high as 20 dB. The input filter minimizes transmit band co-site interference, reducing transmit third-order products in the SATCOM receive band. A final bandpass filter further reduces out-of-band interference for a clean receive channel signal. The entire cascade maintains less than 1 dB flatness across the full receive band. The module operates from a single 5 V power supply with a small 65 mA current draw.

K&L Microwave, Salisbury, MD
(410) 749-2424, www.klmicrowave.com.

RS No. 221

MMIC Power Amplifier



The XP1072-BD is a GaAs MMIC high power amplifier with +35 dBm pulsed saturated output power and 22 dB large signal gain. This power amplifier covers 34 to 37 GHz and achieves 25 percent power added efficiency (PAE). The device is well suited for millimeter-wave military, radar, satellite and weather applications. This XP1072-BD multi-stage amplifier delivers industry leading power and efficiency for

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**.

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 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



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/23284-72> or use RS# 72 at www.mwjjournal.com/info

NEW WAVES: AMPLIFIERS AND OSCILLATORS

FOR MORE NEW PRODUCTS, VISIT WWW.MWJOURNAL.COM/BUYERSGUIDE

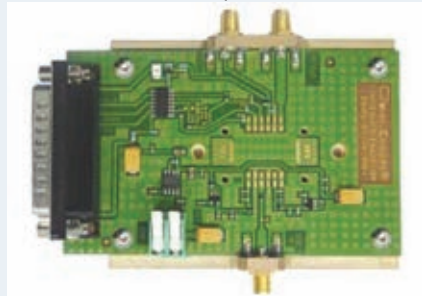
FEATURING **VENDORVIEW** STOREFRONTS

Ka-band applications, with a saturated output power of nearly 4 W, providing a boost to applications that require both high power and efficiency in a small area.

Mimix Broadband Inc.,
Houston, TX (281) 988-4600,
www.mimixbroadband.com.

RS No. 222

56 to 6010 MHz Synthesizers



Mini-Circuits design team can create a custom frequency synthesizer tailored to meet your specific requirements. They will review your requirements and, following technical discussions between your engineers and Mini-Circuits designers, will work closely with you to create final specifications that meet or exceed your requirements. To ensure high yields, the company will factor in component tolerances and even variations in manufacturing processes. You will have full access to performance data from sample units, and can even evaluate sample units in your system to ensure that final production units fulfill your performance requirements. For more information, visit www.minicircuits.com.

Mini-Circuits, Brooklyn, NY (718) 934-4500, www.minicircuits.com.

RS No. 251

High Performance Amplifiers



MITEQ's cost-effective high performance LCN amplifier series are now available in frequency ranges from 1 to 2, 2 to 4, 4 to 8, 8 to 12, 12 to 18, 6 to 18 and 2 to 18 GHz. These amplifiers offer excellent low noise figures and great single unit pricing starting at \$325.00. The LCN series amplifiers are available from stock, have industry standard hermetic housings, removable SMA connectors and drop in compatibility.

MITEQ Inc., Hauppauge, NY
(631) 439-9220, www.miteq.com.

RS No. 223

Power Amplifiers



RFMD's RF720x family of W-CDMA/HSPA+ power amplifiers (PA) is comprised of four PAs designed for 3G multimode devices implementing mode-specific, band-specific front-end architectures. The RF720x product family accommodates all major W-CDMA/HSPA+ bands and band combinations and is optimized to mate with reference designs from the industry's leading open market 3G chipset supplier. The RF7200 (band 1), RF7206 (band 2), RF7203 (band 3, 4, 9 or 10) and the RF7211 (band 11) are designed for single-band operation, while the RF7201 (band 1/8), RF7202 (band 2/5) and the RF7205 (band 1/5) feature two band-specific PAs integrated in a single module package.

RFMD, Greensboro, NC
(336) 664-1233, www.rfmd.com.

RS No. 224

Low Noise General Purpose Amplifier

The SKY65038-70LF is a low noise amplifier that operates in a frequency range from 250 MHz to 6 GHz. The SKY65038 is a general purpose, broadband amplifier fabricated from Skyworks' PHEMT process and packaged in a miniature SOT-89 package. The amplifier's low noise figure of 2 dB and high output IP3 of 40 dBm at 1 GHz allows these devices to be used in various transmit/receive applications. In addition, the amplifier's output impedance is 50 Ω , which enables these devices to be easily cascaded with a simple input impedance matching network.

Skyworks Solutions Inc., Woburn, MA
(781) 376-3000, www.skyworksinc.com.

RS No. 225

Bi-directional Power Amplifier



The SMTR2425-11B40-2 is a military grade bi-directional power amplifier (PA) that is capable of up to 10 W of 802.11b and 2 W of 802.11g or 802.16. Primary applications include: WLAN, video link and C2 products for UAVs. The unit operates from 2.4 to 2.5 GHz and outputs +40 dBm exceeding 802.11b EVM requirements. Transmit/receive gains are 25 and 16 dB, respectively. The PA measures 3.5" x 2.9" x 0.56" and weighs approximately 4 oz.

Stealth Microwave Inc.,
Trenton, NJ (888) 772-7791,
www.stealthmicrowave.com.

RS No. 226

Ultra-low Noise VCXO



The VFVX100 VCXO is a low jitter and phase noise timing solution for Universal Edge QAM. The VFVX100 provides a PECL or LVPECL output with a frequency range of 200 MHz to 1 GHz (245.76 MHz STD). With less than 0.2 ps jitter, the VFVX100 gives a cleaner I-Q constellation, providing lower BER's and higher data throughput. Wider pull ranges of ± 20 to ± 100 ppm are available with phase noise of -142 dBc/Hz at 10 kHz offset for 622.08 MHz. Operating at +3.3 or +5 V power supply, the VFVX100 typically consumes 0.25 W. The VFVX100 is available in a 9.0 x 14.0 mm surface-mount package and is RoHS 6/6 compliant.

Valpey Fisher Corp., Hopkinton, MA
(508) 435-6831, www.valpeyfisher.com.

RS No. 227

Voltage-controlled Oscillator



The model CRO0410A-LF is a new RoHS compliant voltage-controlled oscillator (VCO) in the UHF band. The CRO0410A-LF operates in a frequency range from 390 to 430 MHz with a tuning voltage range of 0.5 to 4.5 VDC. This VCO features a typical phase noise of -117 dBc/Hz at 10 kHz offset and a typical tuning sensitivity of 17 MHz/V. The CRO0410A-LF is designed to deliver a typical output power of -4 dBm at 5 VDC supply while drawing 36 mA (typical) over the temperature range of -30° to 70°C. This VCO features typical second harmonic suppression of -15 dBc and comes in Z-Comm's industry standard MINI-16 package measuring 0.5" x 0.5" x 0.22".

Z-Communications Inc., San Diego, CA
(858) 621-2700, www.zcomm.com.

RS No. 228

IMS 2009

7-12 June
BOSTON MA

2009 IEEE MTT-S International
Microwave Symposium and Exhibition

FREE

Exhibit-Only Registration

Use promotional code: MWJ091211

Compliments of



IMS 2009



WIN TICKETS
TO A
RED SOX
GAME!

Attend IMS using the above promotional code
and enter to *win a pair of tickets to a Boston Red Sox Game.**

**Register in Advance at the IMS Website or Bring This Card to the
Registration Area at the Boston Convention Center.**

Over 500 exhibiting companies from around the world representing the highest concentration of microwave and RF products on the planet – whether you're looking for components, materials, ICs, test & measurement equipment, design software or services, you'll find it on the IMS exhibit floor.

- Join us June 10 for the new Wednesday Evening Exhibit Floor Reception
- Expanded Exhibit hours 10am – 7pm
- Access to the MicroApps sessions Tuesday – Thursday on the exhibit floor

To attend the IMS conference sessions take advantage of Early Bird registration rates. Register before May 15 and save over 25% on registration fees. IEEE members receive a greater discount!

The Boston Convention & Exhibition Center in South Boston offers easy access from both I-90 and I-93 plus on-site parking for \$10/day.

*Complete information is available online by visiting
www.ims2009.org or call +1 303-530-4562 to request a program.*

*Contest details available at www.ims2009.org

IMS 2009

7-12 June
BOSTON MA

2009 IEEE MTT-S International
Microwave Symposium and Exhibition

FREE

Exhibit-Only Registration

Use promotional code: MWJ091211

Compliments of



IMS 2009



BOSTON MA

WIN TICKETS
TO A
RED SOX
GAME!



Attend IMS using the above promotional code
and enter to *win a pair of tickets to a Boston Red Sox Game.**

**Register in Advance at the IMS Website or Bring This Card to the
Registration Area at the Boston Convention Center.**

Over 500 exhibiting companies from around the world representing the highest concentration of microwave and RF products on the planet – whether you're looking for components, materials, ICs, test & measurement equipment, design software or services, you'll find it on the IMS exhibit floor.

