Vol. 57 • No. 5

May 2014

Microwave Journal®

.com

Tampa Bound in the Wake of 5G

MTT-S IMS Show Issue

MAXWELL'S MOJO

AESA

MASSIVE MIMO

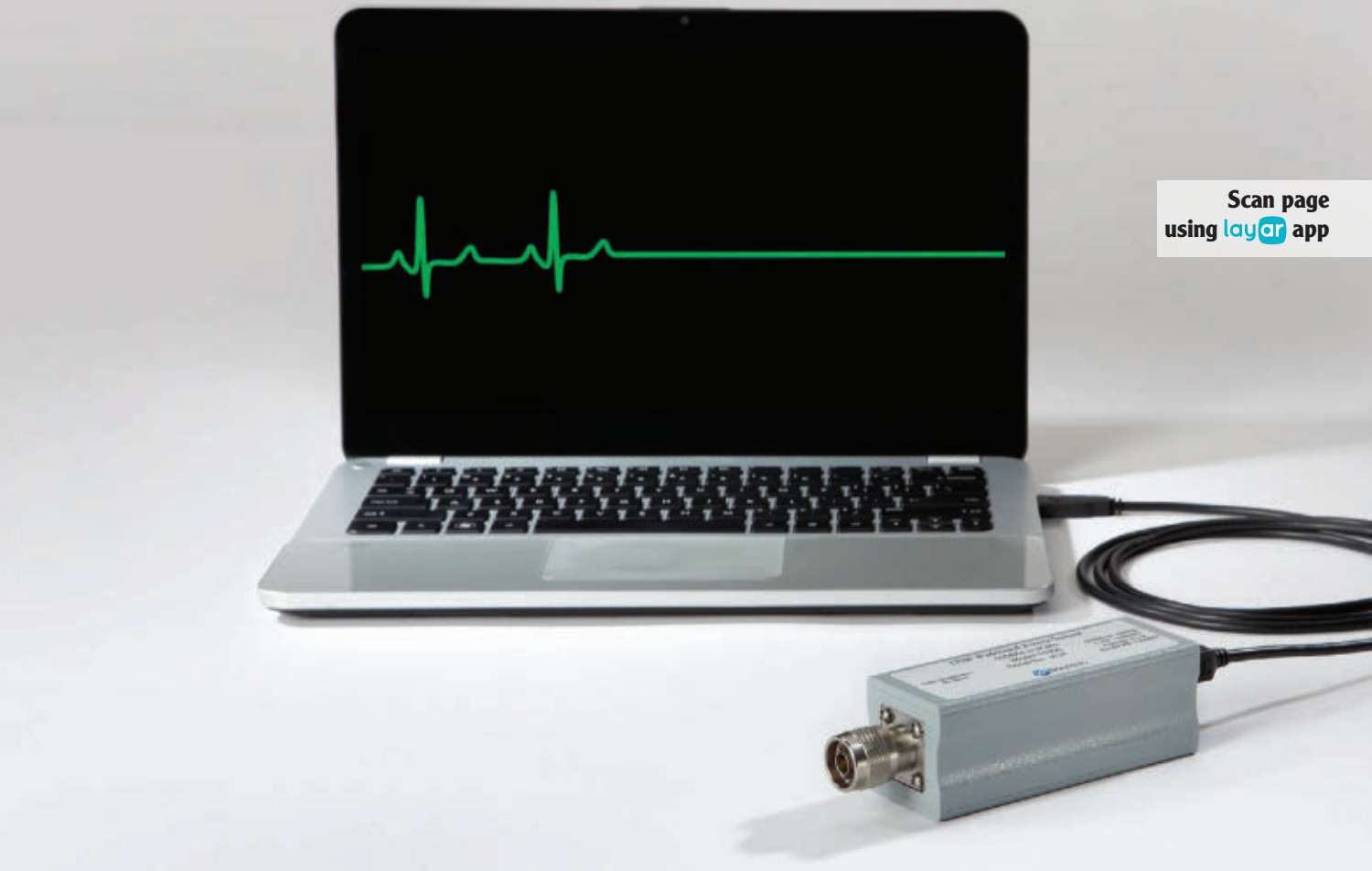
SILICON CORES

MILLIMETER WAVES

horizon house®

Founded in 1958

Missing a Pulse Can Be Deadly.



Scan page using layar app

The Smartest, Fastest and Only Real-Time USB Peak Power Sensor.

Capture every pulse with no missed glitches. The new **55 Series** delivers unsurpassed speed and accuracy for the most demanding RF power measurements thanks to Boonton's **Real-Time Power Processing™** technology. With this revolutionary technique, all processing steps take place in parallel, guaranteeing gap-free signal acquisition and reliable capture of all transients, dropouts or interference.

Taking Performance to a New Peak.

- Real-Time Power Processing™ for gap-free analysis
- 100 MSa/sec SUSTAINED sample rate is world's fastest
- 10 GSa/sec effective rate for superb waveform fidelity
- <5 ns risetime and 70+ MHz video bandwidth
- 100 ps time resolution for enhanced trigger stability
- Triggered acquisition speeds over 40,000 sweeps/sec
- Capture and analyze data more than 100x faster than conventional power sensors

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

Wireless Telecom Group
Boonton Microlab Noisecom

Boonton

See us at IMS Booth 808

Low Frequency Power Combiners
MECA introduces Low Frequency addition to the H-Series, 100-watt Wilkinson high power combiner/dividers. Available in 2 & 4-way configurations covering 5 to 500 MHz. VSWR of 1.30:1 accommodating load VSWR's of 2.0:1 or better! N and SMA connectors. Weatherproof IP 67 rated.

Low PIM Loads
MECA's Low PIM (-165 dBc Typ) Loads for DAS Applications feature industry leading PIM performance of -160 dBc Min all while handling full rated power to 85C. All of the terminations cover 0.698 – 2.700 GHz frequency bands in 7/16 DIN or Type N connectors as 30, 50, 100 & 150 watt rated. Ideal for IDAS / ODAS, In-Building, base station, wireless infrastructure, 4G and AWS. applications.

Low PIM Couplers
MECA's Low PIM (-160 dBc Typ) Directional Couplers for DAS Applications feature unique air-line construction that provides for the lowest possible insertion loss, high directivity and VSWR across the 0.800 - 2.500 GHz bands. Rated for 500 watts average power. Nominal coupling values of 15, 20, 30 & 40 dB.

Low PIM Reactive Splitters
MECA's Low PIM (-160dBc Typ) Reactive Splitters for DAS Applications, rugged construction and excellent performance across all wireless bands from 0.698 – 2.700 GHz make them ideal for in-building or tower top systems. Available 2-way and 3-way, 7/16 DIN and Type-N configurations. Rated for 500-700 watts (max).

BETTER BUILDINGS / BETTER PERFORMANCE

Dr. D.A.S. © Prescribes: MECA Low PIM Products & Equipments
For next generation DAS there is only only one name in passives.

It's simple. Better signals equal better performance. Today's buildings personify the need for next-level Distributed Antenna Systems (DAS). And the engineers that are building them turn to MECA for passive components. American ingenuity and 53 years of experience have resulted in the deepest, most reliable product line of ready-to-ship and quick-turn solutions, such as:

Power Dividers: Up to 16 way and 18 GHz
Attenuators: Up to 60dB and 500W
Terminations: Up to 500W
Couplers: Up to 40dB and 1kW
Integrated Rack Units: Delivered in 3-6 weeks

They come with an industry leading 3 year guarantee and true MECA pride. Ready to build a better DAS? Start with a visit to **www.e-MECA.com.**
"delivered on time every time!!"

Dr. D.A.S. © Prescribes...

Low PIM Adapters
MECA's Low PIM (-165 dBc Typ) Adapters for DAS Applications feature industry leading PIM performance of -160 dBc Min. Available in 7/16 DIN, Type N to SMA and 4.1/9.5 Mini-DIN connectors. Ideal for IDAS / ODAS, In-Building, base station, wireless infrastructure, 4G and AWS applications.

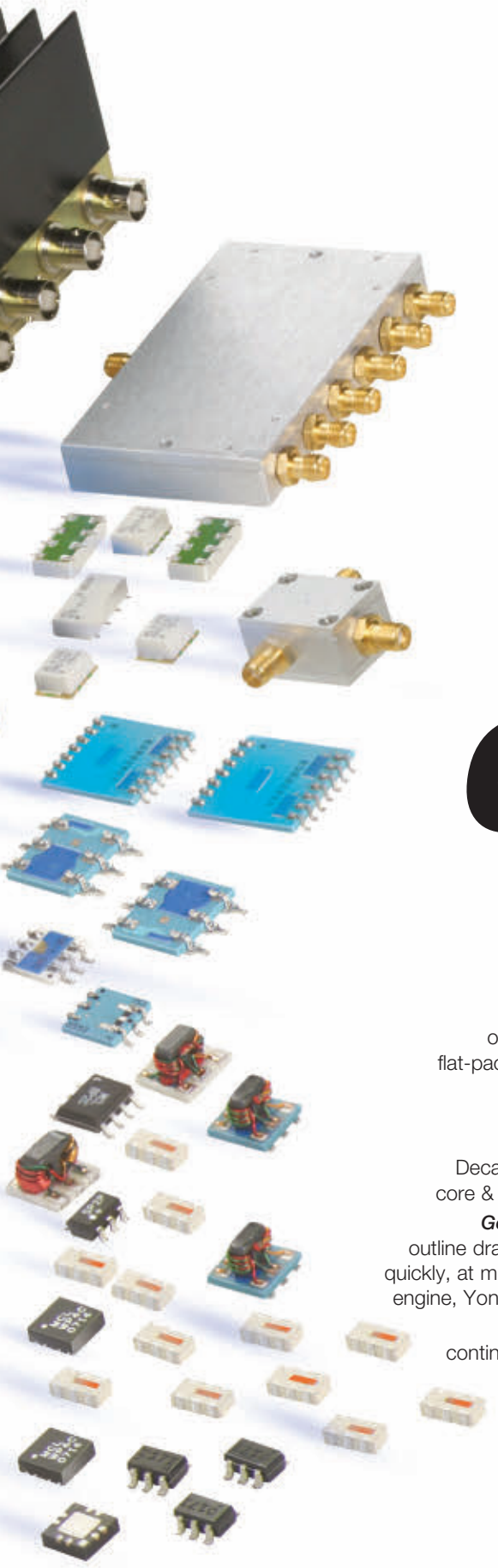
Low PIM Jumpers
MECA's Low PIM (-160 dBc Typ) Adapters for DAS Applications feature industry leading PIM performance of -155 dBc Min. Available in 7/16 DIN, Type N to SMA and 4.1/9.5 Mini-DIN connectors. Ideal for IDAS / ODAS, In-Building, base station, wireless infrastructure, 4G and AWS applications.

Integrated D.A.S. Equipment
Let MECA create an integrated assembly with any of our RF/Microwave products on 19" panels, shelves or NEMA enclosures.

See us at IMS Booth 842

iBwave
Look for the expanding lineup of MECA products in your iBwave library.

Microwave Electronic Components of America
The Professional's Choice for RF/Microwave Passive Components
459 E. Main St., Denville, NJ 07834
Tel: 973-625-0661 Fax: 973-625-9277 Sales@e-MECA.com



POWER SPLITTERS/ COMBINERS

NOW! *from* **2 kHz to 18 GHz** *as low as* **79¢**

The Industry's Largest Selection includes THOUSANDS of models, from 2 kHz to 18 GHz, at up to 300 watts power, in coaxial, flat-pack, surface-mount and rack-mount housings for 50 and 75 Ω systems.

From 2-way through 48-way designs, with 0°, 90°, or 180° phase configurations, Mini-Circuits power splitters/combiners offer outstanding performance for insertion loss, isolation, and VSWR. Decades of experience with multiple technologies make it all possible, from core & wire, microstrip, and stripline, to semiconductors and LTCC ceramics.

Get easy-to-find, detailed data and performance curves, S-parameters, outline drawings, PCB layouts, and everything else you need to make a decision quickly, at minicircuits.com. Just enter your requirements, and our patented search engine, Yoni2, searches *actual test data* to find the models that meet your needs.

All Mini-Circuits catalog models are in stock, continuously replenished, and backed by our 1-year guarantee. We even list *current stock quantities and real-time availability*, as well as pricing, to help our customers plan ahead and make quick decisions. So why wait? Take a look at minicircuits.com today!

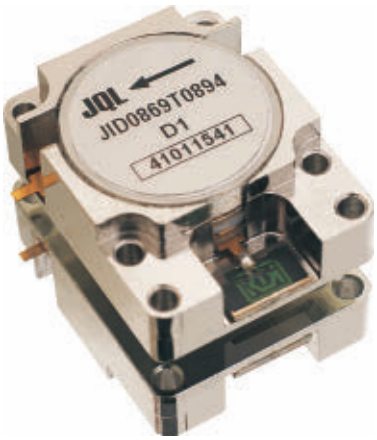
RoHS Compliant
Product availability is listed on our website.

Mini-Circuits®

www.minicircuits.com P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com
See us at IMS Booth 823

448 rev N

Technology On the Move™



Drop-in Isolators

Cavity Filters

Surface Mount Circulators

Waveguide Isolators

Power Combiners

Coaxial Circulators

See us at IMS Booth 212

JQL

Tel:1(888)236-9828(US&Canada)
1(630)930-9917(Worldwide)
www.jqlelectronics.com sales@jqlelectronics.com

Available from Stock for Quick Delivery

Tunable Filters from Stock

Same-Day Shipping Available
Factory-Direct Pricing
Bandpass and Bandreject
Stock Filter List at:
www.klmicrowave.com/tunable.php

Other Options
Additional Frequency Ranges
Custom Bandwidth
Digitally Controlled

Microwave Products Group
A DOVER COMPANY

BSC FILTERS • DOW-KEY MICROWAVE • K&L MICROWAVE • POLE/ZERO

mpg K&L MICROWAVE
A DOVER COMPANY

www.klmicrowave.com
www.klfilterwizard.com
Phone: 410-749-2424
Email: sales@klmicrowave.com

See us at IMS Booth 1404

New Wave in Noise

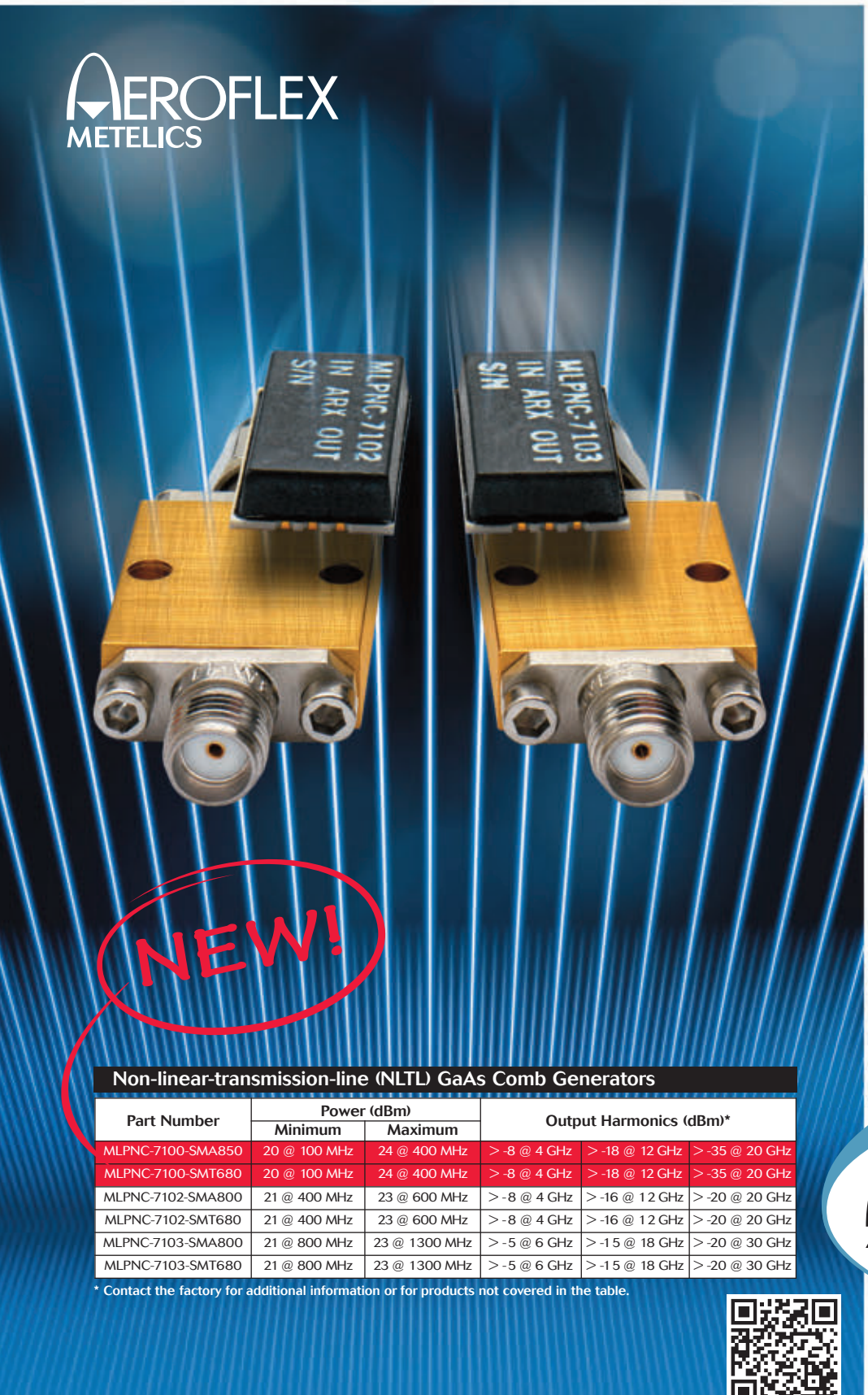
NoiseWave

your supplier of high performance, precise equipment for AWGN

NOISEWAVE
The new wave in NOISE

Ph. (973) 386-1119 • Fax (973) 386-1131 • info@noisewave.com • www.noisewave.com

Control the comb.
Control the clarity.



The sensitivity and the distance you've been striving for from your radar or surveillance receiver is now within reach. New GaAs comb generators from Aeroflex / Metelics are a best-in-class, non-linear-transmission-line (NLTL) innovation that provides 10 to 18 dB lower phase noise for better sensitivity than Si step recovery diode (SRD) comb generators. Offering phase noise as low as -135 dBc/Hz at 100 Hz offset from the 12 GHz harmonic, the MLPNC series creates clean, low conversion loss harmonics to 30 GHz over variable input frequencies from 400 to 1300 MHz. Their variable input power from 21 to 23 dBm make them easy to drive and operate. They provide ultimate system design flexibility and the opportunity to simplify your system architecture.

Visit our website or call **888-641-7364**.

www.aeroflex.com/metelicscomb

See us at IMS Booth 1623

Non-linear-transmission-line (NLTL) GaAs Comb Generators

Part Number	Power (dBm)		Output Harmonics (dBm)*		
	Minimum	Maximum			
MLPNC-7100-SMA850	20 @ 100 MHz	24 @ 400 MHz	> -8 @ 4 GHz	> -18 @ 12 GHz	> -35 @ 20 GHz
MLPNC-7100-SMT680	20 @ 100 MHz	24 @ 400 MHz	> -8 @ 4 GHz	> -18 @ 12 GHz	> -35 @ 20 GHz
MLPNC-7102-SMA800	21 @ 400 MHz	23 @ 600 MHz	> -8 @ 4 GHz	> -16 @ 12 GHz	> -20 @ 20 GHz
MLPNC-7102-SMT680	21 @ 400 MHz	23 @ 600 MHz	> -8 @ 4 GHz	> -16 @ 12 GHz	> -20 @ 20 GHz
MLPNC-7103-SMA800	21 @ 800 MHz	23 @ 1300 MHz	> -5 @ 6 GHz	> -15 @ 18 GHz	> -20 @ 30 GHz
MLPNC-7103-SMT680	21 @ 800 MHz	23 @ 1300 MHz	> -5 @ 6 GHz	> -15 @ 18 GHz	> -20 @ 30 GHz

* Contact the factory for additional information or for products not covered in the table.

AEROFLEX
A passion for performance.

Microwave Journal

May 2014
Vol. 57 • No. 5
MTT-S IMS Show Issue
mwjournal.com

CONTENTS

Editor's Note

24 **Let the Sunshine In**
David Vye, Microwave Journal *Editor*

Cover Feature

26 **The Industry's Next Tipping Point**
David Corman, Anokiwave Inc.; Peter Moosbrugger, Ball Aerospace; and Gabriel Rebeiz, University of California

Special Reports

44 **The Path to 5G Runs Through China**
David Vye, Microwave Journal *Editor*

48 **IMS 2014 MicroApps Special Panel Session**
Path to 5G: Design and Test Challenges for the Future
Patrick Hindle, Microwave Journal *Technical Editor*

Departments

19 Mark Your Calendar
20 Coming Events
73 Defense News
77 International Report
81 Commercial Market
86 Around the Circuit
268 Book End
270 Ad Index
272 Sales Reps
274 STEM Works

IEEE MTT-S International Microwave Symposium & Exhibition

50 **Come Power the Waves with Us at IMS 2014**
Larry Dunleavy, IMS 2014 Chair; Tom Weller, IMS 2014 Vice-Chair

52 **RFIC 2014 Welcome Message**
Lawrence Kushner, RFIC 2014 General Chair; Bertan Bakkaloglu, TPC Co-Chair; Albert Wang, TPC Co-Chair

58 **Microwave Measurements for Emerging Technologies**
Mohamed Sayed, 83rd ARFTG General Chair

62 **WAMICON 2014 General Chair's Message**
Ray Pengelly, WAMICON 2014 General Chair

64 **Tune in to Social Media at IMS 2014**
Sherry Hess, AWR Corp.

66 **Tampa Bay Attractions**
Patrick Hindle, Microwave Journal *Technical Editor (and ex-Floridian)*

68 **MTT-Stories**

229 **IMS 2014 Exhibitor List**

232 **IMS 2014 Floorplan**

234 **IMS Product Showcase**

57 YEARS OF PUBLISHING EXCELLENCE

NATIONAL INSTRUMENTS

AWR A National Instruments Company

Scan page using layar app

© 2014 AWR Corporation. All rights reserved.

Ready to Use 3D Parts.

With Analyst ™ V11, we've done our homework so you don't have to. Simply pull from the ready-built 3D parts library of microwave connectors, coils, packages, antennas and more - or build your own via our user-configurable 3D PCells. Easy to create and even easier to use. 3D parts within your overall Microwave Office® design. Graduate to a higher level of design.

Grab a test copy at awrcorp.com/tryAWR.

Visit AWR at IMS2014 - Booth #633

Microwave Journal

CONTENTS

Technical Features

94 **Toward 5G: What's Changing and How to Address Design and Test Challenges?**
Jan Whitacre, Agilent Technologies Inc.

104 **A Low Phase Noise Octave-Band Synthesizer Using an X-Band Frequency Reference**
Sergey Beltchicov, Andrey Dzisiak and Igor Guletskiy, ELVIRA Production Co. Ltd.

114 **Device Technology and VNA Architecture for Broadband Device Characterization**
Steve Reyes, Anritsu Co.

124 **GaN-on-Diamond: The Next GaN**
Felix Ejeckam, Daniel Francis, Firooz Faili, Frank Lowe, Jon J. Wilman, Tim Mollart, Joe Dodson, Daniel J. Twitchen and Bruce Bolliger, Element Six Technologies; Dubravko Babić, University of Zagreb

140 **Algorithm Development Platform for Dual-Band Digital Pre-Distortion**
Shahin Gheitanchi[1], Christophe Quindroit[2], Patrick Roblin[2], Naveen Naraharisetti[2], Volker Mauer[1] and Mike Fitton[1], Altera Corp.[1] and the Ohio State University[2]

150 **Triple-Mode Filter Using a Spherical Dielectric Resonator and Coupling Structures**
Nam-Shin Park, Don-Yong Lee, Byung-Chul Kim, Jung-Hee Won, In-Ho Na, Geon-Ho Jang, Young-Ho Cho, Xu-Guang Wang and Sang-Won Yun, Sogang University

172 **Ultra-Wideband Double Balanced Mixer Utilizing a Compact Planar Balun**
Yongzhen Gao, ZongXin Tang, Biao Zhang and YunQiu Wu, University of Electronic Science and Technology of China

182 **Design of a Compact Wideband Bandstop Filter with Three Transmission Zeros**
Ting Lang, Lin Li, Li-Li Yang and Zhi-Hao Zhang, Zhejiang Sci-Tech University

Application Notes

194 **TDR, Meeting Specifications Versus Good Transmission Line Performance**
Gordon Vinther, Ardent Concepts Inc.

200 **ZigBee RF Power Measurements in the Field**
Boris Aleiner, Petra Solar

AUGMENTED REALITY: HOW IT WORKS

Refer to page 270 for this month's participants

STEP 1

Download the free Layar app from the iTunes (iOS) or Google Play (Android) store.

STEP 2

Launch the app to view enhanced content on any page with the layar logo.

STEP 3

Frame the entire page in the screen and tap to experience enhancements (tap screen again for full screen view).

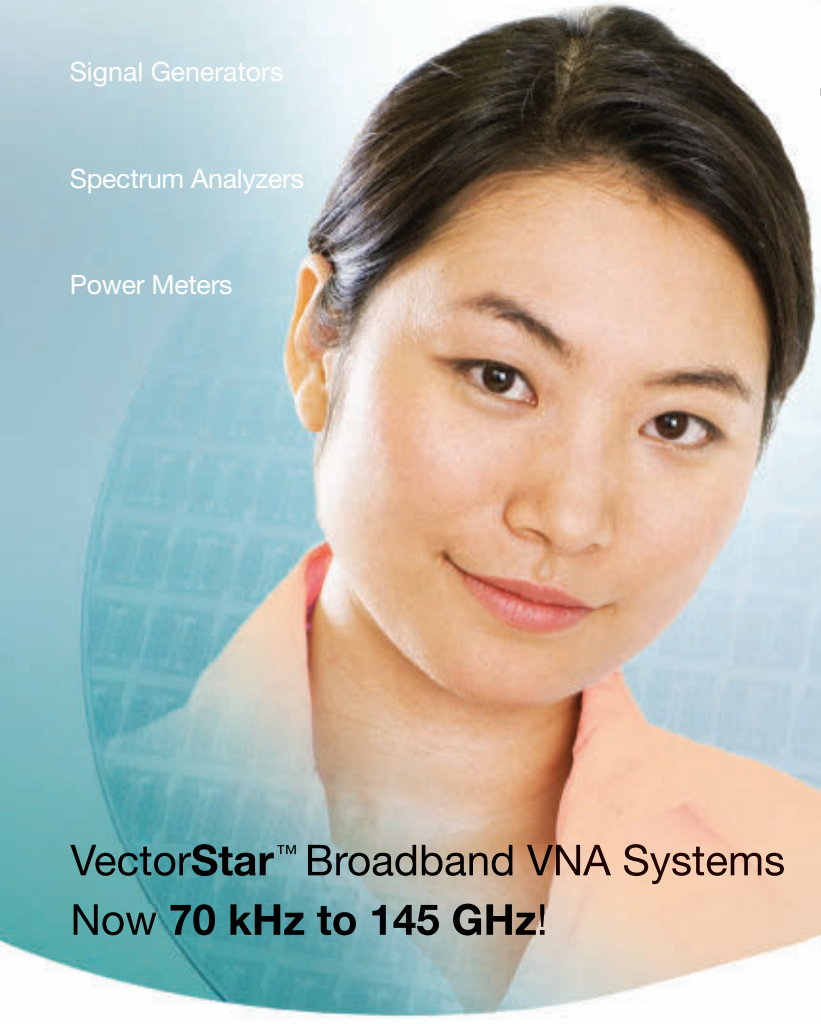
▶ Network Analyzers

Signal Generators

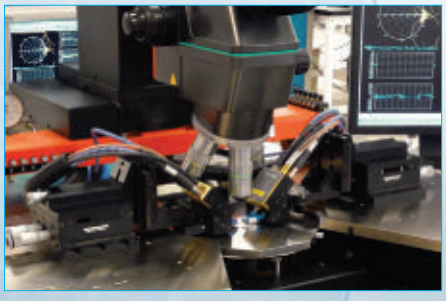
Spectrum Analyzers

Power Meters

Anritsu | Since 1895



The answer to your high-stability broadband on-wafer device characterization needs.



Frequency extension modules connect directly to wafer probes

VectorStar™ Broadband VNA Systems Now **70 kHz to 145 GHz**!

Don't let expired calibrations spoil your data.

Anritsu delivers 109 dB dynamic range at 110 GHz for those important high-sensitivity measurements across **70 kHz to 110, 125 or 145 GHz** with 0.1 dB and 0.5 degrees S_{21} stability over 24 hours. The Vector**Star** ME7838 series system's stable broadband performance means that you can make high accuracy measurements all day, with the confidence that your calibration remains rock solid! **Spend less time calibrating and more time measuring.**

Confidence on the Cutting Edge

Get the true view. Download our complimentary white paper, ***Modern VNA Test Solutions Improve On-Wafer Measurement Efficiency***

Designed and Manufactured in U.S.A.

Visit **www.anritsu.com/en-us/VectorStarMWJ**

Anritsu

envision : ensure

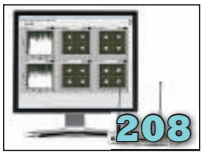
USA/Canada 1-800-ANRITSU Europe 44 1582-433433 Japan 81 (46) 296-1208
Asia-Pacific (852) 2301-4980 Singapore-South Asia (65) 6282-2400
South America 55 (11) 3283-2511 ©2014 Anritsu Company

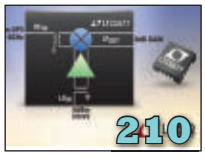
See us at IMS Booth 715

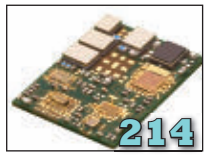
Microwave Journal

CONTENTS

mwjournal.com







Product Features

208 **Wireless Prototyping with Software Defined Radio**
National Instruments

210 **A High IIP3, 300 MHz to 6 GHz Active Mixer**
Linear Technology Corp.

214 **Second-Generation Front End Modules Support Carrier Aggregation**
Skyworks Solutions Inc.

216 **Affordable Real-Time Spectrum Analysis**
Signal Hound

222 **6 in 1 Oscilloscope Instrument**
Tektronix

Tech Briefs

224 **40 GHz Fixed Attenuators**
Mini-Circuits

226 **High Power Pulsed or CW 16 to 18 GHz Amplifier**
Aethercomm

228 **9.5 to 12.5 GHz Down Converter**
Norden Millimeter

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 Barbara Walsh 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 the RF & microwave industry. 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.

©2014 by Horizon House Publications Inc.
Posted under Canadian international publications mail agreement #PM40612608

STAFF

PUBLISHER: CARL SHEFFRES
EDITOR: DAVID VYE
MANAGING EDITOR: JENNIFER DIMARCO
TECHNICAL EDITOR: PATRICK HINDLE
ASSOCIATE TECHNICAL EDITOR: CLIFF DRUBIN
STAFF EDITOR: LAURA GLAZER
EDITORIAL AND MARKETING ASSISTANT: BARBARA WALSH
CONSULTING EDITOR: HARLAN HOWE, JR.
CONSULTING EDITOR: FRANK BASHORE
CONSULTING EDITOR: PETER STAECKER
CONSULTING EDITOR: DAN SWANSON
CONSULTING EDITOR: RAYMOND PENGELLY
WEB EDITOR: CHRIS STANFA
CLIENT SERVICES MANAGER: KRISTEN ANDERSON
AUDIENCE DEVELOPMENT MANAGER: CAROL SPACH
TRAFFIC MANAGER: EDWARD KIESSLING
DIRECTOR OF PRODUCTION & DISTRIBUTION: ROBERT BASS
ART DIRECTOR: JANICE LEVENSON
GRAPHIC DESIGNER: SACHIKO STIGLITZ

EUROPE

INTERNATIONAL EDITOR: RICHARD MUMFORD
OFFICE MANAGER: NINA PLESU

CORPORATE STAFF

CEO: WILLIAM M. BAZZY
PRESIDENT: IVAR BAZZY
VICE PRESIDENT: JARED BAZZY

EDITORIAL REVIEW BOARD

Dr. I.J. Bahl
F.M. Bashore
Dr. C.R. Boyd
M. Goldfarb
J.L. Heaton
Dr. G. Heiter
H. Howe, Jr.
Dr. T. Itoh
Dr. J. Lasker
Dr. S. Maas
Dr. G.L. Matthaei
Dr. D.N. McQuiddy
Dr. J.M. Osepchuk
Dr. Ajay K. Poddar
Dr. J. Rautio
Dr. U. Rohde
M. Schindler
Dr. P. Staecker
F. Sullivan
D. Swanson
Dr. R.J. Trew
G.D. Vendelin
Prof. K. Wu

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

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

www.mwjournal.com

Printed in the USA

TIP 1 For an inductor with the absolute maximum Q, pick one of these air core "Springs". They have flat tops for easy mounting and exceptional current ratings.

TIP 2 If you prefer conventional chip inductors, you'll get the highest Q with our new ceramic body 0402HP and 0603HP families. These tiny wirewound coils handle up to 2 times more current than the nearest competitor.

This new web tool finds inductors with the highest Q at your operating frequency

TIP 3 Need to find coils with the best Q at your L and frequency? Our **Highest Q Finder** web tool tells you in just seconds. Click again to plot the L, Q, Z and ESR of up to 4 parts simultaneously.

TIP 4 When it's time to build your prototypes, be sure to ask us for evaluation samples. They're always free and we can get them to you overnight.

To get started, visit **www.coilcraft.com/Q**

Here are some high Q tips

Coilcraft®

WWW.COILCRAFT.COM

See us at IMS Booth 708

coilcraftdirect.com
No min order. Next day delivery.

Microwave Journal Online

Scan page using layar app

Visit us @ mwjournal.com

Free Webinars

The Design of a 100 W, X-Band GaN PA Module
Presented by: Agilent Technologies EEsof/Cree — On Demand

Advanced Safety Systems in Automotive Designs
Presented by: Isola — On Demand

Antenna Measurements in Under One Second Using Very-Near-Field Technology
Presented by: EMSCAN — 5/14

Practical Antenna Design for Advanced Wireless Products
Presented by: AWR — 5/15

Mixers and Frequency Conversion
Presented by: Besser Associates
Sponsored by: Mini-Circuits — 5/20

Overview of FEKO Suite 7.0
Presented by: EM Software & Systems — 5/21

IEEE 802.11ad (WiGig) PHY and Measurement Challenges
Presented by: Agilent Technologies — 5/20

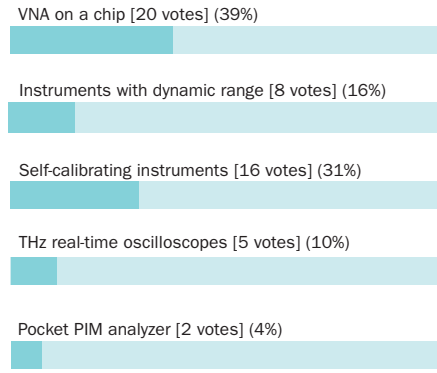
A Guide to the Design of Laminate PCBs at Microwave Frequencies
Sponsored by: Anritsu — 5/22

Web Survey

How often do you attend MTT-S IMS?

Look for our multiple choice survey online at mwjournal.com

March Survey
The Future of RF Test includes:



Executive Interview

Bob Donahue, CEO of **Anokiwave**, discusses the company's unique approach to architecting RF front ends using highly integrated Si core chips.

White Papers

Assessing the Parameters that Influence Reliability in GaN-Based Solid-State Power Amplifier Architectures
Accel-RF

Eliminating the Tradeoffs and Limitations of Your Pulse Measurement Test Solution
Anritsu

AR's Complete Product Catalog for EMC & RF Testing
AR RF/Microwave

RF/Microwave Technologies - A Better Alternative In Defense Electronics
Mercury Systems

Wavelex Products Facilitate Both Multi-Octave Bench Testing and Multi-System Testing
Richardson RFPD

1MA126: Testing S-Parameters on Pulsed Radar Power Amplifier Modules
Rohde & Schwarz

A new Coaxial Flow Calorimeter for Accurate RF Power Measurements up to 100 Watts and 1 GHz
Tegam

Check Out These Channels

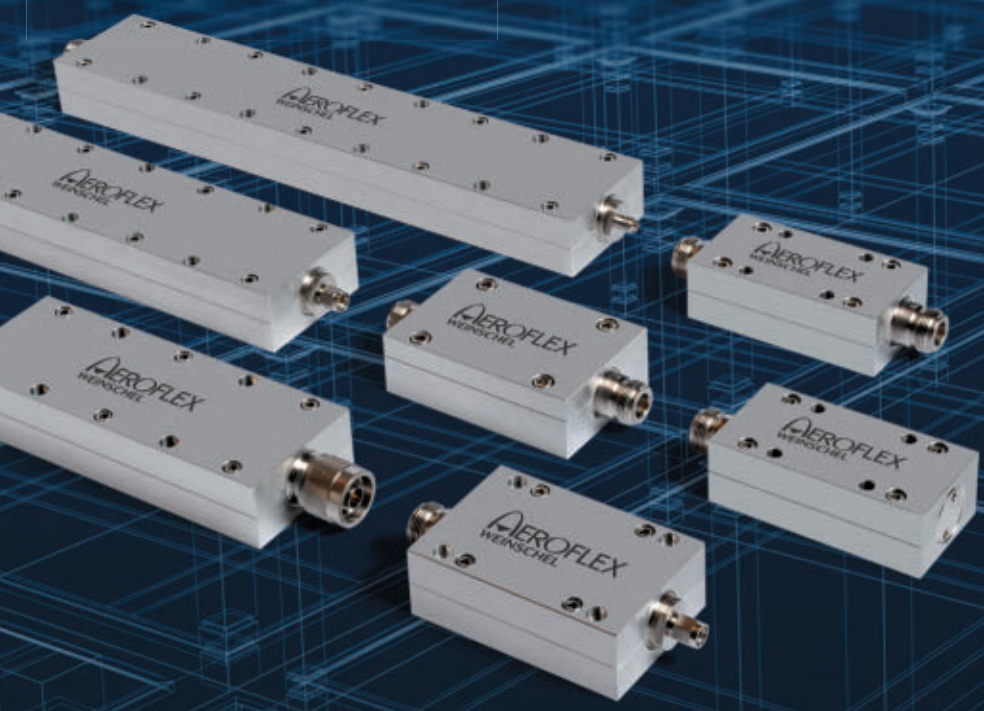
Channels
Aerospace & Defense
Test & Measurement

COM

Catch the newest episode of *Frequency Matters*, the new web series by the editors of *Microwave Journal*, at www.microwavejournal.com/FrequencyMatters

Build a leaner DAS with our conduction-cooled flatpacks

AEROFLEX WEINSCHEL



Offering you up to 550 W average and 10 kW of peak power, Aeroflex / Weinschel's conduction-cooled, fixed attenuators and terminations are designed to fit your next Distributed Antenna System (DAS) challenge.

These ruggedized, compact, low-profile components fit in the tightest spaces. Their connectors are equipped with proprietary, high-temperature, support beads and they are designed specifically for common DAS bands through 6 GHz.

- **-55° C to 100° C**
- **Temperature Indicators**
- **Optional Low PIM Models**
- **Customization Available**

These standardized, Weinschel-quality components are available quickly and at a great value. Visit our website today for complete details.

800-638-9222 / 301-846-9222
www.aeroflex.com/weinschel

See us at IMS Booth 1623

Fixed Coaxial Attenuators

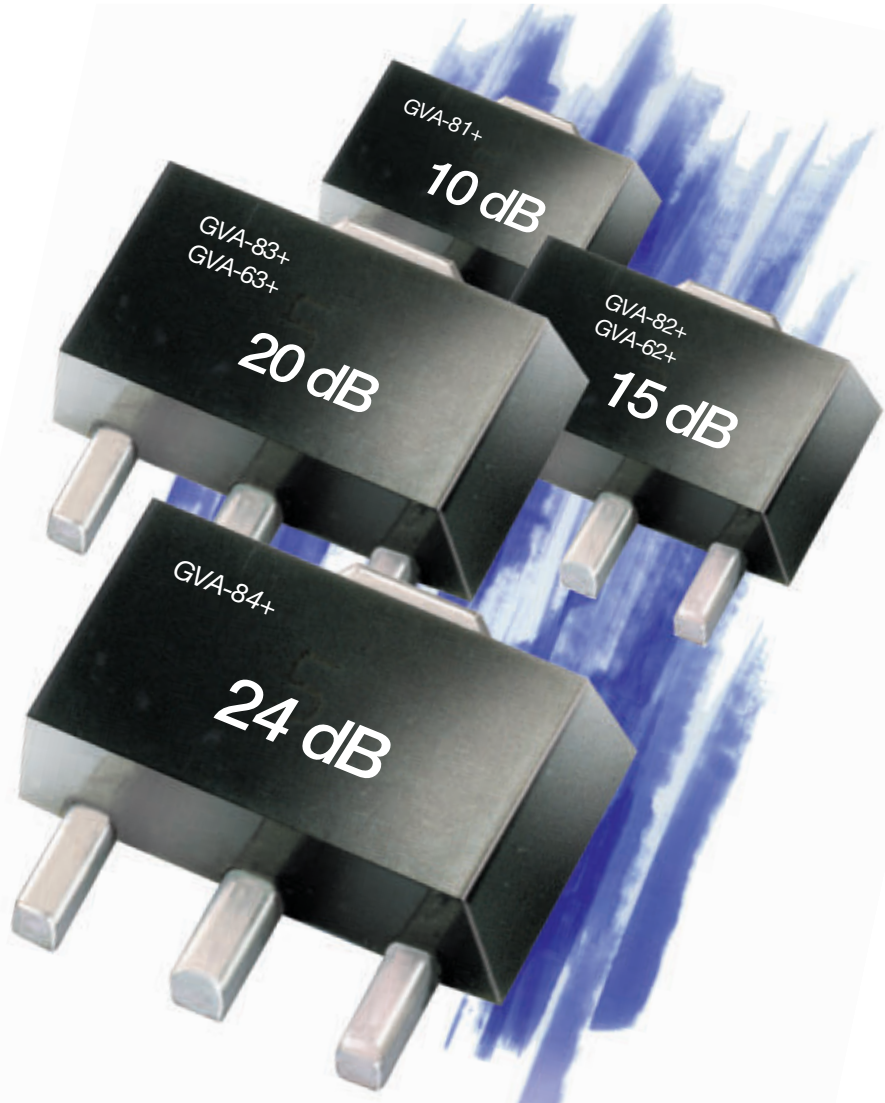
Model	Frequency (GHz)	Avg. Power (W)	Peak Power (kW)	Available dB Values	SWR	Connector Type Available
59	DC to 2.5	100	10	10, 20, 30, 40	1.15	Type N
72	DC to 4.0	50	5	3, 6, 10, 20, 30	1.20	Type N
253	DC to 6.0	550	10	10, 20, 30, 40	1.10 to 1.20*	SMK (2.92mm) or N
257	DC to 6.0	250	10	10, 20, 30, 40	1.10	SMK (2.92mm) or N
258	DC to 6.0	400	10	10, 20, 30, 40	1.10 to 1.25*	SMK (2.92mm) or N
268	DC to 6.0	100	10	6, 10, 20, 30, 40	1.10 to 1.15*	SMK (2.92mm) or N
284	DC to 10.0	50	5	3, 6, 10, 20, 30, 40	1.10 to 1.30*	SMK (2.92mm) or N

Coaxial Terminations

Model	Frequency (GHz)	Avg. Power (W)	Peak Power (kW)	SWR	Connector Type Available
1441	DC to 4.0	50	5	1.20	Type N
1470	DC to 6.0	100	10	1.20	SMK (2.92mm) or N
1471	DC to 6.0	250	10	1.20	SMK (2.92mm) or N
1472	DC to 6.0	400	10	1.20	SMK (2.92mm) or N
1473	DC to 6.0	400	10	1.20	SMK (2.92mm) or N
1476	DC to 10.0	50	5	1.25 to 1.40*	SMK (2.92mm) or N

* Varies with frequency.

AEROFLEX
A passion for performance.



+20 dBm Power Amplifiers with a choice of gain

GVA AMPLIFIERS

DC* to 7 GHz from 94¢ ea. (qty. 1000)

2 New Models!

The GVA-62+ and -63+ add gain flatness as low as ±0.7 dB across the entire 100 MHz to 6 GHz range to our GVA lineup! The GVA series covers DC* to 7 GHz with various gain options from 10 to 24 dB and wide dynamic range to fit your application. Based on high-performance InGaP HBT technology, these patented amplifiers all provide +19 dBm or better output power and IP3 performance as high as +41 dBm. GVA amplifiers are unconditionally stable and designed for a single 5V supply. All models are in stock for immediate delivery! Visit minicircuits.com for detailed specs, performance data, export info, **free X-Parameters**, low prices, and everything you need to choose your GVA today! *US patent 6,943,629*

**Low frequency cut-off determined by coupling cap, except for GVA-60+, GVA-62+ and GVA-63+ low cut-off at 10 MHz.*

FREE X-Parameters-Based Non-Linear Simulation Models for ADS

Modelithics®

http://www.modelithics.com/mvp/Mini-Circuits.asp

Mini-Circuits®

www.minicircuits.com P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com

See us at IMS Booth 823

458 rev N

JUNE 2014

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5

IMS 2014
IEEE MTT-S International Microwave Symposium
Tampa, FL

RFIC 2014

ARFTG 2014

MICROAPPS 2014

WAMICON

IMS 2014 Show Coverage
Catch our exclusive conference information, news, social networking, photos, videos and more at MWJournal.com/IMS2014.

ISPSD'14
Waikoloa, HI

MRW 2014
Gdansk, Poland

DAS & Small Cells Congress
Las Vegas, NV

Webinar:
Simulating Dynamic Load Modulated Amplifiers
Sponsored by
AWR

Webinar:
Aerospace/ Defense
Sponsored by
Agilent Technologies

Webinar:
EEsof
Sponsored by
Agilent Technologies

Go to: mwjournal.com/events

Higher Performance at Lower Cost through Innovative Engineering

Agile
Microwave Technology Inc

POWER AMPLIFIERS

- 0.1 to 18 GHz
- Output Power 1W to 100W
- High Linearity
- Compact Size
- Unconditionally Stable
- Competitive Price & Fast Delivery

LOW NOISE AMPLIFIERS

- Broadband Performance
- Ultra Low Noise Figure
- Excellent Quality
- Unconditionally Stable

Contact us with your custom requirements and let us lower your cost without sacrificing performance or quality

516-931-1760
www.agilemwt.com

Coming**Events**

CALL FOR PAPERS
RFIT
June 11, 2014
RWW 2015
July 25, 2014
mwjournal.com

MAY

CS MANTECH 2014
INTERNATIONAL CONFERENCE ON COMPOUND SEMICONDUCTOR MANUFACTURING TECHNOLOGY
May 19–22, 2014 • Denver, CO
www.csmantech.org

2014 IEEE RADAR CONFERENCE
May 19–23, 2014 • Cincinnati, OH
www.radarcon2014.org

JUNE

RFIC 2014
IEEE RADIO FREQUENCY CIRCUITS SYMPOSIUM
June 1–3, 2014 • Tampa, FL
www.rfic-ieee.org

IMS 2014
IEEE INTERNATIONAL MICROWAVE SYMPOSIUM
June 1–6, 2014 • Tampa, FL
www.ims2014.org

83RD ARFTG MICROWAVE MEASUREMENT SYMPOSIUM
June 6, 2014 • Tampa, FL
www.arftg.org

WAMICON 2014
IEEE WIRELESS AND MICROWAVE TECHNOLOGY CONFERENCE
June 6, 2014 • Tampa, FL
www.wamicon.org

ISPSD 2014
INTERNATIONAL SYMPOSIUM ON POWER SEMICONDUCTOR DEVICES AND ICS
June 15–19, 2014 • Waikoloa, HI
www.ispsd.org

DAS & SMALL CELLS CONGRESS
June 16–18, 2014 • Las Vegas, NV
www.dascongress.com

MRW 2014
6TH INTERNATIONAL CONFERENCE MICROWAVE AND RADAR WEEK
June 16–18, 2014 • Gdansk, Poland
www.mrw2014.lp.edu.ua

JULY

FIRST RESPONDER COMMUNICATION INTEROPERABILITY
July 14–16, 2014 • Washington, DC
www.firstrespondersforum.com

AUGUST

EMC 2014
IEEE INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY
August 3–8, 2014 • Raleigh, NC
www.emc2014.org

METAMATERIALS 2014
8TH INTERNATIONAL CONGRESS ON ADVANCED ELECTROMAGNETIC MATERIALS IN MICROWAVES AND OPTICS
August 25–30, 2014 • Copenhagen, Denmark
http://congress2014.metamorphose-vi.org

RFIT 2014
IEEE INTERNATIONAL SYMPOSIUM ON RADIO-FREQUENCY INTEGRATION TECHNOLOGY
August 27–30, 2014 • Hefei, China
www.rfit2014.org

SEPTEMBER

ICUWB 2014
IEEE INTERNATIONAL CONFERENCE ON ULTRA-WIDEBAND
September 1–3, 2014 • Paris, France
www.icuwb2014.org

ION GNSS+ 2014
September 8–12, 2014 • Tampa, FL
www.ion.org

SUPER MOBILITY WEEK
September 9–11, 2014 • Las Vegas, NV
www.supermobilityweek.com

IRMMW-THz 2014
39TH INTERNATIONAL CONFERENCE ON INFRARED, MILLIMETER AND TERAHERTZ WAVES
September 14–19, 2014 • Tucson, AZ
www.irmmw-thz2014.org

AUTOTEST 2014
September 15–18, 2014 • St. Louis, MO
www.ieee-autotest.com

OCTOBER

EuMW 2014
EUROPEAN MICROWAVE WEEK
October 5–10, 2014 • Rome, Italy
www.eumweek.com

MILCOM 2014
October 6–8, 2014 • Baltimore, MD
www.milcom.org

AMTA 2014
36TH ANTENNA MEASUREMENT TECHNIQUES ASSOCIATION MEETING & SYMPOSIUM
October 12–17, 2014 • Tucson, AZ
www.amta2014.org

ITC/USA 2014
October 20–23, 2014 • San Diego, CA
www.telemetry.org

MWP/APMP 2014
INTERNATIONAL TOPICAL MEETING ON MICROWAVE PHOTONICS (MWP)
9TH ASIA-PACIFIC MICROWAVE PHOTONICS CONFERENCE (APMP)
October 20–23, 2014 • Hokkaido, Japan
www.mwp2014.com

IME/CHINA 2014
9TH INTERNATIONAL CONFERENCE & EXHIBITION ON MICROWAVE AND ANTENNA
October 29–31, 2014 • Shanghai, China
www.imwexpo.com

Power Management | Aerospace & Defense | Mobility

RF & Power

Visit Arrow's RF & Power business at IMS 2014 for our innovative presentations

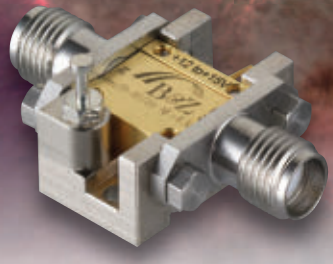
Please join us in booth #609 as we host a full slate of 15-minute presentations and Q&A sessions featuring the leading innovators and suppliers of RF, Wireless and Energy technologies.

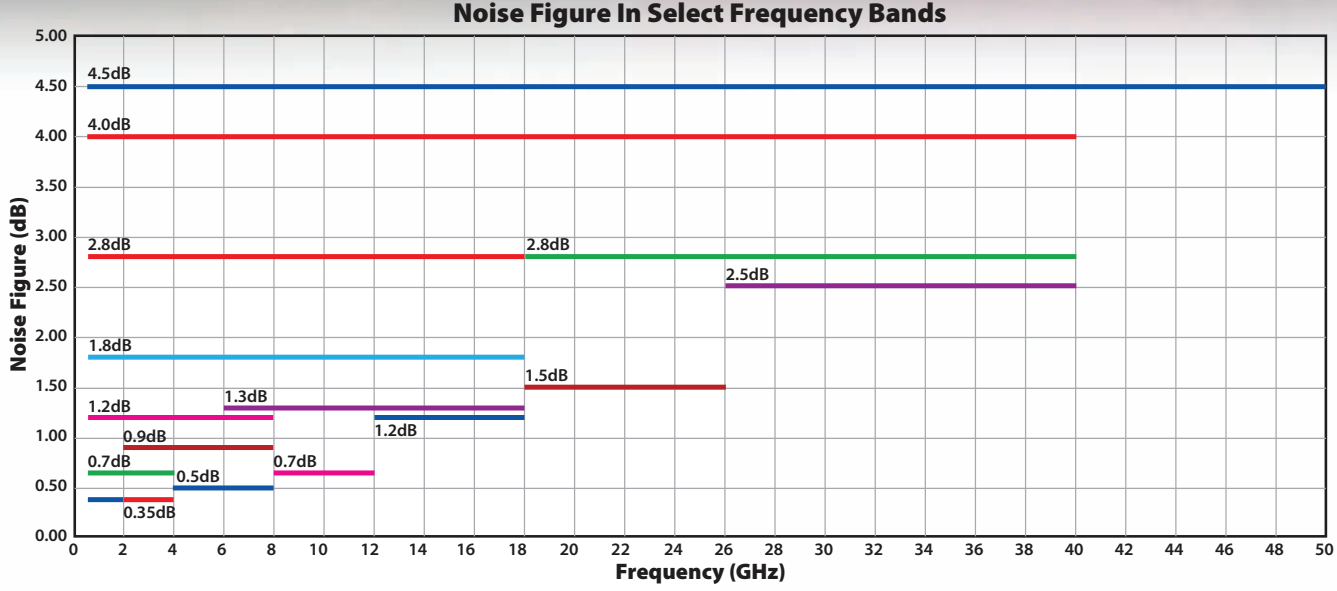
IMS Exhibition 2014 – Booth #609
Tampa Bay, Florida – June 3-5, 2014

arrow.com/rfpower

Five Years Out

State-of-the-Art Amplifiers.





Visit us in **Booth 1040** at **IMS 2014.**

..Now In Stock.

View actual measured performance data on our website.

Features:

- 5 kHz to 50 GHz
- Noise Figures:
  from 0.35 dB @ 23°C
  from 10 K @ Cryogenic
- P1 dB >+30 dBm
- Up to 75 dB Gain
- Input Power Limiter
- Excellent Group Delay
- Gain & Phase Matching
- Temperature Compensation
- Waveguide Connectors
- Weather-Proof Enclosures

B&Z is the preferred source for high perfomance amplifiers.

B&Z TECHNOLOGIES
INNOVATING TO EXCEL

www.bnztech.com

Let the Sunshine In

David Vye
Microwave Journal *Editor*

Another International Microwave Symposium is upon us and the pre-show industry activity suggests it will be a strong event. The exhibition is sold out and the *Microwave Journal* show issue is thick with editorial and advertisers' product previews. Shortly our microwave week days will be filled with scheduled meetings from dawn to dusk. It's great to work in an industry whose economic fortunes are linked to an eco-system as robust and long-term as the one driving global communication networks. This month's issue celebrates both the IMS and the confluence of technologies that will enable the next generation of mobile communications known as 5G.

Since the wireless revolution of the 1990s, RF engineers have answered the call for higher data throughput with technology that delivers. With 5G visionaries setting a goal of a 1000× improvement over today's capacity by the year 2020, I suspect microwave engineers will rise again to the occasion. This time, we may need to use all the tricks in the book, including those originally developed for high performance aerospace and defense applications. To be practical for the commercial world however, engineers will have to adapt high performance millimeter-wave technology to high volume production and find ways to lower device costs to be compatible with mass market products.

This past year, we have witnessed continued market shifts toward lower cost high performance RFICs with the release of major CMOS RF front end devices for cellular frequencies from Peregrine and Qualcomm. The announced merger of TriQuint and RFMD represents another market shift as these companies consolidate their individual strengths in GaAs PA, switch and filter technologies into one organization. This month's cover feature by Anokiwave describing an approach to next generation communication devices based on active electronically steered antennas (AESA), operating at mm-wave frequencies using highly integrated silicon core chips represents another market shift, namely disruptive technology coming from smaller, early-start companies.

The UAV market is another promising area for microwave technology and one that *Microwave Journal* has been covering extensively throughout the past year. Specific to microwave technology development, roadmaps for future UAV systems call for next generation multi-focused, super-cooled, conformal antenna systems. In addition to high gain, rugged and low cost multidirectional (phased array) antennas, component manufacturers will need to develop smaller, lighter weight filter solutions for co-site interference mitigation and high efficiency GaN SSPAs for transmitter and receiver systems.

The satellite industry is another promising sector for the microwave industry with high-capacity Ka-Band platforms gaining a lot of interest this year. Florida, the location of IMS 2014, has a long history with the space program. As a result, the state is home to a number of microwave passive component and cable manufacturers.

Trak Microwave began in 1960 when Trak Electronics opened a branch in Tampa. The company, which specialized in ferrite-based products (circulators and isolators), eventually absorbed St. Petersburg based Geo-Space Corp. (among several acquisitions). Logus provides coaxial and waveguide switches to the satellite industry as does Electro Technik Industries (ETI), a Tampa Bay area manufacturer that owns and operates several subsidiary companies (RES-NET, Nova Microwave, Star Microwave and Wavetronix Corp.) in the passive electronic components field. Other Florida luminaries include SV Microwave, EMC/Florida RF Labs, SGMC Microwave, API Tech and Harris Corp., to name a few.

It was a brutally cold winter, the West Coast experienced one of its worst droughts ever, the Winter Olympics in Sochi had unseasonably high temperatures, ice caps are melting and super storms have become commonplace. The extreme weather predicted by climate scientists and attributed to the build-up of greenhouse gases is increasingly becoming a reality. Addressing this problem is an opportunity for businesses and engineers. Microwave technology consumes the energy linked to the production of greenhouse gases.

As we head down to the Sunshine State, I believe it is a worthy goal for our industry to develop solutions that consume less energy. Reducing energy use is called for in the 5G initiative, doing so makes our products more competitive, saves money for our telecom operator customers and will help keep Florida above water. See you in Tampa. ■

Agilent's Electronic Measurement Group is becoming **Keysight Technologies**.

Performance is its middle name.

Agilent M9393A PXIe performance vector signal analyzer

Introducing the world's fastest, 27 GHz high performance PXIe vector signal analyzer (VSA), the realization of Agilent's microwave measurement expertise in PXI. The M9393A integrates core signal analysis capabilities and proven measurement software with modular hardware speed and accuracy. So you can tailor your system to fit specific needs today and tomorrow. Deploy the M9393A and acquire the performance edge in PXI.

M9393A PXIe performance VSA	
Frequency Range	9 kHz to 27 GHz
Analysis Bandwidth	Up to 160 MHz
Frequency Tuning	150 µs
Amplitude Accuracy	± 0.15 dB

Scan QR code to hear directly from M9393A design engineers.

Download new app note on innovative techniques for noise, image and spur suppression.
www.agilent.com/find/M9393APXI

© Agilent Technologies, Inc. 2014

See us at IMS Booth 1133

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

Agilent Technologies

The Path to 5G

COVER FEATURE
INVITED PAPER

The Industry's Next Tipping Point

David W. Corman *Anokiwave Inc., San Diego, CA*
Peter Moosbrugger *Ball Aerospace, Westminster, CO*
Gabriel M. Rebeiz *University of California, San Diego, CA*

ExecutiveInterview

Bob Donahue, CEO of Anokiwave

Visit www.mwjournal.com to read this in-depth interview.

Radical industry structural change is imminent due to the convergence of an unprecedented demand for bandwidth and the continuing advancements being made in the silicon industry. At the center of this shift, modern military systems and next generation communication devices will feature active electronically steered antennas (AESA) and operate at mm-wave frequencies using highly integrated silicon core chips. When these core chips are coupled with advanced system architectures, a disruptive and refreshing change to our industry will result.

Multiple trends are simultaneously occurring in the industry today: 1) AESAs in the aerospace and defense (A&D) industry are increasingly being required to be "multi-function," i.e. capable of supporting both communication and radar applications from the same array; 2) both A&D and commercial AESAs are moving toward increasingly complex system architectures that feature silicon core chips supporting multiple radiating elements, multiple independently steerable beams, polarization flexibility, and interfacing with smaller amounts of III-V material at each radiating element; 3) AESAs are evolving toward low profile implementations where all electronics reside within the lattice constraints of the array thus forcing higher levels of integration within the silicon core chips; 4) systems are focusing on size, weight, power, and now cost (SWAP-C) where incumbent GaAs-based designs are being displaced by more cost effective silicon solutions; and 5) the demand for bandwidth in next generation communications systems is forcing a migration to mm-wave frequencies and AESAs with steerable beams that offer frequency reuse through spatial diversity. These trends are forcing a powerful disruptive change to the global communications and radar industries.

RF & MICROWAVE FILTERS

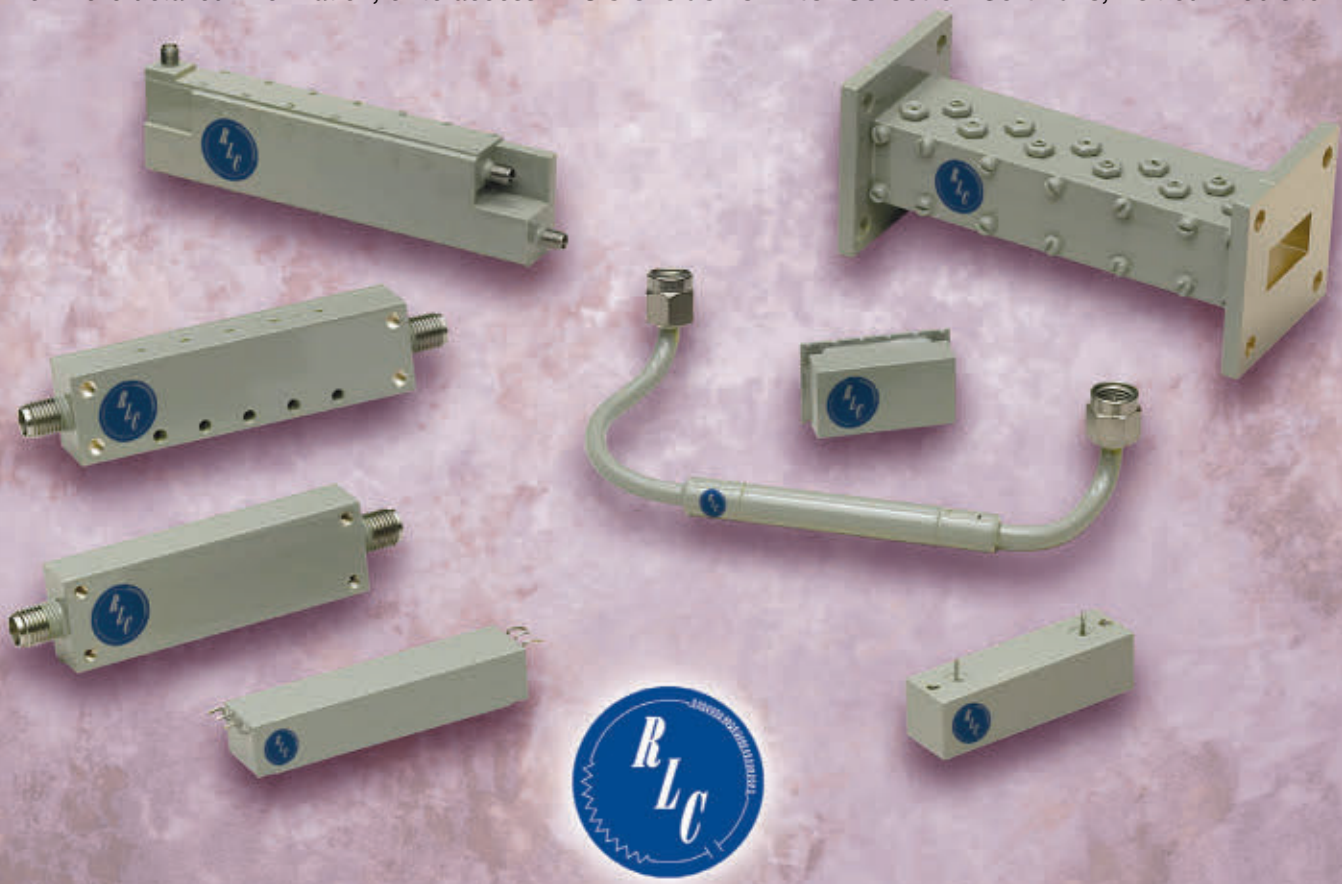
RLC has the customized filter solutions you need.

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

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

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

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



RLC ELECTRONICS, INC.

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

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

ISO 9001:2000 CERTIFIED

VISA MasterCard

RLC is your complete microwave component source...

Switches, Filters, Power Dividers, Terminations, Attenuators, DC Blocks, Bias Tees & Detectors.

See us at IMS Booth 1719

DEMAND FOR BANDWIDTH DRIVING SPECTRUM EXPANSION AND AESAs

The demand for bandwidth is predicted to increase 1000× from 2010 to 2020 with mobile connected devices over the same period increasing from 5 to 50 billon devices.[1] This demand is unprecedented in the industry and is fueling the need for increased spectrum allocations for next generation systems. Traditional cellular and RF bands below 6 GHz are not equipped to meet the demand with global allocations being non-contiguous in nature and aggregating to only 780 MHz.[2] This is pushing the interest to mm-wave frequencies with current 5G activities on-going at 28, 39, 60 and E-Band frequencies where large contiguous bands of spectrum are available. Increased spectrum and the spatial reuse of AESA steerable beams are a compelling solution to meet these high bandwidth demands.

New 5G architectures envision AESAs imbedded in mobile devices to connect with existing 3G/4G base stations via narrow steerable beams over short ranges (<200 m). Mm-wave arrays can offer high directivity in small footprints which offsets the higher path loss associated with mm-wave operation.[3] The antennas will search out best line of sight or reflected signals for system connectivity.[4] Due to the high number of expected mobile devices requiring this technology, the cost structures of such arrays must be very low which is where silicon becomes critical.

SILICON ENABLING AESA ADVANCEMENTS

Advances in silicon have followed Moore's Law since the 1960s, which has resulted in silicon devices that now can operate quite successfully at millimeter wave frequencies.[5] For example, ***Figure 1*** illustrates the continuous improvements in silicon germanium HBT devices since the year 2000 with present devices achieving F_{max} in excess of 300 GHz. This enables feature rich solutions for next generation mm-wave AESAs that will displace traditional, more expensive GaAs solutions. The ability to integrate RF, analog and digital hardware onto a single die provides a compelling reason to go to all silicon solutions for low cost AESAs. Add to this the fact that silicon based phase steering circuits are lumped element in nature rather than distributed, which allows silicon solutions to operate over wider frequency bands and be realized in very compact die sizes.

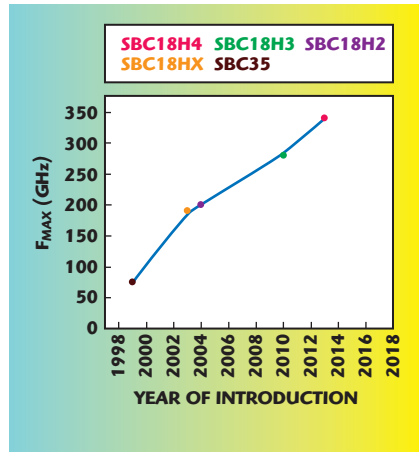
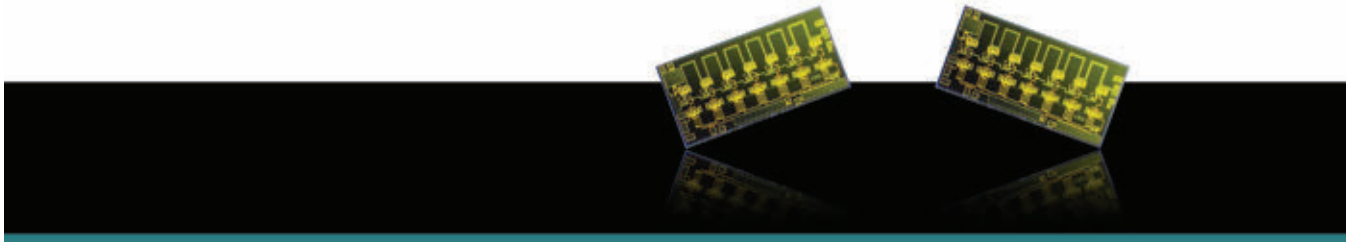


Fig. 1 Evolution of SiGe HBT devices (courtesy of TowerJazz).

The latest phased array antenna solutions are evolving into silicon core chips that support multiple radiating elements, or for applications that require the best possible performance, silicon core chips plus III-V front ends such as GaAs or GaN. The III-V front ends are used to establish best possible NF and output power. Another significant trend occurring in the industry is that GaN is displacing GaAs as the material of choice for high power or broadband front ends. As the cost of GaN continues to decrease, the eventual elimination of GaAs from phased antennas could be expected for many applications.

ECLIPSEmdi
MICROWAVE & RF PRODUCTS

1 watt of power. Operates to 20 GHz.
You're not dreaming

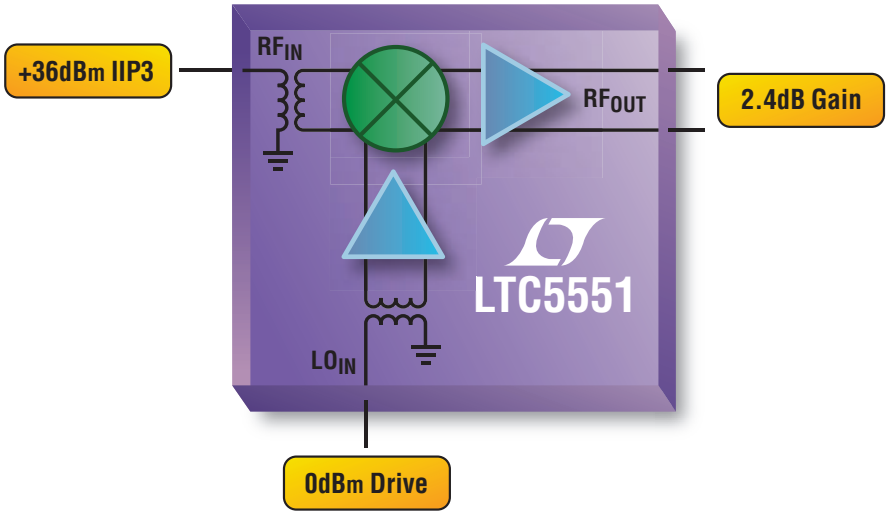


Eclipse Microdevices EMD1211-D is a GaAs MMIC general purpose driver amplifier IC. This device is ideal for applications that require a typical output of +30dBm at 10 GHz, while requiring only 300mA from a +12V supply. Gain flatness is less than 2.0dB across the DC to 20 GHz band. The EMD1211-D is also available in a small connectorized package.

www.eclipsemdi.com
408.526.1100
Let's talk shop.

See us at IMS Booth 1600

+36dBm IIP3 Mixer Boosts Dynamic Range with 2.4dB Gain



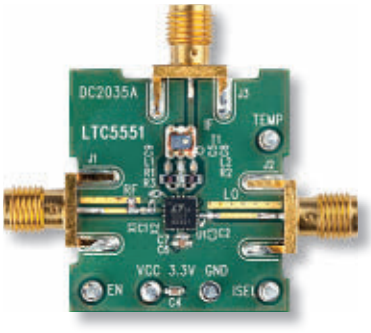
Wideband 300MHz to 3.5GHz Integrated Mixer Lowers Power and Reduces External Components

The LTC®5551's +36dBm IIP3, combined with 2.4dB conversion gain and 9.7dB noise figure, produces outstanding dynamic range performance. Its high gain saves an expensive IF amplifier stage while minimizing noise gain. And its 0dBm LO drive eliminates a high power RF amplifier, ensuring consistent performance without sensitivity to LO level or power supply variations.

Product Features

- 300MHz to 3.5GHz Frequency Range
- +36dBm IIP3
- 2.4dB Conversion Gain
- 9.7dB NF
- 0dBm LO Drive
- Low Power: 670mW

LTC5551 Demo Board



(Actual Size)

Info & Free Samples

www.linear.com/product/LTC5551

1-800-4-LINEAR

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

LINEAR TECHNOLOGY

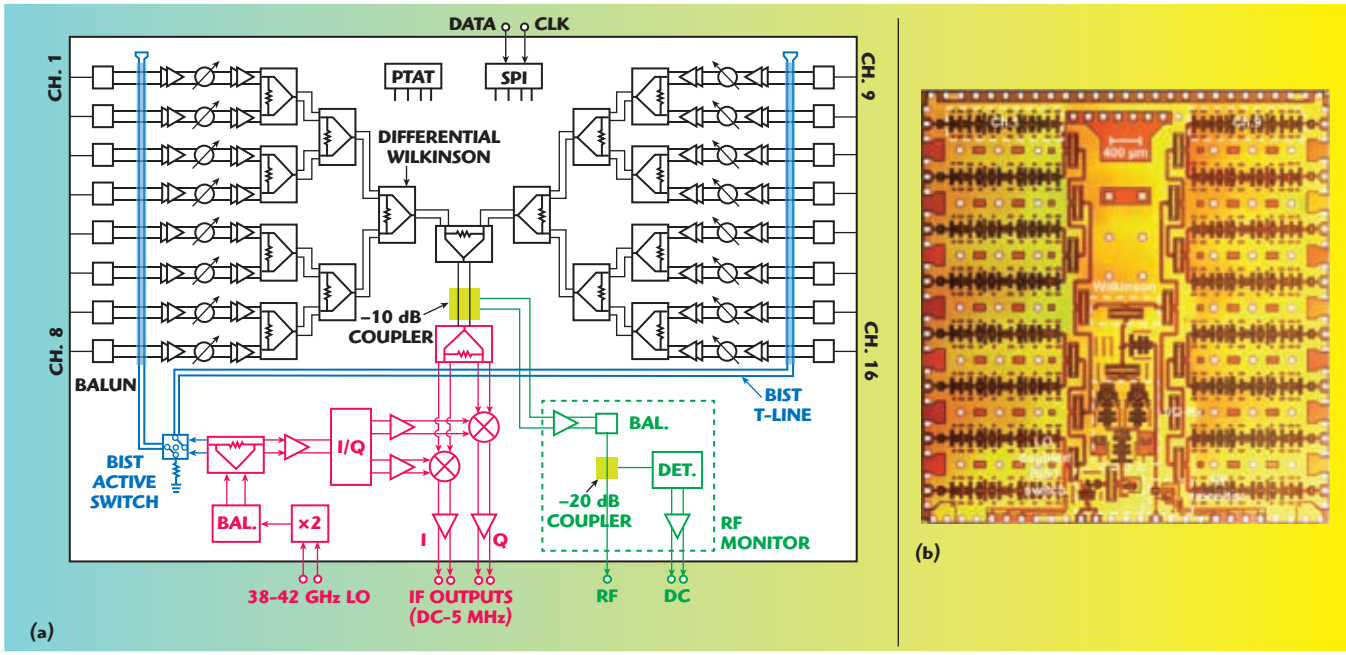


Fig. 2 16-element 77 to 84 GHz phased array with integrated Rx and BIST layout (a) and chip (b). (Reprinted with permission from UCSD).

HISTORICAL REVIEW OF SILICON-BASED CORE CHIPS

AESAs have historically been GaAs-based solutions confined to the aerospace and defense markets, but modern silicon based AESAs are now penetrating a multitude of military and commercial markets. These silicon RFICs are now seen as a technology which has allowed a drastic reduction in phased-array cost up to 110 GHz.

These SiGe chips which contain amplitude and phase control and the required digital interface and control, were first developed as single-elements by Raytheon, Boeing and Professor Rebeiz's group[6-8]

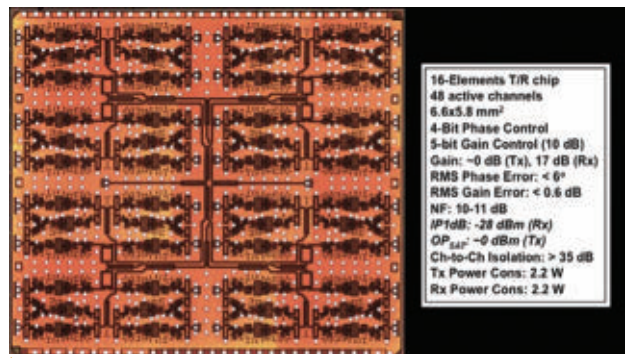


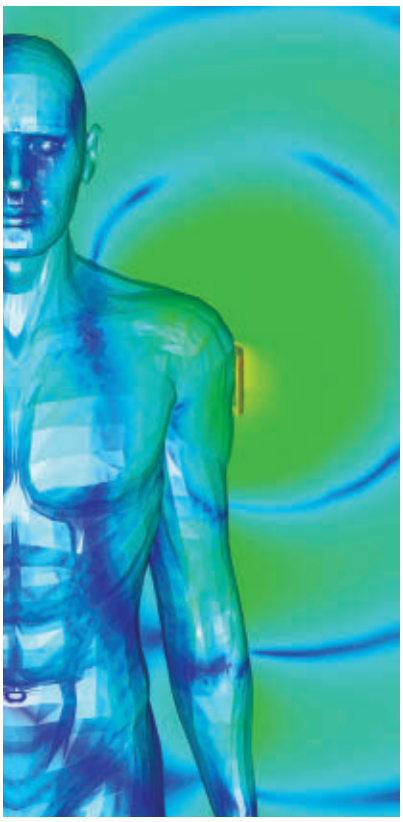
Fig. 3 16-element W-Band Tx+2Rx polarimetric radar RFIC. (Reprinted with permission from UCSD).

ECLIPSEmdi
MICROWAVE & RF PRODUCTS
MMICs
DETECTORS
LIMITERS
GaAs PHEMT MMIC Low Noise Amplifiers
GaAs PHEMT MMIC Driver Amplifiers
GaAs PHEMT MMIC Power Amplifiers
Broadband Schottky Detectors
Pin-Schottky Diode Limiters
Sometimes, the best way to envision the future, is to invent it.
High performance broadband. It's what we're about.
From ultra low noise MMIC amplifiers, driver and power amplifiers, network matched and high sensitivity detectors and limiters with operation to 40 GHz, Eclipse MDI has you covered.
Eclipsing your expectations. We're about that too.
www.eclipsemdi.com
408.526.1100
See us at IMS Booth 1600

Scan page using layar app

Make the Connection

Find the simple way through complex EM systems with CST STUDIO SUITE



Components don't exist in electromagnetic isolation. They influence their neighbors' performance. They are affected by the enclosure or structure around them. They are susceptible to outside influences. With System Assembly and Modeling, CST STUDIO SUITE helps optimize component and system performance.

Involved in antenna development? You can read about how CST technology is used to simulate antenna performance at www.cst.com/antenna.

If you're more interested in filters, couplers, planar and multilayer structures, we've a wide variety of worked application examples live on our website at www.cst.com/apps.

Get the big picture of what's really going on. Ensure your product and components perform in the toughest of environments.

Choose CST STUDIO SUITE – Complete Technology for 3D EM.

See us at IMS Booth 1423

CST SUCCESS STORY

PULSE ELECTRONICS IMPROVES ANTENNA EVALUATION AND REDUCES PRODUCT DESIGN LEAD TIME WITH CST MICROWAVE STUDIO

Heikki Korva, Team Manager, RF, Pulse Electronics Wireless Division

Find out how Pulse Electronics improves antenna evaluation and reduces product design lead time with CST MICROWAVE STUDIO.

CST

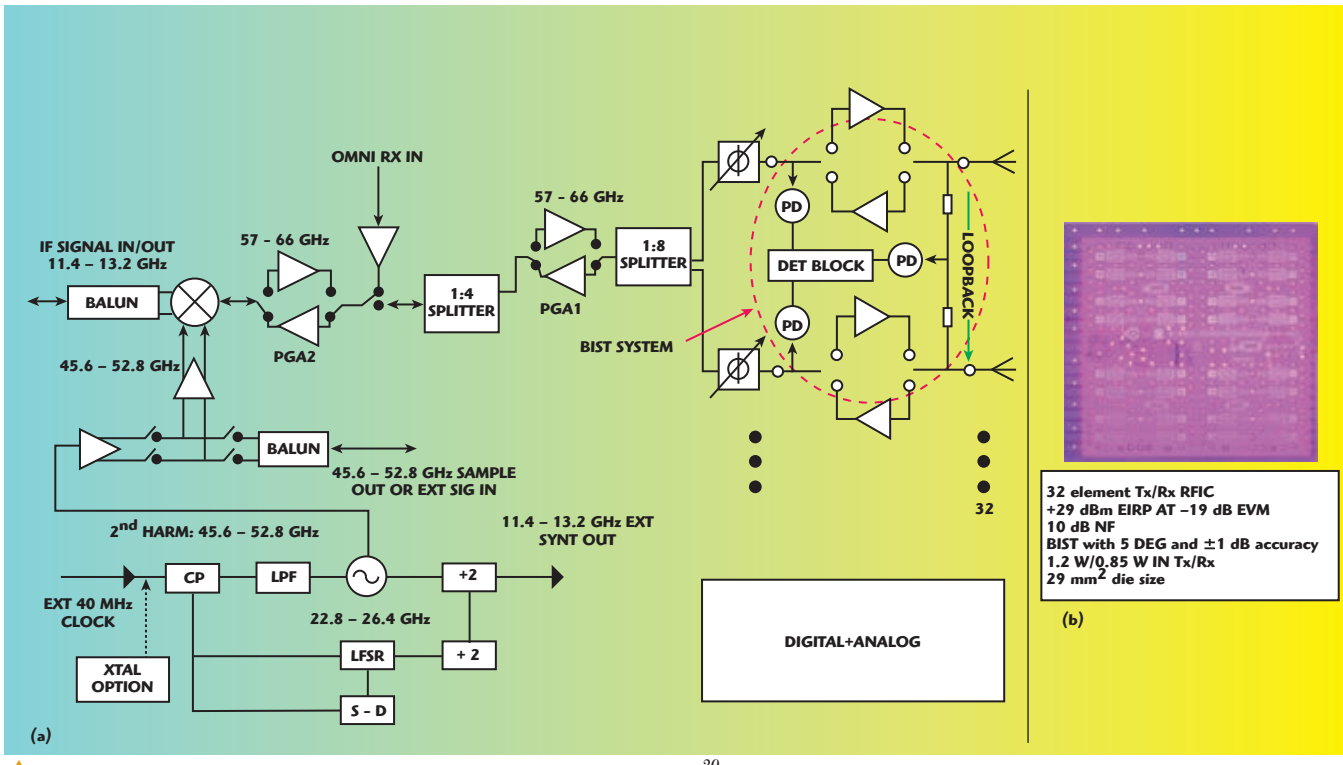


Fig. 4 32-element 60 GHz Tx/Rx RFIC with BIST layout (a) and chip (b).[20]

Covering Your Spectrum

- Fixed Attenuators
- Terminations
- Variable Attenuators
- Power Dividers/Splitters
- RF Adapters
- DC Blocks
- RF Tuners
- DC to 50 GHz
- 1 watt to 1000 watts
- Custom Solutions

Visit our new website with interactive catalog and online RFQ!

www.WeinschelAssociates.com

19212 Orbit Drive
Gaithersburg, MD 20879
Voice: 301.963.4630
Fax: 301.963.8640
RF@WeinschelAssociates.com

WEINSCHEL ASSOCIATES
BROADBAND RF & MICROWAVE SOLUTIONS

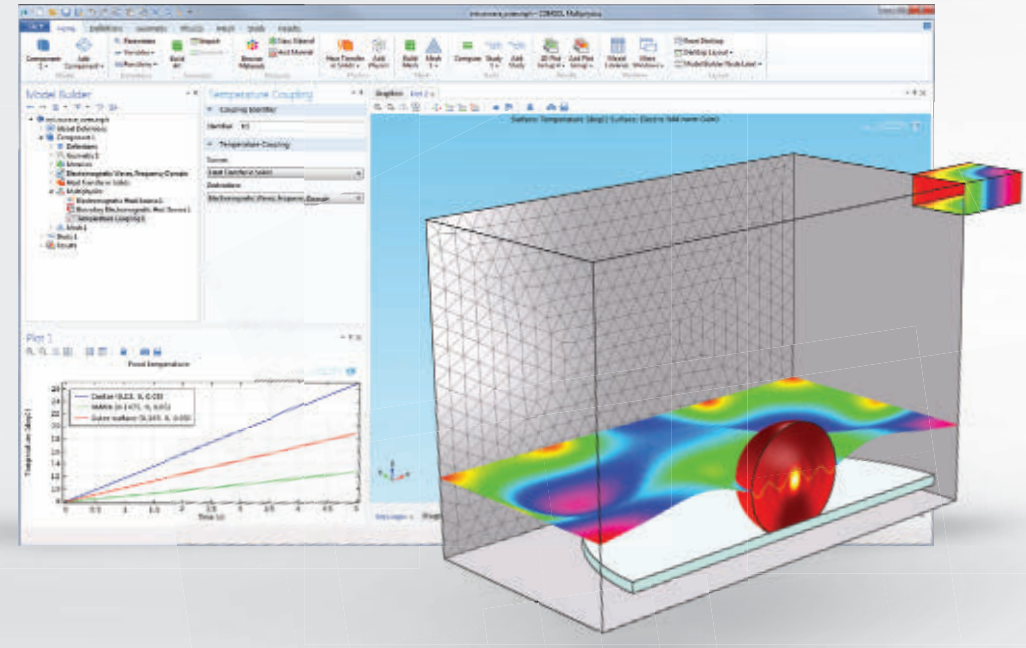
See us at IMS Booth 1814

but enjoyed a huge leap in performance and integration density with the demonstration of the first RF-beamforming SiGe 6 to 18 GHz, 8-element phased-array receiver chip with 5-bit phase control and an on-chip 8:1 combiner.[9] Shortly thereafter, the first 16-element 45 to 50 GHz phased array transmitter was demonstrated.[10] More recently, accurate on-chip built-in-self-test (BIST) at W-Band has been demonstrated, and showed that such techniques can drastically reduce the testing and calibration time (see ***Figure 2***).[11,12]

Demonstrating even higher levels of integration was the first wafer-scale phased array at 110 GHz where high efficiency antennas are directly integrated on-wafer and a full phased-array is achieved without any dicing or mm-wave packaging.[13]

The effect of silicon core chips on the industry has been phenomenal. First, the UCSD work has triggered a large set of defense programs including the ONR Integrated Topside program for advanced AESAs. The 8- and 16-element AESAs with RF-beamforming have become the basis of several 60

MICROWAVE HEATING: Model of the heating process in a microwave oven. Simulation results show the temperature distribution in the food and the electric field.



VERIFY AND OPTIMIZE YOUR DESIGNS WITH

COMSOL MULTIPHYSICS®

Multiphysics tools let you build simulations that accurately replicate the important characteristics of your designs. The key is the ability to include all physical effects that exist in the real world. To learn more about COMSOL Multiphysics, visit www.comsol.com/introvideo

Product Suite

COMSOL Multiphysics

ELECTRICAL
AC/DC Module
RF Module
Wave Optics Module
MEMS Module
Plasma Module
Semiconductor Module

MECHANICAL
Heat Transfer Module
Structural Mechanics Module
Nonlinear Structural Materials Module
Geomechanics Module
Fatigue Module
Multibody Dynamics Module
Acoustics Module

FLUID
CFD Module
Mixer Module
Microfluidics Module
Subsurface Flow Module
Pipe Flow Module
Molecular Flow Module

CHEMICAL
Chemical Reaction Engineering Module
Batteries & Fuel Cells Module
Electrodeposition Module
Corrosion Module
Electrochemistry Module

MULTIPURPOSE
Optimization Module
Material Library
Particle Tracing Module

INTERFACING
LiveLink™ *for* MATLAB®
LiveLink™ *for* Excel®
CAD Import Module
ECAD Import Module
LiveLink™ *for* SolidWorks®
LiveLink™ *for* SpaceClaim®
LiveLink™ *for* Inventor®
LiveLink™ *for* AutoCAD®
LiveLink™ *for* Creo™ Parametric
LiveLink™ *for* Pro/ENGINEER®
LiveLink™ *for* Solid Edge®
File Import *for* CATIA® V5

COMSOL

© Copyright 2014 COMSOL. COMSOL, COMSOL Multiphysics, Capture the Concept, COMSOL Desktop, and LiveLink are either registered trademarks or trademarks of COMSOL AB. All other trademarks are the property of their respective owners, and COMSOL AB and its subsidiaries and products are not affiliated with, endorsed by, sponsored by, or supported by those trademark owners. For a list of such trademark owners, see www.comsol.com/trademarks

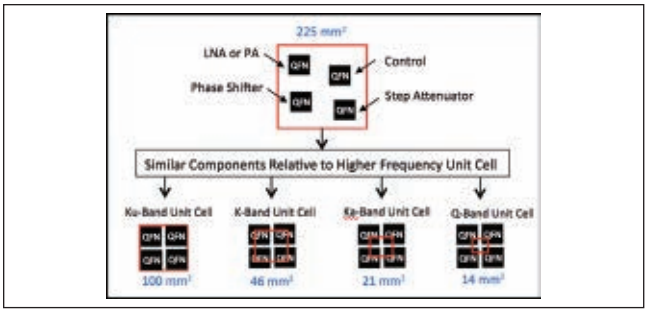


Fig. 5 Half-wavelength area available for parts as a function of operating bands.

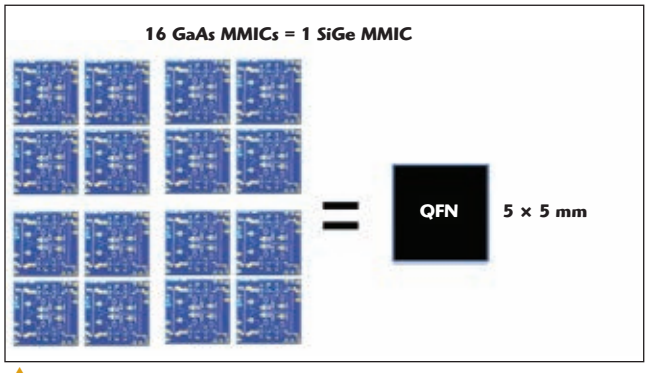


Fig. 6 Relative area of 16 GaAs phase shifter die compared to the area of one 16-channel SiGe phased array die.

GHz communication systems by IBM, Intel, SiBeam and others.[14-16] Toyota, together with UCSD, developed a 77 GHz FMCW radar based on a 16-element phased-array receiver and capable of achieving pedestrian detection at large distances and in high-clutter environments.[12,17,18] The silicon AESAs are also used in a large number of SATCOM systems from X- through Q-Band, both with single and multiple beam capabilities. Recently, SiGe phased array chips with 16-elements and fully polarimetric transmit/receive capabilities have been demonstrated at W-Band frequencies for helicopter landing systems (see ***Figure 3***).[19] It is no exaggeration to state that every commercial or defense phased-array program developed to-date includes a large SiGe (or CMOS) component, and this is resulting in much more complex and lower-cost phased array than previously imagined.

mm-wave AESA EXAMPLE

Intel's Mobile Wireless Group in Haifa, Israel published results for a 32-element 60 GHz transmit/receive AESA implemented on 90 nm CMOS.[20] The chip is shown in ***Figure 4*** and is intended to enable wireless docking in laptop computers. The AESA features a single steerable beam, 32-way analog beamforming, 4-bit phase control, and up/down conversion to/from 12 GHz. When combined with radiating elements implemented in a low cost LCP package, the chip demonstrated >5 GBPS data rate using 16-QAM modulation. The die is 29 mm^2 and consumes 1.2 W of DC power. This achievement demonstrates the ability of silicon to provide excellent performance and cost points at mm-wave frequencies.

LATTICE CONSIDERATIONS FOR PLANAR AESAs

In any AESA, as the frequency of operation increases, available surface area for parts decreases. ***Figure 5*** shows the relative surface area for a half-wavelength by half-wavelength "unit cell" for phased arrays at X- through Q-Band superimposed with packaged GaAs parts that constitute a single beam steering channel. This decrease in available surface area eliminates this GaAs architecture from being a useful technology for single beam planar AESAs above Ku-Band. For AESA applications that require more than a single beam, planar applications above X-Band require a silicon solution.

SiGe and RF CMOS enable significantly higher integration of RF

Modular Automated Multi-Channel RF-Biased Burn-In Test Systems

mitigating the risks of product failures in the field

The only integrated instrument that can demonstrate compliance with aerospace, government, and commercial RF semiconductor life test standards (GaAs, SiGe, GaN, SiC, InP and RFICs). Used by a majority of contractors participating in the DARPA wide-band-gap (WBG) semiconductor initiative and the follow-on Title III Program.

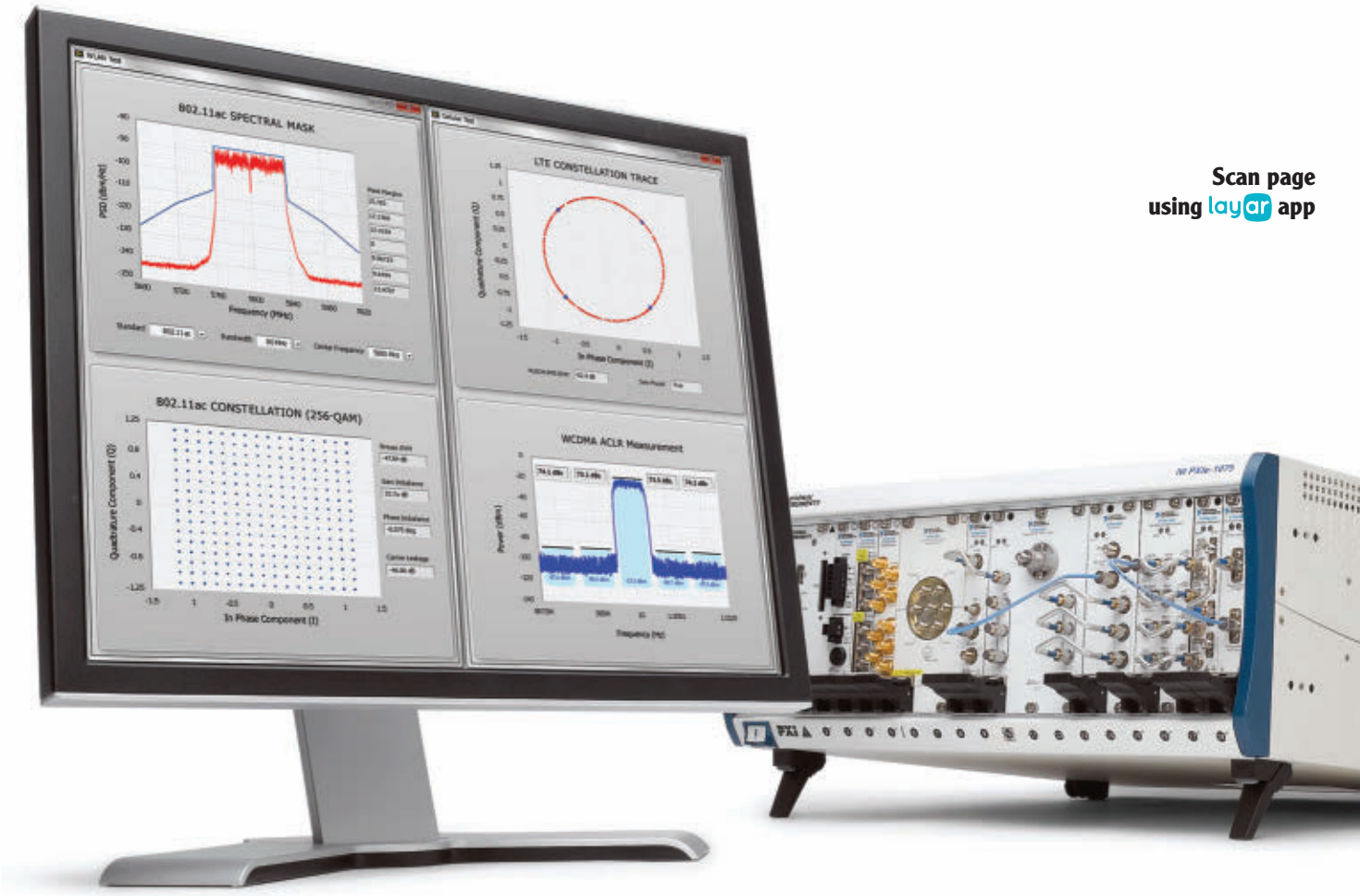
Accel-RF Instruments Corporation

www.accelrf.com
info@accelrf.com

See us at IMS Booth 2132

Redefining RF and Microwave Instrumentation

with open software and modular hardware



Scan page using layar app

Achieve speed, accuracy, and flexibility in your RF and microwave test applications by combining National Instruments open software and modular hardware. Unlike rigid traditional instruments that quickly become obsolete by advancing technology, the system design software of NI LabVIEW coupled with NI PXI hardware puts the latest advances in PC buses, processors, and FPGAs at your fingertips.