- Join us June 10 for the new Wednesday Evening Exhibit Floor Reception
- Expanded Exhibit hours 10am – 7pm
- Access to the MicroApps sessions Tuesday – Thursday on the exhibit floor

To attend the IMS conference sessions take advantage of Early Bird registration rates. Register before May 15 and save over 25% on registration fees. IEEE members receive a greater discount!

The Boston Convention & Exhibition Center in South Boston offers easy access from both I-90 and I-93 plus on-site parking for \$10/day.

*Complete information is available online by visiting
www.ims2009.org or call +1 303-530-4562 to request a program.*

*Contest details available at www.ims2009.org

IMS 2009

**7-12 June
BOSTON MA**



Efficient, Productive, Invaluable

REGISTER NOW for the 2009 MTT-S International Microwave Symposium

Attend IMS and keep ahead of the competition, discover new products to increase your efficiency. Save your company development time and money, and advance your understanding of critical new industry developments.

The technical program offers Focus Tracks on:

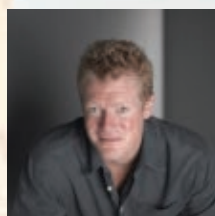
- **Microwave Modeling**
- **Active Components**
- **Passive Components**
- **Microwave Systems**

Don't miss...



Plenary Speaker –
Dr. Petteri Alinikula,
Vice President, Head of Core
Technology Centers, Nokia
Research Center

Topic:
Innovating Openly in Wireless



Banquet Speaker –
Dr. Spencer Wells,
Genographic Project Director,
National Geographic
Topic:
**Deep Ancestry: Inside the
Genographic Project**

Over 500 exhibiting companies from around the world representing the highest concentration of microwave and RF products on the planet – whether you're looking for components, ICs, test & measurement equipment, design software or services, you'll find it on the IMS exhibit floor.

Look forward to...

- *Technical Sessions, Workshops, Interactive Sessions and Informative Keynotes*
- *Exciting Panel and Rump Sessions - Including **electromagnetic invisibility***
- *Take advantage of Early Bird registration rates. Register now and **save over 25%** on registration fees. IEEE members receive an even greater discount!*

***Complete program information is available online by visiting
www.ims2009.org or call +1 303-530-4562 to request a program.***

We'll see you in Boston, June 7-12!



Components

SMA Attenuators



Designed for volume applications and available from stock, Aeroflex Inmet's AHC family of SMA attenuators offer performance at an affordable price. These 2 W units operate in a frequency range from DC to 6 GHz with a 1.20 VSWR while providing excellent attenuation flatness. Built for ruggedness, the AHC attenuators are available in dB values of 1-12, 15, 20 and 30.

Aeroflex/Inmet, Ann Arbor, MI
(877) 367-7369, www.rfmw.com/inmet.

RS No. 229

ZigBee Radio Transceiver



CEL is now shipping its MeshConnect ZigBee radio module, adding to its rapidly growing line of ZigBee/IEEE

802.15.4 transceiver solutions. The module, based on CEL's own MeshConnect single chip integrated circuit (IC), is unique in its ability to deliver market-leading RF performance and range with a very low cost design. It is FCC, CE and IC certified, eliminating costly and time consuming regulatory testing. In conjunction with its development kit, the module is a complete hardware platform with a choice of software tools that enable customers get to market quickly and efficiently.

California Eastern Laboratories (CEL), Santa Clara, CA (408) 919-2500,
www.cel.com.

RS No. 230

SPDT Coaxial Switch



The D2Series SPDT coaxial switches come in a variety of connectors, such as BNC, TNC, N Type, and SMA. Models operate in a frequency range from DC to 12.4

GHz. Actuator options come in Latching and in Failsafe modes, also available are units with TTL circuitry and Integrated Indicator circuits. These switches offer an RF impedance of 50 ohms nominal; operating temperature of -35° to +85°C ambient; operating life of 1,000,000+ cycles; switching time of 35 mSec maximum; switching sequence of Break before Make; and environmentally designed to meet MIL-E-5400 and Mil-S-3928.

Ducommun Technologies Inc., Carson, CA
(310) 513-7214, www.ducommun.com.

RS No. 231

Flexible Coaxial Cable Assembly



This highly flexible series of phase stable M/V flexible coaxial cable assemblies provides accurate and reliable measurements and claims to offer

better performance than general flexible cable assemblies. Typical phase and amplitude stability is $\pm 4^\circ$ and ± 0.08 dB up to 18 GHz. With an impedance of 50 Ω , the PS-Series exhibits a typical insertion loss for 1 m (including two connectors) of 1.6 dB at 18 GHz and has a VSWR of 1.3 up to 18 GHz.

GigaLane Co. Ltd., Gyeonggi-do, Korea
+82 31 233 7325, www.gigalane.com.

RS No. 232

Low Pass Filter



Part number 2515-S is a surface-mount 50 MHz group delay and amplitude equalized

low pass elliptic filter. The filter offers a typical insertion loss of 1 dB. Passband ripple to 50 MHz is 0.25 dB maximum and the filter attains over 40 dB by 68 MHz and over 60 dB by 73.6 MHz. Group delay variation is < 5 nsec to 44 MHz and typically < 7 nsec to 50 MHz. The filter is supplied in a surface-mount package measuring 2" x 0.5" x 0.3" and can also be supplied connectorized. The filter can be customized for other center frequencies and bandwidths.

KR Electronics Inc., Avenel, NJ
(732) 636-1900, www.krfilters.com.

RS No. 233

In-building Combiner Diplexer



Lorch Commercial and Wireless (LCW) offers WP-E056-1, a combiner diplexer that covers the full PCS and AWS frequencies. The combiner di-

plexer exhibits less than 1 dB of insertion loss across the passbands of 1710 to 1755/2110 to 2155 MHz and 1850 to 1990 MHz while providing greater than 60 dB of isolation. The unit measures 7" x 5" x 2", is well suited for in-building applications and is available from stock.

Lorch Commercial and Wireless, Salisbury, MD (410) 860-5100,
www.lorchwireless.com.

RS No. 234

Drop-in Isolators and Circulators



These drop-in isolators and circulators are designed for 802.11a broadband systems operating in the frequency range of 5.15 to 5.825

GHz. These ferrite devices offer 20 dB isolation

over the frequency range of 5.15 to 5.825, allowing manufacturers to stock one device for all 12 of the 802.11a channels. The isolators and circulators feature small dimensions (0.375" x 0.500"), and use ceramic magnets for reliability. Isolators include a termination rated at 10 W.

M2 Global Technology Ltd., San Antonio, TX (210) 561-4800,
www.m2global.com.

RS No. 235

SMP Connectors



Phoenix's SMP series subminiature connectors offer superior electrical performance from DC to 26.5 GHz. Blind-

mate feature allows for board-to-board, cable mount and PCB mount. In-series adapters provide solutions for rack and panel applications. All products manufactured to Mil-Std-348. Features include: subminiature size for high density applications; snap feature for quick mating and reduced assembly time; axial alignment reduces stress from multiple blindmate connections; gang mating is possible. It compensates for up to 0.020" radial and axial misalignment (when used with an adapter); and center-to-center spacing of 0.170".

The Phoenix Company of Chicago, Wood Dale, IL (800) 323-9562,
www.phoenixofchicago.com.

RS No. 236

Power Divider



The model DP-2-218-M-BB is a miniature power divider designed to operate in a frequency range from 2 to 18

GHz. The power divider offers an insertion loss of only 2.2 dB maximum, isolation of 16 dB minimum and a VSWR of 2.0 maximum. The power handling is 1.5 W at 2.0 VSWR and 2.0 W at 1.2 VSWR. The size is only 0.779" x 1.026" x 0.300" with the connector shrouds removed.

Planar Monolithics Industries Inc., Frederick, MD (301) 631-1579,
www.planarmonolithics.com.

RS No. 237

Waveguide Broadwall Coupler



RLC Electronics offers a standard range of multi-hole broadwall directional couplers that operate in a

frequency range from 2.6 to 40 GHz in standard waveguide sizes. The electrical characteristics of high directivity and coupling flatness are achieved by using a precise machined coupling hole pattern and a precision load in the secondary arm. Non-standard configurations or selected electrical parameters are available on request.

RLC Electronics, Mount Kisco, NY
(914) 241-1334, www.rlcelectronics.com.

RS No. 238



2009 National Conference on Microwave and Millimeter Wave in China (NCMMW) 2009 MICROWAVE INDUSTRY EXHIBITION IN CHINA

SPONSORS:

Chinese Institute of Electronics (CIE)

ORGANIZERS:

Microwave Society of Chinese Institute of Electronics (CIE)

Xidian University

Kingradio Technology [Shenzhen] Co. Ltd.