WIRELESS TECHNOLOGIES

National Instruments supports a broad range of wireless standards including:

LTE	GSM/EDGE
802.11a/b/g/n/ac	CDMA2000/EV-DO
WCDMA/HSPA/HSPA+	Bluetooth

>> Learn more at ni.com/redefine

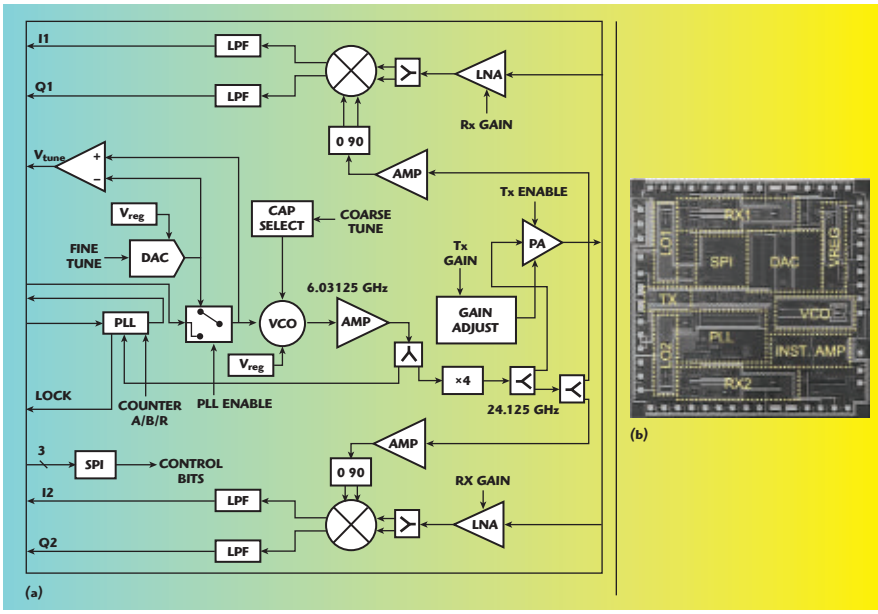
800 813 5078

©2012 National Instruments. All rights reserved. LabVIEW, National Instruments, NI, and ni.com are trademarks of National Instruments.
Other product and company names listed are trademarks or trade names of their respective companies.

NATIONAL INSTRUMENTS™

See us at IMS Booth 633

functions into a single RFIC, allowing higher frequency planar arrays. ***Figure 6*** shows the relative area of 16 GaAs MMIC phase shifters compared to one 16 channel SiGe RFIC at Ku-Band. The sixteen GaAs die, each approximately 2.2 × 2.2 mm, take up a total die area of about 77 mm^2 for the phase shift function alone, compared to the SiGe RFIC, with a total area of about 25 mm^2. The additional benefits of the SiGe MMIC are inclusion of RF amplifiers, RF combining and dividing networks, digital control logic, calibration tables, temperature sensing and compensation, and voltage regulation. Thus a 25 mm^2 die with 16 independent channels (i.e., one phase shifter per channel) could support a 4 × 4 sub-array, enabling planar arrays operating above 100 GHz.



▲ *Fig. 7 Highly integrated 24 GHz FMCW SiGe BiCMOS transceiver layout (a) and chip (b) (Reprinted with permission from ViaSat Inc.).*

IMPORTANCE OF SYSTEMS ENGINEERING

Systems engineering plays a key role in the convergence of silicon and mm-wave frequencies. As the industry shifts toward highly integrated, feature rich core chips, it is increasingly important that RFIC developers have in-house systems engineering expertise to help their customers reap all the benefits that the complex technologies have to offer. The systems engineer can assist the customer in selecting the optimum monolithic process(es) for the application at hand. For example, is an all silicon approach the most appropriate or will some III-V MMICs be warranted? What about an interface control chip between the low voltage silicon core chip and the higher voltage III-V chips? Having the RFIC systems engineer assist with early architecture definition enables the customer to optimize their system and allows them to extract maximum value from it.

Companies like Anokiwave operate with this systems engineering design setup and have designed 20/30 GHz SATCOM and 24 GHz automotive radar solutions.[21,22] ***Figure 7*** shows a highly integrated FMCW radar transceiver implemented in 180 nm BiCMOS SiGe technology with this approach.

FUTURE CONSIDERATIONS FOR OUR INDUSTRY

Since the industry is rapidly evolving, it is important to look for-

See us at IMS Booth 648

Our RF & Microwave Products Give You An Unfair Advantage

Hybrid Power Solid State Modules & Benchtop Amplifiers

700 MHz to 6 GHz and 4-18 GHz Single Band Units

Now you can have Class A designs when linearity is the driving force, as in EMC and wireless applications OR Class AB designs when increased power and efficiency is paramount for EW applications. Standard 6 GHz modular designs provide up to 50 watts P_{out} while benchtops are capable of over 200 watts. 18 GHz products deliver up to 10 watts in a modular package and 40 watts in a benchtop.

Dual Band Amplifiers

AR now offers the widest Class A solid state frequency range coverage in a single amplifier housing. Our widest bandwidth designs now cover 0.7 to 18 GHz in a dual band configuration. These amplifiers come in two different band split configurations from 0.7 to 4.2 GHz and 4 to 18 GHz, or from 0.7 to 6 GHz and 6 to 18 GHz. Output powers provide up to 80 watts for the lower band split while the higher band provides up to 40 watts.

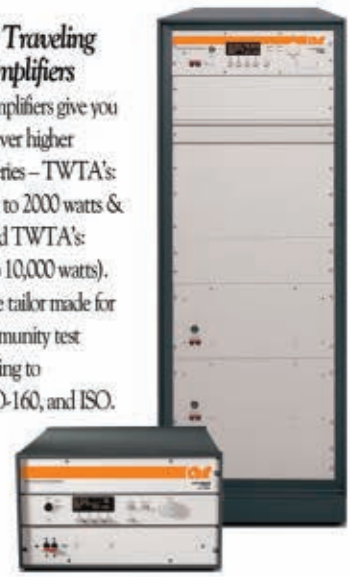
"S" Series Solid State

Numerous models from 0.7 to 18 GHz, 1 to 1200 Watts. For Immunity, Wireless Testing and TWTA replacements. Our "S" Series amplifiers are Mismatch Tolerant providing 100% of rated power without foldback. These amplifiers will reproduce input signals and remain stable with any magnitude and phase load impedance, without damage.

1000S1G2z5 *(1000 watts, from 1 to 2.5 GHz)*

"T" and "TP" Traveling Wave Tube Amplifiers

AR's microwave amplifiers give you more power and cover higher frequencies ("T" Series – TWTA's: 1- 45 GHz; CW 15 to 2000 watts & "TP" Series – Pulsed TWTA's: 1- 18 GHz; 1000 to 10,000 watts). These amplifiers are tailor made for various radiated immunity test applications according to MIL-STD-461, DO-160, and ISO.



"A" Series-Solid State

RF Solid State Amplifiers up to 1000 MHz, and 50,000 watts. All of our RF Solid State Amplifiers have modulation capability that will faithfully reproduce AM, FM or pulse modulation for demanding EMC Radiated Immunity testing applications.

www.arworld.us/advantage

Come See Us at IMS 2014
Tampa Convention Center
Tampa Bay, FL, June 3-5, Booth 1415

ISO 9001:2008 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 +44 1908 282766 • ar France +33147917530 • ar Deutschland GmbH +49 6101 80270 0 • ar Benelux +31 172 423000

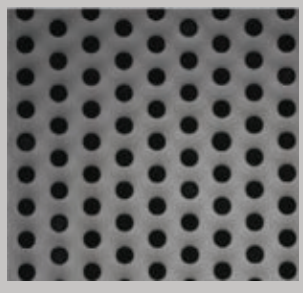
www.arworld.us

Copyright © 2014 AR. The orange stripe on AR products is Reg. U.S. Pat. & TM. Off.

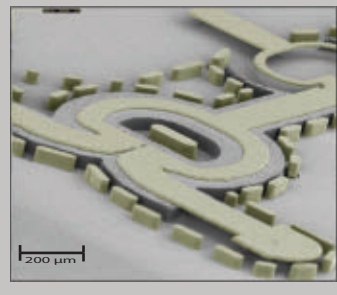
ward and assess what the systems of the future will look like. Motivation to get from antenna-to-bits will become increasingly important and will involve pulling digital capability as close to the radiating element as possible. Replacement of RF front end components with high speed digital signal processing components will become the norm. The steady advance of Moore's Law will generate continually higher speed devices allowing mm-wave and high speed digital circuits to coincide on the same RFICs. Within the next decade we can also expect to see a multitude of everyday devices like garage door openers, videos players, computers, etc. all communicating with each other wirelessly levying ever higher demands on bandwidth. Massive MIMO at mm-wave will be commonplace and will require highly compact, ultra-low cost multi-beam AESAs to be imbedded in everyday devices. It is clear that the industry will continue to advance at a dizzying pace and require ever higher levels of functional integration at consumer cost points.

APEX® Glass

Enabling Breakthrough Electronic Designs



PRECISION THROUGH HOLES



COMPLETE PRODUCT SOLUTIONS

Foundry Services for APEX® Glass Micro-Components and Circuits

Your Product Design

Device Prototyping

Volume Production

Applications Include

- Phase Array Antennas
- Electronic Packaging
- MEMS Packaging
- Test Sockets
- High-Q Designs
- Inductors
- Optoelectronics
- RF & Millimeter Wave

3D GLASS SOLUTIONS

Visit us at IMS 2014
Booth #455

1-866-559-8982
www.3DGlassSolutions.com

CONCLUSION

The industry is at a juxtaposition where the exponential demand for increased data rates coupled with Moore's Law's relentless march are enabling low cost mm-wave AESA solutions, new radars, communication systems and even 5G handsets in the near future. The industry is indeed at a tipping point. ■

References

1. http://spectrum.ieee.org/telecom/wireless/, "Millimeter Waves May Be the Future of 5G Phones," Ariel Bleicher, June 13, 2013.
2. http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=6515173, "Millimeter Wave Mobile Communications for 5G Cellular: It Will Work!," T.S. Rappaport, et al., *NYU WIRELESS,* February 3, 2013.
3. "Coverage and Capacity Analysis of mmWave Cellular Systems," Robert W. Heath, Jr, University of Texas, June 15, 2013.
4. http://nsn.com/news-events/insight-newsletter/articles/, "5G Ultra-Wideband Enhanced Local Area Systems at Millimeter Wave," September 3, 2013.
5. "State of the Art in 60-GHz Integrated Circuits and Systems for Wireless Communications," T.S. Rappaport, et al., *Proceedings of the IEEE*, August 2011.
6. R. Tayrani, M.A. Teshiba, G.M. Sakamoto, Q. Chaudhry, R. Alidio, Y. Kang, I.S. Ahmad, T.C. Cisco and M. Hauhe, "Broad-Band SiGe MMICs for Phased-Array Radar Applications," *IEEE Journal of Solid-State Circuits*, Vol. 38, No. 9, September 2003, pp. 1462-1470.
7. T.M. Hancock and G.M. Rebeiz, "A 12 GHz SiGe Phase Shifter with Integrated LNA," *IEEE Transactions on Microwave Theory Technology*, Vol. 53, No. 3, March 2005, pp. 977-983.
8. B.W. Min and G.M. Rebeiz, "Ka-Band BiCMOS 4-Bit Phase Shifter with Integrated LNA for Phased Array T/R

Your Signal Integrity Depends on NIC's Filters.

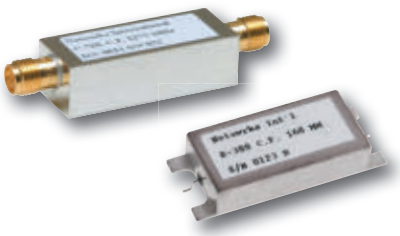
NIC

www.nickc.com

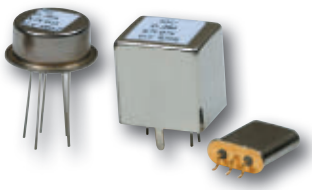
- Innovative Solutions: DC-40GHz
- 3-4 Week Prototype Delivery
- Preferred Supplier to Major OEMs
- 25+ Years of Success

Visit Booth 1501

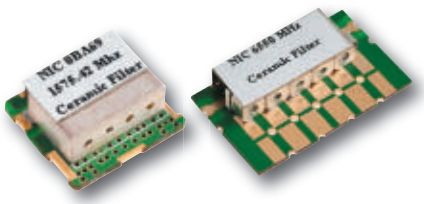
LC Filters



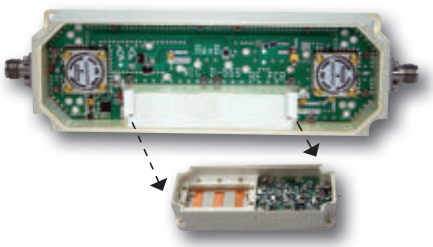
Discrete & Monolithic Crystal Filters



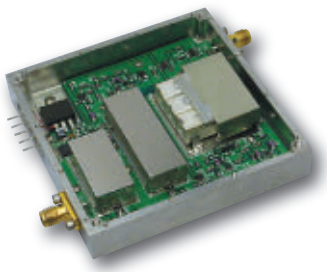
Ceramic Filters



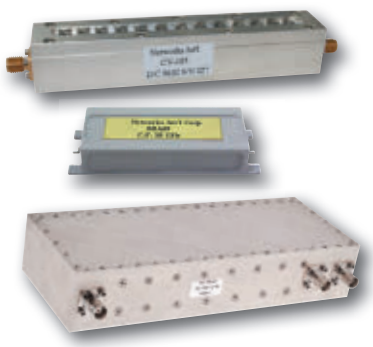
Integrated Assemblies



Switch Filter Banks



Cavity Filters & Diplexers



Radar | UAV | EW | Guidance & Navigation | Communications | GPS & Satellite

ISO 9001:2008
AS9100C
CERTIFIED

NIC NETWORKS INTERNATIONAL CORPORATION

913.685.3400
15237 Broadmoor
Overland Park, KS
e-mail: sales@nickc.com

Modules," *IEEE International Microwave Symposium*, Honolulu, HI, June 3-8, 2007, pp. 479-482.
9. K. Koh and G.M. Rebeiz, "An X- and Ku-Band 8-Element Phased-Array Receiver in 0.18-µm SiGe BiCMOS Technology," *IEEE Journal of Solid State Circuits*, Vol. 43, No. 6, June 2008, pp. 1360-1371.
10. K. Koh and G.M. Rebeiz, "A Millimeter-Wave (40-45 GHz) 16-Element Phased-Array Transmitter in 0.18-µm SiGe BiCMOS Technology," *IEEE Journal of Solid State Circuits*, Vol. 44, No. 5, May 2009, pp. 1498-1509.
11. O. Inac, D. Shin and G.M. Rebeiz, "A Phased Array Chip with Built-In Self-Test Capabilities," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 60, No. 1, January 2012, pp. 139-148.
12. S.Y. Kim, O. Inac, C.Y. Kim, D. Shin and G.M. Rebeiz, "A 76-84 GHz 16-Element Phased Array Receiver with a Chip-Level Built-In Self-Test System," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 61, No. 8, August 2013, pp. 3083-3098.
13. W. Shin, B. Ku, O. Inac, Y.C. Ou, and G.M. Rebeiz, "A 108-116 GHz 4x4 Wafer-Scale Phased Array Transmitter with High-Efficiency On-Chip Antennas," *IEEE Journal Solid-State Circuits*, Vol. 48, No. 9, September 2013, pp. 2041-2055.
14. A. Valdes-Garcia, S.T. Nicolson, J. Lai, A. Natarajan, P. Chen, S.K. Reynolds, J.C. Zhan, D. Kam, D. Liu and B. Floyd, "A Fully Integrated 16-element Phased-array Transmitter in SiGe BiCMOS for 60 GHz Communications," *IEEE Journal of Solid-State Circuits*, Vol. 45, No.12, December 2010, pp. 2757–2773.
15. E. Cohen, C. Jakobson, S. Ravid and D. Ritter, "A Thirty Two Element Phased-array Transceiver at 60 GHz with RF-IF Conversion Block in 90 nm Flip-chip CMOS Process," *IEEE Radio Frequency Integrated Circuits Symposium*, May 2010, pp. 457-460.
16. S. Emami, R.F. Wiser, E. Ali, M.G. Forbes, M.Q. Gordon, X. Guan, S. Lo, P.T. McElwee, J. Parker, J.R. Tani, J.M. Gilbert and C.H. Doan, "A 60 GHz CMOS Phased-array Transceiver Pair for Multi-Gb/s Wireless Communications," *IEEE International Solid-State Circuits Conference*, San Francisco, CA, USA, February 2011, pp. 164-166.
17. B. Ku, P. Schmalenberg, S. Kim, C. Kim, O. Inac, J. Lee, K. Shiozaki and G.M. Rebeiz, "A 16-Element 77–81-GHz Phased Array for Automotive Radars with ±50° Beam-Scanning Capabilities," *IEEE International Microwave Symposium*, June 2013, pp. 1-4.
18. B.H. Ku, O. Inac, M. Chang and G.M. Rebeiz, "A 75-85 GHz Flip-Chip Phased Array RFIC with Simultaneous 8-Transmit and 8-Receive Paths for Automotive Radar Applications," *IEEE Radio Frequency Integrated Circuits Conference (RFIC)*, June 2013, pp. 1-4.
19. F. Golcuk, T. Kanar and G.M. Rebeiz, "A 90-100 GHz 4×4 SiGe BiCMOS Polarimetric Transmit-Receive Phased Array with Simultaneous Receive-Beams Capabilities," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 61, No. 8, August 2013, pp. 3099-3114.
20. E. Cohen et al., "A CMOS Bidirectional 32-element Phased-array Transceiver at 60 GHz with LTCC Antenna," *Radio Frequency Integrated Circuits Symposium (RFIC)*, June 2012, pp. 439-442.
21. S. Lorg et al., "Single Chip K-band Transceiver ASIC with Internal PLLs, Image Reject Mixer, and Multiplexed IF," *GOMAC Tech 2011*, section 8.4.
22. Dave Saunders et al., "A Single-Chip 24 GHz SiGe BiCMOS Transceiver for Low Cost FMCW Airborne Radars," Aerospace & Electronics Conference (NAECON), *Proceedings of the IEEE 2009 National*, July 2009, pp. 244-247.

POWER UP!

Soar with the highest power density solid state RF amplifiers available.

Model BME2969-200
2–6GHz, 200 Watts*
Solid State Power Amp Module

- Highest Power Density to Footprint Ratio
- High Efficiency Over the Entire Bandwidth
- RF Input/Output Sample Ports
- Internal DC to DC Converters
- Optional T/R Switch Available
- Maintains Output Power with Real-World Load Conditions

300 Watts Coming Soon!

Comtech's latest development expands on its proven innovative integrated GaN RF Power Amplifier designs by further increasing the RF power density, while improving overall operating efficiency. These highly integrated designs are ideal for use in communication, electronic warfare, and radar transmitter systems where space, cooling, and power are limited. Applications include ground, surface, and airborne platforms.

Contact us today with your requirements and specs...we'll meet your needs and exceed your expectations.

Comtech...*Simply More.*

ISO 9001:2008 / AS9100C: 2009

COMTECH PST

105 Baylis Road, Melville, NY 11747 • Tel: (631) 777-8900
Fax: (631) 777-8877 • www.comtechpst.com

What's In Your Box?

ROGERS RO4000® Laminate

- Over 50 Years of Materials Experience
- Global RF Design & Fabrication Support
- Quality & Consistency Second to None

TRY OUR
NEW ROG MOBILE APP
For iPad, iPhone and
Android devices
www.rogerscorp.com/rogmobile

Visit Us At
International Microwave Symposium
3-5 June 2014 - Tampa Bay, Florida
Booth #1833

ROGERS
CORPORATION
Advanced Circuit Materials Division

High performance circuit material that comes with a Rogers engineer.

We pioneered it, we manufacture it, and each order of our RO4000 material comes with an engineer to support your high performance circuit material needs. Every box of material includes over 50 years of experience and customer partnerships in developing the most innovative materials, and no other supplier matches our personal service and support. **Visit our website and get more information on all our services and support and to get to know your ROGERS engineer.**

USA - AZ, tel. +1 480-961-1382 • EUROPE - BELGIUM, tel. +32 9 235 3611
CHINA, tel. 86-21-62175599 • www.rogerscorp.com

The superior technology is always the last one standing

The game is over, and only one domino is left standing– UltraCMOS® technology.

The players from the past have all been eliminated. In the final round, **UltraCMOS** technology is knocking down the last real contender, GaAs.

- GaAs requires positive and negative supplies. **UltraCMOS** technology integrates charge pumps.
- GaAs RF performance varies over supply voltage. **UltraCMOS** technology integrates bias generation, eliminating supply variation effects.
- GaAs is limited to the inherent ESD performance of the device. **UltraCMOS** technology integrates high performance ESD protection.
- GaAs has no digital capability or support for control interfaces. **UltraCMOS** technology integrates digital circuitry and control interfaces.

Want to see for yourself? Come experience our demos at IEEE MTT-S in Tampa, Booth #515, or visit our website at www.psemi.com.

Peregrine Semiconductor

www.psemi.com

The Path to 5G Runs Through China

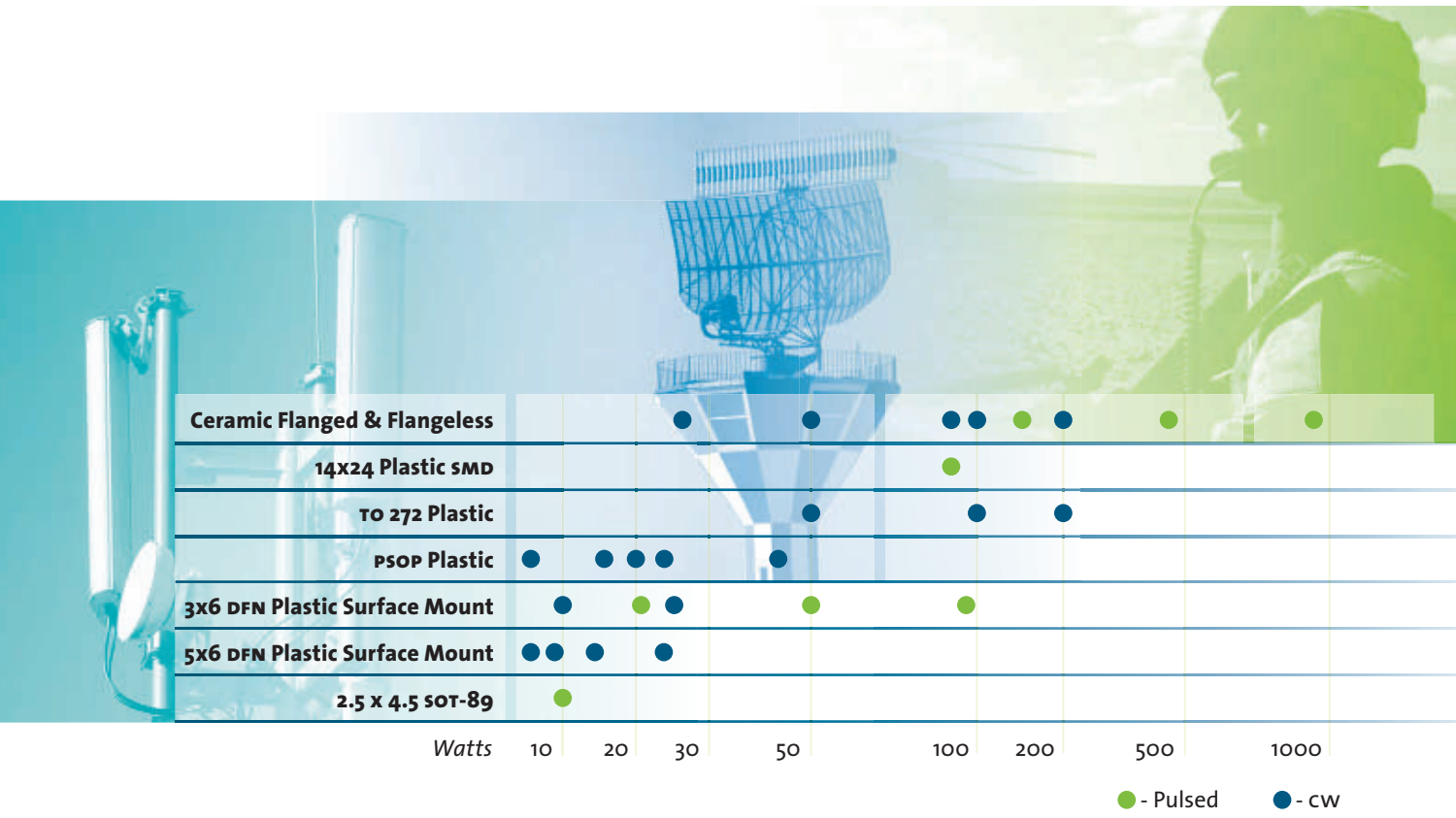
David Vye
Microwave Journal *Editor*

The 600+ seat auditorium at the Beijing International Convention Center was the setting for the plenary session at EDI CON 2014 last month as attendees gathered to hear from this year's keynote speakers. The opening program, featuring invited dignitaries from Chinese government research institutions, academia and industry, provided a range of perspectives on the direction of telecommunications and the underlying requirements for future hardware and architectures. Central to these talks was the topic of where mobile communications will be at the end of this decade, a theme we are exploring in this month's cover feature. All projections from current trends show continued exponential growth in data delivery leading to 1 gigabyte of personalized data per user per day by 2020.

This 1000 times increase in capacity is coupled with calls to lower energy usage as part of a green initiative to reduce global warming and to cut operating costs for carriers that have seen demand and profitability move in opposite directions. These system requirements (more capacity, speed and coverage; less consumed energy and operating costs) fall under the 5G umbrella as presented by speakers from China Mobile Research, Agilent Technologies, National Instruments and Rohde & Schwarz.

Every section of the physical layer in the mobile communication pathway is being investigated for ways to increase data throughput, which in turn impacts requirements for electronic devices, passive components, antenna systems and everything in between. Professor Junde Song, chair of the EDA/CAD department at Beijing University of Posts and Telecommunications and a consultant to the Chinese government on telecommunications, set the stage for attendees with a look at the massive communications requirements behind providing mobile internet access to a market of 1.5 billion users. From the carrier perspective, R&D director Corbett Rowell presented the challenge of 5G as it is being investigated and conceptualized by China Mobile Research.

China Mobile is focused on rethinking five main areas to improve networks by 1000×. These areas are 1. Signaling; 2. Radio design; 3. Antennas; 4. Shannon (impacts capacity through spectral efficiency and modulation methods); and 5. Ring & Young (cell configurations). In particular to Rowell's own area of expertise and the interests of the RF/microwave engineers in the audience, he spoke of the need for large scale antenna systems (LSAS) employing RFIC-enabled active antenna arrays to support more efficient (greater capacity, lower power consumption) beam steering techniques. This message is certainly in line with our cover feature this month. At the radio level, China Mobile is investigating cell level rather than link level full duplexing (same time/same frequency) to double capacity. The topic of cell configurations covers all the implementation



Shattering the Barriers to Mainstream GaN Adoption

MACOM revolutionizes RF applications by securing the supply of the industry's only proven, performance-driven GaN portfolio

MACOM GaN transistors improve upon the high-power handling and voltage operation of LDMOS with the high-frequency performance of GaAs. Improved bandwidth, efficiency and power density give your applications greater power in a variety of packages.

Leveraging deep experience in RF, MACOM engineers are expanding our power transistor family to fuel the future of military and commercial radar as well as other commercial applications. These rugged devices deliver greater flexibility and multi-function capability in your radar communications.

Our growing pulsed power GaN portfolio includes 5W-90W Pk transistors in DFN and SOT-89 plastic packaging, up to 1000W ceramic packages and L-, S-band fully matched modules. Our new CW GaN portfolio includes ceramic package transistors up to 200W, DFN packages from 5W to 25W and TO-272 plastic packages from 50W to 200W.

Only MACOM shatters the final barriers to mainstream GaN adoption by offering dual sourcing for surety of supply.

MACOM™

Partners from RF to Light

Get Samples & Learn How MACOM is Shattering the Barriers to Mainstream GaN Adoption at www.macom.com/gan

See us at IMS Booth 915

challenges behind small cell and HetNet architectures and hardware.

Corbett Rowell of China Mobile explained to the EDI CON audience that the principle interest in 5G for China's leading carrier is not capacity but rather energy savings. The current power consumption by China Mobile's Network is currently greater than the amount used by the county of Taiwan (annually). The goal of 5G is to reduce that by 90%.

The question of why we need 5G performance was addressed by James Kimery of National Instruments. Kimery is deeply involved in the activities of universities and consortiums grappling with the future of wireless technology, from identifying how telecommunication systems can be improved to how they can better serve humanity. Starting with the baseline requirement that 5G deliver 1 Gbps data rates in both the uplink and downlink, Kimery reinforced the notion of three key drivers calling for 5G performance: 1. communcation speed, 2. duration (lower power consumption) and 3. real-time control.

With regard to the third driver, researchers see great opportunities in large distance remote real-time control if current latencies in wireless systems can be reduced by orders of magnitude. Such applications are the focus of over 20 research institutes in partnership with industry. Kimery, who has authored articles on the subject for *Microwave Journal* recently, helped inform this audience in Beijing about the global research efforts and will hopefully help establish connections between the institutions pursuing 5G R&D in North America and Europe with their counterparts in Asia.

Test and measurement equipment manufacturers are always at the forefront of any new technical revolution and that is certainly the case for Agilent Technologies and Rohde & Schwarz, who were represented by Mario Narduzzi and Josef Wolf, respectively, as keynote speakers discussing the emerging challenges for high frequency electronic designers developing the hardware for 5G. In addition to the challenges of working at higher frequencies and significantly broader bandwidths, engineers will need to operate in multiple domains as digital and RF technologies further combine to improve spectral efficiency, MIMO techniques and a host of other technologies being pursued to achieve 1000× data rates.

In addition to the new, more capable test instruments being made available to engineers, there will be a need for greater technical support and expertise offered by industry. The plenary session at EDI CON provided the "what and why" of tomorrow's 5G world. The conference, workshops, panels and exhibition provided the how. Now we look to continue the conversation in Tampa. ■

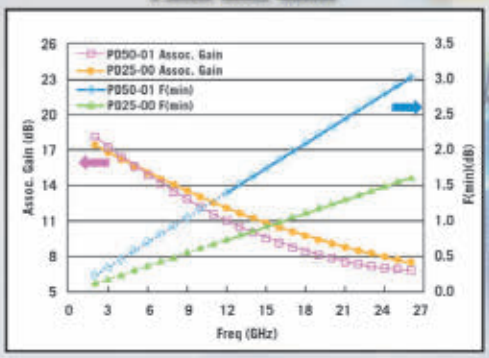
win SEMICONDUCTORS

Leading Global Communications

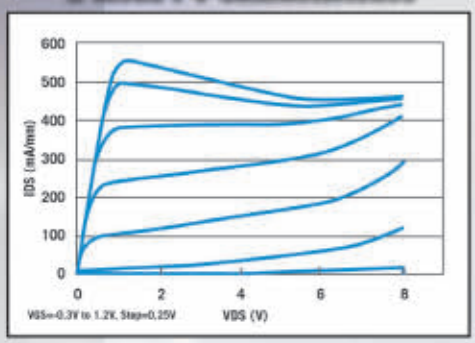
PD25-00 0.25μm E / D pHEMT

- 4th generation E/D PHEMT Technology
- High performance 0.25μm E-mode combined with latest generation 0.5μm D-mode switch
- E-mode device: Ultra low noise and high gain
- D-mode device: Compact layout and low Ron-Coff product

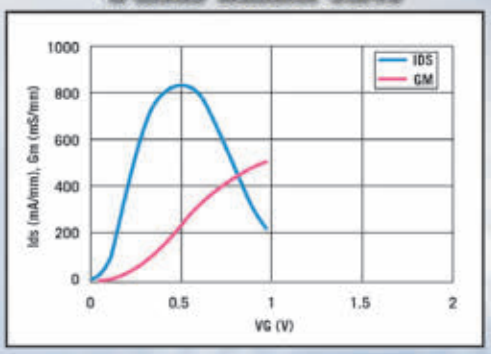
Fmin and Gain



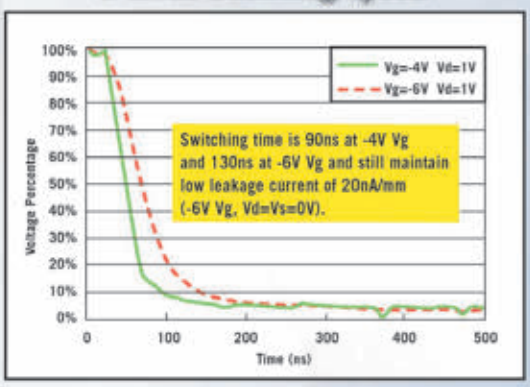
E-mode I-V Characteristics



E-mode Transfer Curve



D-mode Switching Speed



D-mode Device Performance

	PD50-01		PD25-00	
	Single	Triple	Single	Triple
Ron (ohm.mm)	1.9	3.7	1.3	2.2
Coff (fF/mm)	168	83	163	92
RonxCoff(ohm.fF)	316	310	209	198

DUT: NOF x UGW= 5 x 12μm

WIN SEMICONDUCTORS CORP.

Tel:+886-3-397-5999 Fax:+886-3-397-5069 http://www.winfoundry.com

See us at IMS Booth 839

The Path to 5G

Scan page using layar app

IMS 2014 MicroApps Special Panel Session

Path to 5G: Design and Test Challenges for the Future

Wednesday, June 4, 12:00-1:00 PM, MicroApps Theater

Patrick Hindle
Microwave Journal *Technical Editor*

The demand for mobile capacity is projected to double annually due to steadily increasing levels of gaming, web browsing and music and video streaming. As a result, we now have a goal of increasing capacity 1000× with speeds up to 10 Gbps for 5G. How will this be accomplished? A special MicroApps panel session at IMS 2014 will examine the challenges to device design and device/system testing for 5G technologies such as mmwave/terahertz transceivers, massive MIMO, carrier aggregation, CoMP, AESA radios and other related technologies for the future. This panel is open to everyone on the IMS 2014 exhibition floor and will take place Wednesday, June 4 from 12-1 PM.

The moderator is Theodore (Ted) S. Rappaport who will lead the discussion with the panelists and take questions from the audience. Rappaport is a well-known expert in the field. He is the David Lee/Ernst Weber Professor of Electrical Engineering at the Polytechnic Institute of New York University (NYU-Poly), professor of computer science at New York University's Courant Institute of Mathematical Sciences and professor of radiology at the NYU School of Medicine. He is the founding director of NYU WIRELESS, the world's first academic research center to combine engineering, computer science and medicine.

Eric Higham will start off the session with a short 5G market overview. Higham is director of the GaAs and Compound Semiconductors Technologies Program within the Strategic Technologies Practice of Strategy Analytics. Following the introductions, panel members will take questions from the audience and moderator in an open discussion. The panel members include Steve Reyes, manager of product marketing at Anritsu Co.; Roger Nichols, 5G program manager for Agilent Technologies; James Kimery, director of marketing for RF, communications and software defined radio (SDR) initiatives at National Instruments; Henrik Morkner, director of engineering at the MACOM Design Center in California; and Jeffrey L. Hesler, chief technology officer of Virginia Diodes and a visiting research assistant professor at the University of Virginia.

This special session is right on the exhibition floor and features many of the leading experts in 5G technologies that will be realized in the future. Come by at noon on Wednesday to the MicroApps Theater located in booth 1246 to ask questions and participate in this open panel discussion. ■

Reactel, Incorporated

Reacting First to All Your Filter Needs.

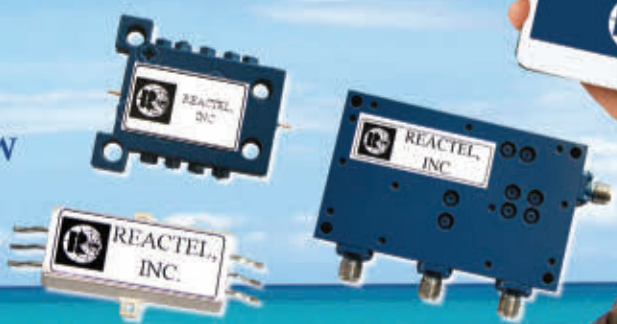
Relax.

When interference happens and filtering needs crash upon your shores, turn to Reactel's expertise and watch your worries drift away with the tide.

Reactel, Incorporated's line of filters can solve any problem you may encounter. From initial concept to final design, your trust in our Engineers will be well placed.

Visit booth 1100 at this year's IMS show in Tampa and we will demonstrate how easy it is to get high performance filters from a recognized leader in the industry.

- DC to 50 GHz
- Profiles as low as 0.125"
- Power levels in excess of 20 kW CW
- Filters
- Multiplexers
- Multifunction Assemblies



8031 Cessna Avenue • Gaithersburg, Maryland 20879 • Phone: (301) 519-3660
For general inquiries, please email reactel@reactel.com • http://twitter.com/reacteljim
Go online to www.reactel.com to download your Reactel catalog.

Get our Filter RFQ App at the App Store or Google play today!

FM Approvals

RoHS Compliant

ISO 9001:2008 Registered

@reactelJim

Available on the App Store

Google play

Scan page using layar app

Come Power the Waves with Us at IMS 2014

Larry Dunleavy
IMS 2014 Chair
Tom Weller
IMS 2014 Vice-Chair

As general chair and vice-chair of the 2014 International Microwave Symposium (IMS 2014), we want to enthusiastically invite you to join us June 1-6, 2014 in Tampa, Florida. IMS encompasses an event-filled week of technical paper presentations, workshops, short courses, exhibits and networking opportunities – all of a scale and level of excellence that you will find nowhere else. As always, "Microwave Week" includes the RFIC and ARFTG conferences; although for the first time this year's ARFTG will be combined with Florida's own IEEE WAMICON which together will offer broader technical coverage, enhanced paper and presentation opportunities and a combined exhibitor area.

The RFIC Symposium brings focus to the technical accomplishments in RF circuits, systems and devices. This year's exciting program will showcase the latest innovations in RF integrated circuit design with sessions that cover a broad spectrum of topics such as cellular and wireless-connectivity system ICs, low power transceivers, reconfigurable and digital RF, broadband wireless communications, silicon millimeter-wave ICs, power amplifier technology, and RF device modeling and characterization. For more information, visit www.rfic2013.org.

The Automatic RF Techniques Group (ARFTG) is a technical organization interested in all aspects of RF and microwave test and measurement. The most important part of the ARFTG experience is the opportunity to interact one-on-one with colleagues, experts and vendors of the RF and microwave test and measurement community. Whether your interests include high-throughput production or one-of-a-kind metrology measurements, complex systems or simple circuit modeling, small signal S-parameter or large-signal nonlinear measurements, phase noise or noise figure, DC or lightwave, you will find a kindred spirit or maybe even an expert. Visit www.arftg.org for more information.

The IEEE Wireless and Microwave Technology Conference (WAMICON) grew out of a series of very successful one-day forums organized by the University of South Florida Center for Wireless and Microwave Information Systems faculty, the WAMI Advisory Board, and the Florida West Coast IEEE MTT/AP/ED chapter. The goal of this conference, hosted annually in Florida, is to create a stimulating environment for the exchange of information about the status and directions of wireless and microwave technology and actions being taken by educators, industrial practitioners and governmental research agencies to address relevant challenges and move the technology forward. WAMICON is an excellent networking and information sharing event with a unique charm. WAMICON is now an international event that is technically and financially sponsored by the IEEE MTT Society. Visit www.wamicon.org for more information.

IMS 2014 is the premier event in the RF/microwave community. We plan to have a great week and your participation will be key to making IMS 2014 all that it promises to be. See you there! ■

UNMATCHED DYNAMIC RANGE.
UNMATCHED PERFORMANCE.

The new VDI Mini-modules have only one-quarter the volume, making them perfect for applications like probe stations and antenna ranges.

BRIDGING THE THz GAP JUST GOT SMALLER.

Introducing VDI's Mini VNA Extension Modules

VDI's VNA Extenders provide high performance frequency extension of vector network analyzers from 50GHz-1.1THz. These modules combine high test port power with exceptional dynamic range and unmatched stability.

VDI's mini-modules are reduced in size, but yield the same industry leading performance as our original designs. Also the power supply is simplified and the cooling fans have been eliminated. Mini-modules are currently available for WR15, WR12, and WR10, with higher frequency bands coming soon.

Waveguide Band (GHz)	WR15 50-75	WR12 60-90	WR10 75-110	WR6.5 110-170
Dynamic Range (BW=10Hz, dB, typ)	120	120	120	120
(BW=10Hz, dB, min)	100	100	100	90
Magnitude Stability (±dB)	0.15	0.15	0.15	0.25
Phase Stability (±deg)	2	2	2	4
Test Port Power (dBm)	6	6	6	0

Virginia Diodes, Inc.
979 2nd St. SE, Suite 309
Charlottesville, VA 22902
434.297.3257

vadiodes.com

See us at IMS Booth 1341

RFIC 2014 Welcome Message

Lawrence Kushner
RFIC 2014 General Chair
Bertan Bakkaloglu
TPC Co-Chair
Albert Wang
TPC Co-Chair

We invite you to join us for the 2014 IEEE Radio Frequency Integrated Circuits (RFIC) Symposium (http://rfic-ieee.org/), to be held in Tampa, Florida on 1-3 June 2014. RFIC is the premier IC conference focused exclusively on the latest developments in RF, microwave and millimeter wave integrated circuit technology and innovation.

RFIC, the International Microwave Symposium (IMS), ARFTG, WAMICON, and the IMS Industry Exhibition make up "Microwave Week 2014," the largest worldwide RF/microwave meeting of the year. Come to Microwave Week to learn from the world's experts through a wide variety of technical sessions, interactive forums, panel sessions, workshops, short courses, industrial exhibits, application seminars and historical exhibits. Share your knowledge with others by presenting your latest results. Expand your network. Catch up with old friends and colleagues. Return invigorated with new ideas and enthusiasm.

For the first time in 2014, RFIC will offer a number of new initiatives specifically geared toward the RFIC industry. First, a new two-page industry brief format is introduced that allows the latest state-of-the-art RF IC design results to be presented, without requiring die photos and detailed schematics (as required in full-length, four-page submissions). Nevertheless, these two-page briefs were subjected to the same technical criteria and rigorous review as full length papers. Secondly, the most innovative and highly-rated industrial papers, both two- and four-page, have been invited to present a poster (and optional demo) at a special Industry Showcase Session to be held concurrent with the popular evening RFIC reception on Sunday, 1 June 2014. In addition to all of the RFIC attendees, the media will be invited to cover this event, making it an excellent opportunity to announce the latest RFIC developments and breakthroughs.

Another new initiative in 2014 was aimed at increasing academic submissions through programs supporting students. All of the RFIC student paper finalists will now receive complimentary RFIC registration. In addition, the lead authors of the top three student papers will receive $500 honorariums along with special recognition at the RFIC Plenary Session where these awards will be announced.

Students have even more ways to participate (and receive financial assistance) this year (http://rfic-ieee.org/student-prgrams). Students may volunteer to help with RFIC (and/or IMS) conference logistics in exchange for complimentary conference registration, meals, t-shirts and other benefits. For the first time in 2014, first- and second-year RFIC PhD students may also participate in the PhD Student Sponsorship Initiative Program, joint with IMS. This program, established and sponsored by the MTT-S Administrative Committee, aims to engage

Explore the limits.
T&M solutions for aerospace and defense.

Please visit us at
IMS 2014
in Tampa Bay,
booth 1439

Today's aerospace and defense technologies demand ever more sophisticated test and measurement solutions to stretch the limits of what is feasible. As a full-range supplier, Rohde&Schwarz offers a broad portfolio that proves its capabilities in even the most demanding applications. Our leading-edge expertise in microwave, RF and EMC helps customers assess performance, optimize platforms and get the most out of systems. Convince yourself.

www.rohde-schwarz.com/ad/sat/fsw

R&S®FSW signal and spectrum analyzer

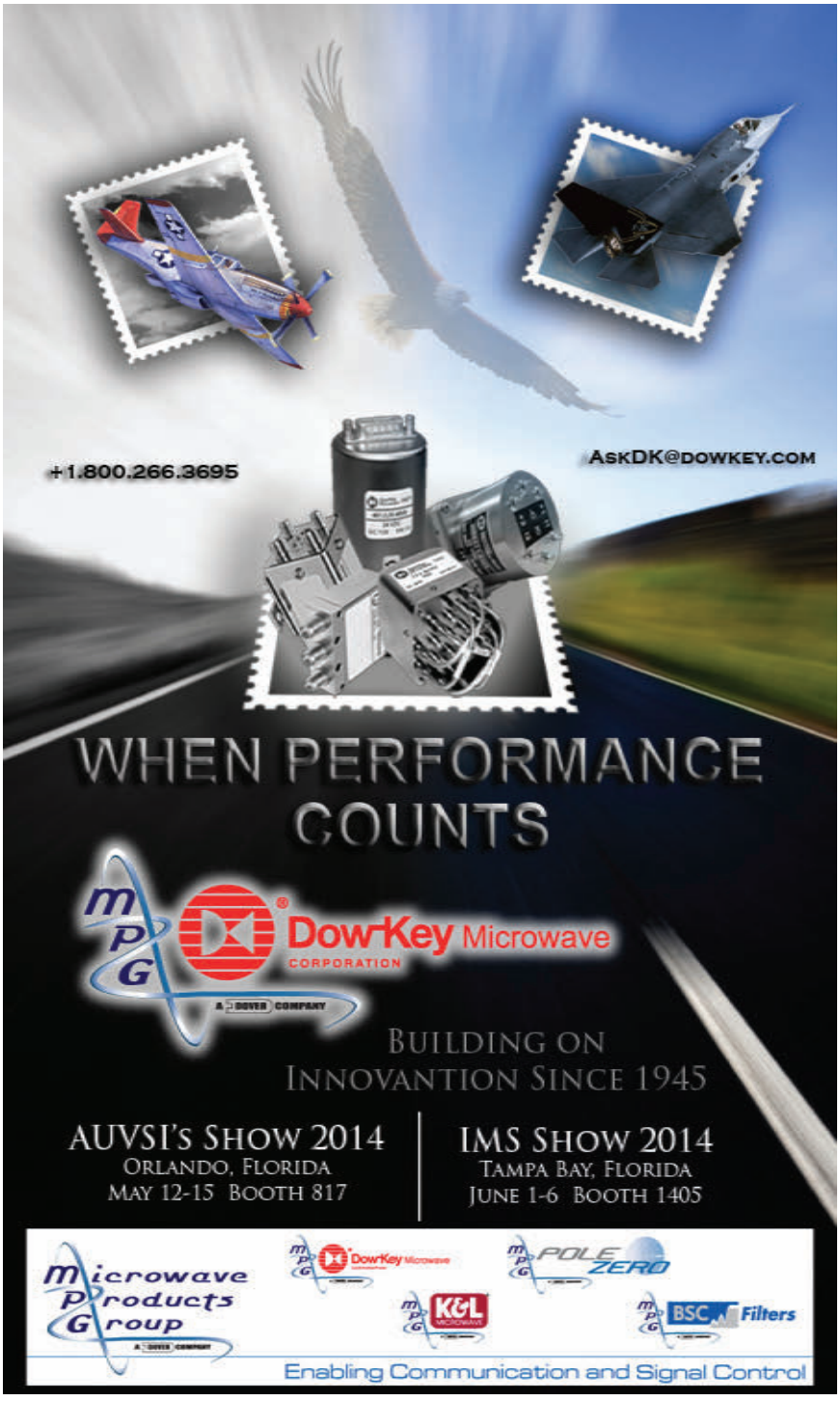
- Models up to 67 GHz **NEW**
- Up to 500 MHz analysis bandwidth **NEW**
- Realtime analysis up to 160 MHz bandwidth **NEW**
- Pulse parameters at a fingertip
- Unmatched low phase noise of –137 dBc (1 Hz) at 10 kHz offset (1 GHz carrier)

ROHDE&SCHWARZ

these PhD students in the conference by having them complete technical assignments during the conference and report on them later in the week. Sponsorship includes complimentary conference registrations (RFIC and IMS), lodging and meals.

The 2014 RFIC Symposium will open on Sunday, 1 June 2014 with a lineup of eight full-day and five half-day workshops (http://rfic-ieee.org/workshops), four of which will be co-sponsored by IMS. Three additional joint RFIC/IMS workshops will be held on Monday. RFIC workshops cover a wide array of topics with presentations from experts in their respective fields, and historically have been highly attended and well received. This year's workshops cover some of the hottest topics in RFIC design. There are a number of workshops focused on power amplifier (PA) design including: silicon and GaN PAs for RF and mm-wave applications, highly-efficient power amplifiers and smart transmitters, power amplifiers for software defined radios, and critical supporting circuit designs such as GaN-based power supply modulators. In the frequency synthesis area, the "frequency synthesis for 60 GHz and beyond: architectures and building blocks" workshop focuses on design techniques for low phase noise frequency synthesizers at mm-wave frequencies. Workshops focused on some of the emerging technologies in RF transceivers include techniques for handling interference and self-interference, RF and wideband data-converters for transmitters and receivers, and EMC/EMI-aware design practices for reducing coupling and interference in integrated circuits.

The RFIC Plenary Session (http://rfic-ieee.org/sunday/plenary) will be held on Sunday evening, in the Marriott Hotel directly across from the convention center. The plenary will begin with some overall conference highlights, followed by the student paper awards. The plenary continues with two outstanding keynote addresses, given by two renowned industry leaders in the RF/microwave community. The first speaker is Pieter Hooijman, vice president R&D and strategy at NXP Semiconductors, whose talk is entitled "How to Differentiate with RF Silicon Technologies in High Volume Applications?" The second speaker is Prof. Lawrence Larson, dean of the School of Engineering at Brown University, who will present a talk entitled "The Next Era of Wireless Communications – Enabling Revolutions in Health Care, Transportation, Energy and the Environment." Be sure not to miss these engaging presentations.



Our Products send a Clear Signal!

Ask us about our latest low-PIM, high-performance products: Quadruplexers, Triplexers, Duplexer and TMAs. We help our customers send a clear signal to the telecom industry.

Vision drives the future

PIVOTONE

PIVOTONE COMMUNICATION TECHNOLOGIES, INC.

7-1 Yanyu Road, Yangiao Industrial Park, Huishan Economic Development Zone, Wuxi, Jiangsu, People's Republic of China Zip code: 214174
Tel: (86).510.8374.0009 Fax: (86).510.8374.2009
Website: www.pivotone.com E-mail: info@pivotone.com

See us at IMS Booth 1049

Immediately following the Plenary Session is the new Industry Showcase Session (http://rfic-ieee.org/sunday/showcase) concurrent with the RFIC reception, providing a mix of "hot chips" and cold drinks. These events will be held in the foyer just outside of the Plenary Session, with a wonderful view of the water and marina. You'll want to be here.

The inaugural RFIC Plenary Round Table Discussion (http://rfic-ieee.org/sunday/roundtable) will be held next, with the stage set "talk show style." Leaders from the RFIC community will engage in a lively discussion on "Beyond 4G Wireless Communications: An RFIC Perspective." Audience participation will be welcome. Once the round table adjourns, the reception will continue where it left off, with plenty of cold beverages to keep everyone cool.

Technical papers will be presented during RFIC oral sessions throughout Monday and on Tuesday morning, followed by the RFIC Interactive Forum on Tuesday afternoon. The Interactive Forum features papers presented in poster format, giving the attendees a chance to speak directly with the authors regarding their work.

During lunchtime on both Monday and Tuesday, the conference features panel sessions (http://rfic-ieee.org/panels) that are sure to draw lively debate among the panelists and audience. Monday's RFIC panel session is titled "Fabless Design: Got Any Problem with That?" and will debate the pros and cons of the fabless design model. The Tuesday panel session, held jointly with IMS, is titled "Is Spectrum Explosion Muffled without Tunable RF?" This panel brings together experts from across the wireless ecosystem to discuss the end user benefits, market opportunities, technical challenges and projected solutions surrounding the spectrum explosion and its impact on RF hardware, and whether or not tunable RF front ends will step in to save the day.

Tampa offers a unique and exciting experience for everyone. A visit to the ever-growing downtown area, or the exciting Channelside and Ybor entertainment districts, will provide you with plenty to see. Tampa has a diverse selection of great restaurants and some of Florida's best attractions, including the Florida Aquarium, Busch Gardens Tampa Bay, the Straz Center for the Performing Arts and Lowry Park Zoo. Of particular note are the new Tampa Bay History Center and the recently opened Tampa Museum of Art.

On behalf of the entire RFIC Steering Committee, we would like to extend to all of you a warm welcome to attend the 2014 RFIC Symposium. We are looking forward to an exciting program and hope you can join us in Tampa! For more details, please visit our website http://rfic-ieee.org. ■

See us at IMS Booth 1205

RF Signal Generators

There's always room for improvement

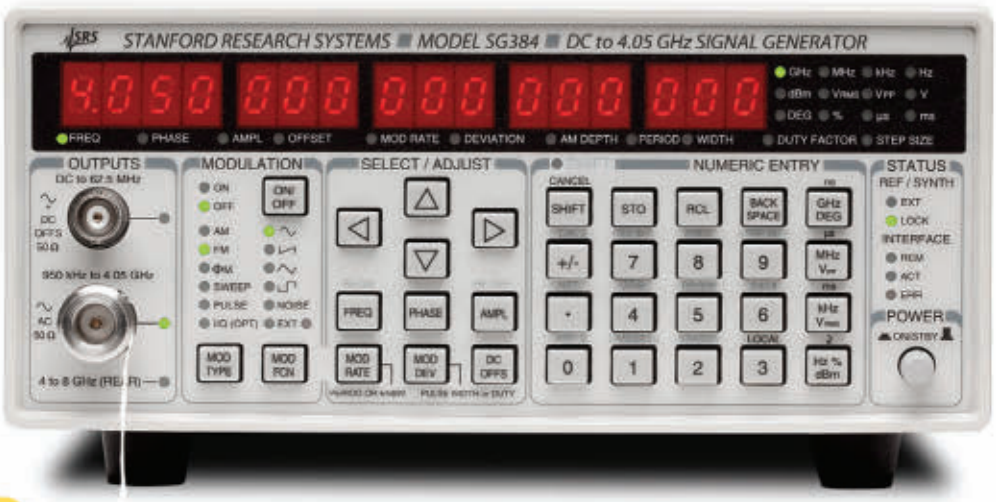
The Agilent N5181A-503 is an excellent 100 kHz to 3 GHz signal generator.

100kHz to 3 GHz ... $8,749

Still, we saw room for improvement ...

- Extending the frequency range to 4 GHz
- Going all the way down to DC
- Adding a low-noise OCXO timebase
- Making AM, FM, ΦM & PM all standard
- And, cutting the price (about in half)

Introducing the SG384 RF Signal Generator ... only from SRS



DC to 4 GHz ... $4,600

You'll even like the fine print: **US List Price $4,600. Standard features:** DC to 4.05 GHz with 1 µHz resolution. Output power from +13 dBm to –110 dBm. Phase noise of –116 dBc/Hz at 20 kHz offset from 1 GHz. A 1 s Allan variance of 1×10^{-11}. 10 MHz timebase input and output. AM, FM, ΦM, pulse modulation and sweeps from internal or external sources. Ethernet, GPIB, and RS-232 interfaces. **Option 1:** Differential clock outputs on SMAs with 35 ps transition times ($750). **Option 2:** Rear-panel SMA output for 4.05 GHz to 8.10 GHz ($750). **Option 3:** I/Q modulator with external BNC inputs ($750). **Option 4:** Rubidium timebase for 0.001 ppm/yr aging ($1500). Please visit **www.thinkSRS.com** for complete specifications.

SRS ***Stanford Research Systems***

Tel: 408-744-9040 • www.thinkSRS.com

Microwave Measurements for Emerging Technologies

Mohamed Sayed
83rd ARFTG General Chair

83RD ARFTG HIGHLIGHTS

Monday

ARFTG Co-Sponsored Workshops (not included in ARFTG registration)

- WMC - Efficient RF Design using Practical Behavioral Models – Bridging the Gap between Measurement and Simulation
- WMI - Challenges and Advances in Wafer-Level Calibration and Characterization at Millimeter and Sub-Millimeter-Wave Frequencies

Thursday

ARFTG/IMS Joint Technical Sessions

- TH1D - Novel Measurement Methods for Microwave Active Devices
- TH2D - Millimeter-wave and Monolithic Measurement Techniques
- Nonlinear Vector Network Analyzer (NVNA) Users' Forum

Friday

Main ARFTG Conference (Co-located with WAMICON)

- Four Oral Presentation Sessions and Interactive Forum
- Vendor Exhibit
- Breakfast, Lunch and Coffee Breaks (AM and PM)
- USB Conference Digest (includes all technical sessions)

Welcome to the 83rd Automatic RF Techniques Group (ARFTG) Microwave Measurement Conference being held at the Tampa Marriott Waterside Hotel and Marina on Friday, June 6, 2014.

The Friday conference schedule includes two invited talks covering important emerging technology measurement issues. Nuno Borges Carvalho (University of Aveiro) will present a talk entitled "Instrumentation in Mixed-Signal and Mixed-Domain Emerging Technologies" opening up the mixed-signal/nonlinear portion of the content. Katia Grenier (LAAS-CNRS) will present "Microwave Measurements for Biological Materials Analysis" starting the portion of the conference content dealing with measurements and calibration in complex media. The program contains 14 additional talks and 18 interactive forum papers in areas of current measurement interest. The interactive forum is co-located with the vendor exhibits over ex-

Any Senario

Performance • Reliability • Repeatability

Scan page using layar app

FlexMatrix For All Your RF Switching Needs

FlexMatrix standard off-the-shelf switch matrices enable designers and test engineers to focus on developing their next generation products.

For over 10 years SenarioTek has offered the market's most competitive alternative for the creation of custom RF and microwave switch matrix products. The FlexMatrix RF Switch Matrix family incorporates our design and manufacturing knowledge from delivering over 400 unique switch matrix designs.

FlexMatrix Highlights

- Frequencies from DC to 40 GHz
- Wide range of standard configurations
- Over 10 million switching cycles
- De-embed with onboard correction
- Delay matching to ± 1 ps
- SCPI compatible remote control
- Three-year standard warranty

SenarioTek

Contact us for a quote: 707.544.2770 • sales@senariotek.com

Learn more at www.senariotek.com

In Pursuit of Excellence Through Engineering

PROUDLY INTRODUCING...

WhisperSyn

Superior low phase noise and fast switching synthesizer technology

APPLICATIONS

Radar, Electronic Warfare, Communications and Test Equipment

- Wide bandwidth coverage: 0.625 to 10 GHz
- Fast switching time: <100 µ sec
- Exellent resolution: 0.001 Hz
- Super low phase noise:

Offset Frequency	0.65 GHz Typ (max.) dBc/Hz	1.0 GHz Typ (max.) dBc/Hz	5.0 GHz Typ (max.) dBc/Hz	10.0 GHz Typ (max.) dBc/Hz
100 Hz	-86(-80)	-84(-78)	-70(-64)	-64(-58)
1 KHz	-126(-120)	-124(-118)	-110(-104)	-104(-98)
10 KHz	-143(-137)	-141(-135)	-128(-122)	-122(-116)
100 KHz	-145(-139)	-143(-137)	-130(-124)	-124(-118)
1 MHz	-151(-145)	-149(-143)	-136(-130)	-130(-124)
Noise Floor	-158(-152)	-156(-150)	-150(-144)	-147(-141)

Model PSYN-06510-100

Serving the Aerospace, Defense, Communications & Scientific Community for over 36 years

1978 36 Years 2013

AMERICAN MICROWAVE CORPORATION

MIL 883 CAPABLE - ISO9001:2008 REGISTERED

7309-A GROVE RD | FREDERICK, MARYLAND
PHONE 301.662.4700 | FAX 301.662.4938
AMERICANMIC.COM | SALES@AMERICANMIC.COM

See us at IMS Booth 509

tended breaks allowing much more interaction than is possible in larger halls.

The contributed conference papers range from practical methods and techniques to cutting edge research on measurement technology and over such topics as nonlinear measurement systems, calibration issues, on-wafer measurement, mixed-signal topics, broadband and millimeter-wave, and other areas of RF and microwave measurement. This year, ARFTG is co-located with the WAMICON Conference (as part of the same registration for even more technical content).

Your ARFTG conference registration also includes access to joint IMS/ARFTG measurement sessions on Thursday, the Nonlinear Vector Network Analyzer (NVNA) Users' Forum on Thursday, and a one year membership in ARFTG. Thursday's joint sessions are "Novel Measurement Methods for Microwave Active Devices" and "Millimeter-wave and Monolithic Measurement Techniques." The NVNA Users' Forum is an informal discussion group devoted to sharing information and issues related to instrumentation utilized in vector large-signal analysis of microwave circuits and systems. This event is open to all ARFTG, IMS and RFIC attendees.

Consider also registering for one of the ARFTG sponsored workshops: "Efficient RF Design using Practical Behavioral Models – Bridging the Gap between Measurement and Simulation" and "Challenges and Advances in Wafer-Level Calibration and Characterization at Millimeter and Sub-Millimeter-Wave Frequencies." These all-day workshops are scheduled for the Monday of Microwave Week and provide focused analysis of these interesting topics.

No better opportunity is available to interact with vendors, experts and colleagues in the RF and microwave test and measurement community. Ask questions, propose collaboration or simply learn from the experiences being discussed. ARFTG's two annual conferences are well-known for this unique opportunity and welcoming environment. Starting with breakfast and continuing through the exhibition, interactive forum and luncheon, there will be ample opportunity for discussion with others facing similar challenges. Attendees find that these interactions are often the best source of ideas and information for their current and future projects.

Full details of the technical program and of the conference are available at www.arftg.org. ARFTG conference registration is available through the IMS website at www.ims2014.org.■

IMS 2014 Show Coverage

Catch our exclusive conference information, news, social networking, photos, videos and more at MWJournal.com/IMS2014.

The Leader in Switching Solutions

The global provider of ultraminiature, hermetically sealed and solid state switching products for over 50 years.

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

MICROWAVE COAXIAL SWITCHES

- SPDT, Transfer, Multi-Throw
- Switches and Switch Matrices
- SP3T-SP10T
- 5 million cycles characteristic life
- DC to 40 GHz
- Custom products

RoHS or Non-RoHS: Your Choice!

ELECTROMECHANICAL RELAYS

- New LoopBack Relay
- Signal integrity up to 20 Gbps
- DC-16 GHz

INDUSTRIAL/COMMERCIAL SOLID-STATE RELAYS

- Single, Dual and 3-Phase products
- Soft Start motor controllers
- High current, high voltage

MILITARY & COTS SOLID-STATE RELAYS

- Robust design, wide temperature range
- AC, DC and Bidirectional
- Short circuit protection

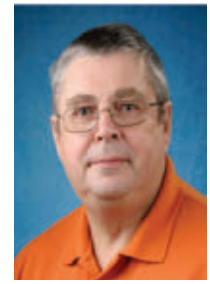
Visit Us at MTT-S IMS June 3-5
Booth # 723 in Tampa Bay, Fl

800-596-3855 ● www.teledynerelays.com
800-351-7368 ● www.teledynecoax.com

TELEDYNE RELAYS Everywhereyoulook™

TELEDYNE COAX SWITCHES Everywhereyoulook™

WAMICON 2014 Chair's Message



Ray Pengelly
WAMICON 2014 General Chairman

As General Chair, I invite you to participate in the 2014 IEEE MTT-S WAMICON, Wireless and Microwave Conference, to be held in Tampa, Florida on Thursday 5th and Friday 6th June 2014. WAMICON 2014 is the 15th consecutive Wireless and Microwave Conference to be held in Florida. WAMICON started life as an outcome of industry/academic exchange between the University of South Florida (USF) Electrical Engineering Department's Center for Wireless and Microwave Information Systems (WAMI Center) and a number of both local and national companies involved in microwave and wireless engineering. The first "conference" was held in February 1999 at the Embassy Suites adjacent to the USF campus. That conference with its small 50 or so attendees has blossomed over the years into an IEEE MTT-S sponsored annual international conference in various locations in Florida with generous support from academia and industry. In 2013, with close to 200 attendees, WAMICON, held in Orlando as an extended weekend event, had Sunday workshops, tutorials on Monday and Tuesday as well as 60 papers, a student poster competition and a separate industry poster interactive session. WAMICON has also grown from the viewpoint of having a range of commercial sponsors, a great mix of industry, governmental and academic attendees and authors as well as an expanding exhibitor presence. One of the aspects that adds to the charm of the event is the strong involvement of student and early career engineers as organizers and participants and one of the highlights has always been a lively, well-attended evening (student presenter dominated) poster session reception to close the first day of the typically two and a half day event.

The International Microwave Symposium (IMS), ARFTG, WAMICON and RFIC as well as the IMS industry exhibition make up "Microwave Week," the largest worldwide RF/microwave meeting of the year.

The theme for WAMICON 2014 is "Emerging RF and Microwave Technologies" where authors have been especially encouraged to submit papers on biomedical applications, wireless sensing, energy harvesting, wireless power transfer, terahertz technologies, nanodevices and circuits.

CONFERENCE HIGHLIGHTS

Keynote Speaker

Chancellor Linda P.B. Katehi
University of California, Davis

Plenary Speaker

Upkar J. S. Dhaliwal
Wireless Technology System Architect & Wireless Business Development Expert

WORKSHOPS

Recent Advances in Radar

Indoor Sensors, Wireless Implantable Devices and Biosensors

Highly Efficient Power Amplifiers and Smart Transmitters

A total of eight invited papers from universities and industry together with 30 other presentations will be given in two parallel sessions during Friday, June 6th. Consistent with WAMICON tradition, there will also be an interactive Student Poster Session held in conjunction with a joint WAMICON/ARFTG welcoming reception early Thursday evening on the 5th June. A separate interactive forum will be held in the afternoon of the 6th June for other university and industry poster contributors with a record number of submissions.

As has also become a tradition for many years at WAMICON, three author awards will be presented (consisting of trophies and gifts) for the best student poster, best student paper and best overall oral presentation. One other award presented is the Rudolf E. Henning Distinguished Mentoring award, given each year since 2009 to a person exemplifying selfless dedication to encouraging students and/or mentoring young engineers to advance their careers in the areas of RF/Microwave and/or Wireless Engineering.

Go to the WAMICON 2014 website to get the latest information at www.wamicon.org.

On behalf of the WAMICON 2014 Steering Committee, I would like to extend to all of you a warm welcome to participate in this year's 2014 Wireless and Microwave Conference which is co-located with ARFTG at the beautiful Marriott Waterside Hotel and Marina. ■

SKYWORKS®

Discrete and Integrated RF Solutions

Skyworks Broad Product Portfolio Supports a Wide Variey of Markets

Visit Us at IEEE MTT-S IMS2014 • Booth 1815 • Tampa, FL • June 1–4!

Cellular and Broadband Communications

Semiconductor, ferrite and ceramic solutions for wireless communications infrastructure systems, including small cell and cellular base stations, LTE access points, land-mobile radio systems, point-to-point radio links and more. Also, highly integrated PA and FEM solutions with embedded mobile connectivity for GSM, GPRS, EDGE and WCDMA, CDMA, and LTE air interfaces.

Smart Energy and the Connected Home

Unique front-end solutions for automated metering infrastructure (AMI), security, medical, and home/industrial automation. Products address all major ISM bands and ZigBee® / IEEE 802.15.4 standards.

Wireless Data Communications (WLAN)

High-performance RF switching and amplification solutions that enable design flexibility for all 802.11a,b,g,n,ac WLAN applications.

Military / Microwave

Amplifiers, switches, diodes, circulators, isolators, optocouplers, optoisolators, ceramic filters and resonators for defense and homeland security systems including radio communications, radars, electronic surveillance, electronic countermeasures and more. Screenings equivalent to JANS level of MIL-PRF-19500 and Class K of MIL-PRF-38534.

Join our customer email program instantly by scanning the QR code with your smartphone, or visit our Web site at ***www.skyworksinc.com***.

USA: 781-376-3000 • Asia: 886-2-2735 0399 • Europe: 33 (0)1 43548540 • Email: sales@skyworksinc.com

www.skyworksinc.com • NASDAQ: SWKS •

Scan page using layar app

Tune in to Social Media at IMS 2014

Sherry Hess
AWR Corp., El Segundo, CA

We're still a few weeks away from the International Microwave Symposium taking over the Tampa Bay area for #ims2014. But you don't have to wait until June to join the conversation. From contests to surprise guests to photos you should "like," we've got a number of social media engagements already in the works. Read on for all the ways to engage with IMS leading up to, during and after the symposium.

BEFORE IMS

The IMS social channels are a great way to interact with other attendees and experience real-time IMS-related updates. You can expect a constant stream of posts on the IMS Facebook and Twitter channels in the weeks leading up to the event. Brush up on the latest industry news on "Microwave Mondays," stay on top of important dates and deadlines with timely reminders and ponder blog posts by your favorite IMS personalities on topics ranging from "STEM is Smart & Sexy" to "Diffusion of Innovation," all from the IMS Facebook, Twitter and homepage – www.ims2014.org.

But don't just sit back and watch! Join the conversation by testing your knowledge with "Trivia Tuesdays" or submitting your photos from previous symposiums for "Throwback Thursdays." It's your contributions that help amp up the enthusiasm for #ims2014 even before the show begins, and we want to hear from you!

AT THE CONFERENCE AND ON THE EXHIBIT FLOOR

WIN! The social media opportunities will grow exponentially at the show as we kick off the second-annual #IMSInsider contest. Didn't catch this last year? Now is your chance. During the contest period, attendees can complete up to five different missions each day by tweeting, sharing on Instagram or posting to the IMS Facebook page. Prizes will be awarded daily with a grand prize at the end of the week. Last year's winners walked away with restaurant gift cards, t-shirts and the grand prize, an iPad Mini. Connect to one or more of the IMS social media sites to stay informed and for more details on this year's #IMSInsider contest and prizes!

CLICK! Want to document your experience on the show floor? Take a fun photo to share on your social channels? The ChirpE iPad photo booths will be back again this year, so grab your colleagues to take a picture, share a quote and post it to the official IMS 2014 photo album on Facebook.

SURPRISE! IMS 2013 attendees may remember a new "exhibitor" roaming the show floor in Seattle and giving away t-shirts to those lucky enough to "Spot Sasquatch." While Sasquatch won't be making the trip this year, make sure to keep your eyes peeled for Tampa's new special guest and the booty he'll have up for grabs.

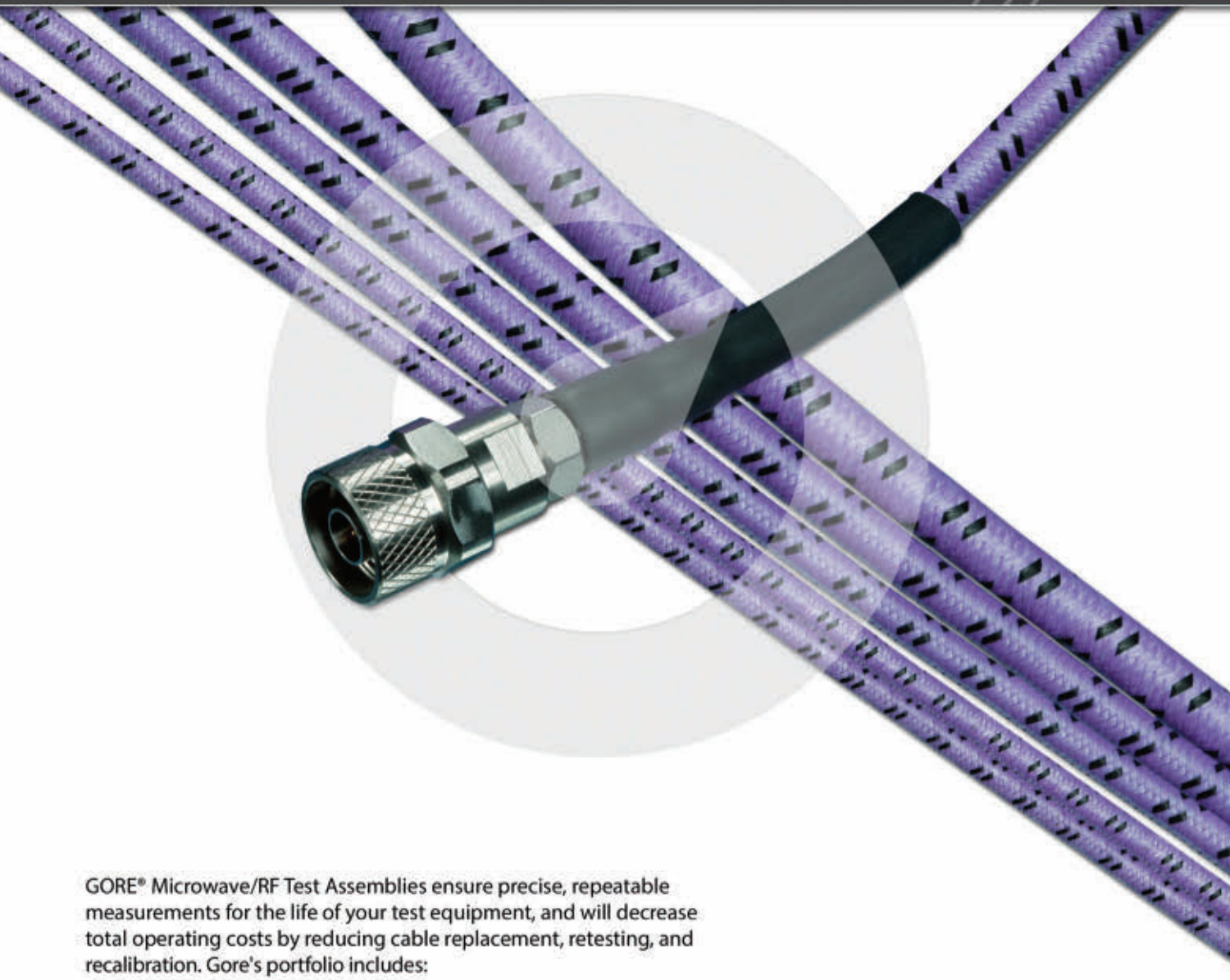
POST SHOW

Social media doesn't sleep. We run 24/7 before, during and even after the show! Check back frequently as we post photos from the symposium, relive our favorite moments, and heat up for IMS 2015. It's the best way to stay up-to-date and connected with your colleagues from around the world, year round.

IMS Social Channels
Facebook:
www.facebook.com/IEEE.MTTS.IMS
Twitter:
www.twitter.com/mtt_ims
Instagram:
www.instagram.com/mtt_ims
LinkedIn:
www.linkedin.com/groups/IEEE-MTTS-International-Microwave-Symposium-2375668/about

Performance Over Time

GORE® Microwave/RF Test Assemblies offer unmatched precision, repeatability and durability.



GORE® Microwave/RF Test Assemblies ensure precise, repeatable measurements for the life of your test equipment, and will decrease total operating costs by reducing cable replacement, retesting, and recalibration. Gore's portfolio includes:

- **GORE® PHASEFLEX® Microwave/RF Test Assemblies –** Provide excellent phase and amplitude stability with flexure.
- **110 GHz Test Assemblies –** Engineered to be flexed, formed and repositioned while maintaining excellent electrical performance.
- **VNA Microwave Test Assemblies –** Provide exceptional performance for precision test applications with frequencies through 67 GHz.
- **General Purpose Test Assemblies –** Excellent electrical performance for everyday test applications.

See us at IMS Booth 1027

GORE
Creative Technologies Worldwide

gore.com/test

Choose GORE® Microwave/RF Test Assemblies.
For the life of your test equipment.

LIKE US ON facebook FOLLOW US ON twitter

GORE, PHASEFLEX, the purple cable and designs are trademarks of W. L. Gore & Associates.

Scan page using layar app

Tampa Bay Attractions

Photo courtesy of the Florida Aquarium.

Patrick Hindle
Microwave Journal *Technical Editor (and ex-Floridian)*

Being the only major city on the west coast of Florida, Tampa is a little quieter than the bustling east coast that has many major cities like Miami, Ft. Lauderdale, West Palm Beach, Daytona and Jacksonville. But it offers a variety of Sunshine State activities such as boating, fishing, swimming and amusement parks. Here are some selected highlights of the attractions in the Tampa Bay area.

AMUSEMENT PARKS

One of the major Tampa Bay attractions is Busch Gardens which covers more than 300 acres in central Tampa. Busch Gardens opened as an adjunct to the Anheuser-Busch Brewery in 1959 and has evolved to compete with Disney World and its sister park, SeaWorld, in nearby Orlando. The park specializes in a wide variety of roller coaster rides with several other amusements. Not far from Busch Gardens—and also owned by SeaWorld Parks & Entertainment—Adventure Island offers a variety of water park activities. The wave pool is nearly half an acre and there is a large variety of slides plus a lazy river for enjoying some wet fun ranging from exciting to relaxing activities.

MUSEUMS

The Tampa Bay History Center is a museum that has information about Tampa Bay's first native inhabitants (the Indians), the conquistadors who occupied the area and state (the Spaniards) and influential people who shaped the area's history. The Museum of Science and Industry (MOSI) has more than 450 exhibits highlighting science and technology in a fun atmosphere. It includes a hurricane simulator, an IMAX Dome theater and a planetarium. The Henry B. Plant Museum, with its Moorish architecture, opulent furnishings and spectacular tropical gardens, has attracted a host of celebrated guests. A visit the museum and the authentically restored rooms of the Tampa Bay Hotel will transport you back to Victorian splendor.

The Tampa Museum of Art is located in downtown Tampa and exhibits modern and contemporary art, as well as Greek, Roman and Etruscan antiquities. There is also the SS American Victory that is one of only four operational World War II ships in the U.S. As a national historic landmark, the Mariner's Museum Ship offers educational tours, event hosting and semi-annual cruises.

RESTAURANTS

Tampa has great restaurants, many right on the water with a great view. One that stands out is Bern's Steak House where you will probably have the best steak dinner you can remember. They have an extensive wine list and special upstairs room just for dessert. Also consider a dinner cruise and for lunch try a Cuban sandwich or deviled crab at a local restaurant like La Tropicana Café. For more restaurant information, visit www.visittampabay.com/eat/.

ENJOY THE OUTDOORS

Honeymoon Island State Park is a natural barrier island. Cross over the bay on a causeway and travel into a little area of what coastal Florida used to look like. The mangrove swamps and tidal flats attract birds and other small animals. Shelling is great along the shoreline and it is a great place to picnic and enjoy the beach. Tampa offers some great fishing in both the flats off shore and deep sea fishing. There is plenty of charter boats available specializing in all types of fishing. There are also many opportunities to enjoy the water like canoeing and kayaking, or for the more adventurous, jet skiing and water skiing. The Florida Aquarium features a fascinating array of animals and birds found along Florida's waterways including more than 20,000 aquatic plants and animals from Florida and all over the world.

Tampa offers some beautiful beaches and outdoor water activities so try to carve out some extra time to see the local attractions. IMS always offers many organized companion activities. So have your significant other or family check those out if they are coming along. ■

EMC Technology

Diamond RF Resistives®

Resistors, terminations, and attenuators up to 150 Watts and 30 GHz.
Ask us how to shrink your high power design with CVD Diamond components.
emc-rflabs.com

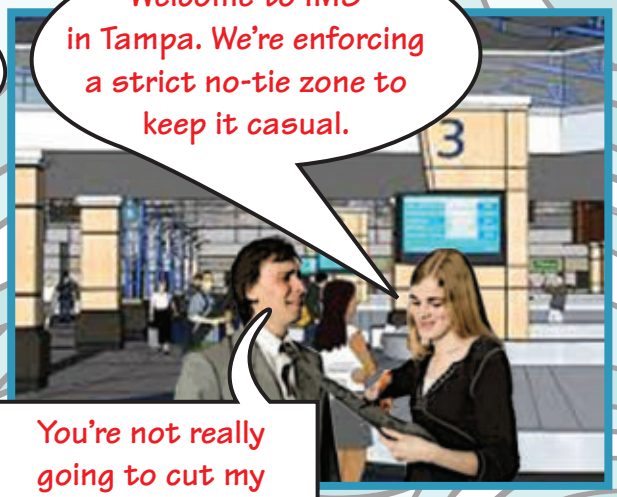
smiths microwave

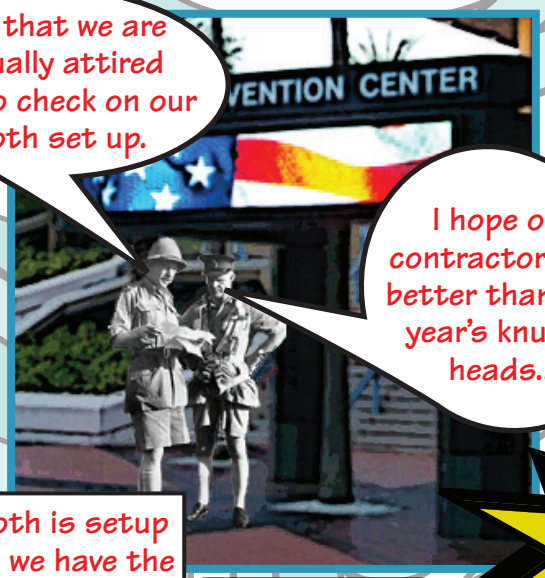
+1 772-286-9300 +1 800-544-5594

See us at IMS Booth 923

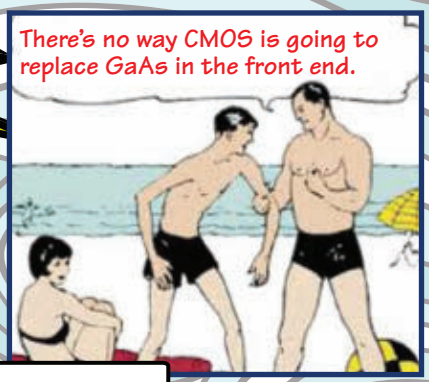
MTT-STORIES 2014

For many engineers in North America it was a long cold winter. But as May turned to June, a select crowd heads south...





MEANWHILE... DOWN BY THE BAY



With the show in Florida, home of
Jimmy Buffet, let's sing a round of

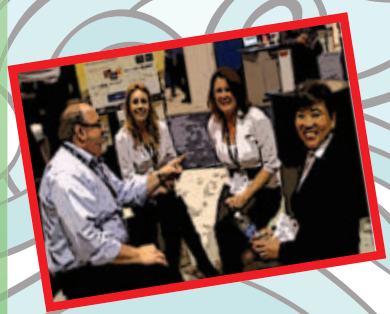
"Wasting away again in Microwave-A-ville"

Nibbling on Twix bars
straight from a glass jar
This could be lunch
for the rest of the day
Had plenty of coffee
and now that I must flee
I'm in conversation and can't get away

Chorus:
Wastin' away again in microwave-a-ville
Hanging out with the reps and PhDs-
Some are obsessed
that's it's the I-M-S
But to me,
it's still the MTT

The booth is now filling
With dudes that are chillin'
Plenty of students looking for bling.
Can give them a sales pitch
or go grab a sandwich
Either way they won't buy a thing

Chorus:
Wastin' away again in microwave-a-ville
Hanging out with the reps and PhDs-
Some are obsessed
that's it's the I-M-S
But to me,
it's still the MTT



Working the show floor
Man are my feet sore
Standing and talking
for hours on end
My energy's waning
and back is complaining
But here comes a lead
with some money to spend

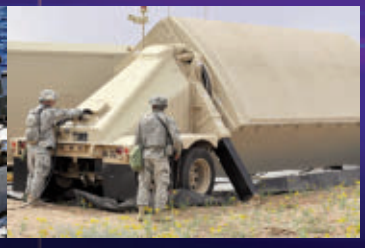
Cap'n Larr says,
"Enjoy Tampa
and thanks for
coming."

Chorus:
Wastin' away again in microwave-a-ville
Hanging out with the reps and PhDs-
Some are obsessed
that's it's the I-M-S
But to me,
It's still the MTT

DOWNTOWN TAMPA
Westshore & Airport Hotels
8 9 10 11 12 13 14 15
Ybor City Hotels
16 17
To Ybor City
To St Petersburg, Clearwater & Beaches
Exit 45A
275
Kay St
Scott St
Laurel St
Fortune St
Harrison St
Tyler St
Cass St
DOWNTOWN
Marion Transit Center
In-Town Trolleys connect to HARTline Buses
PERRY HARVEY SR PARK
HERMAN MASSEY PARK
In-Town Trolley Rt 96
2 Residence Inn
7 Courtyard
Straz Center for the Performing Arts
Tampa Theater
William F. Poe Garage
Tampa Museum of Art
Glazer Children's Museum
CURTIS HIXON PARK
Kennedy Garage
ALEX GARDENS
LYKES GASLIGHT SQUARE
COURT HOUSE SQUARE
Edgecomb Courthouse
Courthouse Annex
County Courthouse
Twiggs St Garage
Pierce St Garage
Jackson St
Madison St
Kennedy Blvd
Washington St
Whiting St
Finley St
Walton St
Cumberland
Eunice
Brorein St
Grand Central Av
Kellar St
Cardy St
W Kennedy
University Dr
University of Tampa
PLANT PARK
Hillsborough River
Poe Plaza
Parker St
Hyde Park Av
Cedar
Plant Av
Ashley Dr
Tampa St
Franklin St
Florida Av
Morgan St
Jefferson St
Nebraska Av
Meridian Av
Governor St
Orange Av
Marion St
Laurel St
Fortune
Madison
Zack St
Polk St
Pierce St
Brush St
Caesar St
SELMON EXPRESSWAY
Exit 7
Exit 8
Exit 8A
Exit 8B
Exit 8C
Exit 8D
Exit 8E
Exit 8F
Exit 8G
Exit 8H
Exit 8I
Exit 8J
Exit 8K
Exit 8L
Exit 8M
Exit 8N
Exit 8O
Exit 8P
Exit 8Q
Exit 8R
Exit 8S
Exit 8T
Exit 8U
Exit 8V
Exit 8W
Exit 8X
Exit 8Y
Exit 8Z
TOLL 618
60
1 Hilton Tampa Downtown
3 Sheraton Tampa Riverwalk
Ft Brooke Garage
Whiting Street Garage
Tampa Conv Center Garage
4 Embassy Suites
South Regional Garage
Tampa Convention Center
6 Tampa Marriott Waterside
Tampa Bay Times Forum
Tampa Bay History Center
Channelside Dr
Channelside Bay Plaza
Cruise Terminal 2
Cruise Terminal 3
Cruise Terminal 6
Tampa Port Authority
Port Authority Garage
CHANNEL DISTRICT
Florida Aquarium
American Victory Ship Museum
Yacht Starship
McCants
Twiggs St
Madison St
Washington St
WASHINGTON STREET PARK
Whiting St
Finley St
Walton St
Cumberland
Eunice
Brorein St
Channelside Dr
Ybor Channel
TECO Line Streetcar
LEAP PARK
FONT PARK
TONY JANUS PARK
Dick Greco Plaza
In-Town Trolleys & Streetcars connect here
Old Water St
COTANCHOBEE FT BROOKE PARK
Garrison Channel
Harbour Place
Harbour Point
Knights Run
DAVIS ISLANDS
HARBOUR ISLAND
5 Westin Tampa Harbour Island
Tampa General Hospital
Bayshore Blvd
Beneficial Blvd
To Hyde Park & SoHo
Exit 3
TOLL 618
Getting Around Downtown Tampa
TECO Line Streetcar System
Route & Stops
MON-THU Noon - 10pm
FRI & SAT 11am - 1:30am
SUN Noon - 8pm
Service every 20 min
Exact Fare or Fare Card Required
Check goHART.org for Holiday Hours
In-Town Trolley
ROUTE 96
Route & Stops
MON-FRI 6am - 8:30am
3:30pm - 6pm
Service every 15 minutes.
Exact Fare or Fare Card Required
Check goHART.org for Holiday Hours
MAP LEGEND
One Way Streets
Recom'd Convention Parking
Major Parking Lots / Garages
Visitor Information
Taxi Stands
Hospitals
Taxi Stands
Tampa River Walk
Map Courtesy of
Discover In-Town Guide & Map
©2014 CJ Publishers 888-FLA-MAPS
DiscoverInTown.com
Conference Hotel Locations
1 Hilton Tampa Downtown
2 Residence Inn Tampa Downtown
3 Sheraton Tampa Riverwalk
4 Embassy Suites Tampa
5 Westin Tampa Harbour Island
6 Tampa Marriott Waterside
7 Courtyard Tampa Downtown
8 Renaissance Tampa Hotel*
9 DoubleTree Airport Westshore*
10 Marriott Tampa Westshore*
11 Marriott Tampa Airport
12 Wyndham Westshore Hotel*
13 Hilton Tampa Airport Westshore*
14 InterContinental Westshore Hotel*
15 Holiday Inn Tampa Westshore*
16 Hilton Garden Inn (Ybor)*
17 Hampton Inn & Suites (Ybor)*
*IEEE Shuttles to Tampa Convention Center
All Rights Reserved. Reproduction in whole or in part without written permission is prohibited. SPRM
IMS2014 Tampa Bay, Florida
Powering the Media
International Microwave Symposium
IEEE 1-6 June 2014, Tampa Bay, FL MTT-S
Stop by CTT's Booth #429 and enter to win an EA-18G Growler model.

Enabling wideband frequency agility

GaN and GaAs Solid-State Power Amplifiers for Multi-Function, Radar and EW System Design



Whether your application is narrowband, wideband or ultra-wideband, operating in pulsed or CW mode, CTT's power amplifiers are an especially attractive choice for new multi-function frequency-agile systems that effectively conserve weight, space and power consumption.

The characteristics of the portion of the electromagnetic spectrum selected for any of these particular system designs are undoubtably the most important to the end user, as it has the greatest impact on the type of information required and received.

Engineered specifically to meet the stringent requirements imposed by many modern system designs, CTT's family of GaN and GaAs-based solid-state power amplifiers excel in a wide range of applications.

CTT has delivered production quantities of amplifiers with power levels from 10 through 200 Watts – and higher – for a variety of multi-function, radar and EW applications.

- AMDR
- Shipboard Radar
- AESA Radar
- VLO/FLO Threats
- New Land Radar
- EW
- UAVs

More than thirty 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.

Microwave Technology Leadership

- **Power Amplifiers**
  - **NEW GaN and GaAs Models**
  - Radar Bands up to 400W
  - EW Bands up to 200W
  - Pulse and CW
  - Rack-Mount Configurations
- **Low-Noise Amplifiers**
- **Up and Downconverters**
- **Subsystems**
- **Custom Engineered Options**

nsai
ISO 9001:2008 QUALITY

USA-based thin-film microwave production facility

CTT INC.

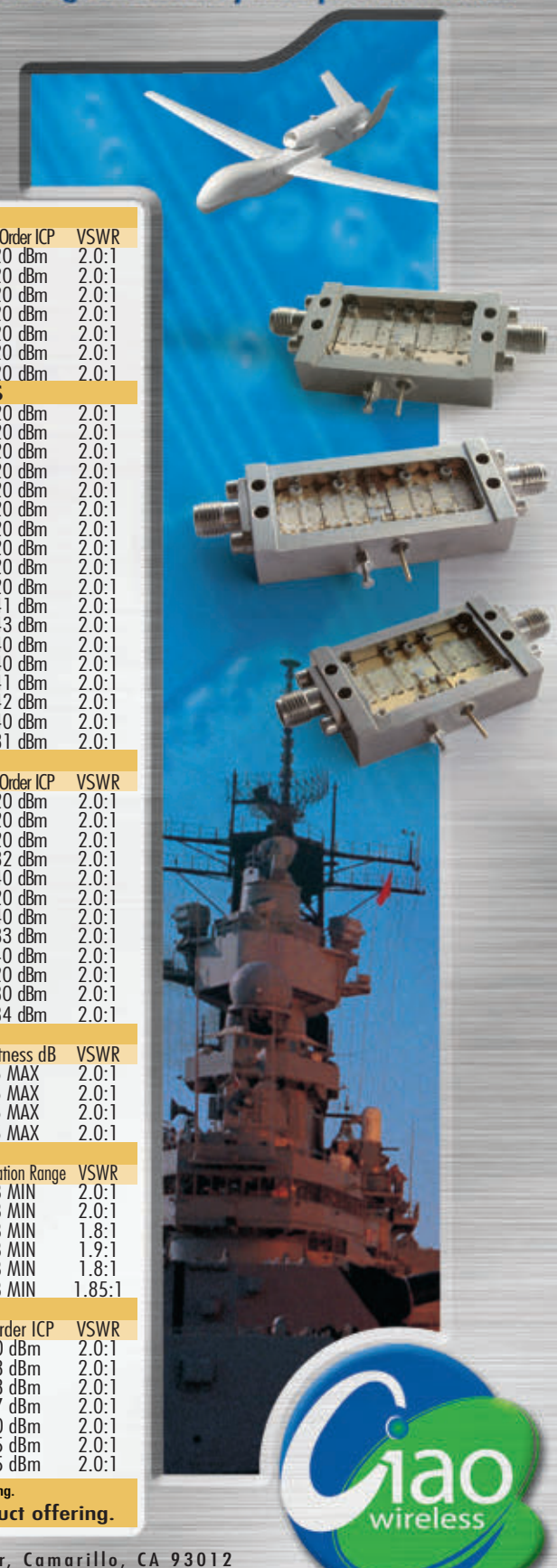
241 East Java Drive • Sunnyvale • California 94089 • Phone: 408-541-0596 • Fax: 408-541-0794
www.cttinc.com • E-mail: sales@cttinc.com

RF Amplifiers and Sub-Assemblies for Every Application

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

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

ISO 9001:2000 and AS9100B CERTIFIED



OCTAVE BAND LOW NOISE AMPLIFIERS

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

NARROW BAND LOW NOISE AND MEDIUM POWER AMPLIFIERS

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

ULTRA-BROADBAND & MULTI-OCTAVE BAND AMPLIFIERS

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

LIMITING AMPLIFIERS

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

AMPLIFIERS WITH INTEGRATED GAIN ATTENUATION

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

LOW FREQUENCY AMPLIFIERS

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

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

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

See us at IMS Booth 604

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

NGC Begins Integrating High-Speed Downlink Antennas for 4th AEHF Communications Payload

VIEW VIDEO

Two downlink antennas that are the fastest of their kind to operate in space are being integrated into the protected communications payload built by Northrop Grumman Corp. for the fourth Advanced Extremely High Frequency (AEHF) satellite.

The company delivered the Super High Frequency Array Unit (SAU), as the antennas are called, in early March to AEHF system prime contractor, Lockheed Martin, in Sunnyvale. These high-speed downlink phased array antennas, the first to operate at 20 GHz in space, provide assured point-to-point connectivity using electronically steerable beams that reach military users at fixed-site and mobile terminals.

Under a hybrid integration plan, Lockheed Martin is integrating the satellite business unit within the system module while a team from Northrop Grumman simultaneously completes remaining payload integration.

Northrop Grumman produces phased array antennas, which are a new technology developed specifically for AEHF satellites. High-speed downlink phased array antennas are the first of their kind to operate at 20 GHz in space. High-speed uplink phased array antennas operating at 40 GHz provide direct radio frequency beams electronically rather than by moving reflectors mechanically.

Advanced EHF anti-jam payloads communicate via super high frequency downlinks, transmitting in the 20.2 to 21.2 GHz frequency band, and EHF uplinks, which also are the first to operate at 40 GHz in space.