COLLABORATING JOURNALS / WEBSITES:

Journal of microwaves

Mobile Communications

Microwave online(kilomega)

Microwave and RF network (mrfn)

Microwave Journal(mwjjournal)

CONFERENCE / EXHIBITION DATE: May 23-26, 2009

**CONFERENCE / EXHIBITION VENUE: Xi'an Qujiang
International Conference and Exhibition Center, P. R. China**

BACKGROUND OF MICROWAVE INDUSTRY EXHIBITION IN CHINA



The Microwave Industry Exhibition has already been held over 10 years. It is held with the National Conference on Microwave and Millimeter Wave in China every odd year, and with the International Conference on Microwave and Millimeter Wave Technology every dual year.

The goal is to provide a platform for enterprises engaged in Microwave Millimeter wave and RF field to publicize your company/ products.

BACKGROUND OF NCMMW

NCMMW is China's largest conference on microwave and millimeter wave technologies. It is organized by Chinese Institute of Electronics (CIE) and held every two years (odd year).

www.mws-cie.org, www.cnmw.org

The proceedings of the conference will be published by Publishing House of Electronics Industry of China.



The year 2009 comes the Microwave Society of Chinese Institute of Electronics 30th anniversary, so more than 500 conferees will participate in this microwave and millimeter wave conference (Specialized visitor will exceed one thousand people), as the conferees are experts, design engineers and scholars in the field of Microwave and Millimeter wave, they will be the most professional visitor. And this will be another grand exhibition after "2008 Microwave Industry Exhibition in Nanjing China".



STANDARD BOOTH: 3 m x 3 m,

Will consist of one board with company name, one table, two chairs and so on.

CUSTOMIZED BOOTH: From 36 m²

Empty area, you can customize the booth to highlight your company / products.

NOTES:

- The exhibitor will have a chromatic page of introduction in the exhibition handbook, which is free.
- Two packs of lunch will be provide for standard booths, four packs of lunch will be provided for customized booths.
- A list of conferees and professional visitor will be provided.

NCMMW 2009 will surely attract a large numbers of scholars and industry companies from China (Mainland), Hong Kong, Macao and Taiwan. It is a great opportunity for publicizing your company / products.



Looking forward to seeing your company taking part in the exhibition !

WHY YOU SHOULD ATTEND?

MIE 2009 is the largest event of microwave field in China, which is organized by Microwave Society of Chinese Institute of Electronics.

MIE 2009 is where to provide a nice opportunity for the scientists and engineers specialized in the field of Microwave and Millimeter wave to present your new ideas and learn from each other.

MIE 2009 is where to provide a platform for enterprises engaged in Microwave Millimeter wave and RF field to publicize your company/ products in China.

EXHIBITORS TO BE ATTENDED:

- Fabricator / distributor for RF / microwave / millimeter wave devices / components: solid state device and circuits (including MMIC): amplifiers, mixers, oscillators, etc. and passive components: filters, duplexers, couplers, attenuators, and antennas etc.
- Designer / distributor for RF / microwave / millimeter wave software.
- Fabricator / distributor for RF / microwave / millimeter wave equipments.
- Fabricator / distributor for RF / microwave PCB and connectors.
- Fabricator / distributor for microwave absorber
- Fabricator / distributor for microwave / millimeter inductor, capacitor and high power resistor
- RF / microwave / millimeter related press and media.

Xi'an is the largest hub of research and development of RF / microwave / millimeter wave products in China. There are many famous universities, institutes and factories in this area, including Xidian University, Xi'an Jiaotong University, Northwestern Polytechnical University, Air Force Engineering University, The Second Artillery Engineering College of PLA, 4th Research Institute of Telecom Science and Technology, 20th and 39th Research Institute of China Electronics Technology Group Corporation, 206th Research Institute of China Arms Industries Group Corporation, and 504th Research Institute of China Aerospace Science and Technology Corporation, etc.

FOR ENQUIRY, PLEASE CONTACT: Mr. Wei Zilun

TEL: 86-755-83655339

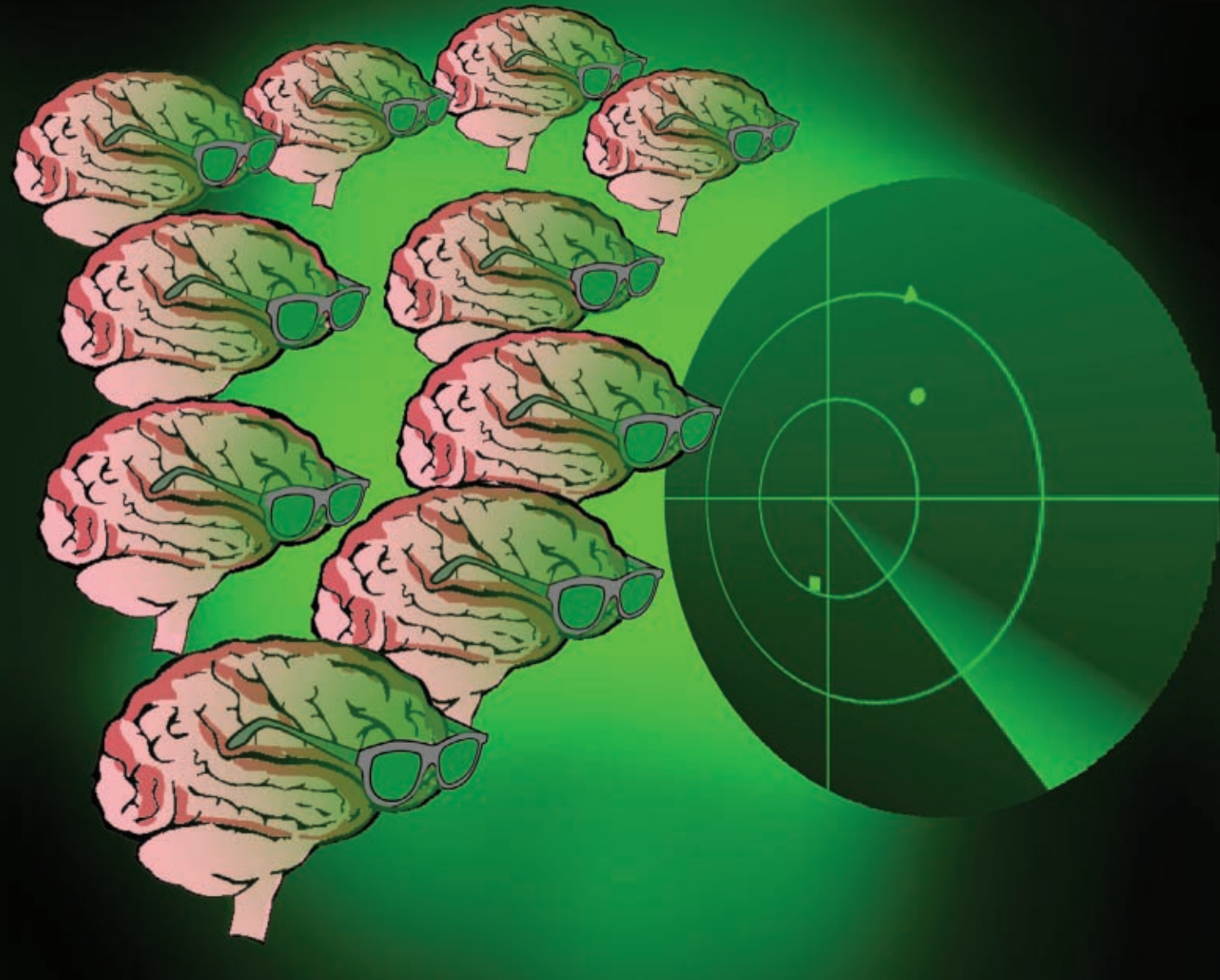
FAX: 86-755-83629073

EMAIL: kingradio@163.net, mwrf@vip.163.com

OR VISIT:

www.cnmw.org www.mws-cie.org

Inquisitive Minds are on our Radar. Are they on yours?



The Microwave Journal/ Besser Associates Webinar Series

The MWJ/Besser Associates Free webinar series attracts thousands of engineers, managers and executives from leading communications and defense companies. Webinar sponsorship gets your message in front of this highly focused audience. For details contact your sales representative or e-mail: webinars@mwjournal.com

March: RF/mW Power Amplifiers – **now on demand**

April: MIMO Systems – **4/21/09**

May: Impedance Matching – **5/19/09**

June: High Speed Boards – **6/23/09**



GaN Power Amplifiers GA Series

Low Cost GaN FET Amplifiers



Need Power Amp? Ask R&K!

Model Number	Frequency (GHz)	Power
GA0538-4540-M	0.5~3.8	10W(min)
GA0538-4540-R	0.5~3.8	10W(min)
GA0830-4344-M	0.8~3.0	25W(min)
GA0830-4344-R	0.8~3.0	25W(min)
GA0830-4747-M	0.8~3.0	50W(min)
GA0830-4747-R	0.8~3.0	50W(min)
GA0827-4552-M	0.8~2.7	150W(min)
GA0827-4552-R	0.8~2.7	150W(min)
GA0827-4754-R	0.8~2.7	250W(min)
CON0827-150W-R	0.8~2.7	150W Peak

* Suffix "-M" is Module type, "-R" is Rack type.