> "This allows one array to do the job of many reflectors, giving the flexibility to point-on-demand in fractions of a second to hundreds of coverage areas..."

"This allows one array to do the job of many reflectors, giving the flexibility to point-on-demand in fractions of a second to hundreds of coverage areas, greatly improving access and automatically countering signal jamming by adversaries," said Stuart Linsky, vice president, Communication Programs, Northrop Grumman Aerospace Systems.

This agility and flexibility of the beams formed by the phased arrays are critical to providing coverage to the dispersed tactical and strategic users on the AEHF system. The high-speed phased arrays are used to form multiple beam types concurrently including high gain earth coverage anywhere in the satellite field of view, super high gain earth coverage to up to 160 locations, and up to 24 medium resolution coverage area spot beams.

The next generation of protected military satellite communications satellites, AEHF provides vastly improved global, survivable, highly secure, protected communications for strategic command and tactical warfighters operating on ground, sea and air platforms. The system also serves international partners including Canada, the Netherlands and the United Kingdom.

Source: Lockheed Martin

With the more compact phased array, AEHF can process greater amounts of information. It will deliver 10 times greater total capacity and channel data rates six times higher than that of Milstar II communications satellites. AEHF is the successor to the Milstar system.

U.S. Gains Additional Protection Against Ballistic Missiles

VIEW VIDEO

The U.S. will soon have another system to defend against ballistic missiles. Raytheon Co. delivered its ninth AN/TPY-2 ballistic missile defense radar to the Missile Defense Agency, six months ahead of schedule.

AN/TPY-2 is an integral element of the Ballistic Missile Defense System. It is a mobile X-Band radar that helps protect civilians and infrastructure in the U.S., deployed warfighters and allied nations and security partners, from the growing ballistic missile threat. U.S. public intelligence estimates indicate there are more than 6,300 ballistic missiles not controlled by the U.S., NATO, China or Russia, with that number expected to reach almost 8,000 by 2020.

> "The AN/TPY-2 consistently demonstrates its ability to pace the evolving threat..."

"Delivering this ninth radar is crucial because our nation's enemies continue to improve and proliferate their ballistic missile technology and tactics," said Raytheon's Dave Gulla, vice president of Integrated Defense Systems' Global Integrated Sensors business area. "The AN/TPY-2 consistently demonstrates its ability to pace the evolving threat, and test after test has proven it effectively defends against every category of ballistic missile."

The radar will be integrated into the U.S. Army's fourth Terminal High Altitude Area Defense missile defense battery, serving as the "eyes and ears" of the system by searching, detecting, tracking and discriminating threats, and guiding the intercepting missile. Raytheon serves as one of

For More Information

Go to mwjournal.com for more defense news items

MDA's prime contractors for THAAD.

Raytheon is currently under contract to provide three additional AN/TPY-2 radars for the MDA, and is in the process of building two radars for a U.S. ally in the Arabian Gulf.

Harris Showcases Emerging Capabilities in HF Tactical Communications

Harris Corp. has successfully created a high-frequency (HF) tactical radio network that linked U.S. military bases in four states and provided clearer communications and greater capabilities than traditional HF solutions.

The network allowed U.S. Special Operations Command (SOCOM) personnel to send and receive voice and data messages simultaneously using beyond line-of-sight communications. Harris established the demonstration network using its Falcon III® RF-7800H wideband HF tactical radio to sites in Colorado, Kentucky, Florida and North Carolina.

The demonstration showcased the radio's emerging capabilities to integrate seamlessly into existing ground tactical networks, delivering voice and data services such as chat, email, position location/tracking, situational awareness and imagery distribution.

"SOCOM forces obtained communications that met or exceeded capabilities offered by legacy tactical satellite systems..."

"SOCOM forces obtained communications that met or exceeded capabilities offered by legacy tactical satellite systems during the demonstration," said George Helm, president, Department of Defense business, Harris RF Communications. "Our next-generation HF radio provides an important alternative for connecting team members when it matters most."

The RF-7800H offers data rates that are up to 10 times greater than current HF manpacks. The new radio also offers spectrum sensing tools that automatically identify optimal communication channels with the least amount of interference.

Smaller and lighter than previous HF manpacks, the new RF-7800H is a software-defined radio that can be easily upgraded. It is fully compatible with the Harris Falcon II® HF product line and accessories, such as power amplifiers, antenna couplers and antennas. Harris has delivered more than 100,000 Falcon II high-frequency manpack radios worldwide.

See us at IMS Booth 2019

Planar Monolithics Industries, Inc.

Offering State-Of-The-Art RF and Microwave Components & Integrated Assemblies From DC to 40GHz

- Amplifiers
- Attenuators - Variable
- DLVA & ERDLVA & SDLVA's
- DTO's & Frequency Synthesizers
- Filters
- Form, Fit & Function Products
- IFM's & Frequency Discriminators
- Integrated MIC/MMIC Modules
- I/Q Vector Modulators
- Limiters & Detectors
- Log Amplifiers
- Pulse & Bi-Phase Modulators
- Phase Shifters
- Rack & Chassis Mount Products
- Receiver Front Ends & Transceivers
- Single Sideband Modulators
- SMT & QFN Products
- Solid-State Switches
- Switch Matrices
- Switch Filter Banks
- Threshold Detectors
- USB Products

HIGH POWER & CUSTOM 100MHz TO 40GHz SOLID STATE SWITCHES

6.0 to 18.0 GHz 1.6KW SPDT Switch
P2T-6G18G-40-R-570-TFF-1D6KW

- 6.0 to 18.0 GHz
- 1.6 Kilowatts Peak, 8% Duty Cycle
- 250uS Maximum Pulse Width
- 2.2dB Maximum Insertion Loss
- 40dB Minimum Isolation
- 200nsec Maximum Switching Speed
- TNC - Female Connectors
- 2.0" x 2.0" x 0.75"

6.0 to 18.0 GHz 100W CW, Absorptive, SPDT Switch
P2T-6G18G-25-T-TFF-100W

- 6.0 to 18.0 GHz
- 100 Watts CW
- 2dB Typical Insertion Loss
- 25dB Minimum Isolation
- 1usec Maximum Switching Speed
- +/-5 Degrees Phase Tracking
- TNC - Female Connectors
- 1.78" x 0.60" x 2.03"

1.0 to 1.1GHz 100W Avg., 5KW Peak, SPDT Switch
P2T-1G1R1G-25-R-SFF-100W

- 1.0 to 1.1 GHz
- 5 Kilowatts Peak Power
- 100 Watts Average Power
- 0.8dB Maximum Insertion Loss
- 25dB Minimum Isolation
- 5uS Maximum Switching Speed
- TNC - Female Connectors
- 4.22" x 2.98" x 0.70"

100MHz to 40.0GHz 90dB Isolation, Terminated, SP8T Switch
P8T-100M40G-85-T-512-292FF

- 100MHz to 40.0 GHz
- >90dB Isolation
- 10dB Maximum Insertion Loss
- 30nsec Typical Switching Speed
- +20dBm CW Operating Input Power
- Independent TTL Control (Option 3-BIT)
- SMA - Female Connectors
- 4.0" x 1.5" x 0.4"

0.5 to 18.0GHz Absorptive, High Speed, SP32T Switch
P32T-0R5G18G-60-T-SFF

- 0.5 to 18.0 GHz
- 70dB Minimum Isolation
- 9.5dB Maximum Insertion Loss
- 100nsec Maximum Switching Speed
- 5-Bit Decoded TTL Control Logic
- SMA - Female Connectors
- 8.0" x 3.5" x 1.0"

West Coast Operation:
4921 Robert J. Mathews Pkwy, Suite 1
El Dorado Hills, CA 95762 USA
Tel: 916-542-1401 Fax: 916-265-2597
Email: sales@pmi-rf.com

East Coast Operation:
7311-F Grove Road
Frederick, MD 21704 USA
Tel: 301-662-5019 Fax: 301-662-1731
Website: www.pmi-rf.com

Hermetic Sealing, High Reliability to Mil-Std-883, Small Quantity Requirements accepted.
We offer Custom Designs

ISO9001:2008 REGISTERED

See us at IMS Booth 1705

United Monolithic Semiconductors

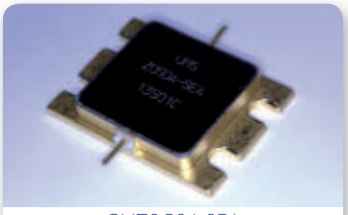
Innovation in UMS: 3 new GaN products

• Integrated and Fully Matched • High Power • High Efficiency • Thermally Optimised

The Quasi-MMIC concept consist of the combination of GaN power bars with matching networks realised on high power passive MMIC technology, recently developed in UMS.

UMS GaN internally-matched power transistors from L to C-band

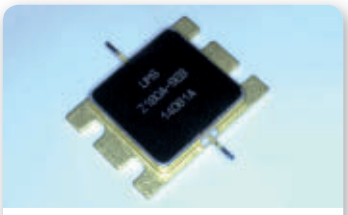
• High power Quasi-MMIC approach • Hermetic thermally enhanced metal-ceramic packages



CHZ050A-SEA

C-band 50W

CHZ050A-SEA Main features	
Frequency range	5.2-5.8GHz
Small signal gain	15dB
Output power	50W
Associated gain	12dB
PAE (pulsed mode)	>40%
DC bias	VDS 50V @ ID_Q 400mA



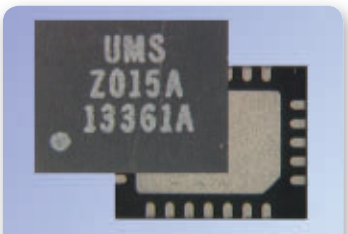
CHZ180A-SEB

L-band 200W

CHZ180A-SEB Main features	
Frequency range	1.2-1.4GHz
Small signal gain	20dB
Output power	200W
Associated gain	15dB
PAE (pulsed mode)	52%
DC bias	VDS 45V @ ID_Q 1.3A

Internally-matched Quasi-MMIC devices in low cost SMD plastic packages

• QFN 4x5 • Multi-chip package • Integrated gate biasing



CHZ015A-QEG

L-band 15W

CHZ015A-QEG Main features	
Frequency range	1.2-1.4GHz
Small signal gain	19dB
Power	>15W
Associated gain	>13dB
PAE	Up to 55%
Saturated drain current	650mA
DC bias	VDS 45V @ ID_Q 100mA

Build your own solution with UMS

www.ums-gaas.com

See us at IMS Booth 1204

China and Europe Make CHOICE on ICT Research

As Chinese indigenous innovation capability continues to increase, European researchers can benefit from accessing the burgeoning ICT research environment, while Chinese ICT research can also profit from integration into the European research community. The CHOICE project, funded by DG CONNECT through the FP7 programme, has been established to ensure that this vital EU-China partnership on ICT research is suitably nurtured and a bridge is created towards Horizon 2020.

CHOICE will provide continuity and progress in supporting and strengthening collaboration between China and Europe on ICT research. Project partners are keen to capitalise on Horizon 2020's shift away from technology-driven towards innovation-driven ICT R&D based on societal needs and consumer aspirations. This shift in focus means that there are many opportunities for the programme to play an important role in helping to meet increasing Chinese domestic demand.

CHOICE will build on the work of a previous project in the same area – OPENCHINA-ICT –which also worked to facilitate ICT-related research cooperation between Europe and China. OPENCHINA-ICT succeeded in completing a survey of the European and Chinese ICT research environments, created an EU-China ICT research online community and prepared the EU-China ICT Cooperation Plan, among other things.

CHOICE will benefit from this work as it moves forward over the next two years. Its main aims are now to identify obstacles to reciprocity; support European nationals, companies and organisations in accessing Chinese research programmes; showcase both EU and Chinese excellence in ICT R&D and strengthen EU-China industrial ICT R&D cooperation.

> "...showcase both EU and Chinese excellence..."

eRamp to Strengthen European Electronics Industry

The objective of the three-year eRamp project, which is one of the most important European research projects focused on energy efficiency, is to strengthen and expand Germany and Europe as centres of expertise for the manufacture of power electronics. Infineon Technologies is leading 26 research partners from six countries participating in the €55 million project, which is co-funded by grants from ENIAC Joint Undertaking and from Austria, Germany, the Netherlands, Romania, Slovakia and the UK.

eRamp research activities will focus on the rapid introduction of new production technologies and further exploration of chip packaging technologies for power semiconductors. The German project partners will investigate and develop new methods for speeding up the start of the production run. In order to investigate research results for practical viability exactly where the new production technologies will be implemented, the German research partners will use existing pilot lines and comprehensive production expertise at various German sites.

"The research results from eRamp will be an important contribution to even more efficiently use energy," said Dr. Reinhard Ploss, CEO of Infineon Technologies AG. "Europe and Germany are distinguished by their characteristic knowledge and expertise. The partners in the eRamp project have the entire power electronics value creation chain in mind, from generation and transmission all the way to consumption of electric energy. Together we will create new knowledge and thus new products that will mean economic and ecological progress for Europe."

> "Together we will create new knowledge..."

Prof. Wolf-Dieter Lukas, department head at the BMBF (German Federal Ministry of Education and Research) commented: "Power electronics is a key technology and a determining factor in the competitive ability of fundamental industry sectors in Germany and Europe. The cooperative approach of the European Commission and the German federal government in funding eRamp is a clear example of the benefits of joint action in Europe."

EB Develops MIMO Test Environment for Satellite Networks

Elektrobit (EB) has completed a multi-year study with the European Space Agency (ESA), analyzing the benefits of using multiple antennas (MIMO) in satellite communications. During the study the company developed a sophisticated, software-defined radio (SDR) based test environment, which is now globally available for satellite operators and infrastructure vendors. This advanced test environment can be utilized by EB's customers to study the RF link performance on their existing or planned satellite networks, as well as ancillary terrestrial links.

In this study with ESA, EB studied the challenges and benefits of MIMO techniques in satellite systems by carrying out a literature study, computer simulations and finally practical lab experiments of an existing satellite system to reveal the benefits of MIMO techniques on the radio link performance.

The developed EB MIMO test environment is based on the company's earlier development of EB RACE, a software defined radio platform for wireless technology development, evaluation and demonstration. This platform connects computer simulations to real RF interface and provides a smooth transition from simulation up to real implementation in small controllable steps. The MIMO test

For More Information **Go to mwjournal.com for more international news items**

> "...highly beneficial in designing new satellite systems..."

environment also includes a high-end radio channel emulator.

"The benefits of using multiple antennas in satellite communications are now proven, and we welcome customers to experience how using MIMO can help to improve their spectral efficiency, data rates and overall quality of the communications link. The test environment also expands to other use cases, such as studying new waveforms, and this way is highly beneficial in designing new satellite systems," said Jarno Majava, director of EB's wireless segment, business development and sales.

Plextek Consulting Joins EBDS Consortium

Plextek Consulting has joined the Selex ES-led Evidence Based Decision Support (EBDS) consortium – a collaborative partnership between industry, academia, SMEs and end users providing impartial evidence-based benefits to the UK Home Office, Police and Crime Commissioners and their forces, Fire and Ambulance Services and the Criminal Justice System.

In its first EBDS project, Plextek Consulting will be using its expertise in communications technology, and knowledge of the requirements of the emergency services, to contribute to the peer review of the Emergency Services Mobile Communications Programme (ESMCP) requirements.

"EBDS is a fantastic collaborative project bringing government bodies, industry, academia and SMEs together," commented Nicholas Hill, defence and security director at Plextek Consulting. "Plextek Consulting's reputation is built on its high-value strategic advice and proven ability to tackle complex problem solving under strict time and budget constraints. Thanks to a culture dedicated to innovation and the cross-pollination of ideas, coupled with many years experience of successfully exploiting commercial technologies into security & homeland defence applications, we think we're ideally placed to help add value to EBDS projects."

> "EBDS is a fantastic collaborative project..."

Amanda Lachlan at Selex EBDS stated: "EBDS's role is to deliver efficiencies in technology, business processes and resources by providing impartial access to a broad range of knowledge and expertise from across the industrial sector. We look forward to forging a strong relationship with Plextek Consulting in order to leverage its capabilities in support of some of the government's most challenging procurement issues. By using the wealth of know-how from across industry, we're helping the government save money, improve efficiency and identify best of breed ideas and business solutions."

NOW!

ULTRA·REL®

CERAMIC MIXERS

300 MHz to 12 GHz

from only **$5.95** ea. qty. 10

- **Hermetically Sealed,** *100% Tested*
- Rugged LTCC Construction
- Easy Visual Solder Inspection, *gold-plated terminals*
- Low Profile, *only 0.06"/1.5 mm thick*

- Highly Repeatable Performance
- Flat Conversion Loss & High Isolation across the whole band
- Outstanding Thermal Stability, *-55 to +125°C*

Mini-Circuits new MAC mixer family combines rugged ceramic construction with monolithic quad semiconductor technology to produce the most reliable mixers available in the marketplace today—the only mixers anywhere backed by a ***3-year guarantee!*** Top to bottom, inside and out, they're designed and built for long-term reliability under hostile conditions such as high moisture, vibration, acceleration, and thermal shock from -55 to +125°C.

Excellent electrical performance across the entire frequency range makes them ideal not only for aerospace and military ground applications, but anywhere long-term reliability adds bottom-line value: instrumentation, heavy industry, high-speed production, and unmanned facilities, to name just a few. So why wait? Go to minicircuits.com for performance data, technical specifications, and ***remarkably low prices***, and see what MAC mixers can do for your applications today!

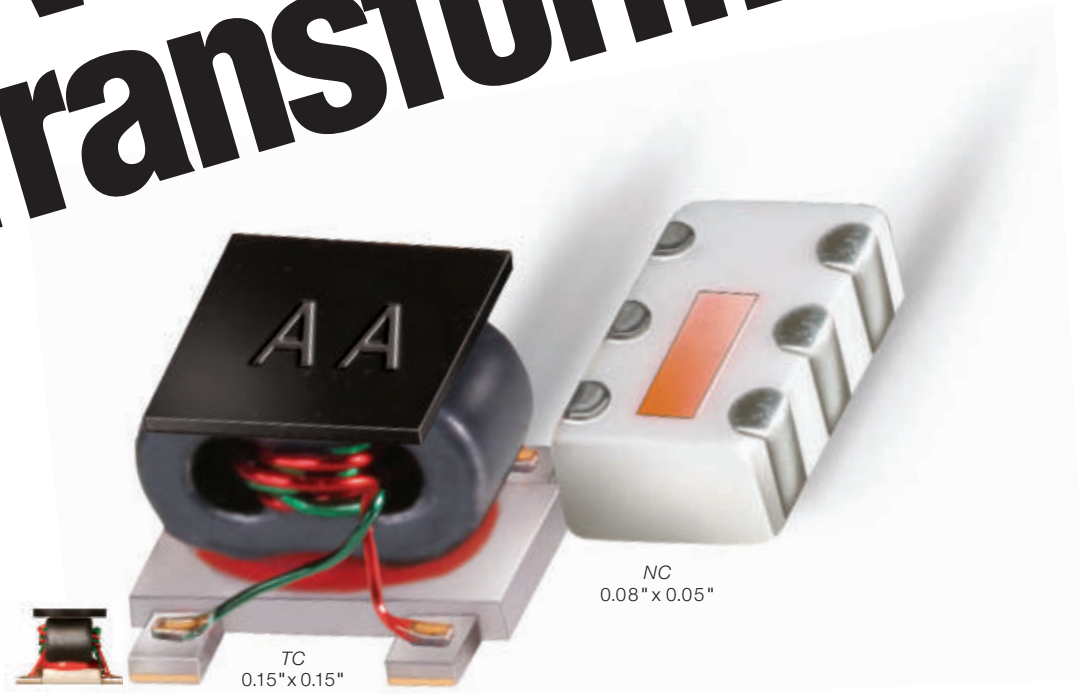
Mini-Circuits®

www.minicircuits.com P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com

See us at IMS Booth 823

TINY

Wideband Transformers



0.15-8000 MHz *as low as* **99¢** each *(qty. 1000)* RoHS compliant.

Rugged, repeatable performance.
At Mini-Circuits, we're passionate about transformers. We even make own transmission line wire under tight manufacturing control, and utilize all-welded connections to maximize performance, reliability, and repeatability. And for signals up to 8 GHz, our rugged LTCC ceramic models feature wrap-around terminations for your visual solder inspection, and they are even offered in packages as small as 0805!

Continued innovation: Top Hat.
A Mini-Circuits exclusive, this new feature is now available on every open-core transformer we sell. Top Hat speeds customer pick-and-place throughput in four distinct ways: (1) faster set-up times, (2) fewer missed components, (3) better placement accuracy and consistency, and (4) high-visibility markings for quicker visual identification and inspection.

More models, to meet more needs
Mini-Circuits has over 250 different SMT models in stock. So for RF or microwave baluns and transformers, with or without center taps or DC isolation, you can probably find what you need at minicircuits.com. Enter your requirements, and Yoni2, our patented search engine, can identify a match in seconds. And new custom designs are just a phone call away, with surprisingly quick turnaround times gained from over 40 years of manufacturing and design experience!

Mini-Circuits®

www.minicircuits.com P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com

See us at IMS Booth 823

377 rev AB

Small Cells Market Healthy as 2014 Deployments Reach $1.8B

ABI Research's latest forecast for Outdoor Small Cells indicates a healthy 2014 growth in equipment revenue at a year-on-year rate of 33 percent to $1.8 billion. This growth comes thanks to operators like AT&T, Verizon, Vodafone, Telefonica, Softbank, SK Telecom and Sprint driving shipments of both outdoor and Metrocell deployments.

"As mobile network operators implement small cell outdoor networks, several success factors emerge as critical for a successful deployment," says Nick Marshall, principal analyst at ABI Research. "We see multiple solutions for backhaul, power, permitting, and siting employed by the operator community throughout the rest of 2014 and which will increase small cell momentum in 2015."

> ABI Research forecasts the number of LTE small cells to grow by 2× in 2014 and by a similar factor each year through 2019...

In 2014, 4G small cells are the fastest growing small cell type in the market driven by venue and dense urban deployments. ABI Research forecasts the number of LTE small cells to grow by 2× in 2014 and by a similar factor each year through 2019 where the value of LTE small cells will reach more than half of a $10 billion equipment market.

The Asia-Pacific region, given its large size and 4G deployments in South Korea and Japan and the start of commercial TD-LTE operations in China and India will grow to represent over 50 percent of the worldwide small cell equipment market by 2019.

More than Half a Billion Wireless Smart Home Monitoring Devices to be Installed Worldwide by 2018

VIEW VIDEO

The smart home concept is increasingly moving center stage and demand for wireless devices continues to grow. In 2013, sales of wireless embedded smart home monitoring devices, including contact and motion sensors, smart thermostats and smart plugs, grew to 17.23 million, almost double shipments in 2012. Continuing momentum will ensure that by 2018, more than half a billion wireless smart home monitoring devices will be deployed in homes around the world. Growth will develop as new users move to use smart home systems and as users extend their existing systems.

Vendors including Honeywell, GE, Nest (now Google), Kwikset, UTC and many others are increasingly adding wireless connectivity to their home devices, bringing network connectivity and remote management to their offerings in order to appeal to growing numbers of smart home consumers.

Contact sensors for detecting whether windows and doors are closed were the most popular smart home monitoring device shipped last year while motion sensors were in second place. Both devices support smart home monitoring functionality but can also be used for additional applications such as energy management. "Combined, over 84 million contact and motion sensors will ship annually by 2018; however, it is smart plugs, smart door locks and connected smoke and CO detectors that will see the greatest shipment growth," comments senior analyst Adarsh Krishnan.

> "...it is smart plugs, smart door locks and connected smoke and CO detectors that will see the greatest shipment growth."

As the market for wireless smart home devices grows, there remains competition between wireless protocols to capture market share. Currently it is dominated by proprietary wireless protocols but that is challenged by standards such as Wi-Fi, Bluetooth Smart and ZigBee. Each protocol has its advantages and disadvantages and some will play more to the smart appliance rather than smart device space. For example, Wi-Fi support in residential home-area networks and mobile devices facilitates easy network setup without additional gateways or bridges but power demands will push adoption into appliances and devices with a fixed power supply. For its part, Bluetooth Smart support in mobile devices will also drive significant adoption in smart home devices. Even so, other protocols will continue to compete and will be supported in a range of devices from security panels to gateways and smart devices themselves.

Source: EMC Security

For More Information **Go to mwjournal.com for more commercial market news items**

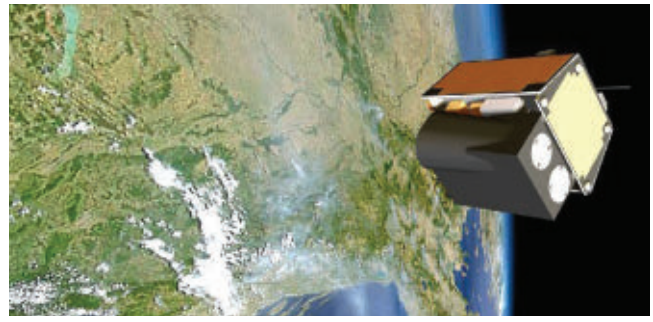
Nano and Microsatellite Market Worth $1887.1 M by 2019

According to ASDReports, the Nano and Microsatellite market is estimated to grow from $702.4 million in 2014 to $1887.1 million in 2019. This represents a compound annual growth rate (CAGR) of 21.8 percent from 2014 to 2019. The commercial sector is expected to be the largest contributor for Nano and Microsatellite by 2019. In terms of regions, Asia Pacific (APAC) is expected to be the biggest market in terms of revenue contribution by 2019 surpassing North America.

The major forces driving this market are price reduction, increasing demand, investments from Silicon Valley, superior mission launches and continual decrease in average satellite mass. The significance of the Nano and Microsatellite has increased, due to an increase in the number of application areas such as academic training, scientific research, earth observation, remote sensing and many others wherein such satellites can be leveraged. The increase in use of these satellites across a range of commercial applications in all regions of the world has been noted as one of the major factors behind continual increase in Nano and Microsatellite market size.

> The commercial sector is expected to be the largest contributor for Nano and Microsatellite by 2019.

Players such as Lockheed Martin, Northrop Grumman, Raytheon, Surrey Satellite Technologies, Sierra Nevada Corp., Clyde Space, Planet Labs and many others are expected to provide technological advanced satellites and offer better competitive services. The companies in this industry must take advantage of the growing awareness of Nano and Microsatellite in the high growth markets such as Middle East and Africa (MEA) as well as APAC. Earth observation and remote sensing, space science and academic training are the applications that have high growth rate in the market.



Source: ASDReports – Market Research

Maximize

Your Design Capabilities With

FILTER SOLUTIONS

- Band Pass, Low Pass, High Pass, and Band Stop Filters
- Diplexers and Triplexers
- Radial. Delta or Butterfly Stubs
- Microstrip; Stripline; Suspended Substrate
- Folded Cross-coupled resonator designs
- Adjustable Group Delay equalization
- Combline, Hairpin and Interdigital: Edge Coupled or Shunt Stub
- Output directly into AutoCad
- Touchstone format S, Y and Z Parameter netlists
- Integrate designs directly into AWR's simulators
- Integrate designs directly into CST STUDIO SUITE®
- Sonnet® EM structure extraction option for export to AWR's simulators
- Export distributed element filters directly to Sonnet's EM tools
- EM corrected designs using Sonnet Co-calibrated™ ports

Nuhertz

www.nuhertz.com

North America: (973)228-7800

Europe: +44 (0)1536 524255

See us at IMS Booth 638

ONE Resource

Overlapping Technologies Ultimate Solutions

Teledyne's A3CP6025 Broadband Amplifier *0.01 to 6.0 GHz. Gain is 24 dB typical, output power is +25 dBm, 3rd order intercept +34 dBm. Reverse isolation -50dB. Operates on 15 VDC, 300 mA.*

Teledyne's ACP20015 Ultra-Broadband Amplifier *2.0 - 20.0 GHz, 10 dB gain, 16.0 dBm typical output power. 3rd order intercept +26 dBm. -55 to +85°C, fully-hermetic. Operates on 5 VDC at 76 mA. Military or space-level manufacturing/ screening is an available option. EAR-99.*

Broadband Amplifiers

High power, broadband, helix ***Traveling Wave Tubes*** *for ECM, Radar, Communication & Instrumentation in airborne, shipboard, ground mobile and laboratory environments.*

Traveling Wave Tubes

Your Microwave Solutions are here.

Six industry-leading providers have come together to deliver the most comprehensive Microwave RF solutions. One Resource providing the Ultimate Solutions.

Ultra low phase noise ***YIG Oscillators*** *covering multi-octave bands up to 18GHz. Surface Mount or connectorized packages for commercial and military applications.*

YIGs

Ku-Band SSPA *Exceptionally small size 15W P1 Ku-Band Solid State Power Amplifier for Satcom & CDL frequency bands. Product includes Forward power detect, Thermal Monitor, VSWR monitor and high speed blanking. Unit also incorporates a low output power mode.*

SSPAs

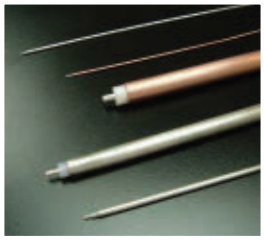
TELEDYNE
MICROWAVE SOLUTIONS
Everywhere**you**look™

11361 Sunrise Park Drive | Rancho Cordova, CA 95742
T: 916.636.7423 |TeledyneMicrowaveSolutions.com

See us at IMS Booth 723

30 Years

In 2014, EZ Form Cable is proud to celebrate its 30th Anniversary. While most of our competitors have been acquired and have disappeared within larger entities, we are proud that we are independent, able to satisfy customer specific requirements and still making news:



EZ Form produces more **Semi-Rigid Cable** than any other cable manufacturer, in diameters ranging from .020 to .500. EZ Form is QPL'd to MIL-DTL-17 on 27 items.

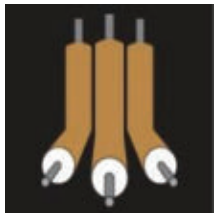
EZ Form has established itself as a leader in the supply of **EZFlex 47, 86, 141 and 250 Formable Cable**. Flexible Cable with the Performance of Semi-Rigid.

For Customers who truly need Flexible cables with Performance comparable to Semi-Rigid, EZ Form supplies **EZFlex 401, 402 and 405 Flexible Cables.**

EZ Form offers a variety of **RF Connectors** including MCX, MMCX, SMA, SMB, BMA, N, TNC and BNC, in both Standard and Custom designs, many available from stock.

EZ Form manufactures a full range of **Cable Assemblies**, from flexible to complex Semi –Rigid. All are 100% Inspected, Mechanically and Electrically. RoHS compliant Assemblies are also available.

Standard and Custom **Delay lines** and **Phase Matched Assemblies** designed and built by EZ Form to exacting customer requirements.



EZ Form Cable Corporation

285 Welton Street, Hamden, CT 06517

Tel: (203) 785-8215 Fax: (203) 785-0466 **www.ezform.com**

and counting...

EZ Form Cable now offers **Phase Track Cable Assemblies** (Incorporating TF4™ Dielectric Technology) in .047, .086 and .141 Semi-Rigid Diameters. The Assemblies exhibit superior Phase performance over temperature.

TF4 and PhaseTrack are registered Trademarks of Times Microwave Systems

EZ Form has launched a line of Virtually **Non-Magnetic Connectors and Cables** addressing new markets, such as quantum computing. The EZ Form Connectors are void of ferrous material and contain no nickel plating. In fact, the connectors are 500 times less magnetic than standard connectors.

EZ Form Cable Corporation has introduced Flexible Cable Assemblies that replace the need for custom .086 Semi-Rigid Cable Assemblies with special lengths and bends. **EZ Mini-Flex 405 Cable Assemblies** are complete and fully tested and are available in a variety of standard lengths.

EZ Form is **International Traffic in Arms Registered (ITAR).**

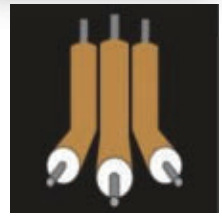
EZ Form personnel are **"Certified IPC Specialists"** to IPC/WHMA-A-620B (Requirements and Acceptance for Cable and Wire Harness Assemblies).

EZ Form maintains **AS 9100 Rev. C Certificate of Registration**.

EZ Form Cable Corporation

285 Welton Street, Hamden, CT 06517

Tel: (203) 785-8215 Fax: (203) 785-0466 **www.ezform.com**



See us at IMS Booth 1710

Around the **Circuit**

Laura Glazer, Staff Editor

MERGERS & ACQUISITIONS

Hittite Microwave Corp. announced that it has entered into a definitive agreement to buy substantially all the assets of the **Keragis Corp.**, a provider of extremely high power wideband amplifier modules, located in San Diego, CA. The purchase price was not disclosed. This acquisition expands Hittite's power amplifier portfolio and capabilities. This union combines Hittite's world class capabilities of design and manufacture of high performance integrated circuits, modules and subsystems with Keragis' patented extremely wideband high power amplifier module products.

Mentor Graphics Corp. announced that it has acquired **Berkeley Design Automation Inc.** (BDA), a recognized leader in nanometer analog, mixed-signal and RF circuit verification. With over one hundred customers worldwide, BDA uniquely addresses nanometer circuit design challenges via its Analog FastSPICE™ unified verification platform and exceptional vertical-application expertise. The acquisition of BDA aligns with Mentor's goal to deliver technologies with superior performance and automation for the growing challenges of analog/mixed-signal verification.

Hunter Technology Corp. announced its acquisition of the equipment and inventory assets of **Spectral Response LLC** (Lawrenceville, GA), an EMS supplier providing a broad range of product design and manufacturing solutions to electronics and RF OEM customers. This is Hunter's second major acquisition in the past six months, following the purchase of assets of NBS Designs Inc. (Milpitas, CA) last October.

COLLABORATIONS

Anite has announced its participation in a project initiated by **Intel** to develop 'virtualised' testing environments in order to accelerate 4G and 5G technology development and testing. Project Virtuoso – Virtualised environment for communication system development and optimisation – subsidised by the Danish High Technology Foundation, will run for four years and other partner companies include Telenor and Aalborg University Department of Electronic Systems that will bring valuable operator and research knowledge. Within this project, Anite aims to enhance its Virtual Drive Testing Tools (VDT) to utilise data measured in the field to 'virtually' recreate the field test environment in a laboratory.

NEW STARTS

Selex ES, a Finmeccanica company, has created two new entities – Selex ES Inc. in the USA and Selex ES GmbH in Germany, each incorporating the activities carried out within those two countries. The strategic rationale for these two mergers is to continue Selex ES's development of a strong international network of subsidiaries delivering reliable financial returns, while at the same time creating a firm foundation and presence in key markets.

The **e2v Group** has announced that, as part of a merger of its current operations and an expansion of resources and capabilities focusing on the North American market, it has merged its North American operations into e2v inc., headquartered in Milpitas, CA. This organisation brings together the current structures of e2v aerospace and defence, based in Milpitas and e2v inc., based in Tarrytown, NY, and will encompass the company's North American based RF power, high performance imaging, and high reliability semiconductor business units, providing products and services for six major market segments: civil aerospace, defence, space, industrial, medical & science and security and rescue.

MACOM announced an IP licensing program for GaN on silicon technology. MACOM detailed recent progress in two areas critical to realizing its future vision of enabling the mainstream adoption of GaN as a large-scale RF semiconductor technology across the industry. As a first step, MACOM announced a license and epitaxial (epi) wafer supply agreement which will enable **IQE**, the world's largest supplier of compound semiconductor epi, to manufacture GaN-on-Silicon epi at 4, 6 and 8-inch diameters in high volume for RF applications. Further, MACOM announced that it is in active discussions to make GaN-on-silicon technology available to select companies for use in RF applications.

ACHIEVEMENTS

TEGAM Inc. was recently awarded Patent No. 8,558,556, "Planar-axial thermistor for bolometry." This patent describes a novel way to construct very small planar thermistors on a substrate with very low heat transfer. The thermistors are more thermally isolated from the environment than are commercially-produced thermistors. Both the small size and thermal isolation make them useful for measuring RF power at microwave frequencies up to 70 GHz.

New analyses of **NASA** airborne radar data collected in 2012 reveal the radar detected indications of a huge sinkhole before it collapsed and forced evacuations near Bayou Corne, LA, that year. The findings suggest such radar data, if collected routinely from airborne systems or satellites, could at least in some cases foresee sinkholes before they happen, decreasing danger to people and property. Sinkholes are depressions in the ground formed when Earth surface layers collapse into caverns below. They usually form without warning. The data were collected as part of an ongoing NASA campaign to monitor sinking of the ground along the Louisiana Gulf Coast.

Airbus Defence and Space has finalised the deployment of the National Security Shield (NSS) to the **Qatar Ministry of Interior and Armed Forces**, covering the entire Qatar territorial waters and land border. The fully integrated system for all forces, which is operated by the

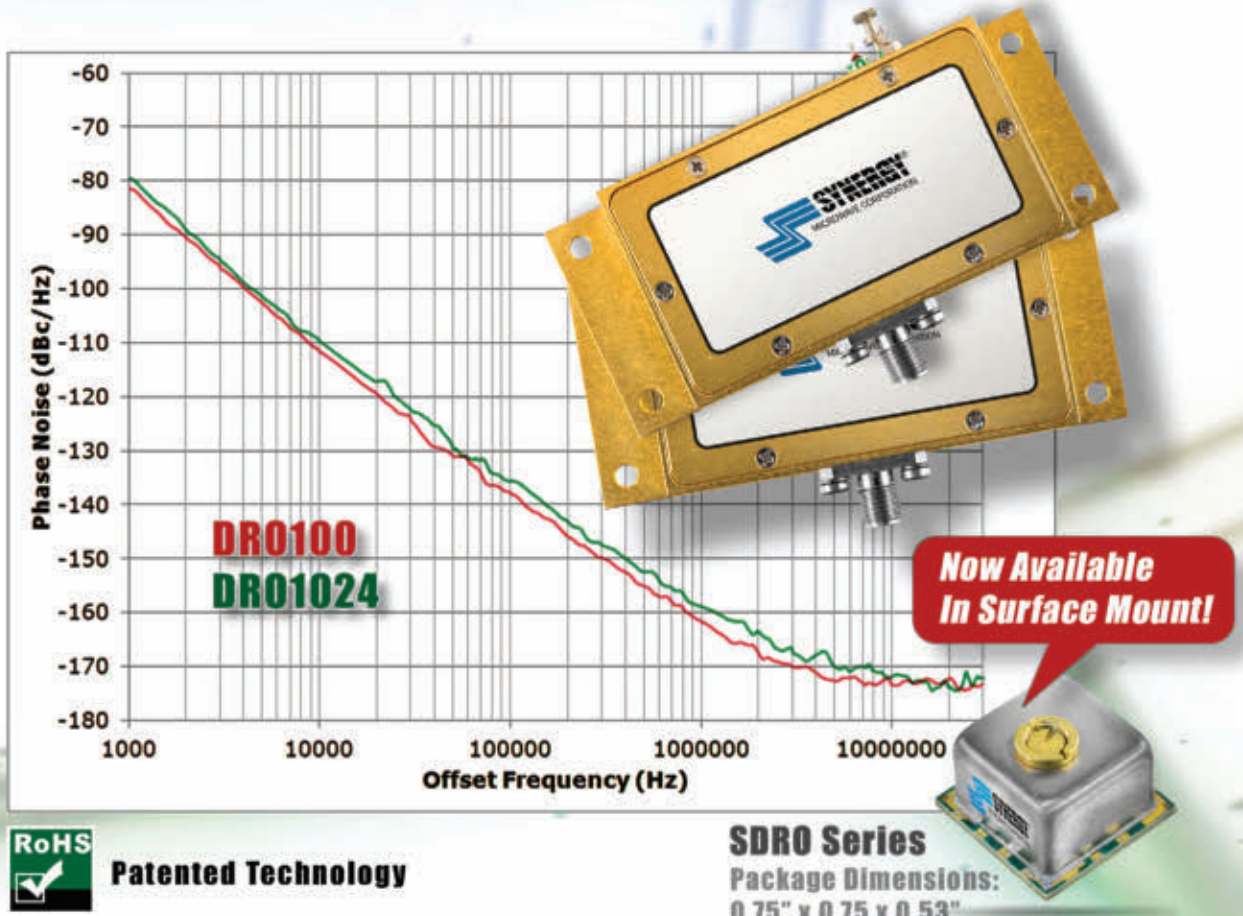
For More Information

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

Exceptional
Phase Noise Performance
Dielectric Resonator Oscillator

DRO100 & DRO1024

10 GHz **10.24 GHz**



RoHS

Patented Technology

SDRO Series
Package Dimensions:
0.75" x 0.75 x 0.53"

Call Factory For Your Specific Requirement

SYNERGY® MICROWAVE CORPORATION

Phone: (973) 881-8800 | Fax: (973) 881-8361
E-mail: sales@synergymwave.com
Web: WWW.SYNERGYMWAVE.COM
Mail: 201 McLean Boulevard, Paterson, NJ 07504

See us at IMS Booths 704 & 705

Qatar Border Guards and Coast Guards, is said to be the most evolved solution worldwide. The system includes surveillance towers and surveillance vehicles equipped with different sensors such as radars, cameras and direction finders, distributed throughout the territory. Consisting of land sectors, coastal border sectors and offshore site, full coverage of Qatari 600 km borders is now achieved.

Watchkeeper, the unmanned aircraft system (UAS) developed by **Thales** for the **British Army**, is now the first UAS to be awarded a full Release to Service (RTS), and is the only UAS of its type allowed to fly in UK airspace. The RTS follows rigorous safety and airworthiness reviews to ensure the system can be operated safely by the British Army. It will support British Army operations by allowing training on the system in the UK. Watchkeeper is a high-performance, multi-sensor, all-weather UAS that can remain airborne for more than 16 hours in a single mission. The tactical UAS will be deployed by the British Army for life-saving surveillance and intelligence capabilities in support of military operations and is unarmed. Crucially, Watchkeeper is certified to the same safety standard as manned aircraft.

Continuing its support for the **U.S. Air Force**'s Global Positioning System (GPS), **Northrop Grumman Corp.** has delivered 32 self-deploying, monopole JIB antennas for the third, fourth, fifth and sixth GPS III satellites. The company's Astro Aerospace strategic business unit delivered the antennas to Lockheed Martin, which leads the industry team developing GPS III satellites in Littleton, CO. Once installed, eight JIB antennas on each GPS III satellite will deploy to form an RF antenna array. This is the delivery of the first 32 antennas supporting the third through sixth GPS III space vehicles out of 48 total antennas on order for GPS III space vehicles three through eight.

Millitech Inc., a Smiths Microwave business and a designer and manufacturer of millimeter wave products, has been named "2013 Supplier of the Year" by Northrop Grumman Aerospace Systems in the Special Recognition category.

CONTRACTS

LONGBOW International, a joint venture of Lockheed Martin and Northrop Grumman, received a $96 million contract in 2013 from **AgustaWestland** to support LONGBOW Fire Control Radars on UK Apache AH Mk.1 aircraft. The five-year contract includes engineering services, integrated logistics support and an in-country repair capability. The effort is part of the overall Integrated Operational Support solution for the UK Apache helicopter fleet provided by AgustaWestland to the UK Ministry of Defence. Support services under this contract will continue through March 2019.

Harris Corp. has received $82 million in orders from an international customer for radio communication systems that enable enhanced command and control and real-time situational awareness. The nation's armed forces are acquiring Falcon III® RF-7800H wideband high-frequency (HF) and RF-7800V very-high-frequency (VHF) radios in handheld, man-portable, vehicular and tactical base station configurations. These systems provide wideband tactical networking to the edge of the battlefield, as well as interoperable line-of-sight and beyond-line-of-sight voice and data communications. The systems allow forces to communicate securely and more immediately with their command structure, enabling more informed decisions.

Exelis has received an award totaling more than $36 million to provide electronic warfare (EW) equipment, spares and support services to the **Turkish Air Force**. When fully definitized, the contract could be valued at up to $80 million. Under the foreign military sales contract issued by the Warner Robins Air Logistics Center at Robins Air Force Base, GA, Exelis will supply Turkey with Advanced Integrated Defensive Electronic Warfare Suite (AIDEWS) systems to protect its F-16 fighter jets from a range of advanced and evolving electronic threats.

RFMD announced it has signed a $9.7 million agreement with the Manufacturing and Industrial Technologies Directorate within the **Air Force Research Laboratory** (AFRL) to transfer and produce a 0.14 micron Gallium Nitride (GaN) monolithic microwave integrated circuit (MMIC) technology. The technology will be scaled to 6-inch diameter wafers using RFMD's industry-leading 6-inch GaN-on-Silicon Carbide (SiC) manufacturing line.

Mercury Systems Inc. announced that its **Mercury Defense Systems** subsidiary has received a $1.7 million order from the **U.S. Navy** for advanced Digital RF Memory (DRFM) jammers to support both U.S. Navy and U.S. Air Force requirements. The order is part of the firm-fixed-price, indefinite delivery/indefinite quantity (IDIQ) time and material contract award worth up to $56.7 million. The IDIQ was originally received by KOR Electronics (now Mercury Defense Systems) in March 2010 and increased in 2013.

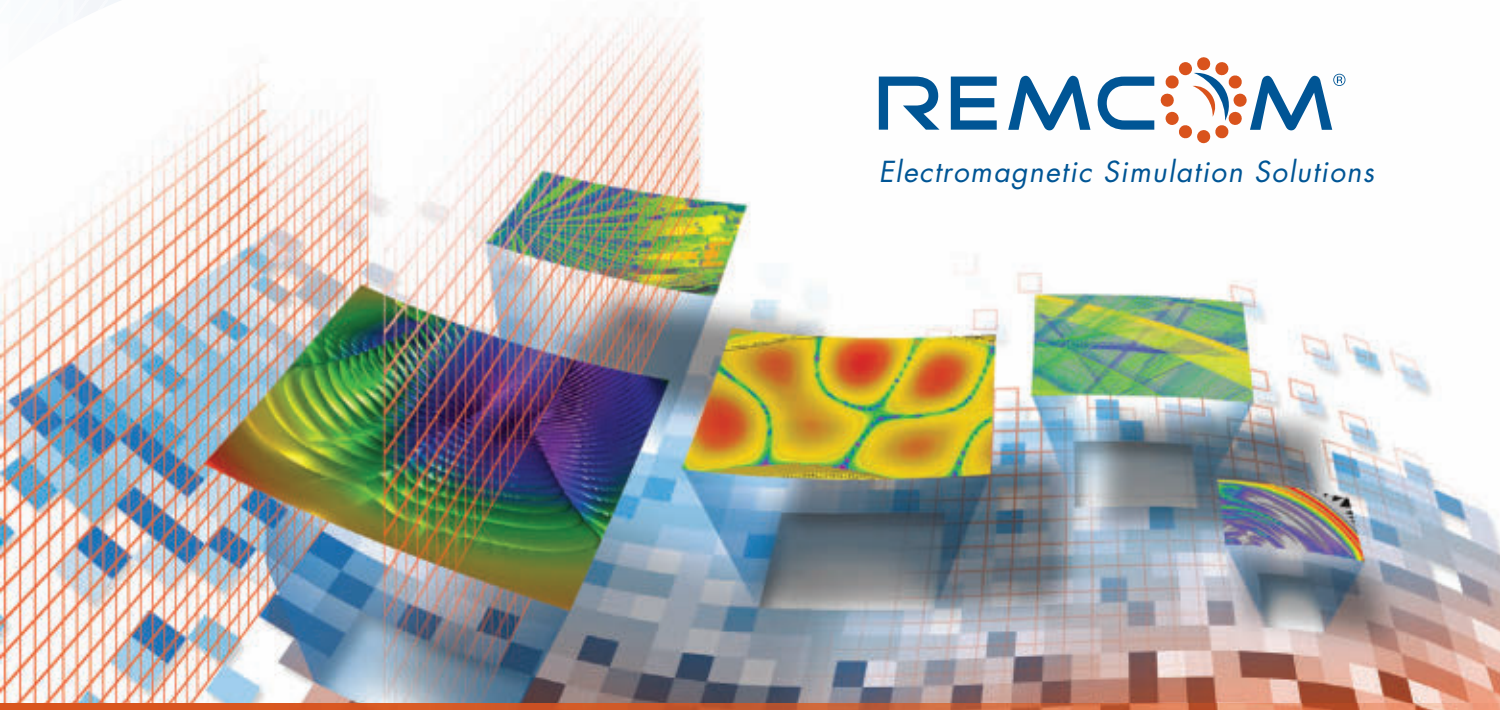
Comtech Telecommunications Corp. announced that its New York-based subsidiary **Comtech PST Corp.** received follow-on orders totaling $3.7 million for broadband, solid-state, high-power RF microwave amplifier systems from an international OEM. The amplifier systems, which include the latest solid-state switching and transistor technology and provide for very broad frequency coverage, will be utilized as part of communications jamming systems.

Aeroflex Inc., a wholly owned subsidiary of Aeroflex Holding Corp., announced an agreement with **Hytera Inc.** to provide automated test and alignment capabilities for Hytera DMR Series Radios on the Aeroflex 3920B Digital Radio Test Set. Initial test capabilities will be focused on the following Hytera DMR portable radios: PD702, PD782, PD792, PD882, HD702, HD782, HD795, SD982, X1e and X1p. The program will be later expanded to provide test and alignment of Hytera DMR mobiles.

Elbit Systems Ltd. was awarded a contract by the **Brazilian Air Force** (FAB) for the supply of a Hermes 900 Unmanned Aircraft System (UAS). The Hermes 900, which will be equipped with a new and advanced intelligence gathering

REMCOM®

Electromagnetic Simulation Solutions



No Limits. Unrivaled Speed. **XF7 Makes it Real.**

XF7 is the Leader for **Complex, High-Fidelity** EM Simulations

Visit Us at IMS 2014
Booth #1105.

- Visit us at **IMS 2014 – booth #1105!** Features include:
  - New Automotive Radar Whitepaper.
  - Automated Workflow Options for MRI Analysis.
  - Preview of New Features in XF7: enhanced biological thermal solver, MATLAB export, and project optimized gridding.

For more details, go to **www.remcom.com/make-it-real**

- Visit Remcom at **IMS 2014 – booth #1105** to receive our latest whitepaper, **"EM Simulation of Automotive Radar Mounted in Vehicle Bumper."**

REMCOM® +1.888.7.REMCOM (US/CAN) | +1.814.861.1299 | **www.remcom.com**

When failure is NOT an option

Rely on Crane for your Mission Critical needs

NEW!
Ku-Band
Iso-Dividers

- Low Insertion Loss
- Broad-band Performance
- Small Size
- Designed for Space Flight

Visit us at
IEEE IMS • Tampa, FL • Booth #332

CRANE
AEROSPACE & ELECTRONICS

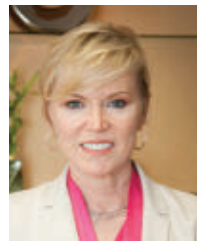
Microwave Solutions
MERRIMAC® • SIGNAL TECHNOLOGY

www.craneae.com/kubid

Around the **Circuit**

system considered as a breakthrough operational solution, will be operated by FAB in combined missions with the Hermes 450 fleet, already in operational use. Both UAS will carry safety and security missions in the 2014 FIFA World Cup Games. The contract is in an amount that is not material to Elbit Systems, and the Hermes 900 will be supplied within two months.

PEOPLE



▲ *Penny Cotner*

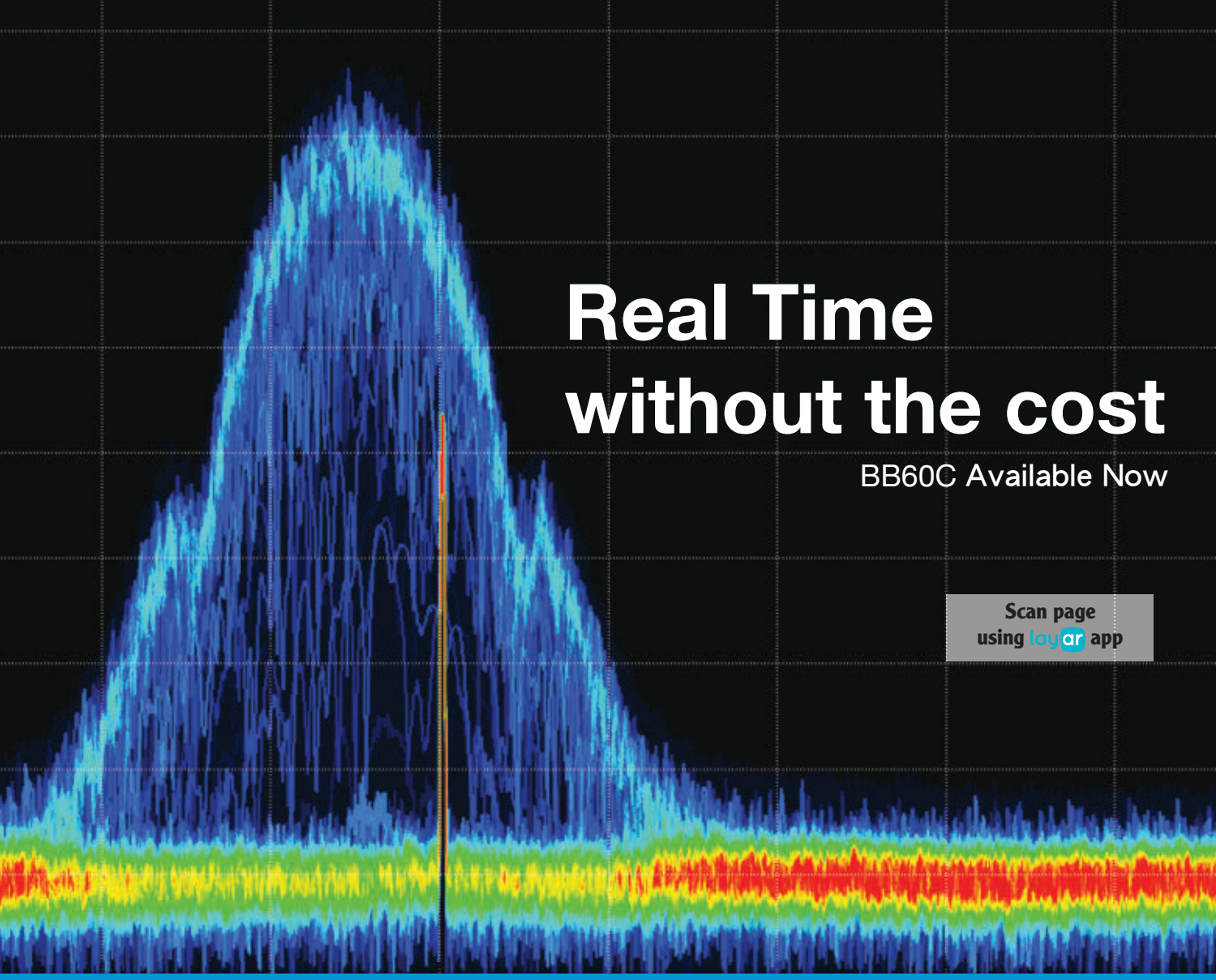
Pasternack Enterprises Inc. announced the appointment of **Penny Cotner** as the new vice president of sales & service. Cotner's early career included engineering positions at Hughes Aircraft Co. and on Rockwell's Space Station Program. She has spent the last 20 years of her career at Wyle Electronics and Arrow Electronics where she was most recently director of sales operations. Cotner was responsible for driving numerous important initiatives at Arrow in the areas segmentation analysis and strategy development, technical sales training, technical sales, and web strategy and implementation as well as leading cross functional teams across the Arrow organization.

NXP Semiconductors has appointed **Li Zheng** as senior vice president of sales and marketing, Greater China and country manager for China. He will be based in Shanghai. Prior to taking up this position, Zheng was SVP, worldwide marketing for SMIC Corp. where he was responsible for the product line roadmap, technology readiness management, technology promotion and joint development programs with major customers. Prior to that he held a series of high profile management positions including chairman and CEO of Renesas Electronics China and Hong Kong, and Senior Vice President of NEC Electronics China and Hong Kong region.

Anokiwave Inc. announced the expansion of its leadership team with the appointment of industry veterans to the roles of VP of operations (**Deborah Dendy**), VP of business development (**Glen Fields**), VP of sales (**Gary St. Onge**), distinguished fellow of technology (**Ian Gresham**), and VP of engineering for the Boston Design Center (**Robert McMorrow**). These hires come at a time of strategic expansion for Anokiwave.

▲ *Tony Teo*

Indium Corp. announced that **Tony Teo** has been hired as associate director for sales and marketing for the Asia-Pacific region, including China. Teo's primary responsibility is to continue the successful and profitable growth of Indium Corp.'s business in Asia by investing in staff training, supporting new product development, enhancing branding efforts and training staff. He is based at Indium Corp.'s facility in Singapore.



Real Time without the cost

BB60C Available Now

Scan page using layar app

Real-Time Spectrum Analyzer & RF recorder

Performance

Sweeps 24 GHz / sec

Exceptionally Clean Spurious and Residual Responses

Selectable Streaming Bandwidths from 250 kHz up to 27 MHz

Specs

9 kHz to 6 GHz

DANL -159 dBm + 1 dB/GHz (>10MHz)

-40°C to +65°C Operating Temp Available

+/- 50 ns Time Stamp (w/ ext. GPS)

Value

Try the BB60C risk-free for only

$2,879

Made in the USA

30-day money back guarantee & 1-year warranty. Hardware, Open Source Spectrum Analyzer Software, & API included.

Signal Hound®

See us at IMS Booth 1550

1.800.260.TEST

www.signalhound.com/MWJ

pico Technology

PicoScope:

THE NEW FACE OF SAMPLING OSCILLOSCOPES

20 GHz bandwidth

- 17.5 ps rise time
- 40 ps differential TDR / TDT
- 11.3 Gb/s clock recovery
- Industry's fastest 1 MS/s capture rate
- Optical input 9 GHz typical

Integral signal generator: Pulse, PRBS NRZ/RZ, 500 MHz clock, Eye diagram, eye line, histograms and mask testing

YES REALLY

From only $14,995

www.picotech.com/RF940

See us at IMS Booth 1551

Around the **Circuit**

REP APPOINTMENTS

Blighter Surveillance Systems, a British electronic-scanning (e-scan) radar and sensor solution provider, has appointed **Liteye Systems Inc.**, a provider of thermal imaging systems, as a distributor in North America.

CTS Electronic Components announced **Chinook Technical Sales** is now representing CTS and promoting its products in CO, UT and WY territories of the United States.

Global Test Solutions (GTS), a supplier of high-performance test and measurement instrumentation, announced it has signed a North American distribution agreement with **Delta Elektronika**. Delta manufactures programmable DC power supplies.

IW-Microwave Products Division has appointed **Seltec Sales** with offices in Hiawatha and Cedar Rapids, IA to handle sales of RF/coax cable assemblies and cable in IA and MN. **Cain Sweet** has been appointed for OR, WA and all of Canada.

MITEQ Inc. announced the appointment of **Proton LLC** as the company's non-exclusive sales representative in Russia. Proton LLC will represent MITEQ's Component and SATCOM divisions.

Link Microtek, the Basingstoke, UK based supplier of microwave and RF components and subsystems, has been appointed as a UK and Ireland representative for **Peregrine Semiconductor Corp.** founder of RF silicon on insulator (SOI) and pioneer of advanced RF solutions.

Spacek Labs, a leading manufacturer of microwave and millimeter-wave products, has appointed **Southeast Atlantic Sales LLC** of Fort Pierce, FL to represent Spacek Labs in FL, GA, NC, SC, AL, MS and TN.

ECM announced a new authorized distribution agreement with **MECA Electronics Inc.** to supply the manufacturer's line of USA made rugged & reliable RF/microwave passive DC – 20 GHz microwave components and solutions globally.

IMS 2014 Show Coverage

Catch our exclusive conference information, news, social networking, photos, videos and more at MWJournal.com/IMS2014.

photo courtesy of the
U.S. Military & NASA

ULTRA-REL®

10 MHz to 6 GHz

CERAMIC MMIC AMPLIFIERS

Low NF 0.5 dB High IP3 up to 38 dBm Low DC current 65 mA

$4.95 ea. (qty 20)

When failure is not an option. Our new CMA MMIC amplifiers deliver outstanding performance in a rugged, nitrogen-filled, hermetic LTCC design, just 0.045" high. These models are so tough, they've qualified for use under MIL environmental conditions:

Robust performance across wide bandwidths makes them ideal for instrumentation, or anywhere long-term reliability adds bottom-line value. Go to minicircuits.com for all the details today, and get them in your hands as soon as tomorrow!

MIL Qualifications *(see website for complete list and details)*

Gross and Fine Leak	*HTOL (1700 hours+ @ +105°C)*
Mechanical Shock	*Thermal Shock*
Vibration	*Steam Aging*
Acceleration	*Solder Heat Resistance*
PIND	*Autoclave (and more)*

Electrical Specifications *(-55 to +105°C)*

3 x 3 x 1.14 mm

Model	Freq. (GHz)	Gain (dB)	P_{OUT} (dBm)	IP3 (dBm)	NF (dB)	DC (V)	Price $ ea. (qty 20)
CMA-62+	0.01-6	15	19	33	5	5	4.95
CMA-63+	0.01-6	20	18	32	4	5	4.95
CMA-545+	0.05-6	15	20	37	1	3	4.95
NEW CMA-5043+	0.05-4	18	20	33	0.8	5	4.95
NEW CMA-54SG1+	0.4-2.2	32	23	36	0.9	5	5.45
NEW CMA-162LN+	0.7-1.6	23	19	30	0.5	4	4.95
NEW CMA-252LN+	1.5-2.5	17	18	30	1	4	4.95

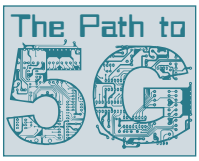
RoHS compliant

Mini-Circuits®

www.minicircuits.com P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com

See us at IMS Booth 823

503 Rev E



Toward 5G: What's Changing and How to Address Design and Test Challenges?

Jan Whitacre
Agilent Technologies, Santa Clara, CA

Even as LTE and LTE Advanced (4G cellular systems) are being deployed, work is already starting on their successor, 5G. This article describes the needs that demand continued development of mobile communications systems, and explains some of what is currently happening to bring 5G from theory to reality.

According to ABI Research, more than 30 billion devices will be wirelessly connected to the Internet of Things (now becoming the Internet of Everything) by 2020, and the most active area of research is in connecting these devices to the internet via low power radio. So, the question that must be answered is, "How do tomorrow's communications networks support a change to our lives that is bigger than the arrival of the Internet itself?"

WHAT'S CHANGING

The need for high speed connectivity is the common denominator as we look ahead to next-generation networks. Achieving 24/7 access to high bandwidth services requires that the industry continues on its current growth path; going far beyond simple voice and data services and moving to a world with billions of Internet-connected devices, ranging from simple sensors to high definition streaming video terminals, with "everything everywhere and always connected."

For individual subscribers, the main wireless delivery mechanisms have become public and private Wi-Fi hotspots routed from fixed-line networks, and third and fourth generation cellular networks (aka "mobile broadband"). In cellular networks, successive advances in mobile network technology and system specifications have provided higher cell capacity and consequent improvements in single-user data rate. Along with the latest mobile network specifications, there is a concurrent move to the Evolved Packet Core (EPC) – the simplified all-packet network architecture designed specifically to improve data throughput and latency, and to better match the air interface part of the mobile network to the architecture of the network's backhaul and of fixed-line networks.

These improvements have produced new services and a new set of end-user expectations, witnessed by the rise of more complex and data-hungry applications for smartphones and tablets. The latest of these is "seamless connectivity" – the ability to move an application amongst devices: for instance, tablet to smartphone to home entertainment center – without interruption of the content. To provide this capability requires access to, and control of, the content over multiple networks: WiFi hotspot, cellular and landline. (It's not just a technical challenge – associated billing requires a plethora of roaming agreements as well.)

The vision for 2020 that is presented in the studies for fifth generation mobile networks "5G" is one of "everything everywhere and always connected." It assumes devices can operate on frequencies from a few hundred mega-

Millimeter Wave Intermodulation Distortion (IMD) for Amplifier Test (50 to 110 GHz)

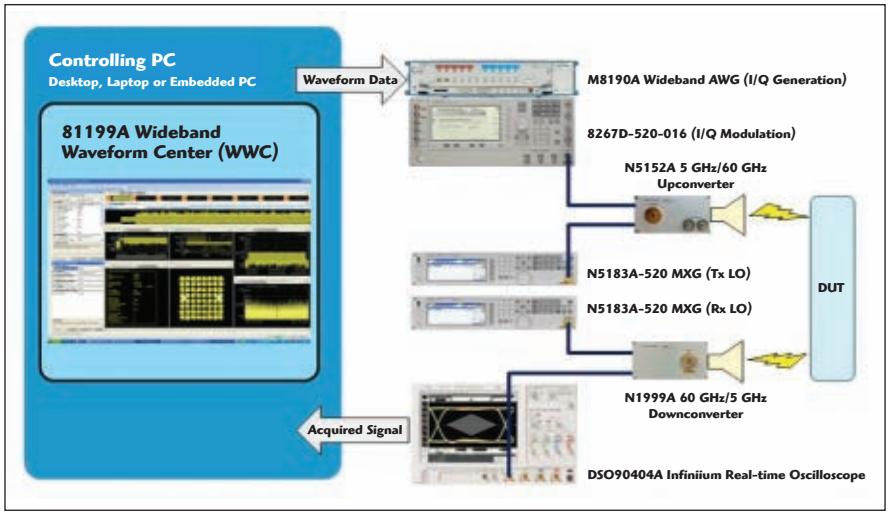
See us at Booth 2235 IMS 2014

With a single connection, measure S-parameters, Gain Compression and Intermodulation Distortion (IMD).

Learn more at www.omlinc.com/find/imd

Innovation in Millimeter Wave Solutions
www.omlinc.com
(408) 779-2698

OML



▲ *Fig. 1 WLAN 802.11ad test system working at 60 GHz.*

hertz to (in some cases) 80 GHz. Indoor cell sizes may be as small as a single room. Since wireless spectrum is limited, it employs pico- and femto-cells to maximize frequency reuse at RF. ITU's definition of 4G has an expectation of 1 Gbps single-user data rate. The goal for 5G is not necessarily to increase this, but to have a high capacity network capable of delivering this rate to a much bigger user community; in other words, to provide higher aggregate capacity for more simultaneous users. None of the studies have yielded specific details of the core network that joins everything together, but they assume that seamless connectivity, mentioned earlier, will be a given.

To support vastly increased numbers of devices and performance requirements, the latest studies postulate the key network attributes that will be required: an integrated wireline/wireless network, where the wireless part comprises a dense network of small cells with capacity enhanced through high-order spatial multiplexing (MIMO), cell data rates of the order of 10 GB/s and round-trip latency of 1 ms. Most studies now assume multiple air interfaces, which will include operation at microwave or millimeter wave frequencies. With these attributes, the combined network will support everything from simple M2M devices to immersive virtual reality streaming, with monitoring and control of literally billions of sensors and multiple simultaneous streaming services, and will support the massive data collection and distribution needs of the "Internet of Things." With the massive infrastructure costs involved, it's difficult to see individual operators affording the investment separately; shared, jointly-managed resources have been predicted as being much more likely.

You've known us for more than 40 Years
as your component manufacturer, but . . .

Did you know we make great Switch Matrices?

Check out our 24 x 12 Solid-State Non-Blocking Switch Matrix

A Plug n' Play system with an intuitive touch-screen GUI (patent pending) control interface. Ethernet connectivity and password protected browser access makes networking easy, secure, and platform independent.

- Frequency: 0.7 to 3.0 GHz
- Isolation: >70 dB
- Switches: Hot-Swap / Solid-State
- Attenuators: 70 dB (0.5 dB steps)
- Operating Power: >1W
- 10.4" Fanless Panel PC
- 6U / 17" Deep Rack Mountable
- Type N-F RF Inputs & Outputs
- RJ45 Ethernet Connectors
- Power <30W @ -48VDC Input

cmc

Custom Microwave Components, Inc.
www.customwave.com
info@customwave.com
Phone: (510) 651-3434

See us at IMS Booth 2114

The center for all your RF designs

RFMW Ltd. is a premier RF & Microwave specialty distributor created to support your component selection, technical design and fulfillment needs. RFMW offers a complete range of services for commercial, military, and space requirements.

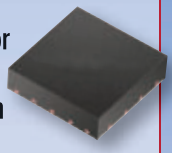
RFMW is a cut above the typical distributor.
We understand your need for on-time delivery and value because we face the same issues on a daily basis. Our focus on RF devices and technology enables us to meet your expectations with the highest service levels.

RFMW Value-Added Services.
We provide many value-added services driven by customer requirements – because we know RF and microwave.

- DIE Services • Packaging • Electrical Test Capabilities
- Device Tape & Reel • Kitting • Hi-Rel Screening
- Solder Tinning • Documentation Related Services
- Obsolete Parts Replacement • Custom Product Development

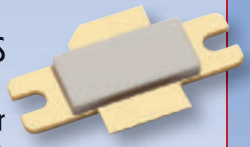
From antenna to baseband, RFMW is the center for all your RF designs. Contact RFMW today or visit our website.

RF Switches
- SPnT
- Semiconductor
- Mechanical
- High Isolation
- High Power
- GaN • Die



RF Amplifiers
- Gain Blocks
- Coaxial Module
- Low-Noise
- Linear Drivers
- High Power
- Variable Gain

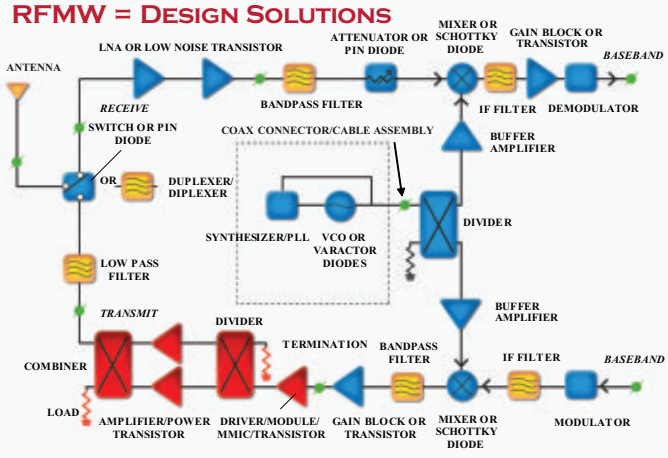
RF Transistors
- GaN
- LDMOS
- GaAs
- Bipolar
- High Power
- High Frequency



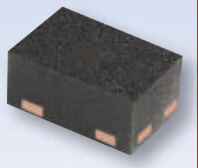
RF Filters
- Monoblock
- SAW / BAW
- HP / LP / BP
- Ceramic Resonator
- Duplexer / Diplexer
- Cavity

RF Oscillators
- OCXO
- VCXO
- TCXO
- PLL Synthesizers
- RF Generators

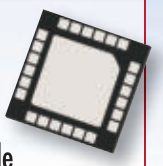
RFMW = Design Solutions



RF Diodes
- PIN
- Schottky
- Varactor
- Limiter
- Gunn



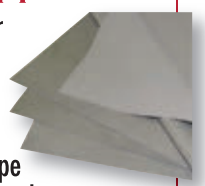
RF Attenuators
- Fixed
- Digital
- Coaxial
- Chip
- Voltage Variable
- Temperature Variable



RF Cable Assemblies
- High-Performance Test
- In-Box Solutions
- Pigtails
- Conformable
- Flexible
- Semi-Rigid

Test & Measurement
- USB Controlled
- Signal Generators
- Power Meters
- Switches • Attenuators
- Vector Modulators
- Cable Assemblies
- Coax Components

EMI / RFI
- RF Absorber
- RF Gaskets
- Wire Mesh
- Fingerstock
- Shelding Tape
- Filtration Panels
- Shielded Windows



www.RFMW.com

Scan for RFMW Solutions

RFMW Ltd. • 188 Martinvale Lane • San Jose, CA 95119 U.S.A.
Toll Free: +1-877-367-7369 • Fax: +1-408-414-1461

ISO 9001:2008 Certified

• **Canada** (Western) +1-877-367-7369 • (Eastern) +1-877-367-7369 • **RFMW Mexico** +1-408-414-1450 • **RFMW.CO.UK** +44 (0) 20 8848 4732 • **RFMW Italia** +39 0774 689994 •
• **RFMW Deutschland** +49 (0) 8233 738 747 • **RFMW Europe Ltd** +44 20 8848 4732 • **RFMW France** +33 1 83 64 53 97 • **RFMW Israel Ltd.** +972 9 740 6884 •

Immagine a world without limits.

It's here, thanks to Anokiwave.

mmPower your immagination

Experience the mmW revolution with Anokiwave.

Visit booth #2056 at the IEEE MTT International Microwave Symposium to see how Anokiwave is enabling a new world, and meet Anokiwave Authors and Entrepeneurs. For schedule of availability visit anokiwave.com/worldwithoutlimits

Vipul Jain: *Automotive Radar Sensors in Silicon Technologies*

Noyan Kinayman: *Modern Microwave Circuits*

Dave Corman: "Industry Tipping Point: Moore's Law, AESAs and mm-wave are Changing the Landscape" *Microwave Journal,* May 2014

Glen Fields: "Phased Array Radar At the Intersection of Military and Commercial Innovation" *Microwave Journal,* January 2014

Dave Corman: Founder US Monolithics
Nitin Jain: Founder Anokiwave

::: Celebrating our 15th year :::

Prepare to be ammazed.

ANOKIWAVE
/ ENABLING A NEW WORLD.

Anokiwave

anokiwave.com

Anokiwave is years ahead of the market – so you can be way ahead of the competition.

Immagine:

- The potential of **10X** increase in capability.
- The ordinary becoming **extraordinary.**
- The realization that, now,virtually **nothing is immpossible.**

Anokiwave products offer lower weight, smaller size, and higher performance, enabling low cost solutions.

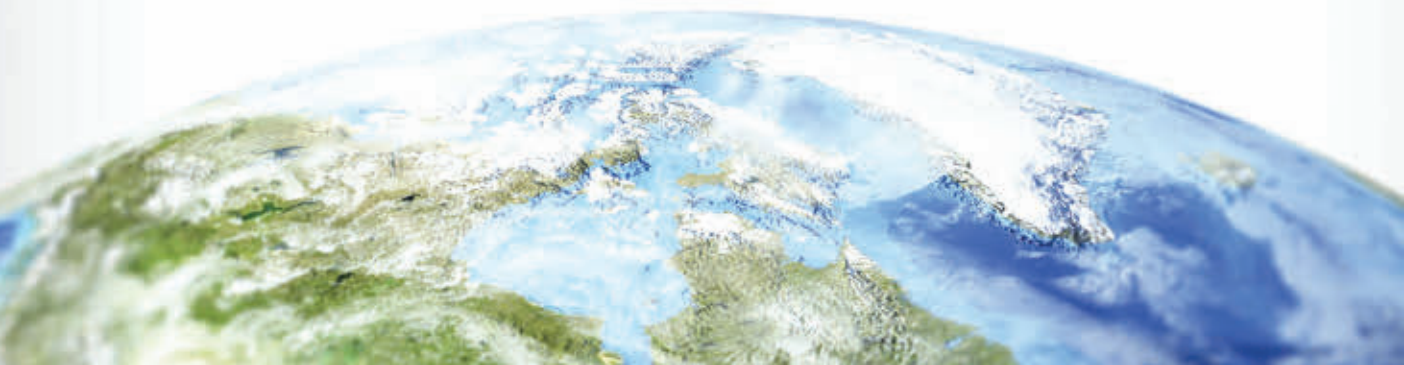
Anokiwave offers complimentary III/V products to optimize your system.

Anokiwave's proprietary chip architectures allow feature rich solutions for unprecedented performance.

ANOKIWAVE
/ ENABLING A NEW WORLD.

Anokiwave

Be ammazed at:
anokiwave.com



ANOKIWAVE / ENABLING A NEW WORLD.

Innovative AESA & mmW Silicon Core IC Solutions @ Anokiwave.

Pioneers of the **mmW revolution** and leading designers of integrated silicon IC chips for AESA and mmW applications. Anokiwave is proud to bring you a future without limits.

- Highly adaptive and innovative designs.
- Integrated core chips that enhance your AESA and mmW systems.
- Feature rich solutions give you more than you ever thought possible.

::: Celebrating our 15th year :::

Anokiwave is years ahead of the market – so you can be way ahead of the competition.

Anokiwave

Be ammazed at:

anokiwave.com

>> Visit us in booth 2056 at the IEEE MTT International Microwave Symposium >>>>>>>>>

In the mobile world, capacity gains come essentially from three areas: more spectrum, better efficiency and better frequency reuse through progressively smaller cell size. The fourth generation networks currently being built use more frequency bands than previous generations, and can use both broader channel bandwidths and aggregated carriers (the combination of two or more channels at different frequencies to further increase capacity). The work on EPC does recognize, and seek to limit, the packet delivery overhead in wireless networks, since signaling absorbs (finite) network capacity. However, with mobile data consumption currently forecast to almost double year-on-year for the next five years, network operators maintain that they will struggle to meet long-term demand without even more spectrum. Freeing up frequency bands currently used for other systems will become a major priority.

The official process of 5G standardization should be launched in the 2015-2016 time frame. The International Telecommunication Union (ITU) holds an international conference every three to four years, known as the World Radiocommunication Conference (WRC), to agree on international radio frequency issues, including frequency allocation standards for mobile networks. The next WRC is scheduled to be held in Geneva in 2015 (ITU-R WRC-15). The 5G standard is expected to be one of the topics of discussion for international delegates.

DESIGN AND TEST CHALLENGES

Compared to previous generations of mobile network, 5G presents a number of new design and test challenges. The first of these is the extension to higher frequencies. Experimental use of frequencies from 28 to 80 GHz and multiple-antenna configurations for either enhanced capacity (spatial multiplexing or MIMO) or signal steering are featured in a number of studies. New techniques for self-organizing network topologies, software defined radios capable of multiple air interface standards and software defined networks based on cloud computing are already being proposed for future 4G standards releases, and these will be extended to 5G. The integration of wireline and wireless networks may provide both anti-trust and regulatory issues beyond the obvious technical challenges.

Component and system design and test at microwave and millimeter wave frequencies is a well-understood and established science, but its application to high volume, low cost devices for the consumer market is new. Two major differences are the much wider modulation bandwidth than other wireless communications systems and the physical construction of the devices which may not allow direct RF connection. There's already an unlicensed frequency band being used at 60 GHz for the wireless LAN standard 802.11ad, which features a 2 GHz channel bandwidth. Similar use may be made of licensed spectrum in the 28 GHz range, where Samsung and others have already reported experimental results, and in the 70 GHz range, where a number of university studies are underway. In

Wherever you need RF, we've got you covered.

Whether you're interested in a hybrid coupler measuring .04 x .04 inches – or a sophisticated, high-complexity beamformer bound for space – Anaren is your proven, reliable, and high-integrity provider.

- **Our Space & Defense Group** offers a fast-growing range of passive and active solutions, including multichip modules and IMAs. Exciting, new substrates, high-rel PCB, and packaging choices. And a growing line up of next-gen, space-grade power combiners/dividers.
- **Our Wireless Group** continues to reinvent the passive components category. From new, Femto-sized Xinger®-brand components for today's smaller base stations. To tiny baluns, couplers, and PDs for consumer devices. To low-cost or high-powered terminations, attenuators, and resistors. To our new family of Anaren Integrated Radio (AIR) modules based on Texas Instruments low power RF chips, ideally suited to all kinds of traditionally non-RF applications that will form tomorrow's industrial, commercial, and residential "internet of things".

To learn more – visit **www.anaren.com** or email us at **sales@anaren.com** today!

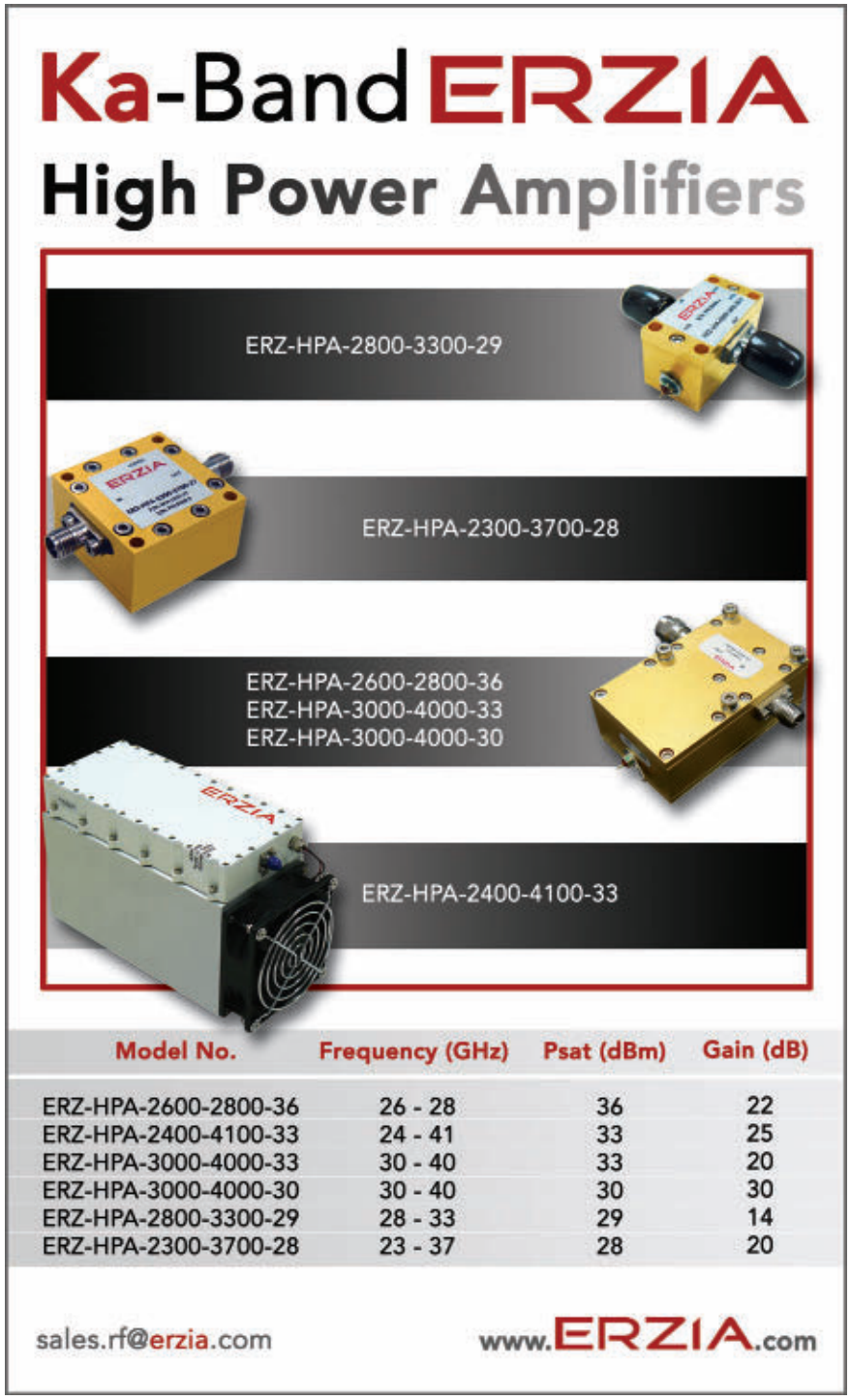
Anaren®
What'll we think of next?®
800-411-6596 > www.anaren.com

"real" user devices, these frequencies would likely use antenna components bonded directly to the transmitter and receiver chips, making connection to test equipment difficult. Base station radios will typically feature antenna matrices for beam steering (directing RF attributes toward a specific device), and/or multiple transmit/receive streams (MIMO) for capacity enhancement. Testing user devices will mean duplicating these real-world conditions, and test equipment suppliers will need to provide new channel measurements and simulation models for initial development, and complex baseband and microwave sources for performance verification. ***Figure 1*** shows a system designed for testing 802.11ad components at 60 GHz, and gives an idea of what might be needed for millimeter wave 5G design and development.

Potential new physical layer technology (PHY) attributes are still to be decided, but it's likely that any 5G devices will need to operate in a number of different radio access networks (RAN). The new PHY will include new, more efficient modulation and coding schemes that are efficient at very high symbol and bit rates (e.g., the use of Golay sequences in 802.11ad). Challenges here include everything from battery power consumption (meeting user expectations) to demodulating and decoding data from multiple carriers using different PHY characteristics simultaneously.

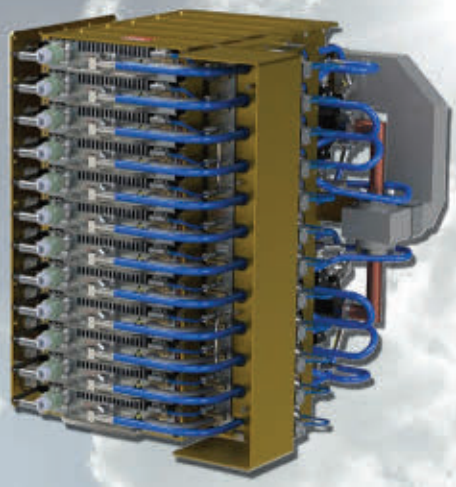
Today, much of the research into next-generation systems is being carried out in universities, either on their own or with the help and direction of commercial partners; or in the R&D departments of network operators, chip manufacturers and network equipment manufacturers. While the standardization process for next-generation cellular systems has not yet officially started, it's likely that some of the work currently underway will be incorporated into the 5G systems we'll begin to see rolling out around 2020.

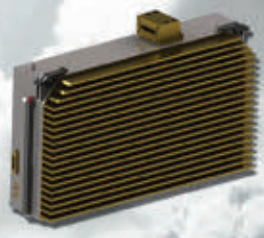
Vector network analyzers enable in-depth design and test of millimeter wave components such as the antenna array elements needed for beam-steering and MIMO. Software can enable a system-level design automation environment that accelerates design and verification of communications systems at the physical layer, where advanced digital signal processing meets RF. It combines with measurement products to create an expandable environment for modeling, implementing and validating next-generation communications systems. It enables a virtual system to be verified from the first day of a project, beginning with simulation models, and gradually incorporating more measurements as the design is translated into working hardware. It can be used in conjunction with signal sources to create complex arbitrary waveforms to test theoretical channel models in the real world. Systems can give a comprehensive set of tools that work with a range of signal analysis products for demodulation and vector signal analysis. Together these measurement, simulation and signal generation and analysis tools enable the exploration of virtually every facet of the components and signals that will become part of the advanced designs needed for next-generation communications systems. ■



Solid State Power Amplifiers

S-Band



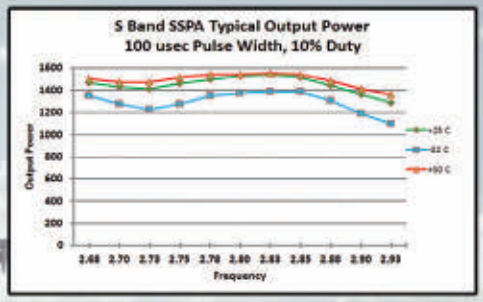


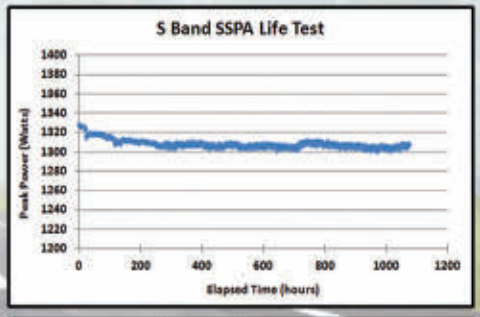
X-Band

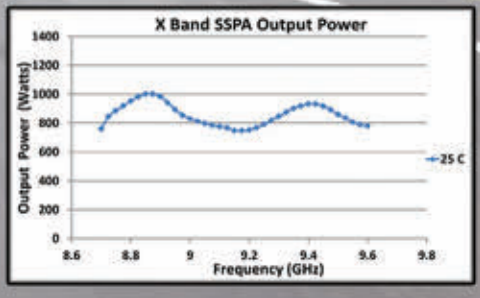
GaN Solid State Amplifiers

FEATURES

- High Efficiency Pulsed Modules (10% duty)
- BIT & Controls via - EIA 422
- Compact Light Weight
- High Reliability
- Field Replaceable Modules
- 9.0 - 9.2 GHz X-Band: 1 kW Modules
- 2.7 - 2.9 GHz S-Band: 1.3 kW Modules
- 1.2 - 1.4 GHz L-Band: 700 W Modules
- Power Combine Modules up to 25KW







For more information contact

Communications & Power Industries
Beverly Microwave Division
150 Sohier Road Beverly, MA 01915
Phone:(978) 922-6000 Fax: (978) 922-2736
Email: bmdmarketing@cpii.com

See us at IMS Booth 1639

Communications & Power Industries

www.cpii.com/bmd
Beverly Microwave Division

MWJ REVIEW BOARD APPROVED

A Low Phase Noise Octave-Band Synthesizer Using an X-Band Frequency Reference

Sergey Beltchicov, Andrey Dzisiak and Igor Guletskiy
ELVIRA Production Co. Ltd., Russia

An ultra-low phase noise synthesizer with more than an octave tuning capability uses an indirect multiple PLL approach based on an X-Band frequency reference. Measurements of the prototype synthesizer's phase noise performance are made and are believed to be among the best results achieved to date.

Any modern microwave system whether in communications, aerospace or defense market could be hardly imagined without one of its indispensable components – a frequency synthesizer. The key performance criterion for any frequency synthesizer along with requirements for tuning speed, size and resulting cost is the spectral purity of the generated signal which can be evaluated in terms of residual phase noise level and unwanted signals (harmonics, spurious) rejection. The spectral purity of the generated signal will most likely be the prevailing characteristic of a high-end frequency synthesizer used for research and reference measurements at the test bench. A study of modern high-end synthesizer architectures[1] reveals several observations:

- A high performance microwave synthesizer will likely use either direct analog synthesis or an indirect synthesis approach using multiple PLLs (with the latter being a more frequent case).
- Indirect synthesis using PLLs will likely use some implementation of frequency conversion in the voltage controlled oscillator (VCO)/YIG-tuned oscillator (YTO) feedback path to suppress excessive phase noise.
- A major hindrance to further improvement of high performance synthesizer phase noise (for both direct analog synthesis and indirect synthesis using PLLs) is deviation from the 20logN rule due to non-ideal multiplication of the 100 MHz oven controlled crystal oscillator (OCXO) references.

Figure 1 shows the typical phase noise performance of several high-end frequency synthesizers. The blue curve shows the best commercial PLL synthesizer (using a YTO as a tuned oscillator in a frequency offset scheme) at 10 GHz. The red curve shows the best result of ultra-low phase noise OCXO multiplication up to 10 GHz. This will likely be the best obtainable

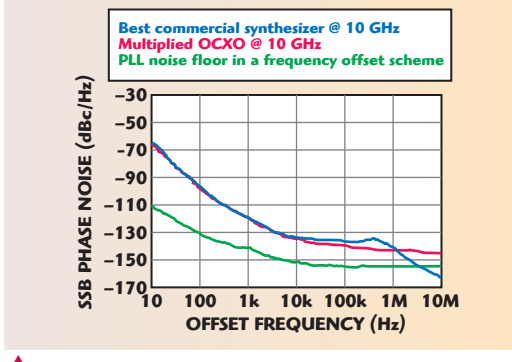


Fig. 1 Typical synthesizer phase noise performance.

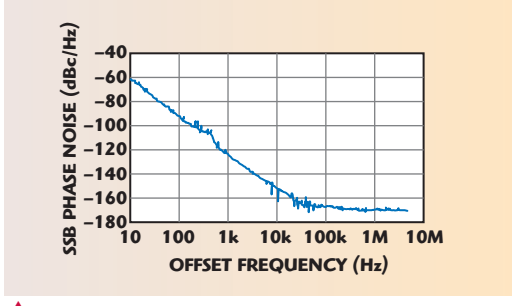


Fig. 2 Phase noise of SLCO reference at 10 GHz.

QB

QuarterBack

HIGH FREQUENCY
CONNECTIVITY
WITH A TWIST.

SV Microwave's new QuarterBack line of connectors combines the high frequency performance of an SMP style connector with the mating durability and ease of a bayonet style connector.

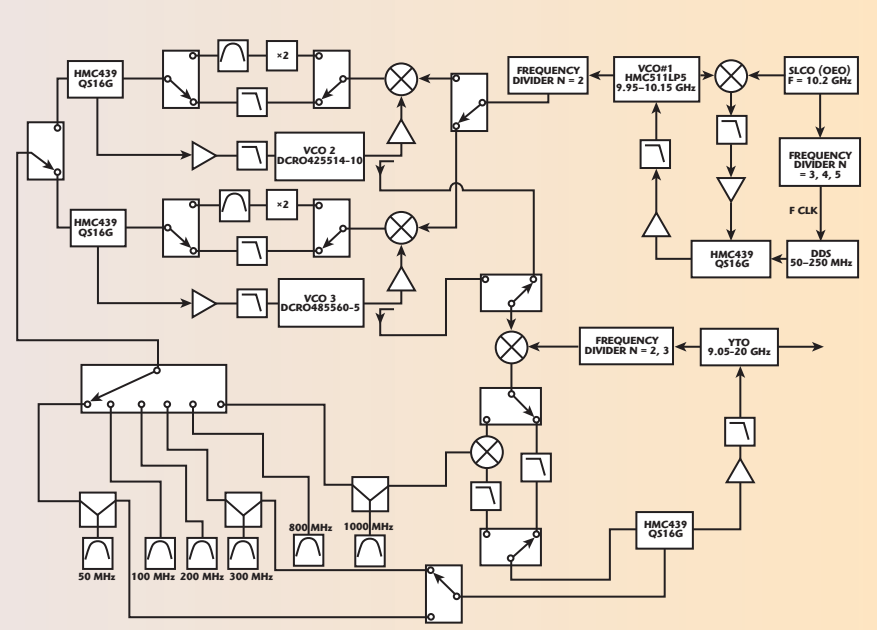
- Positive Mating
- SMP (40 GHz) / SMPM (65 GHz)
- Quick Connect/Disconnect Applications
- Low Mating Forces
- High Vibration Environments
- Custom Configurations Available

Come visit SV Microwave in Tampa, June 1st-6th, for the IEEE MTT International Microwave Symposium (IMS)
Booth 1104!

Amphenol
SV MICROWAVE®
www.svmicrowave.com

result for a direct analog synthesizer using a 100 MHz OCXO as a reference oscillator. The green curve shows the PLL noise floor in a frequency conversion PLL. It is the sum of direct digital synthesizer (DDS) and phase frequency detector (PFD) phase noise at an arbitrarily chosen reference frequency of 100 MHz (with no frequency division in the loop). This green curve also provides a fair representation of good phase noise performance for a small step synthesizer in a direct analog synthesis approach.

From the graphs in Figure 1 it is clear that if there was some way to increase the quality of the reference frequency used in a frequency conversion PLL (or used as a coarse step synthesizer in the direct analog approach), dramatic improvements could be achieved in phase noise performance up to the limitations imposed by the PLL noise floor (or by the small step synthesizer phase noise in the direct analog approach). The proposed solution is to use an X-Band fixed frequency source for the reference frequency generation instead of multiplying 100 MHz OCXOs.



▲ *Fig. 3 Prototype synthesizer simplified block diagram.*

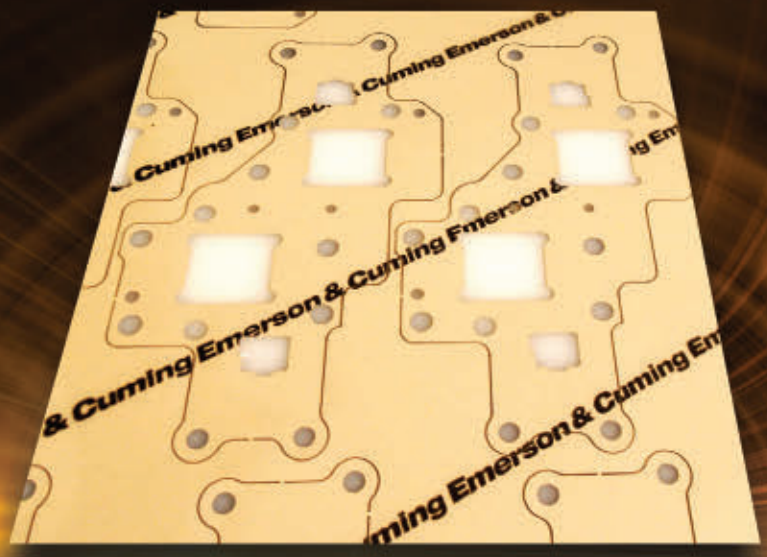
DESIGN

For the 10 GHz frequency reference, a sapphire loaded cavity oscillator was used; however, a 10 GHz opto-electronic oscillator (OEO) can be used as well. The 10 GHz frequency reference used in the design does not represent the state-of-the-art for SLCO performance; however, it is sufficient for this design purpose (see ***Figure 2***). The 10 GHz low phase noise frequency reference technology is not addressed here, which has been thoroughly investigated by others[2-9] with results being generally better than this report.