R&K Company Limited

info@rkco.jp
http://www.rk-microwave.com
Country in Origin

SEKI TECHNOTRON USA
A subsidiary of SEKI TECHNOTRON CORP.

sfumo@sekitech.com
http://www.sekitechusa.com
US Sales Partner

Visit http://mwj.hotims.com/23284-86

RF Power Amplifiers ALM Series

Low Cost GaAs FET Amplifiers



Need Power Amp? Ask R&K!

Model Number (Module Type)	Frequency (MHz)	Power
ALM000110-2840FM-SMA(F)	1 ~ 1000	10W(min)
ALM001110-2840FM-SMA(F)	10 ~ 1000	10W(min)
ALM1015-2840FM-SMA(F)	1000 ~ 1500	10W(min)
ALM1520-2840FM-SMA(F)	1500 ~ 2000	10W(min)
ALM1922-2840FM-SMA(F)	1900 ~ 2200	15W(min)
ALM00505-4546-SMA	50 ~ 500	40W(min)
ALM0105-4748-SMA	100 ~ 500	60W(min)
ALM0510-3846-SMA	500 ~ 1000	25W(min)
ALM2527-4547-SMA	2500 ~ 2700	50W(min)

* A bench top type is also available that features 100-240V AC.

R&K Company Limited

info@rkco.jp
http://www.rk-microwave.com
Country in Origin

SEKI TECHNOTRON USA
A subsidiary of SEKI TECHNOTRON CORP.

sfumo@sekitech.com
http://www.sekitechusa.com
US Sales Partner

NEW PRODUCTS

IED Jamming and other mobile applications requiring a high frequency, lightweight design with low power consumption.

EM Research Inc., Reno, NV
(775) 345-2411, www.emresearch.com.

RS No. 244

Composite N Receptacle

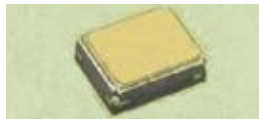


Radiall Composite N receptacle is made with a typical metal RF insert, maintaining the standard N dimensions and performance, and a composite (plastic) outer body or housing offered in a variety of colors. Composite N receptacles offer outstanding electrical performance and are the best compromise in terms of weight/cost/mechanical characteristics to replace existing brass technology. These connectors feature 100 percent compatibility with standard N brass connectors (MIL-STD-348-304); intermodulation performance of IMP3 < -115 dBm; low VSWR of 1.14 maximum at 6 GHz; 50 percent weight reduction; and corrosion free housing.

Radiall AEP Inc., New Haven, CT
(203) 776-2813, www.radiall.com.

RS No. 245

Temperature-compensated Crystal Oscillator



This ultra-compact temperature-compensated crystal oscillator (TCXO) features solderable reflow and SMD package base offers superior flatness. This TCXO is ultra-compact (2.0 x 1.6), low height (0.8t maximum) light weight and low current consumption type. High frequency (f0 = 52 MHz) and low frequency are available using built in 1/2 frequency divide down function. These TCXOs are RoHS compliant. Applications include: cell phone, base station, GPS and mobile radio application.

TEW America, San Jose, CA
(650) 962-8330, www.tewamerica.com.

RS No. 246

Subsystems

Two Down-converters



The FBC-xx-xx series is a down-converter for use as a frequency extender for noise figure measurement test systems. It is available in a 2U 19 inch rack system. The systems consist of a single waveguide input (WR-28 to WR-10) and an IF output (SMA-F). The RF input frequencies are down-converted to an IF in the 4 to 18 GHz range, which is suitable for frequency extending any standard noise figure analyzer. Also, the FBC-K-xx series is a down-converter for use

with a 2 to 20 GHz tuned receiver, which is available in a 1U 19 inch rack system. The system consists of a three RF channel input with one IF output. The three channels are selectable by TTL control.

Farran Technology Ltd., Ballincollig, Co. Cork, Ireland,
+ 353 21 487 2814, www.farran.com.

RS No. 247

Rental Offer

VENDORVIEW

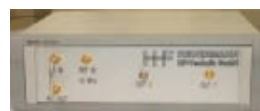


AR has introduced a new rental plan with great low rates and an incredible buyout to make it easy to get the AR equipment you need now. With a three-month minimum rental, credit towards a buyout will accumulate at 90 percent of each rental payment—up to 95 percent of the list price. For full details 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. 248

Comb Generator



The innovative SG-CG1 comb generator has a wide input frequency range from 30 MHz to 4 GHz, a low input power requirement of 0 dBm and its output harmonics reaches 18 GHz. It is applicable with an internal (100 to 200 MHz) or external synthesizer. Features include two ECL compatible outputs, 400 kHz tuning step size and PC interface (serial/USB). It can be used for a wide range of applications such as frequency multipliers, signal generators, EMC source, UWB applications and FMCW radars.

Heuermann HF-Technik GmbH, Aachen, Germany +49 (0) 241 6009-52108,
www.hhft.de.

RS No. 249

Test Equipment

Next-generation PHS Technology

VENDORVIEW

Anritsu Co. introduces test solutions that support next-generation PHS (XGP: eXtended Global Platform) to help ensure the successful rollout of XGP in the marketplace. Three software packages have been developed for use with Anritsu's MS269xA signal analyzers and MG3700A vector signal generator to offer designers and manufacturers of XGP mobile devices, base stations and devices a test solution to ensure the performance of their products and speed time to market. The MX269016A XG-PHS Measurement Software and the MX269909A XG-PHS IQproducer are for use with the MS269xA series, while the MX370109A XG-PHS IQproducer PC software is for the MG3700A.

Anritsu Co., Richardson, TX
(800) 267-4878, www.anritsu.com.

RS No. 250

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 77

REVOLUTIONARY HERMETIC SMP CONNECTORS

These SMPs meet the requirements of MIL-STD-348, but utilize unique housing interface features, which significantly improves reliability and production assembly yields. Proprietary techniques are used to independently control plating thickness on pin and housing.



**For use with Aluminum, Kovar
and other package materials**



SPECIAL HERMETIC PRODUCTS, INC.
PO BOX 269 - WILTON - NH - 03086
(603) 654-2002 - Fax (603) 654-2533
E-mail: sales@shp-seals.com
Web: www.shp-seals.com

RS 103



Advanced
Switch
Technology

Double Ridge Waveguide Switches



**For superior quality & quick turnaround,
Call AST**

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**

Since 1993

www.rftec.com

RS 90

KR Electronics

www.krfilters.com
ISO 9001:2000 Certified



Custom & Standard Filters to 3 GHz
35+ Years of Military & Commercial Applications

Bandpass	Lowpass
Anti-Aliasing	Notch
Highpass	Root Cosine
Video Filters	Equalizers
Diplexers	Linear Phase
Delay Equalized	Absorptive
Surface Mount	Matched

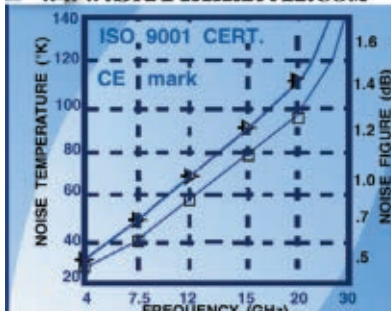
KR Electronics, Inc.
Avenel, NJ
www.krfilters.com

sales@krfilters.com
Phone 732.636.1900
Fax 732.636.1982

RS 47

LOW NOISE AMPLIFIERS

www.SATELLINK.com



SATELLINK, INC.
3525 MILLER PARK DR.
GARLAND, TX 75042
CALL (972) 487-1434
FAX (972) 487-1204

RS 98

**Microwave
Journal**

**WHAT CAN YOU FIND AT
www.mwjjournal.com?**

BUYER'S GUIDE

Use this invaluable reference source
for locating companies, their products
and services.
*Is your company
in the guide?*

SECTOR MICROWAVE SWITCHES



MILITARY **HI-REL** **COMMERCIAL**


(631) 242-2300 PHONE (631) 242-8158 FAX
WWW.SECTORMICROWAVE.COM

RS 99

ULTRA LOW PHASE NOISE VCO

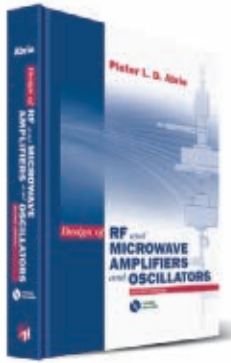
Modco MD Series VCOs offer very low Phase Noise in a half inch package. Models are low cost and available for a variety of Frequency Bands. No NRE for custom designs.