The prototype is a triple offset loop synthesizer (see ***Figure 3***). The first offset loop is used to phase-lock a Hittite VCO to a 10.2 GHz SLCO to achieve 200 MHz of synthesized tuning around 10 GHz while preserving the low phase noise of the sapphire reference. We use a broadband 3.5 Gsps DDS for better spurious in the tuning range with additional suppression provided by varying the clock frequency and by using the PLL as a spurious filter. The spurious signals are further suppressed to an acceptable level of <-80 dBc by dividing the 200 MHz tuning range of the 9.95 to 10.15 GHz first loop synthesizer into the frequency range of 4975 to 5075 MHz, which is then used as a tunable reference for the second offset loop.

The second loop increases the 100 MHz tuning range of the first loop synthesizer by a factor of 11. This is

RF/Microwave Epoxy Pre-form Specialists



bonding source

We have served over 700 customers since 2006 and shipped over 1 million pre-forms worldwide.

Speed
Bonding Source offers 1-2 day delivery of epoxy pre-forms to keep your line running.

Support
Bonding Source offers layout support and recommendations to help your pre-form and circuit board attachment process run smoothly.

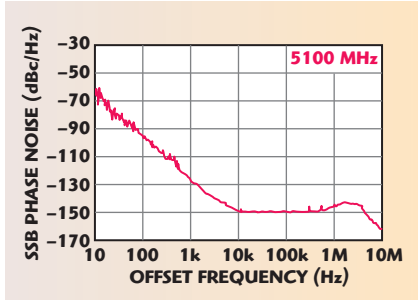
In Stock
We carry the industry's best epoxy pastes and films for the RF/Microwave industry. Always in stock with no minimum charges.

www.bondingsource.com

EPOXY TECHNOLOGY · Ablestik™ · Henkel · SPM · Emerson & Cuming™ · CoorsTek Amazing Solutions.

accomplished by changing the comparison frequency in coarse steps and using both sidebands of the loop frequency conversion. We use two low noise VCOs, one for each sideband, to optimize the resulting phase noise profile of the second loop synthesizer. Also, doublers are used in the loops to additionally lower the phase noise of the locked VCOs in cases where the inherent PFD noise floor becomes high (see ***Table 1***). The fixed reference signals of 50, 200, 300, 800 and 1000 MHz are all derived from an ultra-low noise 100 MHz OCXO which is also used to phase-lock the SLCO for long term frequency stability.

The switched second loop synthesizer provides a 1100 MHz tuning range with the phase noise performance shown in ***Figure 4***. The loop bandwidth is kept around 3 MHz for both VCOs. This second loop synthesizer maintains spurious content below -80 dBc across the entire tuning range.



▲ *Fig. 4 Second loop synthesizer SSB phase noise.*

To achieve an octave tuning range in the microwave region, the third offset loop uses the second loop synthesizer as a tunable offset reference to phase lock a 9 to 18 GHz YTO. Shown in Figure 3, dividers are used in the loop to pull the YTO into the narrower range of the second loop synthesizer. The division ratio is kept as low as possible, with N=3 being the maximum division value. This is achieved by switching the IF (comparison frequency at the PFD) and using double conversion (double offset) in the loop (see ***Table 2***).

TABLE I

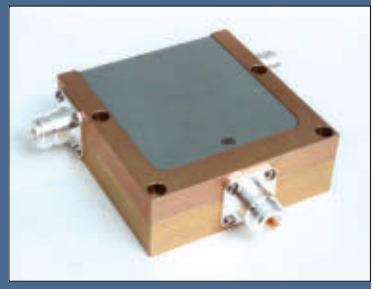
FREQUENCY AND PHASE NOISE AT SEVERAL LOCATIONS

VCO 1 after Division (MHz)	*IF/REF Frequency (MHz)*	*Phase Noise VCO 1:N/REF/ PFD (dBc/Hz)*	*VCO 2 and VCO 3 (MHz)*	*Effective Phase Noise VCO 2/ VCO 3 (dBc/Hz)*
4975 to 5075	–500/1000	–153/–160/–149	4475 to 4575	–147
4975 to 5075	–400/800	–153/–162/–150	4575 to 4675	–148
4975 to 5075	–300/300	–153/–164/–148	4675 to 4775	–147
4975 to 5075	–200/200	–153/–168/–150	4775 to 4875	–148
4975 to 5075	–100/100	–153/–174/–153	4875 to 4975	–150
5025 to 5075	–50/50	–153/–164/–156	4975 to 5025	–151
4975 to 5025	+50/50	–153/–164/–156	5025 to 5075	–151
4975 to 5075	+100/100	–153/–174/–153	5075 to 5175	–150
4975 to 5075	+200/200	–153/–168/–150	5175 to 5275	–148
4975 to 5075	+300/300	–153/–164/–148	5275 to 5375	–147
4975 to 5075	+400/800	–153/–164/–150	5375 to 5475	–148
4975 to 5075	+500/1000	–153/–164/–149	5475 to 5575	–147

MEASUREMENTS

Phase noise of the synthesizer is measured by mixing output signals from two prototype synthesizers in a Marki M8-0326MS double balance mixer and applying the resulting IF (100 MHz) to the Agilent E5052A signal source analyzer. Assuming that the phase noise of both prototype synthesizers is essentially equal, we apply a 3 dB correction to the measured results. The measured phase noise performance for output frequencies of 10 and 18 GHz (see ***Figure 5***) is at least 10 dB lower than that of any commercially available general purpose synthesizer. Spurious performance of this octave-band synthesizer is better than -70 dBc. If this synthesized core is used to provide lower frequency coverage by means of octave frequen-

HIGH POWER
100 MHz to 20 GHz

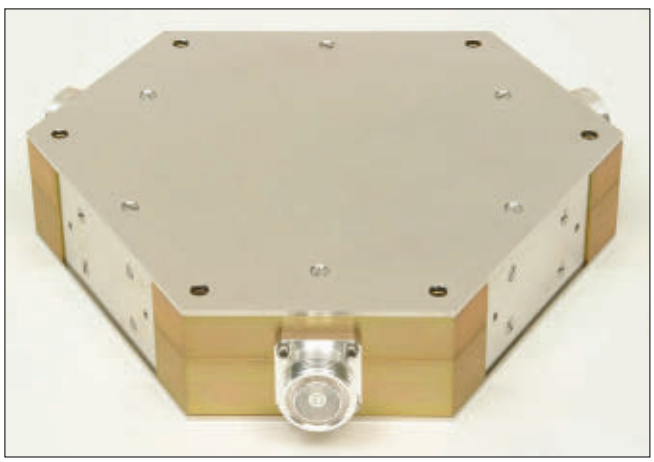


For Military/Radar Applications.

Isolators/Circulators

As one of the leading suppliers of ferrite components in the industry, UTE Microwave has pioneered innovative designs, quality craftsmanship and exceptionally high quality products. Custom designs, standards...many of them off-the-shelf, are the result of over 35 years of experience in the industry. UTE Microwave continues this tradition with new products for ever changing applications. Our broad line of HIGH POWER, low loss circulators and isolators spans the spectrum from below 100 MHz in coax/stripline units to waveguide devices at 18 GHz for both peak and average powers.

100 MHz HIGH POWER Circulator for Medical, Scientific and Industrial applications



A new HIGH POWER Circulator suitable for FM Broadcast, Scientific and Medical applications is now available. The unit provides 10 MHz bandwidth in the 85–110 MHz spectrum.

Specifications are 20 dB min. isolation, 0.3 dB max. loss and 1.25 max. VSWR. Operating power is 1 kW average and 25 kW peak. The 8-1/2" hex x 2" thick unit operates over a 15°–50° C temperature range. DIN 7/16 connectors are standard. Other units are available at higher frequencies.

HIGH POWER Drop-in Series

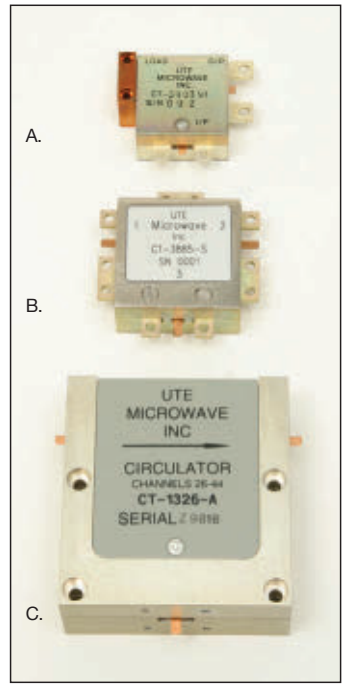
A broad line of low loss HIGH POWER Drop-in circulators are available from VHF to Ku band including Kilowatt average power levels at VHF thru S band. L and S band radar are a specialty. A few of these are shown here.

A) 2.7–3.1 GHZ 1 kW pk, 100 W av

B) 1.2–1.4 GHZ 3 kW pk, 300 W av

C) UHF TV Band 5 kW pk, 500 W av

Our "POWER-LINE" serves the COMMUNICATIONS, TELECOM, MEDICAL, SCIENTIFIC, TV, PCS and INDUSTRIAL markets.



The following models are examples of our High Power units

Model No.	Power	Connectors	Freq. Range
CT-1542-D	10 Kw Pk 1 Kw Av	DIN 7/16	420–470 MHz
CT-2608-S	3 Kw Pk 300 W Av	"Drop-in"	1.2–1.4 GHz
CT-3877-S	2.5 Kw Pk 250 W Av	"Drop-in"	2.7–3.1 GHz
CT-3838-N	5 Kw Pk 500 W Av	N Conn.	2.7–3.1 GHz
CT-1645-N	250 W Satcom	N Conn.	240–320 MHz
CT-1739-D	20 Kw Pk 1 Kw Av	DIN 7/16	128 MHz Medical

Broadband Units • Common Band Devices • High Isolation Units • Multiport Devices • Drop-In Devices • Wireless/PCN Devices • High-Power Industrial/Medical Iso Adaptors Waveguide Junctions • High-Power TV Units • VHF and UHF Devices

sales@utemicrowave.com

FEATURES:

- **Power levels to 5 KW CW, 75 KW Pk.**
- **Low Intermod Units**
- **Low Loss Options**
- **Extended Octave Bandwidths**
- **Power Monitors and DC Blocks**
- **Iso Filter-Monitor Assemblies**

UTE MICROWAVE INC.
3500 Sunset Ave., Asbury Park, NJ 07712
Tel: 732-922-1009 Fax: 732-922-1848
E-mail: info@utemicrowave.com

See us at IMS Booth 1704

Contact us for more information on our extensive product line and current catalog. We accept Visa, MC, Amex

TABLE II

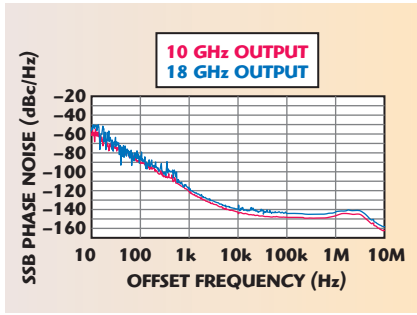
FREQUENCY AND PHASE NOISE AS A FUNCTION OF THE FREQUENCY DIVIDER RATIO

VCO 2 & VCO 3 (MHz)	YTO Output Frequency (MHz)	N	Phase Noise 2nd Loop Synth/Divider/PFD/REF + 20logN (worst case) (dBc/Hz)	IF/PFD Comparison Frequency (MHz)
4475 to 5575	9050 to 11250	2	–147/–153/–156/–164 = –140	50/50
4575 to 5575	11250 to 13250	2	–147/–153/–156/–164/–154 = –139	1050/50
5325 to 5525	13250 to 13650	2	–147/–153/–148/–164/–154 = –137	1300/300
4500 to 5575	13650 to 16875	3	–147/–153/–156/–164 = –136	50/50
4575 to 5575	16875 to 19875	3	–147/–153/–156/–164/–156=–136	1050/50

cy division and careful subsequent filtering, its phase noise and spurious performance will further improve following the 20logN rule.

CONCLUSION

It has been demonstrated that the use of an X-Band fixed frequency reference can overcome the phase noise performance limitations of traditional multiplicative schemes. The proposed solution is just the first implementation (and possibly not the best) of an SLCO-based synthesizer; however, it offers a significant improvement (>10 dB) over results previously advertised as best in the industry for a commercially available general purpose synthesizer. Further performance improvements are planned: reducing the spurious performance to <-90 dBc, providing better phase noise performance at offset frequencies <10 kHz by adding some fast circuit switching



▲ *Fig. 5 Prototype synthesizer SSB phase noise.*

(FCS) to the reference SLCO, and offering a direct analog core built around the SLCO to meet requirements for extremely low phase noise and high switching speeds in a microwave synthesizer. ■

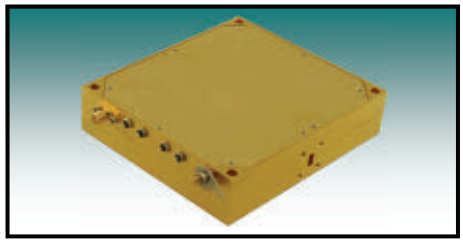
References

1. A. Chenakin, *Frequency Synthesizers: Concept to Product*, Artech House, Norwood, MA, 2011.
2. D.A. Howe and A. Hati, "Low-Noise X-Band Oscillator and Amplifier Technologies: Comparison and Status," *IEEE International Frequency Control Symposium and the Precise Time and Time Interval Systems and Applica-*

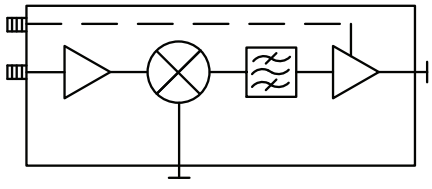
YOUR SYSTEM SOLUTION

millitech

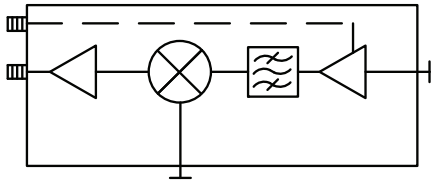
ACTIVE UPCONVERTER AND DOWNCONVERTER



Block Up-Converter Order (BUC)



Block Down-Converter Order (BDC)



FEATURES:

- Pulse/Mute Control
- Up/Downconverters share same outline
- Multiple options for gain, output power, noise figure.
- Available COTS Bands 57-66, 71-76, 81-86, 92-95 GHz
- Small size compared to individual components
- Low VSWR (RF)

APPLICATIONS:

- Test Equipment
- Larger Assemblies

Come see us at Booth 923. Enter to win an iPad.

smiths microwave

Contact info@millitech.com

www.millitech.com

RF-LAMBDA

THE POWER BEYOND EXPECTATIONS

ITAR & ISO9000
Registered Manufacture
Made in USA

LEADING GaN AMPLIFIERS & SWITCHES SOLUTION

- Low Noise Amplifier
- GaN Power Amplifier
- RF GaN PIN Switch
- PIN Attenuator Phase Shifter

Solution to 120GHz Millions IN STOCK!

- Ultra wide band 98%
- High Power Handling
- Low Noise Figure
- Fast Switching Speed
- High Isolation
- Wire Bond Technology

Plano, TX, USA
San Diego, CA, USA
Ottawa, ONT, Canada

www.rflambda.com

tions (PTTI) Meeting Joint Conference Proceedings, August 2005, pp. 481-487.
3. D.A. Howe, A. Hati, C. Nelson, F.L. Walls, J.F. Garcia Nava and A. Sengupta, "Wide-Range Microwave Frequency Synthesis Using An Offset Passive Resonator," *IEEE International Frequency Control Symposium Proceedings*, May 2002, pp. 584-589.
4. C. McNeilage, J.H. Searls, E.N. Ivanov, P.R. Stockwell, D.M. Green and M. Mossamaparast, "A Review of Sapphire Whispering Gallery-Mode Oscillators Including Technical Progress and Future Potential of the Technology," *IEEE International Frequency Control Symposium Proceedings*, August 2004, pp. 210-218.
5. D. Green, C. McNeilage and J.H. Searls, "A Low Phase Noise Microwave Sapphire Loop Oscillator," *IEEE International Frequency Control Symposium Proceedings*, June 2006, pp. 852-860.
6. E.N. Ivanov, M.E. Tobar and R.A. Woode, "Microwave Interferometry: Application to Precision Measurements and Noise Reduction Techniques," *IEEE Transactions on Ultrasonics Ferroelectronics and Frequency Control*, Vol. 45, No. 6, November 1998, pp. 1526-1536.
7. M.E. Tobar, E.N. Ivanov, R.A. Woode and J.H. Searles, "Low Noise Microwave Oscillators Based on High-Q Temperature Stabilized Sapphire Resonators," *IEEE International Frequency Control Symposium Proceedings*, June 1994, pp. 433-440.
8. J.G. Hartnett, M.E. Tobar, E.N. Ivanov and J. Krupka, "Room Temperature Measurement of the Anisotropic Loss Tangent of Sapphire Using the Whispering Gallery Mode Technique," *IEEE Transactions on Ultrasonics Ferroelectronics and Frequency Control*, Vol. 53, No. 1, January 2006, pp. 34–38.
9. E. Rubiola, *Phase Noise and Frequency Stability in Oscillators*, Cambridge University Press, Cambridge, UK, 2009.

Sergey A. Beltchicov *received his M.Sc. degree from Lomonosov Moscow State University in 2001 and his PhD degree from Moscow Power Engineering Institute in 2003. He is vice president of engineering and co-owner of ELVIRA Co. Ltd., Zheleznodorozhny, Russia. His main scientific interests are associated with ultra-low noise signal generation and synthesis at microwave frequencies.*

Andrey B. Dzisiak *received the M.Sc. from his Belarussian State University of Informatics and Radiotechniques, Minsk, Belarus, in 1996, and PhD degree from the Moscow Technical University of Communications and Informatics, Moscow, Russia, in 2008. His PhD thesis involved experimental and theoretical studies of phase noise measuring systems for microwave signals. He has been working for ELVIRA Co. Ltd. since 2007. Since 2009 he has been the chief of microwave business unit in the company. His recent interests include precision phase noise metrology, low noise frequency synthesis, design and manufacture of sophisticated measuring systems for the frequencies up to 178 GHz and their metrology maintenance.*

Igor N. Guletskiy *received his M.Sc degree from Moscow Power Engineering Institute (MPEI, Moscow, Russia). He has been working for more than 15 years in R&D department of ELVIRA Co. Ltd., Zheleznodorozhny, Russia, holding various positions from engineer to the chief of the synthesis group. His primary areas of expertise are RF and microwave frequency synthesizers, low-noise und ultra-low noise microwave oscillators and crystal-controlled oscillators.*

NEW…The Best Performance in Convertibility Just got better: One Head for Ball/Wedge/Ribbon

Model 7KE delivers Wedge-Wedge and Ball-Wedge Wire Bonding in one machine, with convertibility for either 45° or 90° wire feed for Wedge, Deep Access Ball and Ribbon Bonding. Our exclusive X-Y-Z controlled manual Ultrasonic Wire bonding Machine bonds Au, Al Cu:

- ***45° and 90° Wire Feed Convertibility***
- ***Wire or Ribbon Bonding***
- ***Ball-Wedge Bonding***
- ***Throatless Chassis***
- ***Patented 8/1 Ratio Micromanipulator***
- ***ESD Protection***
- ***Adjustable Work Platform***
- ***Orthogonal X, Y, and Z Axes***

See the West·Bond Model 7KE and other fine West·Bond equipment June 3-5, 2014 at the ***IMS MTTS*** *Show in* **Tampa Bay, FL Booth #1615**

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

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

EWT

Where Performance Counts

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

Military • Commercial
Wireless • Space

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

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

www.ewtfilters.com

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

Device Technology and VNA Architecture for Broadband Device Characterization

Steve Reyes
Anritsu Co., Morgan Hill, CA

Engineers characterizing semiconductors and high speed components face increased challenges in broadband millimeter wave (mm-wave) testing. Developing accurate models often involves measurements at frequencies that range from near DC to 100+ GHz. These measurements are typically performed using a vector network analyzer (VNA). In order to ensure accuracy, VNA recalibration may be required as frequently as every hour. This consumes valuable test time and, in production, reduces throughput. While these limitations have always been a consideration, they are now becoming a major issue, due to the preponderance of mm-wave frequency applications. These include E-Band LOS links, 94 GHz imaging radar and 77 GHz long/medium range automotive radar as well as other emerging applications above 110 GHz.

DEVICE CHARACTERIZATION ISSUES

For adequate characterization of on-wafer devices, the greatest challenge is to obtain high quality S-parameter data over a sufficiently broad range of frequencies. The upper end of the measured frequency range must, at least, cover the operating frequency of the target application, although higher frequency coverage is required to properly represent the device model. For example, higher sweep frequencies provide more accurate predictive results when performing circuit simulation of MMIC designs. Measurements at low frequencies are important to identify the potential for low frequency oscillation when S-parameter models are used in simulations and also to understand how low frequency bias networks may cause memory effects at higher frequencies. Many model element extractions, such as the components of FET output admittance, rely on asymptotic frequency data, so the higher and lower in frequency that one can obtain accurate data, the better.

Making S-parameter measurements over a wide range of frequencies, potentially spanning tens of kHz to in excess of 110 GHz, has traditionally required both low and high frequency network analyzers. Apart from the is-

Stop by our booth at IMS, Booth # 1005

Get Connected...

Emerson Connectivity Solutions brings together technology and engineering to create innovative customer solutions.

EmersonConnectivity.com

Toll free: 800-247-8256
Phone: 507-833-8822

EMERSON™
Network Power

Johnson
Connectivity Solutions

Midwest Microwave
Connectivity Solutions

Semflex
Connectivity Solutions

Trompeter
Connectivity Solutions

EMERSON. CONSIDER IT SOLVED.™

Fig. 1 *Traditional broadband VNA system using waveguide frequency extension modules.*

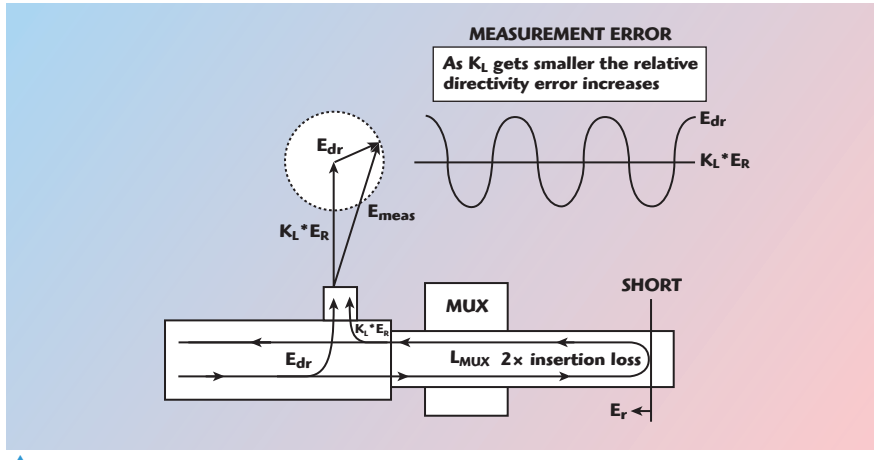


Fig. 2 *Measurement error due to directivity.*

sues of time and cost, this also leads to concatenation issues at the boundary between the low and high frequency measurements. A measurement is essentially an estimate with an associated uncertainty; hence, measurements at the high end of the low frequency system are unlikely to agree with those at the low end of the high frequency VNA.

Quality broadband mm-wave measurements have also been challenging due to limitations in calibration and measurement stability typically caused by high frequency multiplexing schemes, physically large and inhomogeneous measurement structures and complex receiver chains. Multiplexers are necessary to permit coaxial measurement up to 67 GHz to be combined with waveguide band measurements from 67 to 110 GHz in a single 1 mm test port connector. The loss through the MUX combiner and any coaxial cables between the multiplexer and the probe tip degrade directivity of the couplers in the waveguide path and typically has resulted in raw *negative* directivity. An example of this system is shown in ***Figure 1***.

Directivity is a measure of the ratio of reflection from a short circuit to the level of the leakage signal through the coupler. The reflectometer measures the signal reflected by the load plus the leakage. After calibration, changes in phase between the leakage and the measured signal can result in directivity measurement uncertainty (see ***Figure 2***). These phase changes can occur due to temperature and physical cable movement.

Addressing these issues has required technology changes for S-parameter measurement frequency extension modules above 70 GHz, architectural innovations to enable very low frequency measurements and innovations in coaxial connector design to achieve a capability significantly exceeding 110 GHz.

TECHNOLOGY FOR HIGH FREQUENCY SAMPLING

The mainstays of microwave VNA receivers have been samplers based on step recovery diodes (SRD) or harmonic mixers. Harmonic samplers tend to have better conversion efficiency when compared to harmonic mixers, especially at higher multiplication numbers. A sampler based on nonlinear transmission line (NLTL) technology provides an even more beneficial alternative for generating high frequency harmonics much more efficiently. The SRD transfer function tends to drop off by 50 GHz, whereas NLTL technology offers a higher comb frequency with less drop-off in higher frequency performance (see

GaAs'd Up Switches

See us at IMS Booth #1844

Part Number	Function	Frequency	Ins Loss @ 20 GHz	Iso @ 20 GHz
CMD204	SPST	DC - 30 GHz	1.2 dB	44 dB

Part Number	Function	Frequency	Ins Loss @ 10 GHz	Iso @ 10 GHz
CMD195C3*	SPDT	DC - 20 GHz	2.0 dB	45 dB
CMD196C3	SPDT	DC - 20 GHz	1.5 dB	46 dB

Part Number	Function	Frequency	Ins Loss @ 20 GHz	Iso @ 20 GHz
CMD203C4	SP4T	DC - 20 GHz	3.0 dB	40 dB

*Positive gain slope.

Best-in-class switching performance for your high frequency designs.

Download complete datasheets today.

Custom MMIC
Let Performance Drive
CustomMMIC.com

WITH AN ANALOG VTF YOU NEVER MISS A BEAT

High-Speed Voltage Tuned Filters For Airborne and Ground Communications

Voltage-tuned filters from Anatech Electronics can place their center frequencies anywhere within their range rather than in digitally-tuned steps using a DC control voltage. They deliver superb performance, are built for hostile operating environments, and are extremely compact perfect for both airborne and ground-based environments.

Contact us today with your requirements!

- 225 to 300 MHz (surface-mount)
- 225-400 MHz (connectorized)
- On/off isolation is 70 dB or better
- At least 50 dBc spurious rejection
- Custom packaging, operating frequencies, and other specifications are available

IMS2014 - Tampa Bay, Florida

VISIT US AT IMS 2014 in Tampa! BOOTH 239

ANATECH ELECTRONICS INC
RF & Microwave Filters & Products

23 years of filters expertise at your service

Check out Anatech's broad range of high-performance RF and microwave filters, duplexers, triplexers, multiband combiners and many other products on our Web site: www.anatechelectronics.com

Bring us your challenge, we'll provide the answer

sales@anatechelectronics.com | (973) 772-4242 | www.anatechelectronics.com

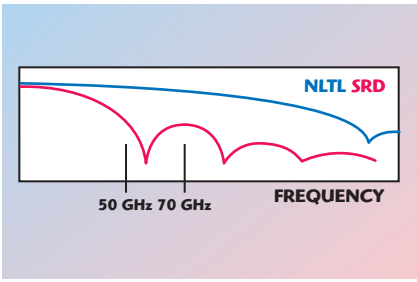


Fig. 3 NLTL-based sampler vs. SRD transfer coefficients.

Figure 3). Excellent dynamic range at 70 GHz and beyond without the need for large amplification is achieved with the promise of scalability to hundreds of GHz.

Anritsu's engineers in Morgan Hill, working together with Anritsu's fabrication facility in Japan, have successfully overcome many challenges, both process-related and physical (such as issues related to surface waves), to produce repeatable devices based on NLTL technology that achieve much greater dynamic range at frequencies of 110 GHz and beyond.

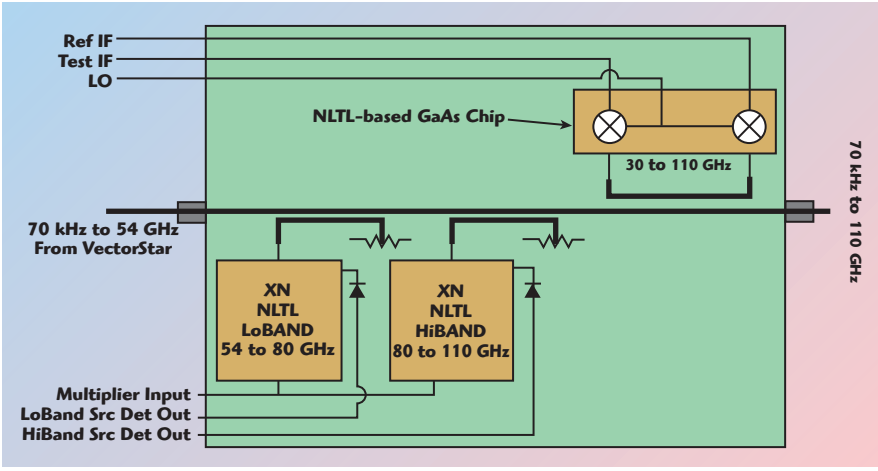


Fig. 4 NLTL-based broadband frequency extension module.

ARCHITECTURAL SOLUTIONS

An S-parameter measurement requires a combination of sources, directional devices to separate forward and reverse signals, and receivers. NLTL-based multipliers and samplers provide the enabling source and receiver technology, while the key to providing good directivity is eliminating the need for the MUX combiner, inherent in the waveguide frequency extension modules.

Figure 4 shows the architecture of a frequency extension module using GaAs NLTL devices integrated with couplers on a coplanar waveguide substrate. Everything is built around a through-line. Measurements below 30 GHz are made in the parent VNA, while the directional devices for measurements at 30 GHz and beyond are located within the frequency extension module, with no intervening loss due to a MUX combiner. This provides high directivity and results in more stable measurements. Using this system, improved stability over the 70 kHz to 110 GHz frequency range has been demonstrated with S_{21} deviations of less than 0.1 dB in amplitude and 0.5° in phase over a 24 hour time period. This allows for longer intervals between calibration and improved measurement accuracy. The use of the NLTL technology enables a VNA system dynamic range of up to 109 dB at 110 GHz. The product of this technology and architecture is shown in ***Figure 5***. As can be seen, the extremely small size of the modules means that, in many cases, the probes can be directly connected to the modules further enhancing stability.

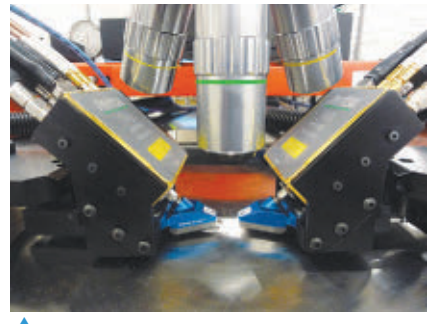
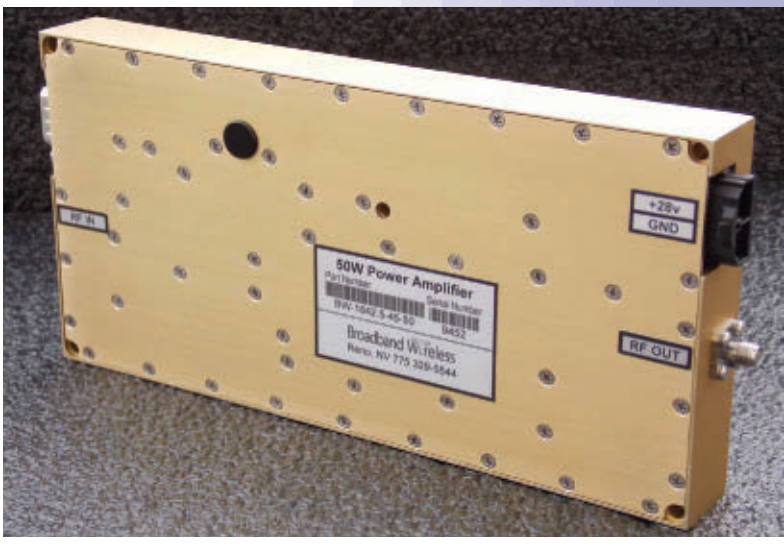


Fig. 5 Miniature 70 kHz to 110 GHz frequency extension modules.

REDUCE YOUR PA POWER CONSUMPTION

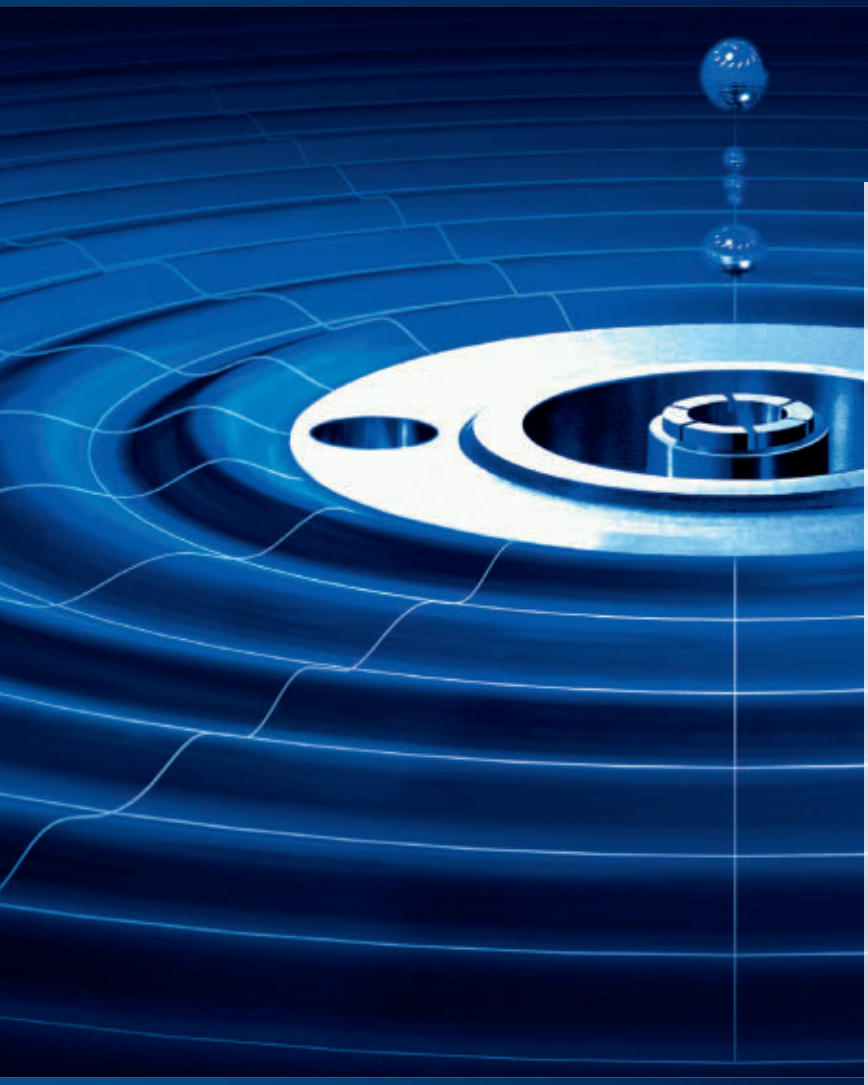


CONTACT BROADBAND WIRELESS TO SEE HOW WE CAN PUT OUR HIGH-EFFICIENCY / HIGH-LINEARITY DESIGNS TO WORK IN YOUR SYSTEM

CUSTOM DESIGNS | STANDARD PRODUCTS | QUALITY COMPETITIVE| MADE AND DESIGNED IN USA

Broadband Wireless
www.bwt-amps.com | Phone: (775) 329-5544

Rosenberger



Test, Measurement & Calibration

RF and microwave components from Rosenberger play a key role in a variety of test, measurement & calibration applications. The product range includes

- **RF high precision connectors**, adaptors and devices, e.g. connector heads, opens, shorts or loads of all popular connector series such as RPC-N, -7.00, -3.50, -2.92, 2.40, -1.85 or -1.00 mm
- **Calibration and verification kits** for a number of coaxial standard test interfaces
- **Test cables & test devices**, e.g. VNA microwave test cables, high performance cable assemblies, airlines, interchangeable port connectors, T-calibration adaptors
- **Automated Test Equipment (ATE) products**
  Multiport Mini-Coax connectors for semiconductor test equipment applications

New:

- Monolithic compliant interconnects – 0.8 mm pitch
- Ruggedized test port adaptors – for VNA applications

Exploring new directions

Europe

Rosenberger
Hochfrequenztechnik GmbH & Co. KG
Hauptstraße 1 – 83413 Fridolfing
Germany
Tel. +49 - 86 84-18-0
info@rosenberger.de
www.rosenberger.com

North America

Rosenberger
of North America, LLC.
1100 Professional Drive #100
USA-Plano, Texas 75074
Phone: + 1 - 972 - 423 8991
salesinfo@rosenbergerna.com
www.rosenberger.com/us_en

See us at IMS Booth 1519

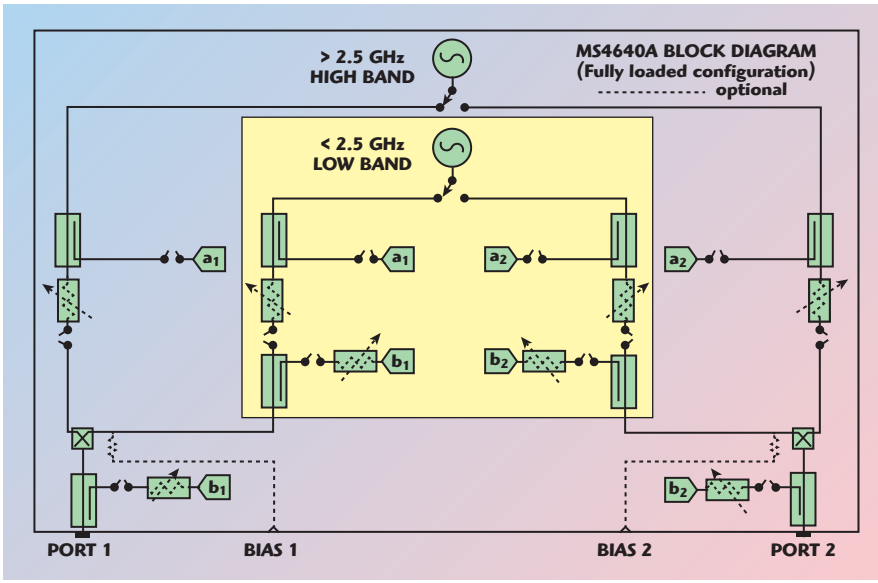


Fig. 6 VNA based on a hybrid bridge architecture.

While couplers provide great performance at higher frequencies, a coupler designed to operate to 70 GHz will fall off in performance at 500 MHz and below. This issue is solved in hybrid bridge architecture, as shown in ***Figure 6***. Above 2.5 GHz, couplers are used, whereas below 2.5 GHz, RF bridges used as the directional devices provide a flatter raw conversion performance all the way down to 70 kHz (see ***Figure 7***). The complete VNA system, as embodied in the Anritsu ME7838A (70 kHz to 110 GHz, operational to 125 GHz), shown in ***Figure 8***.

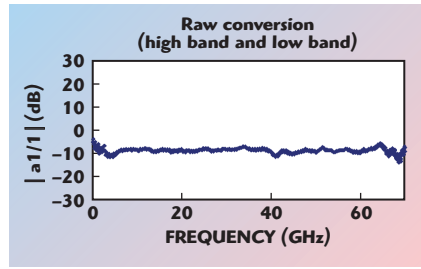


Fig. 7 Low frequency performance extended with a hybrid bridge architecture.

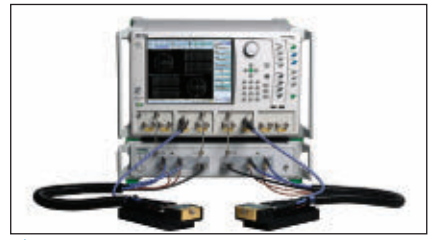


Fig. 8 ME7838A in bench-top coaxial two-port measurement configuration.

CONNECTOR TECHNOLOGY

Making broadband measurements at a single test port requires a coaxial connector for operation at low frequency. W1 (1 mm) connectors permit measurements to be made up to 110 GHz with limited operational capability to 125 GHz. For traceable measurements beyond 110 GHz, smaller connectors are needed. Anritsu has already demonstrated a 70 kHz to 145 GHz broadband VNA system featuring NLTL-based frequency extension modules with a newly developed 0.8 mm coaxial connector.

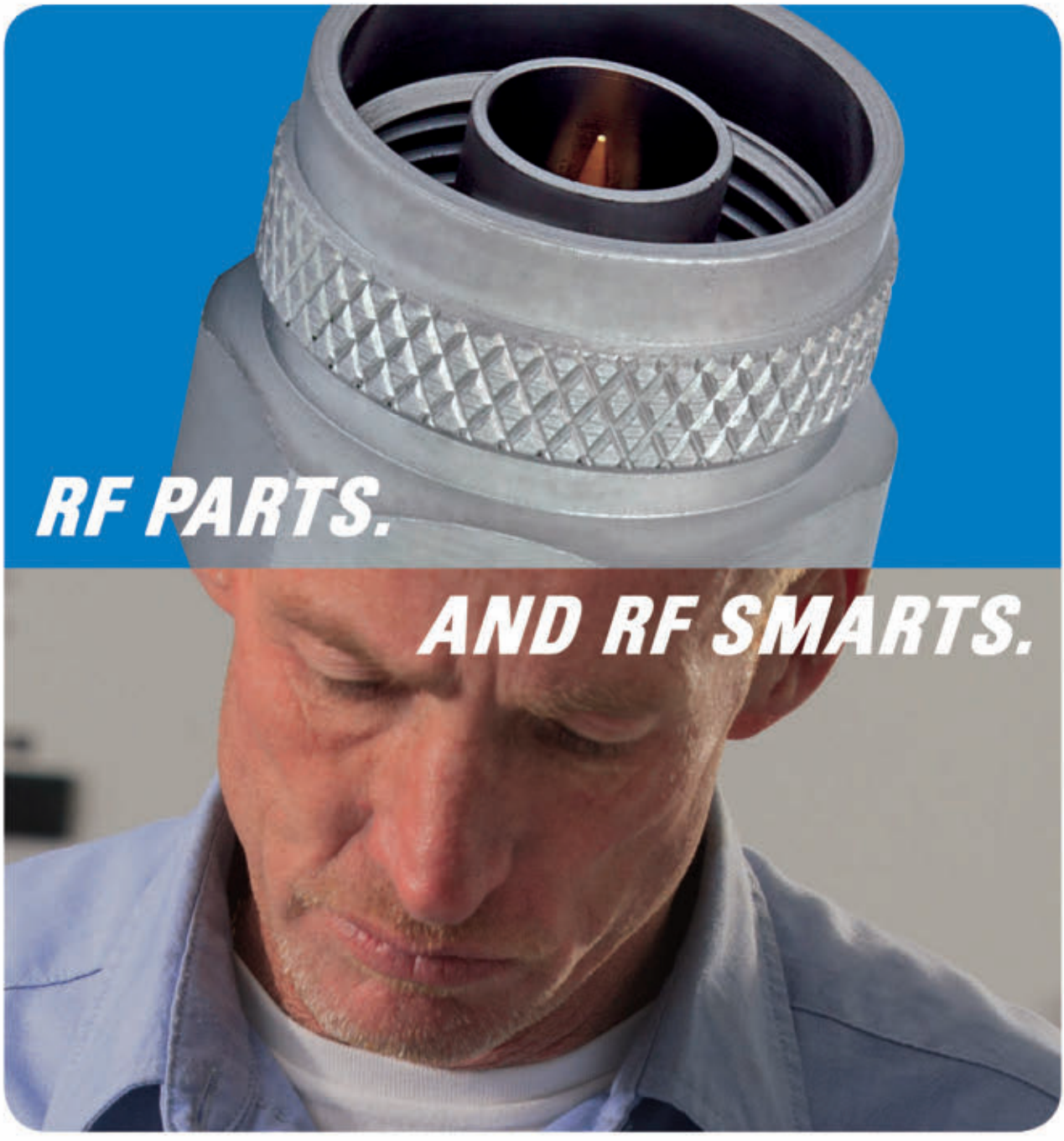
CONCLUSION

A new VNA architecture provides better test data and more accurate information to improve and refine device models. The ability to combine stable, accurate high frequency and low frequency S-parameter data in a single frequency sweep eliminates the need for data concatenation and its associated errors. Improved stability allows more time spent measuring, because less time is needed for recalibrating. Reduced measurement uncertainty provides engineers with greater confidence in their mm-wave designs. ■

Steve Reyes, *product marketing manager, network analyzers, for Anritsu. Steve has 20+ years of sales and marketing experience of wireless communication equipment to semiconductor, component and equipment manufacturers.*

See us at IMS Booth 1814

PASTERNACK®
THE ENGINEER'S RF SOURCE



Armed with the world's largest selection of in-stock, ready to ship RF components, and the brains to back them up, Pasternack Component Engineers stand ready to troubleshoot your technical issues and think creatively to deliver solutions for all your RF project needs. Whether you've hit a design snag, you're looking for a hard to find part or simply need it by tomorrow, our Component Engineers are at your service. Call or visit us at pasternack.com to learn more.

RF SPECIALIST SUPPLIER ✓

LARGEST RF INVENTORY ✓

SAME-DAY SHIPPING ✓

pasternack.com
866.727.8376

Exceptional companies have superior labs —

Test port cable assemblies & metrology adapters - the industry's best VSWR spec!

Turnkey in-fixture characterization of non-50Ω load pull, noise parameters & s-parameters up to 110 GHz.

Stability™ cable assemblies for all VNA application – phase stability at its best!

Pulsed IV/RF solutions for model development & validation – essential for GaN R&D!

MT2000 – the world's fastest active load pull system and the only solution to control wide-band impedances for modulated signals!

Visit our Web Store to purchase Test Essentials™ & ColorConnect™ adapters, Stability™ & Utility™ cable assemblies *with next day delivery!*

Your Calibration, Measurement & Modeling Solutions Partner!

Maury Microwave Corporation • 2900 Inland Empire Blvd., Ontario, California 91764
Tel: 909-987-4715 • Fax: 909-987-1112 • Email: maury@maurymw.com

www.maurymw.com

– complete your lab with Maury Microwave!

Turnkey on-wafer characterization of non-50Ω load pull, noise parameters and s-parameters up to 110 GHz.

Torque Wrenches & Connector Gages – for guaranteed interconnections!

Utility™ cable assemblies for everyday lab applications - the industry's best price/ performance!

Test Essentials™ lab adapters for everyday use!

ColorConnect™ precision adapters – color coded to avoid expensive mismate mistakes!

Coaxial & waveguide calibration kits for all VNAs – when only mechanical calibrations will do!

Visit Maury at IMS2013, Booth #1241 on Agilent Avenue and at µApps.