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 78



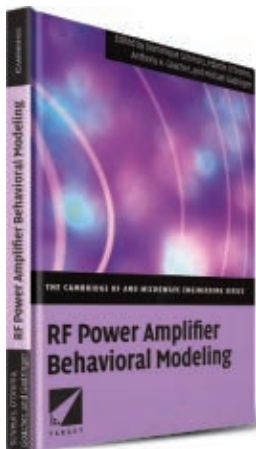
Design of RF and Microwave Amplifiers and Oscillators, Second Edition

Pieter L.D. Abrie

This newly revised edition of this classic book has been updated to include expanded derivations and problem sets, helping to make the material even more accessible and easier to master. The second edition adds critical coverage of nodal analysis and derivation of the power parameters for simple FET and bipolar transistors. There is also a new chapter on wideband distributed amplifier design, more focus on power amplifiers, and new tables of network elements for resistive matching networks over various passbands. This practical book helps one estimate the 1 dB compression point of class A and class B linear circuits, initialize the fundamental component voltages and currents in a harmonic balance simulator, and more easily generate load-pull contours for class A and class B transistors. Considered as a generalization of the Cripps approach, this book presents an independently developed method that can be applied easily to control or predict the output power in single- or multi-stage amplifiers.

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
600 pages; \$118, £63 • ISBN: 978-1-59693-098-8



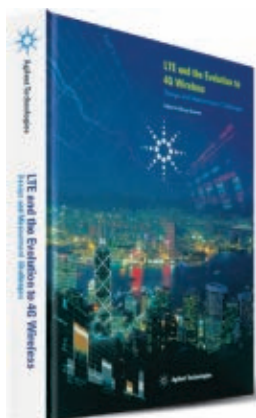
RF Power Amplifier Behavioral Modeling

Dominique Schreurs, Mairtin O'Droma, Anthony A. Goacher and Michael Gadringer, Eds.

This is a very good book for the engineer or RF designer who is working with wireless transmitter power amplifier models as a comprehensive and up-to-date review of nonlinear theory and power amplifier modeling techniques. Including a detailed treatment of nonlinear theory, as well as chapters on memory effects, implementation in commercial circuit simulators and validation, this one-stop reference makes power amplifier modeling more accessible by connecting the mathematics with the practicalities of RF power amplifier design. The book explains systematically how to evaluate a model's accuracy and validity, compares model types and offers recommendations as to which model to use in which situation.

To order this book, contact:

Cambridge University Press • 100 Brook Hill Drive • West Nyack, NY 10994-2133 • (845) 353-7500
288 pages; \$99 • ISBN: 978-0-52188-173-9



LTE and the Evolution to 4G Wireless—Design and Measurement Challenges

Moray Rumney, Ed.

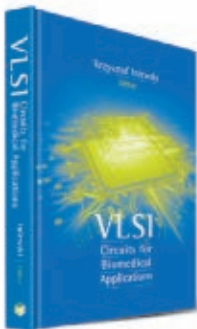
This book draws on the expertise of engineers in Agilent Technologies with contributions by Anite and LTE expert K.F. Tsang to present valuable insight into the LTE specifications and its design and verification challenges. It begins with an LTE overview, describes the evolution from UMTS and how to access the LTE specifications before offering insights into air interface concepts such as OFDMA, SC-FDMA, the new uplink transmission scheme and MIMO. It aims to provide an understanding of FDD and TDD physical layers and upper layer signaling, and describes the System Architecture Evolution (SAE) project. The book provides a detailed study of the extensive range of design and measurement techniques and tools that are available to help bring LTE from theory to deployment. It offers the latest information on RF and signaling conformance testing and concludes by looking toward 4G – LTE Advanced.

To order this book, visit:

www.agilent.com/find/ltebook
455 pages; \$100 • ISBN: 978-9-88179-351-5

ArtechHouse.com

Your Complete Source for RF & Microwave Design Know-How



Recent Release! **VLSI Circuits for Biomedical Applications**

Krzysztof Iniewski, *Editor*

Written by top-notch international experts in industry and academia, this groundbreaking 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 biosensing, body implants, biosensing interfaces, and molecular biology.

- Hardcover • 430 pp. • 2008 • ISBN: 978-1-59693-317-0
- Order Book No. MW083178 • \$139 £75



Bestseller **Foundations of Oscillator Circuit Design**

Guillermo Gonzalez

Offering broader coverage than other oscillator design books on the market, this comprehensive resource considers the complete frequency range, from low-frequency audio oscillators to more complex oscillators found at the RF and microwave frequencies. Packed with over 1,200 equations,

the book gives you a thorough understanding of the principles and practice of oscillator circuit design and emphasizes the use of time-saving CAD simulation techniques.

- Hardcover • 500 pp. • 2007 • ISBN: 1-59693-162-0
- Order Book No. MW081628 • \$139 £84



Designing Bipolar Transistor Radio Frequency Integrated Circuits

Allen A. Sweet

If you're looking for an in-depth and up-to-date understanding bipolar transistor RFIC design, this practical resource is a smart choice. Unlike most books on the market that focus on GaAs MESFET or silicon CMOS process technology, this unique volume is dedicated exclusively to RFIC

designs based on bipolar technology. Until now, critical GaAs HBT and SiGe HBT process technologies have been largely neglected in reference books. Finally, this book offers a detailed treatment of this increasingly important topic.

- Hardcover • 334 pp. • 2008 • ISBN: 978-1-59693-128-2
- Order Book No. MW071288 • \$119/£66



CMOS RFIC Design Principles

Robert Caverly

Turn to this practical resource for comprehensive, expert guidance on designing CMOS RF integrated circuits. You get complete design details on elemental and advanced CMOS RF circuits, from low noise amplifiers, general gain amplifiers, mixers, and oscillators, to voltage controlled oscillators, phase lock loops, frequency synthesizers, and power amplifier architectures. The book discusses ideal circuit topologies and then looks at non-ideal CMOS circuit elements to provide insight into circuit modifications needed to achieve design specifications.

- Hardcover • 456 pp. • 2007 • ISBN: 978-1-59693-132-9
- Order Book No. MW081328 • \$129 £72

Find complete book descriptions and order at the Artech House Online Bookstore www.artechhouse.com

- Special discounts on forthcoming titles • Secure ordering with email confirmation • "Special Offers" page with great ways to save
- Sample chapters and demonstration software • Ability to check status of your order • In-stock orders ship within 24 hours

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.**

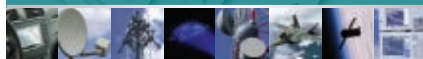
Also available from major online retailers and at fine bookstores where professional-level high-tech books are sold.



ARTECH HOUSE BOSTON | LONDON

685 Canton Street, Norwood, MA 02062 USA
46 Gillingham Street, London, SW1V 1AH, UK

Hittite Microwave Corporation is a manufacturer of analog/digital microwave integrated circuit components for Broadband, Cellular & Microwave applications.



Application Engineer

Responsible for providing engineering support directly to customers & sales engineers out in the field. This position requires a degreed engineer with design & test experience of the entire RF/microwave signal chain. You will be applying RF theory, simulation tools & empirical data to support customer design work, problem diagnosis, & solutions identification. This position requires someone who can readily learn new technologies & help our customers apply them. Requires MSC/BSC (EE or Applied Physics) & 3 years direct experience with RF hardware implementation & customer support.

Business Development Manager Military & Space Programs

Generate new business opportunities for military & satellite programs with major defense contractors and R & D contracts from Government research agencies. Develop advanced circuit design solutions in response to customer solicitations. Generate technical, cost & management proposals. Conduct marketing initiatives & lead cross-functional program teams. BSEE/MSEE or equivalent experience. Experience in R&D & production of advanced Microwave & Millimeterwave circuits & sub-systems. 5 to 10 years business development experience. Active security clearance preferred.

Sales Engineer

Position requires knowledge of RF technology & the ability to develop & maintain relationships with a customer's RF design, management, & purchasing organizations. The Sales engineer will have responsibility for winning new design-ins & maintaining customer contacts. BSEE is required & relevant sales and/or technical experience in the Microwave Components industry. Military, Space, Industrial and/or Automotive experience are desirable.

We offer competitive salary and excellent benefits.

U. S. Citizenship or Permanent Residency Required.
Please e-mail your resume to hmcexec@hittite.com
No faxes or phone calls, please.

www.hittite.com



Hiring RF Engineers: Matching Personality and Organization

Whether you are hiring or looking to be hired, a resume is an inevitable introductory step. For us RF engineers, a typical resume is very much like a technical spec sheet, detailing the diverse range of skill-sets to include every achievement, course and technology.

Yet, one aspect is often ignored—the human perspective.

Microwave engineers typically seek to satisfy more than one goal when making a career decision. They also tend to get bored if the job is not challenging enough or if the professional challenges turn out not to be within their line of interest. Workplace environment is a factor affecting the success of the match because it relates to personal likes and dislikes. Successful placement will therefore have the engineer placed in a position where he or she is most comfortable, creative and passionate about their job.

Many hiring managers include and highlight the workplace environment among other benefits in published job descriptions. They know that this increases the value of their proposition. These recruiters have already realized what people look for in a workplace beyond compensation and technology. In a similar way, the manager reading through piles of resumes is looking for the person behind the skills.

The words of wisdom in the article below highlight these important and often overlooked aspects when writing your resume. These observations really boil down to the basic things people look for in a workplace, in colleagues and employees. This is definitely something to think about when writing your resume or reading someone else's.

Isaac Mendelson
ElectroMagneticCareers.com
Isaac@ElectroMagneticCareers.com

The Boring Resume: Who Are YOU

Our DC to Light crowd is undoubtedly made up of great engineers, technologists and researchers, but to sift through these resumes is like read-

CAREER CORNER

ing one technical paper after another. Don't get me wrong—you will be hired for your technical skills and your ability to produce for the company.

The resumes I see just bore me to death and I know why. You have all read books on "How to Write an Effective Resume" written by an unemployed person.

Rules of Thumb:

1. Put yourself in the position of the person that may want to hire you. Imagine trying to cram 13 years of experience on to one page. That cannot work!

2. Write as many pages as you think the hiring manager will be interested in for the position.

3. Show that you are versatile and can multitask, which will be an asset to the department and company.

4. List your goals so the company will know what you want.

Who You Are:

With my almost 40 years of recruiting primarily in the RF/microwave/defense fields, I have found that people who are interesting get hired first even if they have less experience.

When I interview a candidate I also interview the spouse (if they have one) and the children. I look for the family's goals and interests (hobbies) to insure that the hiring company is right for them including location.

For example, a small paragraph at the end of the resume stating:

My outside interests are running, white water rafting, volcano hiking, fishing (salt water), golf, hiking and reading.

I am married to Mary who is a volunteer for the Red Cross, and has a part-time business teaching people basic computer skills.

We have two children, Jack who plays soccer and swims on the school team, and Jenny, who is a violinist and plays field hockey. Both children are on the dean's list.

With this, you have given to the company your personality and a better reason to hire "A PERSON". All this extra shows WHO YOU ARE beyond a spec-sheet of skills.

David Germond
Cleared Executive Search
dave@clearedsearch.com
(813) 425-3100

CustomerMedix

The complete solution for moving beyond survival to success

Attention MTT-S Exhibitors

Why wait...start with a focus group!

Your customers will be at the show.
We're just a five-minute walk away

Survival

[ser-vahy-vuhl]

noun; The act or fact of surviving, esp. under adverse or unusual circumstances.

"If your company went out of business tomorrow, who would really miss you and why?" –Jim Collins

Your company would be missed because it provides a product or service so unique that it can't be provided nearly as well by any other company. YOU have forged a connection with YOUR customers that other companies can't replicate. Do you know what it is that makes YOU unique and keeps your customer coming back?

The CustomerMedix Process

- Connect with your customers
- Refine / enhance your services
- Retain your customers
- Attract new customers
- Grow your business (even in adverse times)

The key to an effective survival program is to learn from your existing customer base. Bennett consultants will work with you to develop a survey strategy that targets the exact information you need to succeed. Depending on the issues at hand, proven techniques may include:

- Analyzing your customer database for hidden trends to identify opportunities
- Focus Groups
- Telephone, Web, or In-Person Surveys
- Implementing a customer feedback mechanism

Business Survival Packages Starting as Low as \$999

Visit <http://mwj.hotims.com/23284-18> or use RS# 18 at www.mwjjournal.com/info



World Trade Center East • Two Seaport Lane Boston MA, 02210
617-746-2600 • survival@bernett.com • www.bernett.com

RS No.	ADVERTISER	PAGE No.	PHONE	FAX	WEB ADDRESS
1	Advanced Control Components Inc.	79	732-460-0212	732-460-0214	http://mwj.hotims.com/23284-1
2	Advanced Switch Technology.....	137	613-384-3939	613-384-5026	http://mwj.hotims.com/23284-2
3	Aeroflex / Inmet, Inc.	36	734-426-5553	734-426-5557	http://mwj.hotims.com/23284-3
4	Aeroflex / Metelics, Inc.	33	888-641-7364	408-733-7645	http://mwj.hotims.com/23284-4
5	Aeroflex Plainview	111	800-645-8862		http://mwj.hotims.com/23284-5
6	Aethercomm	63	760-598-4340	760-598-4342	http://mwj.hotims.com/23284-6
7,8	Agilent Technologies, Inc.	13,103	800-829-4444	415-857-5518	http://mwj.hotims.com/23284-7
9	American Microwave Corporation.....	80	301-662-4700	301-662-4938	http://mwj.hotims.com/23284-9
10	AML Communications Inc.	39	805-388-1345	805-484-2191	http://mwj.hotims.com/23284-10
11	Anaren Microwave.....	71	800-411-6596	315-432-9121	http://mwj.hotims.com/23284-11
12	Anatech Electronics, Inc.	112	973-772-4242	973-772-4646	http://mwj.hotims.com/23284-12
13	Ansoft Corporation	29	412-261-3200	412-471-9427	http://mwj.hotims.com/23284-13
14	AR RF/Microwave Instrumentation	97	215-723-8181		http://mwj.hotims.com/23284-14
15	Artech House	139	800-225-9977	781-769-6334	http://mwj.hotims.com/23284-15
16	AWR	53	310-726-3000		http://mwj.hotims.com/23284-16
17	B&Z Technologies, LLC	31	631-444-8827	631-444-8825	http://mwj.hotims.com/23284-17
18	Bernett Research	141	617-746-2600		http://mwj.hotims.com/23284-18
19	Bonding Source	35	603-595-9600		http://mwj.hotims.com/23284-19
20	Ciao Wireless, Inc.....	42	805-389-3224	805-389-3629	http://mwj.hotims.com/23284-20
21,22	Cobham Defense Electronic Systems ..	11,20-21	215-996-2000		http://mwj.hotims.com/23284-21
23	Compex Corporation.....	104	856-335-2277	856-335-7223	http://mwj.hotims.com/23284-23
24	CPI Beverly Microwave Division.....	75	978-922-6000	978-922-2736	http://mwj.hotims.com/23284-24
25	Crystek Corporation	34	800-237-3061		http://mwj.hotims.com/23284-25
26	CST of America, Inc.....	25	508-665-4400	781-576-5702	http://mwj.hotims.com/23284-26
27	CTT Inc.....	57	408-541-0596	408-541-0794	http://mwj.hotims.com/23284-27
28,29	Ducommun Technologies	64,84	310-513-7214	310-513-7298	http://mwj.hotims.com/23284-28
30	Eastern Wireless TeleComm, Inc.	91	410-749-3800	410-749-4852	http://mwj.hotims.com/23284-30
31	ET Industries	105	973-394-1719	973-394-1710	http://mwj.hotims.com/23284-31
32	EuMW 2009	127	+ 44 20 7596 8742	+ 44 20 7596 8749	http://mwj.hotims.com/23284-32
33	GGB Industries, Inc.	3	239-643-4400	239-643-4403	http://mwj.hotims.com/23284-33
34	Greenray Industries, Inc.	52	717-766-0223	717-790-9509	http://mwj.hotims.com/23284-34
35	Herotek, Inc.....	100	408-941-8399	408-941-8388	http://mwj.hotims.com/23284-35
36,37,38,39,40	Hittite Microwave Corporation	66,67,68,69,140	978-250-3343	978-250-3373	http://mwj.hotims.com/23284-36
41	Holzworth Instrumentation	74	303-325-3473		http://mwj.hotims.com/23284-41
42	Huber + Suhner AG.....	73	+41 71 353 41 11	+41 71 353 44 44	http://mwj.hotims.com/23284-42
	IEEE Comcas 2009.....	119			www.comcas.org
	IEEE MTT-S International Microwave Symposium	131			www.ims2009.org
43	ITT Microwave Systems.....	44	978-441-0200		http://mwj.hotims.com/23284-43
44	IZT GmbH.....	118	+49(0) 9131 4800-181	+49(0) 9131 4800-190	http://mwj.hotims.com/23284-44
45	JQL Electronics Inc.....	98	888-236-9828	630-823-2902	http://mwj.hotims.com/23284-45
46	K&L Microwave, Inc.....	7	410-749-2424	443-260-2268	http://mwj.hotims.com/23284-46
47	KR Electronics, Inc.	137	732-636-1900	732-636-1982	http://mwj.hotims.com/23284-47
48	Linear Technology Corporation.....	15	800-454-6327		http://mwj.hotims.com/23284-48
49	Lorch Microwave.....	45	800-780-2169	410-860-1949	http://mwj.hotims.com/23284-49
50,51	M/A-COM Technology Solutions	18,19	800-366-2266		http://mwj.hotims.com/23284-50
52	Massachusetts Bay Technologies, Inc.....	61	781-344-8809	781-341-8177	http://mwj.hotims.com/23284-52
53	MECA Electronics, Inc.....	COV 2	973-625-0661	973-625-9277	http://mwj.hotims.com/23284-53
54	Microlab/FXR, (a Wireless Telecom Group Company).....	9	973-386-9696	973-992-0513	http://mwj.hotims.com/23284-54
55	Microsemi	110	541-382-8028		http://mwj.hotims.com/23284-55
56	Microwave Filter Company, Inc.	116	800-448-1666	315-463-1467	http://mwj.hotims.com/23284-56
	Microwave Journal.....	126,135,137,145	800-225-9977	781-769-5037	www.mwjjournal.com
57	Microwave Solutions, Inc.	108	619-474-7500	619-474-4600	http://mwj.hotims.com/23284-57
58	MIE 2009.....	133	86-755-83655339	86-755-83629073	http://mwj.hotims.com/23284-58
59	Milmega Limited.....	109	+44 (0) 1983 618004	+44 (0) 1983 811521	http://mwj.hotims.com/23284-59
60	Mimix Broadband, Inc.	COV 3	281-988-4600	281-988-4615	http://mwj.hotims.com/23284-60
61,62,63,64, 65,66,67,68, 69,70,71, 72,73	Mini-Circuits.....	4-5,16,27,49, 50,59,77,95, 101,113,121, 129,143	718-934-4500	718-332-4661	http://mwj.hotims.com/23284-61
74,75,76	MITEQ Inc.....	37,87,123	631-436-7400	631-436-7430	http://mwj.hotims.com/23284-74
77,78	Modco, Inc.....	137	775-331-2442	775-331-6266	http://mwj.hotims.com/23284-77
79	Morion, Inc.	122	+7 812 350 75 72	+7 812 350 72 90	http://mwj.hotims.com/23284-79
80,81	Narda Microwave-East, an L3 Communications Co.	8,32	631-231-1700	631-231-1711	http://mwj.hotims.com/23284-80
82	Nexyn Corporation	92	408-982-9339	408-982-9275	http://mwj.hotims.com/23284-82
83	OEwaves	83	626-449-5000		http://mwj.hotims.com/23284-83
84	OML Inc.....	107	408-779-2698	408-778-0491	http://mwj.hotims.com/23284-84
85	Pascall Electronics Limited.....	48	+44(0) 1983 817300	+44(0) 1983 564708	http://mwj.hotims.com/23284-85
	QuinStar Technology, Inc.....	99	310-320-1111	310-320-9968	www.quinstar.com
86,87	R&K Company Limited.....	136	+81-545-31-2600	+81-545-31-1600	http://mwj.hotims.com/23284-86
88	Reactel, Incorporated.....	46	301-519-3660	301-519-2447	http://mwj.hotims.com/23284-88



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!



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



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/23284-73> or use RS# 73 at www.mwjjournal.com/info

RS No.	ADVERTISER	PAGE No.	PHONE	FAX	WEB ADDRESS
89	RF Connectors, Division of RF Industries.....	118	800-233-1728	858-549-6340	http://mwj.hotims.com/23284-89
90	RF TEC Mfg., Inc.	137	770-487-2187	770-486-9499	http://mwj.hotims.com/23284-90
91	RFcore Co., Ltd.....	134	82 31 708 7575	82 31 708 7596	http://mwj.hotims.com/23284-91
92,93	RFHIC.....	88,90	82-31-250-5011	82-31-250-5088	http://mwj.hotims.com/23284-92
94	RFMD.....	93	336-678-5570	336-931-7454	http://mwj.hotims.com/23284-94
95	RLC Electronics, Inc.....	23	914-241-1334	914-241-1753	http://mwj.hotims.com/23284-95
96	Rockwell Collins.....	26	319-295-3673		http://mwj.hotims.com/23284-96
97	Rosenberger.....	78	+49-8684-18-0	+49-8684-18-499	http://mwj.hotims.com/23284-97
98	Satellink, Inc.	137	972-487-1434	972-487-1204	http://mwj.hotims.com/23284-98
99	Sector Microwave Industries, Inc.....	137	631-242-2300	631-242-8158	http://mwj.hotims.com/23284-99
100	Seekon Microwave.....	82	0086-28-81705322	0086-28-81700845	http://mwj.hotims.com/23284-100
101	Sivers IMA AB.....	38	46 (0) 8 703 68 04	46-8-7519271	http://mwj.hotims.com/23284-101
102	Spacek Labs Inc.....	30	805-564-4404	805-966-3249	http://mwj.hotims.com/23284-102
103	Special Hermetic Products, Inc.....	137	603-654-2002	603-654-2533	http://mwj.hotims.com/23284-103
104	Spectrum Elektrotechnik GmbH.....	85	+49-89-3548-040	+49-89-3548-0490	http://mwj.hotims.com/23284-104
105	Spinnaker Microwave, Inc.	76	408-732-9828	408-732-9793	http://mwj.hotims.com/23284-105
106,107	Synergy Microwave Corporation.....	55,117	973-881-8800	973-881-8361	http://mwj.hotims.com/23284-106
108	Tecdia, Inc.....	102	408-748-0100	408-748-0111	http://mwj.hotims.com/23284-108
109	Tektronix, Inc.....	58	800-426-2200		http://mwj.hotims.com/23284-109
110	Teledyne Cougar.....	89	408-522-3838	408-522-3839	http://mwj.hotims.com/23284-110
111	TriQuint Semiconductor, Inc.	40-41	503-615-9000	503-615-8900	http://mwj.hotims.com/23284-111
112	Universal Microwave Components Corporation.....	94	703-642-6332	703-642-2568	http://mwj.hotims.com/23284-112
113	Valpey Fisher Corporation.....	81	800-982-5737		http://mwj.hotims.com/23284-113
114	Vectron International.....	6	1-88-VECTRON-1	888-FAX-VECTRON	http://mwj.hotims.com/23284-114
115	Weinschel Associates.....	112	877-948-8342	301-963-8640	http://mwj.hotims.com/23284-115
116	Wenzel Associates, Inc.	28	512-835-2038	512-719-4086	http://mwj.hotims.com/23284-116
117	Werlatone, Inc.	COV 4	845-279-6187	845-279-7404	http://mwj.hotims.com/23284-117
118,119	Win Semiconductors Corp.....	65,115	310-530-8485	310-530-8499	http://mwj.hotims.com/23284-118

Visit Microwave Journal on the Web at **www.mwjjournal.com**

Visit mwjjournal.com/info and enter RS# to request information from our advertisers



May 2009
Issue

The History of IMS in Boston

Attending IMS 2009

Insider's Guide to Boston

Sales Representatives



microwave journal

CARL SHEFFRES, PUBLISHER

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
Katsuhiko 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

ED KIESSLING, TRAFFIC MANAGER

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

FREE **Product Information**

Now Available Online
at

Info Zone

The new Web-based reader service system
from



Just visit

mwjournal.com/info

and enter the RS number from
the ad or editorial item

or

request information by company
name or product category

It's Easy

It's Fast

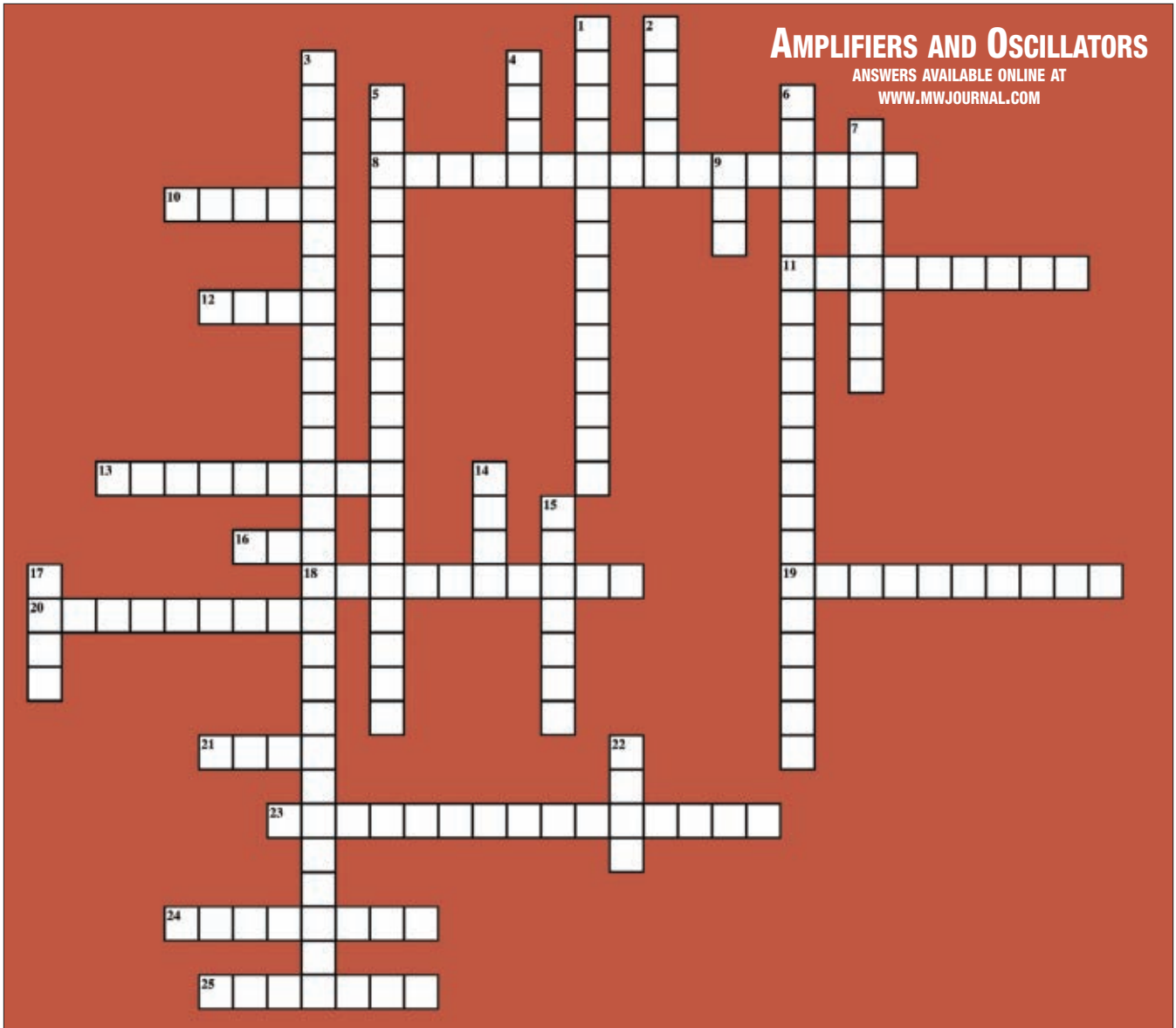
It's FREE



GET IN THE ZONE!



AMPLIFIERS AND OSCILLATORS

ANSWERS AVAILABLE ONLINE AT
WWW.MWJOURNAL.COM

ACROSS

- 8** The amount of electrical power converted to heat by a device (2 words)
10 Pseudo-morphic high electron mobility transistor
11 A circuit or device whose output signal is a faithful version of the input signal but with increased amplitude
12 The terminal of a field effect transistor that controls the resistance of the channel through the application of an electric field
13 The state of operation of a device or circuit in which there is no increase in output for an increase in input
16 Phase-locked loop
18 A measure of the random phase instability of a signal (2 words)
19 A circuit that produces an alternating current signal
20 The region of a bipolar transistor into which current flows from the base of the transistor under the influence of reverse bias across the two regions
21 Complementary metal oxide semiconductor

23 The change in frequency of the oscillator after it has been driven to and attained a new frequency and after the tuning voltage has reached a stable state (3 words)

24 Undesired signals present at the output of a device under test that are neither harmonics nor intermodulation products

25 The failure mode in a device that is induced by excessive power dissipation in the device

DOWN

- 1** Wideband gap material being used to produce very high power amplifiers (2 words)
2 Laterally diffused metal oxide semiconductor
3 The digital implementation of the predistorter and presence of a feedback loop adapting to the changes in the response of the PA due to varying operating conditions (3 words)
4 Adjacent channel leakage ratio
5 The modification of the magnitude of a higher, constant frequency carrier signal controlled by the amplitude and phase of a lower frequency baseband or audio signal (2 words)

6 A feedback system that changes the gain of an amplifier or the attenuation of an attenuator in response to variations in magnitude of the input signal, thereby maintaining the output signal of the system (3 words)

7 The process of varying the impedance seen by the output of an amplifier to other than 50 ohms in order to measure performance parameters (2 words)

9 Peak to average power ratio

14 The ratio between the amplitude of the output signal of a device or circuit compared to the amplitude of the input signal

15 The layer of a bipolar transistor through which all current flows and from which majority carriers are injected into the base of the transistor

17 Oven-controlled crystal oscillator

22 The reduction in gain of an amplifier by 1 dB that results from saturation as a consequence of increased input signal magnitude



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 P1 dB (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)	XPI035-QH	5.9-9.5	26.0	+/-1.0	+29.0	+39.0	500 @ 6.0	4x4
Power Amplifier (QFN)	XPI050-QJ	7.0-9.0	15.0	+/-0.5	+34.5 Psat	+48.0	1.2 A @ 8.0	6x6
Power Amplifier (QFN)	XPI042-QT	12.0-16.0	21.0	+/-1.0	+25.0	+38.0	500 @ 5.0	3x3
Power Amplifier (QFN)	XPI043-QH	12.0-16.0	21.5	+/-1.0	+30.0	+41.0	700 @ 7.0	4x4
Power Amplifier	XPI057-BD	13.5-16.0	17.0	+/-1.0	+39.0	+48.0	3.7 A @ 7.5	DIE
Power Amplifier	XPI058-BD	14.5-16.0	27.0	+/-1.0	+36.0	+44.0	2.2 A @ 8.0	DIE
Power Amplifier	XPI072-BD	34.0-37.0	22.0	+/-2.0	+35.0 Psat	-	2.4 A @ 5.5	DIE
Power Amplifier	XPI073-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/23284-60> or
use RS# 60 at www.mwjjournal.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

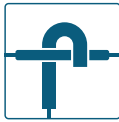


WERLATONE

Breaking
all the
Rules



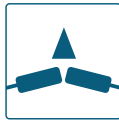
QUADRATURES



COUPLERS



DIVIDERS



COMBINERS



HIGH POWER 180° HYBRIDS

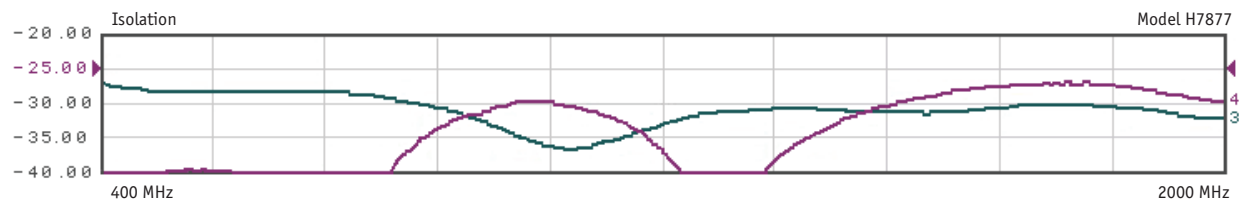
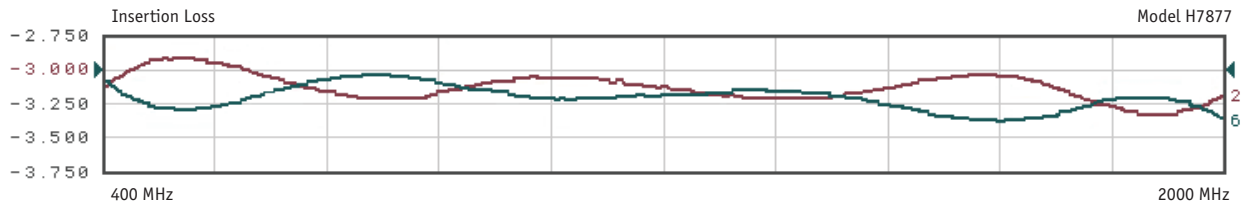
Multi-Octave Performance

Our Standard Line of 180° Hybrids features multi-octave performance.
Transmission line techniques guarantee low loss for both the sum and difference ports, while providing exceptional isolation.

Our Patented Stripline 180° Hybrids exhibit an incredible 5:1 Bandwidth!!
Disruptive Microwave Techniques and Advanced Stripline Designs provide high power performance with incredible isolation.



HYBRIDS



Model	Frequency (MHz)	Power (Watts)	Insertion Loss (dB)	VSWR	Isolation (dB)	Size (Inches)
H6287	0.1-50	500	0.5	1.30:1	30	9 x 8 x 3.6
H6152	0.2-35	50	0.4	1.30:1	20	2.5 X 1.5 X 1.12
H1484	2-32	500	0.2	1.30:1	25	5 X 3 X 2
H6751	20-512	50	0.8	1.40:1	25	4 X 1.6 X 0.8
H7450	100-500	200	1.0	1.35:1	20	6 X 5 X 2.25
H7733*	100-500	2000	0.2	1.30:1	20	15 X 10 X 2
H3670	200-400	400	0.2	1.40:1	20	5 X 3 X 2.25
H7498*	200-1000	750	0.3	1.30:1	20	8.5 X 5 X 1.5
H7877*	400-2000	300	0.35	1.25:1	20	4.5 X 2.5 X 1.2
H7492*	500-2500	200	0.4	1.30:1	20	4 X 2.2 X 0.85

Visit <http://mwj.hotims.com/23284-117> or use RS# 117 at www.mwjjournal.com/info

*Utilizing Werlatone's Patented Stripline Design to achieve extremely low loss and high isolation!

www.werlatone.com