Maury Microwave

Strategic Partners

Agilent Technologies
Global Solutions Partner

AMCAD Engineering
Advanced Modeling for Computer-Aided Design

anteverta microwave

Scan page
using layar app

GaN-on-Diamond: The Next GaN

Felix Ejeckam, Daniel Francis, Firooz Faili, Frank Lowe, Jon J. Wilman, Tim Mollart, Joe Dodson, Daniel J. Twitchen and Bruce Bolliger
Element Six Technologies, Santa Clara, CA
Dubravko Babić
University of Zagreb, Unska, Croatia

Engineers in the defense community have long sought to replace the bulky and heavy traveling wave tubes (TWT) used in high power systems such as radar, communications satellite and electronic warfare (EW) with compact, lightweight, cheaper and more efficient semiconductor components.[1] Semiconductors also enable system level features like phased array radars. More than any other semiconductor material, GaN exhibits intrinsic properties that make it as promising as a TWT replacement;[2] its wide band gap enables high voltage operation and high power added efficiencies (PAE). However, thermal limitations have so far impeded the industry's progress toward GaN's optimal performance as GaN's RF power is increased.[3]

TABLE I
PHYSICAL PROPERTIES OF VARIOUS SUBSTRATE MATERIALS' PROPERTIES

	Si	*GaAs*	*SiC*	*Sapphire*	*CVD Diamond*
Thermal Conductivity (W/m-K)	135-150	35-50	390-450	35	1000, 1500, 2000
Electrical Resistivity @ RT (Ω-cm)	~2.3×10^5	~10^4 - 10^8	~10^4 - 10^6	~10^{17}	~10^{13} - 10^{16}
Young's Modulus (110) @ RT (GPa)	130	~83	~390 - 700	~250 - 400	~1,100
Diameter Availability Today	12"	6"	6"	2" - 4"	Up to 150 mm

It has been shown via modeling and preliminary device demonstrations that replacing GaN's host substrate (typically SiC) with directly deposited CVD diamond would boost RF area power density three-fold compared to GaN-on-SiC.[4-6] Heat is extracted via bottom thermal conduction. The three-fold boost to power density derives from the 40 percent reduction in the transistor's channel temperature rise compared to GaN-on-SiC; at a reduced channel temperature rise, the GaN's transistor gate fingers may be brought three times closer together without fear of thermal cross-talk. ***Table 1*** compares the electrical and thermal properties of diamond with other substrates typically used to host GaN.[5] Note that diamond's thermal conductivity is about five times greater than that of SiC. Diamond is also an excellent electrical insulator – a property needed for high frequency power amplifiers. Additionally, the spatially shrunken GaN-on-diamond devices can operate amidst a much higher ambient temperature compared to GaN-on-SiC. This is due to the reduced thermal impedance stack between the GaN channel and the substrate/package. Key to the success of GaN-on-diamond is that the diamond can be grown to within tens of nanometers of the GaN epitaxy maximizing its heat spreading function.

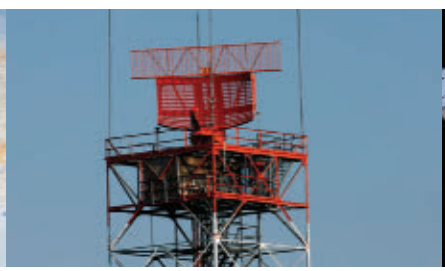
GaN-on-diamond PAs also hold promise for use in cellular base stations where operating

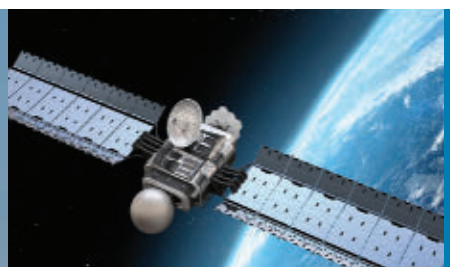
High-Reliability GaN Power Where You Need It

From tactical communications to the challenges of space, count on the leader in GaN technology for higher reliability, more power, and more performance.

GaN for Communication

5.8 to 6.7 GHz	100W IMFET
7.7 to 8.5 GHz	100W IMFET
13.75 to 14.5 GHz	50W IMFET
13.75 to 14.5 GHz	25W MMIC
27 to 31 GHz	10W MMIC



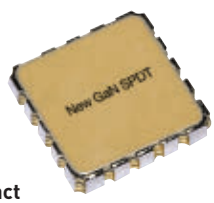


GaN for Mobile

UHF to 3.5 GHz
10/30/45/70/90W

SPDT Switch

VHF to 6.0 GHz	15W
VHF to 3.5 GHz	30W
VHF to 2.5 GHz	60W



To learn more, contact usacomm@sei-device.com

GaN for Radar

S-Band

2.7 to 3.1 GHz	500W	Single Ended
2.9 to 3.3 GHz	600W	Discrete & Pallet
3.1 to 3.5 GHz	600W	Discrete & Pallet

C-Band
5.2 to 5.9 GHz
200W Discrete

X-Band
8.5 to 10 GHz
200W Discrete
9.2 to 10 GHz
120W Discrete

To learn more, contact usaradar@sei-device.com

GaN for Space

UHF to S-Band
4/8/20/50/100/150W

C/X-Band
20/40W

To learn more, contact usaspace@sei-device.com

www.sei-device.com

SUMITOMO ELECTRIC
Ingenious Dynamics

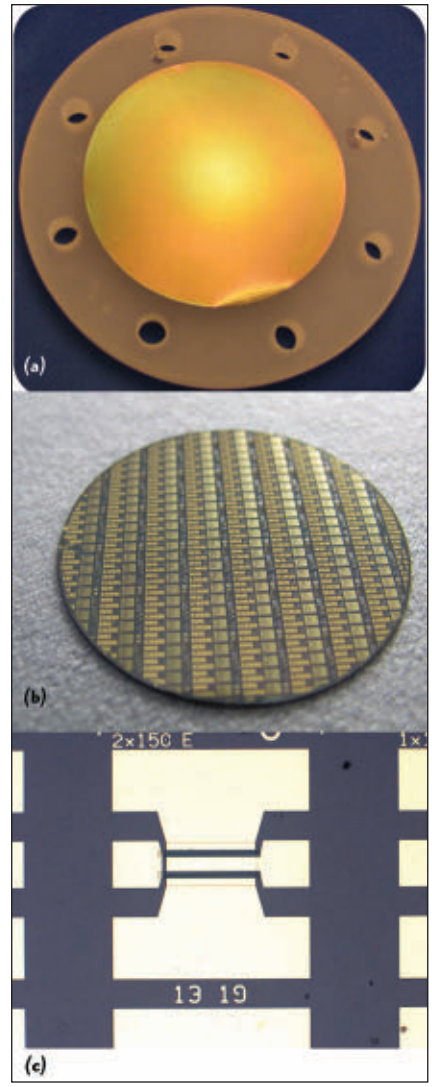
See us at IMS Booth 333

energy costs in cooling the PAs can be significant for service providers. GaN-on-diamond's ability to operate in a much higher ambient temperature and at a higher PAE than any other semiconductor material translates into direct costs savings from reduced physical space, smaller power supplies and less energy use.

MAKING GaN-ON-DIAMOND EPITAXIAL WAFERS

GaN-on-diamond wafers are shown in ***Figure 1***. The AlGaN/GaN HEMT layer structure was grown by metal-organic chemical vapor deposition (MOCVD) on a high resistivity Si (111) substrate. Starting from the Si substrate, epitaxial layers included a 1.1 µm thick proprietary transition buffer, an 800 nm thick undoped GaN buffer layer, a 17 nm thick $Al_{0.26}Ga_{0.74}N$ Schottky barrier, and a 2 nm GaN cap layer. A 100 µm thick CVD diamond layer was grown on a dielectric-coated GaN epitaxial substrate (GaN buffer, AlGaN barrier and GaN cap). The process for diamond growth is as follows: the host Si (111) and transition layers beneath the AlGaN/GaN epitaxy are removed, a 50 nm thick proprietary dielectric is deposited onto the exposed AlGaN/GaN and finally a 100 µm thick CVD diamond substrate is grown onto the dielectric adhering to the epitaxial AlGaN/GaN films.

In understanding whether the GaN-on-diamond wafer formation process used here negatively affected the GaN epitaxy, numerous tests were conducted on the GaN epitaxy including high-resolution X-ray, CV, Lehighton, Low-Temp PL, Hall and TEM. Those test results were reviewed before and after the diamond deposition on the GaN epitaxy.[7] None of the tests could detect any changes to the GaN epitaxy. ***Table 2*** shows the result of high-resolution X-ray tests on GaN-on-diamond wafers; no changes to the lattice constant (d_{0002}) of the GaN epitaxy were resolvable and the aluminum compositions (X_{Al}) were nearly identical (to within 1 percent).



▲ *Fig. 1 Photo of an unprocessed 4-inch GaN-on-diamond wafer (a), a photo of 1-inch GaN-on-Diamond wafer processed into HEMTs by AFRL[4] (b), and a photo of a 2-finger GaN-on-diamond HEMT[4] (c).*

MEASURED GaN-ON-DIAMOND DC AND RF RESULTS

TriQuint Semiconductor fabricated the GaN-on-diamond RF HEMT devices discussed in this article, the details of which have been already published.[5,8] Then the company characterized the DC electrical performance of the fabricated devices, measuring an electron mobility of 1400 $cm^2/V\text{-}s$, a sheet charge density of 9.6×10^{12} cm^{-2}, and a sheet resistance of about 440 Ω/sq on the GaN-on-diamond wafers. The 50 µm gatewidth HEMT drain-current measurements show excellent pinch-off characteristics and a maximum current density of about 1100 mA/mm. ***Figure 2*** depicts the DC transfer charac-

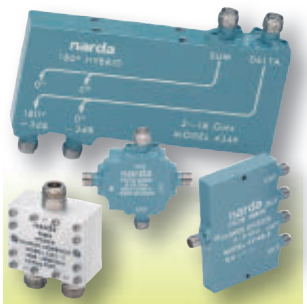
See us at IMS Booth 111

the NEW NARDA

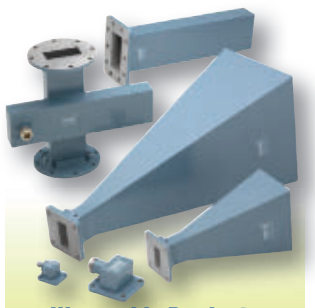
The Engineer's First Choice for RF & Microwave Products

Attenuators
- Fixed, Step, or Variable
- Power Levels Up to 500W
- DC to 40 GHz

Directional Couplers
- Broadband Coverage
- High Power (up to 1 kW CW)
- Flat Frequency Response
- .05-40 GHz



Power Dividers
- Low VSWR
- 2-, 3-, 4-, 6-, and 8-way
- High Isolation
- .25-45 GHz



Waveguide Products
- Newly Expanded Line, Including 130 New Products
- 1.7-40 GHz
- Gain Horns, Adapters, Terminations, and Couplers

Terminations
- Low VSWR
- High Power (up to 500W CW)
- DC-40 GHz

SEM Switches
- Electro-Mechanical
- SPDT through SP12T
- DC-26.5 GHz

PIN Switches
- Solid-State
- Small Package Size
- Fast Switching Speeds
- .1-40 GHz

New Catalog Available

60 TM ANNIVERSARY narda an L3 company SERVICE • SUPPORT • SELECTION

Visit Us At The **IMS Show** 6/1-6/6 Booth 405

narda

an L3 company

www.nardamicrowave.com • 631.231.1700

Six decades of technological innovation.

TABLE II

LAYER X-RAY ANALYSIS OF THE LATTICE-CONSTANTS OF GaN-ON-DIAMOND AND GaN-ON-SILICON WAFERS

GaN Layer: Established lattice constants for GaN d_{0002}=2.593 Angstroms, c=5.186 Angstroms

Structure	ω-2θRC FWHM (arc. sec)	$L_{coher\perp}$ (nm)	ω RC FWHM (arc. sec)	$L_{coher\perp}$ (nm)	N (cm^{-2})	d_{0002} (Ang)
GaN/Si	38	440	618	86.5	3.9×10^{8}	2.591
GaN/Dia, A	49.3	337	669	80	4.6×10^{8}	2.591
GaN/Dia, B	41.4	402	805	66	6.65×10^{8}	2.591

AlGaN Layer

Structure	ω-2θRC FWHM (arc. sec)	$L_{coher\perp}$ (nm)	ω RC FWHM (arc. sec)	$L_{coher\parallel}$ (nm)	N (cm^{-2})	X_{Al} (%)
GaN/Si	130	128	915	59	8.6×10^{8}	~24
GaN/Dia, A	121	138	908	59	8.5×10^{8}	~25
GaN/Dia, B	126	132	1,095	49	1.25×10^{8}	~25

teristics of the same device at a drain voltage of 10 V; measurements of peak transconductance gave 300 mS/mm and a threshold voltage of –3.4 V. Measurements of the gate-drain breakdown voltage across 10 sample devices, at a gate-drain current of 1 mA/mm, varied between 25 and 52 V. It is suspected that the wafer surface preparation process, still under development, at the time, may have caused this breakdown voltage variation; isolation currents measured between two mesa patterns with ohmic contacts and a spacing of 5 µm indicated very low buffer leakage current with < 10 µA/mm at a maximum applied voltage of 80 V.

To characterize RF performance, continuous wave (CW) load pull tests of 2×100 µm gate width HEMTs at 10 GHz were conducted using a Focus Microwave test setup. Devices biased at a quiescent drain voltage of 40 V and a drain current of 100 mA/mm were tuned for peak PAE. ***Figure 3*** shows the measured input-output power response with a peak PAE of 46.7 percent at 20 dBm of input power (Pin). The device was tuned for PAE at a drain voltage of 40 V and a quiescent drain current density of 100 mA/mm. At the PAE peak, the output power (Pout) is 31.7 dBm (7.4 W/mm) and associated gain is 11.7 dB. At 28 V drain voltage, an output power of over 5 W/mm along with a PAE of about 55 percent was achieved. To the authors' best knowledge, these results demonstrate the highest RF power for GaN-on-diamond HEMTs at 10 GHz and are equivalent to the maximum power ever extracted from the same epitaxy and device structure.[9] The high leakage current that caused the variation in breakdown voltage mentioned earlier also makes the PAE in these devices lower than expected; the authors believe that reducing the leakage will significantly increase the PAE. Adding

Which is Your Favorite Band?

Whether you prefer L-Band, S-band, C-band, X-band, Ku-band, K-band or Ka-band, ***ims*** has something you'll like. From our RCX-PW series of partial wrap high frequency resistors to our A-Series, IAX Series and IMA Series RF attenuators to our IPS broadband splitters to our IMK resistive couplers, N-Series resistors and terminations, and ThermaBridges™, ***ims*** is in harmony with your repertoire. With ***ims*** on your team, the hits will just keep on coming.

ims ...rock steady!

Resistors • Attenuators • Terminations • Splitters
Couplers • Dividers • Filters • Thermal Transfer Devices

www.ims-resistors.com/mwj.html

Visit us in booth 1224!

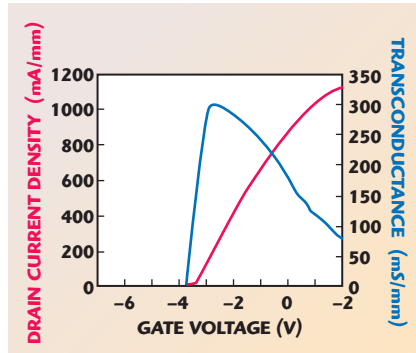


Fig. 2 Transfer characteristics of a 50 µm GaN-on-diamond HEMT at a drain voltage of 10 V.

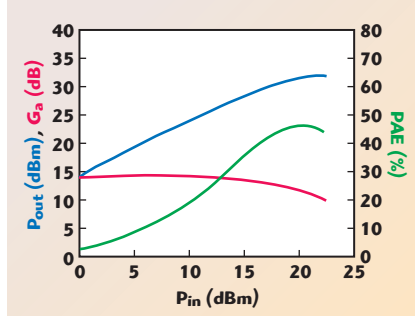
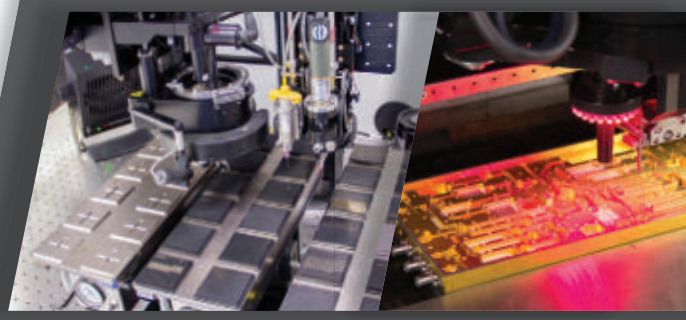


Fig. 3 10 GHz CW load-pull results of a 2 × 100 µm GaN-on-diamond HEMT.

Scan page using layar app

Innovation **That Scales.**

Mercury's Advanced Microelectronics Centers (AMC) offer state-of-the-art RF and Microwave design, manufacturing, testing and ESS. Co-located design and manufacturing engineers take on your most demanding design to spec or build-to-print needs.



Our AMC's Offer:

- *One-stop shopping for components, IMAs and multi-function modules*
- *World-class automation*
- *Scalability from design to full-rate production*

MERCURY SYSTEMS™

INNOVATION THAT MATTERS™

Visit mrcy.com/scales and download our whitepaper:
RF/Microwave Technologies- A Better Alternative In Defense Electronics

Copyright © 2014 Mercury Systems and Innovation That Matters are trademarks of Mercury Systems, Inc.

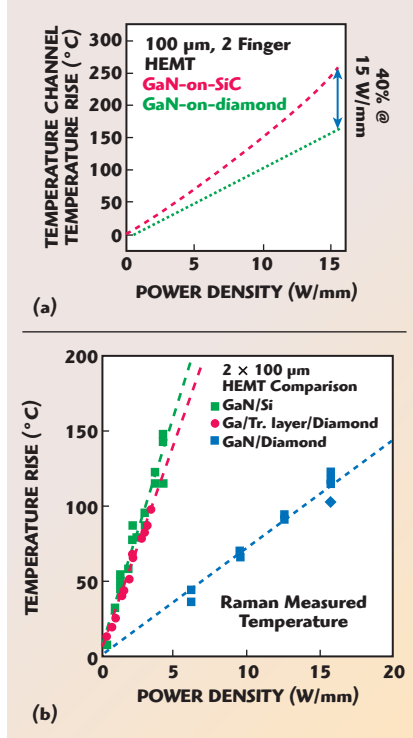
See us at IMS Booth 742

a source connected field plate in the channel is also expected to improve the high voltage performance of these devices. This improvement work is in progress, and a comprehensive report, including thermal performance, will be published in the future.

THERMAL MEASUREMENTS OF GaN-ON-DIAMOND HEMTS

Peak temperatures shown here have been calculated using measured micro-Raman temperatures. Thermal performance evaluation of GaN-on-diamond devices was done using micro-Raman spectroscopy. Details of the micro-Raman technique are presented by Pomeroy et al.[10] The spot size measured with the micro-Raman technique is about 1 µm^3 from the surface of the GaN adjacent to the gate between the drain and the gate. Test HEMTs with gate width of 2×100 µm and TLM structures with 100 µm width and 20 µm spacing were used to measure the channel temperature rise at different DC power dissipation conditions. For comparison, TriQuint's standard 100 µm thick 2×100 µm GaN-on-SiC HEMTs were also tested using the micro-Raman technique. According to the measurements (see ***Figure 4***), GaN-on-diamond HEMTs exhibited an approximately 40 percent lower thermal resistance or ~160°C per W/mm compared to GaN-on-SiC. Figure 4 also shows that the thermal resistance of GaN-on-diamond HEMTs as nominally made with no transition layers between GaN and diamond is lower by over four times than GaN-on-Silicon or GaN-on-diamond with the transition layers still included between GaN and diamond (trends lines are included for illustrative purposes).

The reduction in the GaN thermal resistance shown is attributed to a) the high thermal conductivity diamond situated in close proximity (~1 µm) of the hot GaN HEMT junction, and b) the removal of defective transition layers of GaN-on-Si beneath the AlGaN/GaN films. Simulations show that a 40 percent reduction in thermal resistance could enable 2.5 to 3× increases in the density of gates (or output power) in a power amplifier,



▲ *Fig. 4 Peak channel temperature derived from micro-Raman measurements on GaN-on-diamond and GaN-on-SiC HEMTs (a) and peak channel temperatures of GaN-on-diamond HEMTs compared to GaN-on-Si, and GaN-on-diamond where the transition layers have not been removed (b).*

as well as significant reductions in the cost of cooling – since the transistor may be allowed to operate at a higher ambient temperature. Note that in this work, the GaN's gate fingers were not brought closely together compared to GaN-on-SiC – a key feature that is now possible by the reduced channel temperature rise.

RELIABILITY MEASUREMENTS

With GaN resting on a new foreign substrate – and one whose thermal expansion coefficient, crystal structure, surface properties, and internal stress are very different from that of GaN – device reliability becomes a concern for engineers using GaN-on-diamond. In an effort to assess the reliability question seven GaN-on-Si and 12 GaN-on-diamond HEMT, devices were subjected to channel temperatures of up to 350°C with a constant source-drain voltage of up to 24 V.[11] The source-drain current and the gate leakage current were monitored during the endurance tests. After 3000 hrs at a 350°C channel temperature, 9000 hrs at 290°C, and 17000

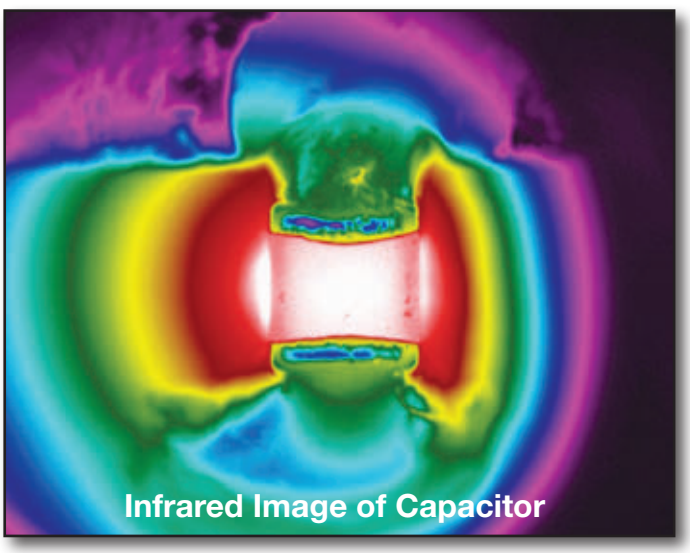
PRESIDIO COMPONENTS, INC.

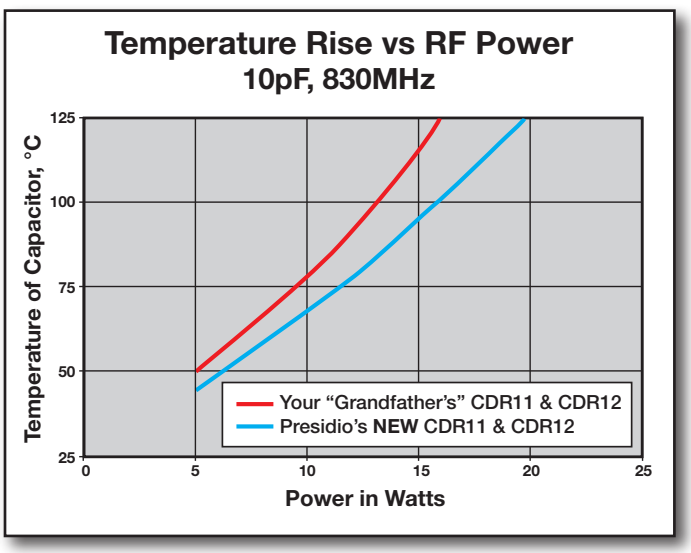
Porcelain 0505

PRESIDIO'S CDR 11 & 12 CAPACITORS ARE "S" LEVEL QUALIFIED AND CAN HANDLE THE POWER

Presidio Components, Inc. is proud to announce the qualification to failure rate level "S" for CDR 11 and 12 on Mil-PRF-55681.

These capacitors have not only earned the industry's highest reliability rating but also have extemely high Q, exceptionally low ESR, and very cool performance with RF power.





Founded in 1980, Presidio Components, Inc. is a supplier of the highest quality and most innovative capacitors available in the world today. Visit us at IMS in Tampa (Booth 1205) to learn more about our new 0505 qualification and capability as well as our many other capacitor products, including our innovative single layer capacitors, patented broadband DC blocking capacitors, and unique broadband bypass capacitors.

CALL TODAY FOR SAMPLES

7169 Construction Court • San Diego, CA 92121 USA
Phone: (858) 578-9390 • Fax: (858) 578-6225
www.presidiocomponents.com

HIGH POWER BROAD BAND
LIMITERS
0.5 - 12 GHz

New 40 WATT CW

- Low Limiting Threshold (+6 dBm Typical)
- 40 Watt CW and 200 Watt Peak (1 microsec) power handling capability
- Built-In DC Block @ input and output
- Hermetically Sealed Module
- Typical Recovery Time is less than 10 Microsec

Typical Performance @ + 25 Deg. C

MODEL	FREQ. RANGE (GHz)	MAXIMUM INSERTION LOSS (dB)	MAX VSWR	MAX LEAKAGE @ 40 W CW INPUT (dBm)
LS0510 P40B	0.5 – 1.0	0.5	1.4:1	+21
LS0520 P40B	0.5 – 2.0	0.6	1.4:1	+21
LS0540 P40B	0.5 – 4.0	0.8	1.4:1	+21
LS0560 P40B	0.5 – 6.0	1.3	1.5:1	+21
LS05012P40B	0.5 – 12.0	1.7	1.7:1	+21
LS1020 P40B	1.0 – 2.0	0.6	1.4:1	+21
LS1060 P40B	1.0 – 6.0	1.2	1.5:1	+21
LS1012P40B	1.0 – 12.0	1.7	1.7:1	+21
LS2040P40B	2.0 – 4.0	0.7	1.4:1	+20
LS2060P40B	2.0 – 6.0	1.3	1.5:1	+20
LS2080P40B	2.0 – 8.0	1.5	1.6:1	+20
LS4080P40B	4.0 – 8.0	1.5	1.6:1	+20
LS7012P40B	7.0 – 12.0	1.7	1.7:1	+18

Note: 1. Insertion Loss and VSWR tested at -10 dBm.
Note: 2. Typical limiting threshold: +6 dBm.
Note: 3. Power rating derated to 20% @ +125 Deg. C.

Other Products: Detectors, Amplifiers, Switches, Comb Generators, Impulse Generators, Multipliers, Integrated Subassemblies

Please call for Detailed Brochures

Herotek

155 Baytech Drive, San Jose, CA 95134
Tel: (408) 941-8399 . Fax: (408) 941-8388
Email: info@herotek.com
Website: www.herotek.com
Visa/Mastercard Accepted

See us at IMS Booth 1327

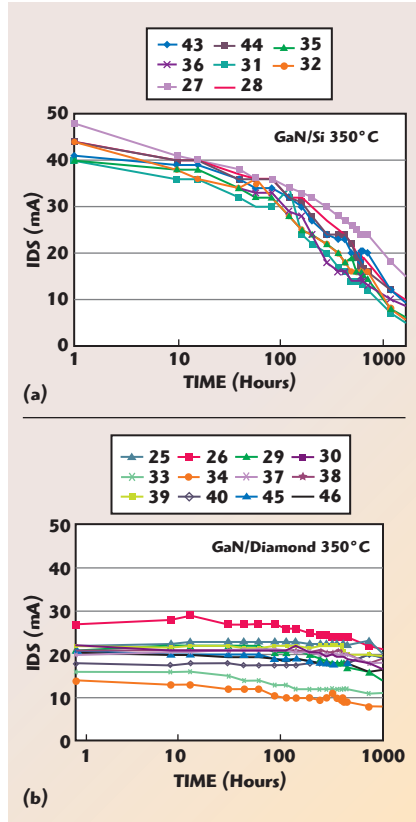
hrs at 215°C, the authors were unable to quench the GaN-on-diamond HEMTs; in contrast, all the control GaN-on-Si devices, sharing the same GaN epitaxy and device structure as the GaN-on-diamond devices, catastrophically failed.[11]

Figure 5 shows the endurance results measured from GaN-on-Si and GaN-on-diamond HEMT devices. In the tests, all the GaN-on-Si and GaN-on-diamond devices were subjected to a 24 V DC bias (source-drain) for 5000 hrs at a 215°C channel temperature. During this 5000 hr period, the drain currents of both GaN-on-Si and GaN-on-diamond devices declined slowly (not shown here); detailed analysis of this behavior has been published.[11] The channel temperatures of all the aforementioned devices were then increased to 350°C; almost immediately, the GaN-on-Si drain-source current began a precipitous drop. The GaN-on-diamond device currents remained relatively flat in the same period that GaN-on-Si dropped.

The graphs shown in Figure 5 began after the initial 5000 hrs soak at 215°C. After 100 hrs at 350°C, all the GaN-on-Si devices dropped 20 percent or more from their starting point. The GaN-on-diamond devices remained generally flat at 1000 hours when all the tests were terminated for logistics reasons. The results are virtually identical for devices biased at channel temperatures of 290°C as published in the literature.[11] Unable to completely terminate any of the GaN-on-diamond devices during the tests – due to their robustness, the GaN-on-diamond's activation energy could not be calculated. The authors point out that the starting currents of the GaN-on-diamond devices shown in Figure 5 are generally lower than the GaN-on-Si devices; this is due to variations in wafer processing of the wafers. The authors believe that the relatively low level of the current densities in the device will have little affect on the outcome of the tests.

IMPACT ON SYSTEMS

In the design of radar, EW, radio jammer, satellite communications, naval and avionics systems, two critical GaN-on-diamond features distinguish the material from other semiconductors. First, GaN-on-diamond devices



▲ *Fig. 5 Source-drain current measured from GaN-on-Si HEMTs (a) and GaN-on-diamond HEMTs (b) while all the devices' channel temperatures were maintained at 350°C (source-drain voltages were 24 V).*

exhibit a total thermal resistance (traversing the HEMT's gate down to the substrate) that is 40 percent less than the industry benchmark GaN-on-SiC HEMTs;[12-16] there are variations in the numbers due to use of different measurement techniques, which will be better understood in the months ahead. Secondly, GaN-on-diamond devices also exhibit a reduced lateral thermal profile and cross talk; this latter parameter is due to the effective heat spreading of diamond.

Impact on Cooling Costs – A semiconductor's thermal resistance is an important parameter in the design of a microelectronic system because it determines the resilience of the system to high ambient temperatures. For instance, consider two devices that exhibit the same channel temperature of 200°C: device A (GaN-on-diamond) harbors a thermal resistance of 10°C/W, and device B (GaN-on-SiC) harbors 20°C/W. Assuming a 5 W power dissipation along the GaN-on-substrate stack, device A will exhibit a 50°C temperature drop between

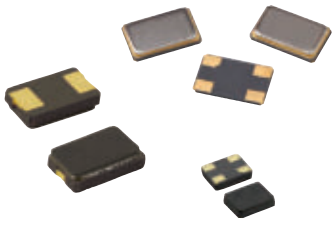
CTS®
ELECTRONIC COMPONENTS

IMS-2014 - Tampa Bay, Florida
BOOTH #322
POWERING THE WAVES
International Microwave Symposium
IEEE 1–6 June 2014, Tampa Bay, FL MTT–S

Launching Innovative Products Into The Future

Automotive Crystals NEW

AEC-Q200 compliant quartz crystals for automotive applications such as remote keyless entry (RKE), audio and video systems, mobile multi-media systems, wireless communication and tire pressure monitoring system (TPMS).



Download Data Sheets

EMC Products

An extensive line of EMI/RFI Filters and Capacitors that uses ceramic dielectric technology not only set the industry standard, but lead the way in the development of tomorrow's EMI Technology.

Surface Mount Filters

Trimmer Capacitors

Feed Through Filters

Terminal Block Filters

Download Catalog

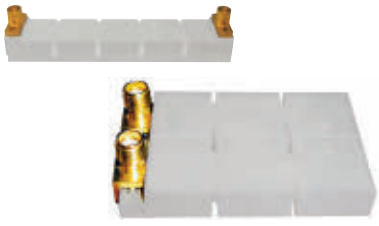
Fansinks for High Temp Applications

- Operating temperature range: -10 to 90°C
- Calculated MTTF @ 90°C: 86,858 hours (GEM, 90% confidence)
- Large selection of footprints and fin heights available

Download Selection Guide

ClearPlex® Waveguide Filters

RF ceramic filters with high performance attributes. Its peak power rating exceeds 500 Watts. The high Q factor is 30% greater than a ceramic coaxial filter, offering better insertion loss and rejection rate. Applications may include remote radio heads and small cells.

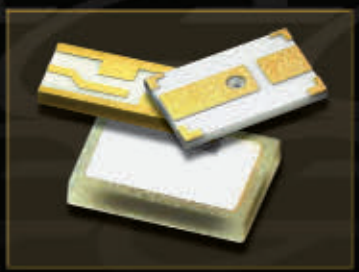


Scan for More Details

www.ctscorp.com

Compex
Promises Made, Promises Kept.

Single Layer Ceramic Capacitors
• Broadest Variety Available
• Gold, Tin, Silver and Platinum Terminations
• 150 pF X7R from 10x10 mils
• 1,000 pF from 25x25 mils
• Custom Diced to Your Value and Size

Mounting Shorts
• Instant Bonding Pads
• Height Matching Reduces Lead Length and Inductance
• Any Size Available
• Available in Alumina or Aluminum Nitride

Sub-Mounts
• Alumina, Aluminum Nitride, Quartz, Kovar
• Custom Patterns and Shapes
• Thickness from 3 to 100 mils and Beyond
• Thickness Accuracy to 5 microns
A Veteran Owned, Solar Powered Small Business
ISO 9001:2008
RoHS and REACH Compliant
Established 1976
439 Commerce Lane, West Berlin, NJ 08091
856 335 2277 • www.compexcorp.com
See us at IMS Booth 311

the gate and the substrate (leaving the substrate at 150°C), whereas device B will exhibit 100°C between the same points (leaving the substrate at 100°C). In other words, whereas both devices are firing at the same channel temperature producing the same RF power, the GaN-on-diamond substrates, packages, and ambient temperatures can be allowed to operate 50°C hotter simply because its thermal resistance is lower by 50 percent. In practice, the costs of maintaining a complex electronics system's ambient temperature at 100°C (device B) as opposed to allowing it to operate hotter at 150° or 166°C (device A) can be prohibitive. For numerous applications, this feature can be enabling and strategic.

Impact without Cooling – If devices A (GaN-on-diamond) and B (GaN-on-SiC) described previously are allowed to float at the same ambient temperature without active cooling, then compared to device B, the lower thermal resistance of device A would equate to a much lower channel temperature while the device A is firing. In the scenario described above, device A would for instance operate at 133° to 150°C whereas device B would operate at 200°C – while producing the same RF power. The impact of this reduced operating temperature is quite profound for the system since RF power amplifiers lay at the core of many of RF electronic systems including radar, EW, avionics, jammers, etc. Reliability-related parameters of activation energy, mean-time-to-failure, and lifetime all derive directly and exponentially from operating temperature.[17] Substantial energy savings for the system operator can be had over a 20 to 30 year system lifetime of operating costs that requires less use of energy.

Impact on Power Amplifier, Power Density and Costs – The reduced lateral thermal crosstalk of GaN-on-diamond devices enables higher power densities. Various groups have recently shown that the GaN HEMT gate fingers on diamond can be brought nearly threefold closer together on diamond than on SiC.[8,15] This 3× tighter gate finger separation equates to a 3× greater RF power density from the packaged device, enabling the cost per watt for GaN-on-diamond to be close to 3× lower than GaN-on-SiC; a wafer customer need only process one GaN-on-diamond wafer rather than three GaN-on-SiC wafers to achieve the same RF output power. Fab process costs would be saved from the fewer runs.

Impact on Low Power Devices – In the case of smaller electronics systems or low power electronics (under 50 W), power densities can still soar (~kW/mm^2) since gate feature sizes are small (~ microns) – begging the need for effective materials-level thermal management.

CONCLUSION

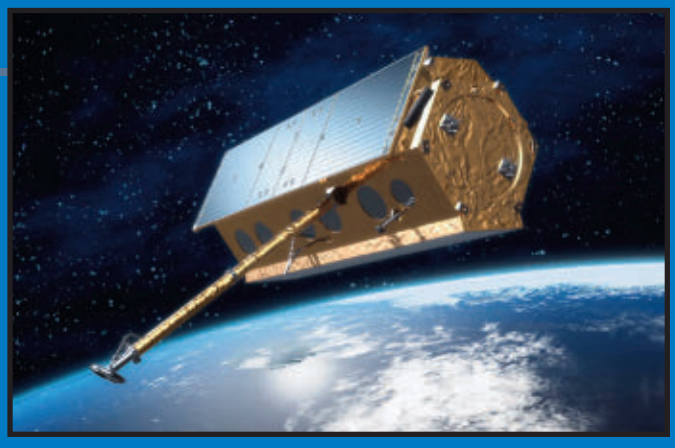
High-quality GaN-on-diamond wafers have demonstrated whereby the crystal quality of the GaN epitaxy is virtually identical to the original layers as grown on SiC substrates. State-of-the-art HEMTs made on GaN-on-diamond wafers show excellent electrical DC and RF properties, along with a clear thermal improvement over current GaN-on-SiC HEMTs. Preliminary high-temperature operating life test data collected by the authors over a 7 to 24 month period show a clear reliability improvement in GaN-on-diamond devices compared to the control GaN-on-Si devices which produced the original GaN epitaxy. The GaN-on-diamond HEMTs at 290° and 350°C channel temperatures never failed while all of the control GaN-on-SiC devices failed at the same temperatures within dozens of hours.

Various parties have also begun to quantify the extent of GaN-on-diamond's thermal benefits. GaN-on-diamond's lower channel temperature and its lower thermal impedance (40 percent lower than GaN-on-SiC) will lead to a) reduced $ per watt components due to more devices per wafer, b) reduced system cooling costs – both fixed costs, and operating expenses – due to a higher allowable ambient temperature, c) reduced size of the power amplifier and its related parts; this is noteworthy for low power devices (< 10 W) and applications where space is a premium, and d) reduced size and weight at the system level where cooling apparatus are typically bulky and heavy. ■

ACKNOWLEDGMENT

This work was sponsored by DARPA's Near Junction Thermal Transport (NJTT) effort, which is managed

Instantly Improve the Performance of Your Phased Array Radar!

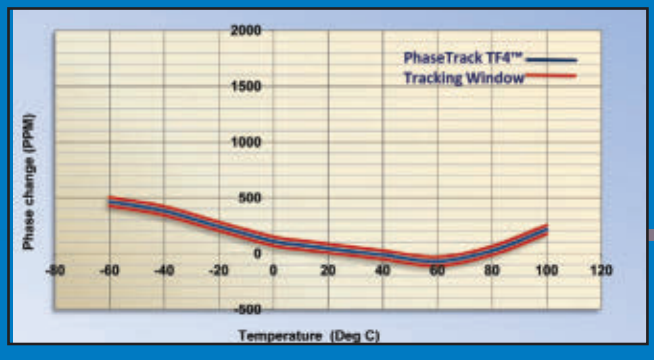


Phased Array Radar system performance has long been limited by the phase change over temperature of coaxial cables.

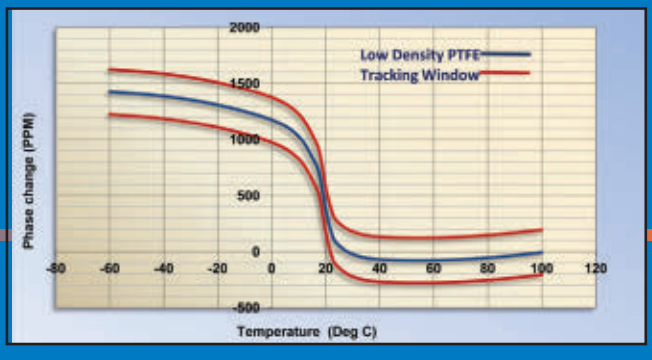
Not anymore!

TF4™ - our proprietary, ultra stable dielectric material significantly improves Phased Array Radar system performance by reducing the phase change of the interconnecting coaxial cables.

Typical PhaseTrack TF4™ Performance



Typical Low Density PTFE Performance



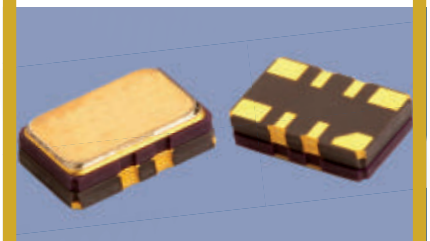
- Available NOW in various flexible coaxial cable and semi rigid coaxial cable assembly sizes
- Perfect for all Ground, Naval, Airborne or Spaceflight Phased Array Radar applications
- Frequency ranges to 40 GHz
- Wide range of connector types available
- Best Phase Tracking and Absolute Phase Change performance available

TIMES MICROWAVE SYSTEMS
An Amphenol Company

World Headquarters: 358 Hall Avenue, Wallingford, CT 06492 • Tel: 203-949-8400, 1-800-867-2629 Fax: 203-949-8423
International Sales: 4 School Brae, Dysart, Kirkcaldy, Fife, Scotland KY1 2XB UK • Tel: +44(0)1592655428
www.timesmicrowave.com

See us at IMS Booth 1118

OeXO's®
from Pletronics



TCXO's equivalent to OCXO's in accuracy and precision with the new OeXO® Series!

Available in three different packages, the new OeXO®'s feature stability of:
±50 ppb over 0°C to +70°C
and
±100 ppb over -40°C to ±85°C.

Ideal for battery powered devices wherever OCXO precision is needed.

- Low power!
- Short stabilization time
- HCMOS or Clipped Sinewave output
- From 10 - 40 MHz
- No turn-on surge warm up current required
- Smaller than traditional OCXO's
- Lower cost

For samples or to find out more about the new OeXO® Series and our complete line of superior frequency control products visit:
www.Pletronics.com
or call 425-776-1880

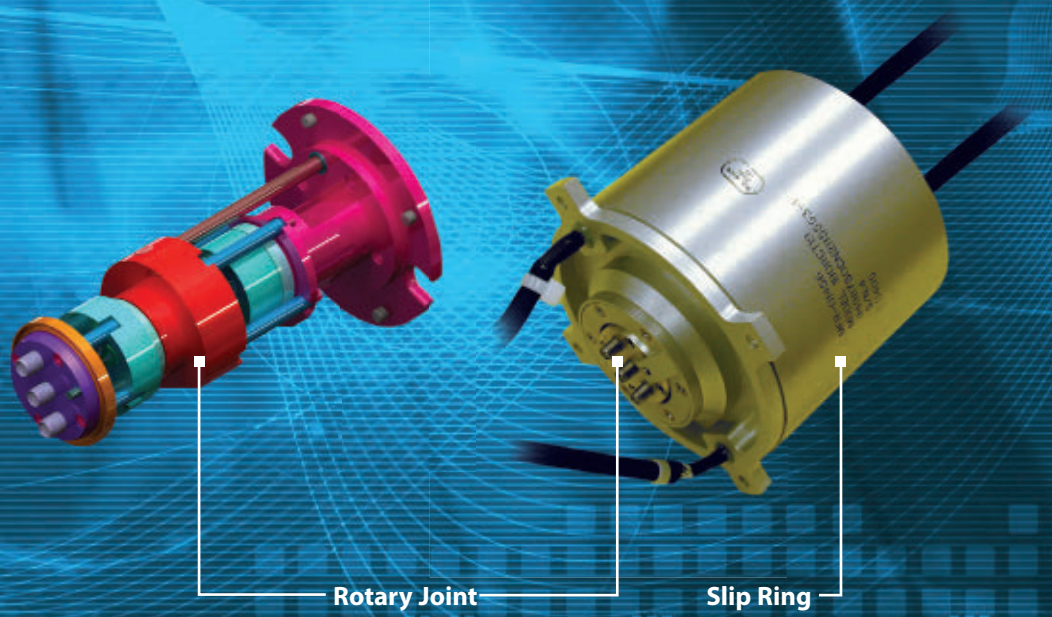
ple
PLETRONICS
Innovations in Frequency Control

by Dr. A. Bar-Cohen, and supported by Dr. J. Felbinger, Dr. J. Maurer and Dr. A. Kane. This work was also sponsored by the Navy SBIR Phase-II Topic # N08-170 program managed by C. Pagel. The authors also acknowledge M. Kubal of Bristol University for the Micro Raman thermal measurements shown here. **Distribution Statement A (Approved for Public Release, Distribution Unlimited).**

References

1. "*Electronic Warfare and Radar Systems Engineering Handbook*," by NAVAIR Electronics Warfare/Combat Systems, Rev 4 of June 1, 2012. (Unclassified, Approved for public release).
2. O. Madelung, *Semiconductors – Basic Data*, Ed., Springer, 2nd revised Edition, 1996.
3. G.J. Riedel, J.W. Pomeroy, K.P. Hilton, J.O. Maclean, D.J. Wallis, M.J. Uren, T. Martin, U. Forsberg, A. Lundskog, A. Kakanakova-Georgieva, G. Pozina, E. Janzen, R. Lossy, R. Pazirandeh, F. Brunner, J. Wurfl and M. Kuball, "Reducing Thermal Resistance of AlGaN/GaN Electronic Devices Using Novel Nucleation Layers," *IEEE Electron Device Letters*, Vol. 30, No. 2, February 2009, pp. 103-106.
4. G.D. Via, J.G. Felbinger, J. Blevins, K. Chabak, G. Jessen, J. Gillespie, R. Fitch, A. Crespo, K. Sutherlin, B. Poling, S. Tetlak, R. Gilbert, T. Cooper, R. Baranyai, J.W. Pomeroy, M. Kuball, J.J. Maurer and A. Bar-Cohen, "Wafer-Scale GaN HEMT Performance Enhancement by Diamond Substrate Integration," *10th International Conference on Nitride Semiconductors*, ICNS-10, August 25-30, 2013, Washington DC, USA.
5. D.C. Dumka, T.M. Chou, F. Faili, D. Francis and F. Ejeckam, "AlGaN/GaN HEMTs on Diamond Substrate with Over 7 W/mm Output Power Density at 10 GHz," *Electronics Letters*, Vol. 49, No. 20, September 26, 2013, pp. 1298-1299.
6. H.C. Nochetto, N.R. Jankowski and A. Bar-Cohen, "GaN HEMT Junction Temperature Dependence on Diamond Substrate Anisotropy and Thermal Boundary Resistance," *34th IEEE Compound Semiconductor IC Symposium (CSIC)* October 14-17, 2012, La Jolla, CA, ISSN: 1550-8781, pp. 1-4.
7. F. Ejeckam, D. Francis, F. Faili and D. Babic, "GaN-on-Diamond Semiconductors," in a final project *AFRL report for Contract # FA8650-09-C-5404*, March 2012.
8. D.C. Dumka, T.M. Chou, J.L. Jimenez, D.M. Fanning, D. Francis, F. Faili, F. Ejeckam, M. Bernardoni, J.W. Pomeroy and M. Kuball, "Electrical and Thermal Performance of AlGaN/GaN HEMTs on Diamond Substrate for RF Applications," 35th *IEEE Compound Semiconductor IC Symposium (CSIC)* October 13-16, 2013, Monterey, CA, Section F.4.
9. D.C. Dumka and P. Saunier, "GaN on Si HEMT with 65% Power Added Efficiency at 10 GHz," *IEEE Electronics Letters, 2010*, Vol. 46, No. 13, pp. 946-947.
10. J. Pomeroy, M. Bernardoni, A. Sarua, A. Manoi, D.C. Dumka, D.M. Fanning and M. Kuball, "Achieving the Best Thermal Performance for GaN-on-Diamond," 35th *IEEE Compound Semiconductor IC Symposium (CSICS)* October 13-16 2013, Monterey, CA, Section H.4.
11. F. Ejeckam, D. Babic, F. Faili, D. Francis, F. Lowe, Q. Diduck, C. Khandavalli, D. Twitchen and B. Bolliger, "3,000+ Hours Continuous Operation of GaN-on-Diamond HEMTs at 350°C Channel Temperature," Accepted for publication to *Semi Therm Conference*, March 9-13, 2014, San Jose, CA.
12. J. Felbinger, M.V.S. Chandra, Y. Sun, L.F. Eastman, J. Wasserbauer, F. Faili, D. Babic, D. Francis and F. Ejeckam, "Comparison of GaN HEMTs on Diamond and SiC Substrates," *IEEE Electron Device Letters*, Vol. 28, No. 11, November 2007, pp. 948.
13. Y. Won, J. Cho, D. Agonafer, M. Asheghi and K.E. Goodson, "Cooling Limits for GaN HEMT Technology (Invited)," *35th IEEE Compound Semiconductor IC Symposium (CSIC)* October 13-16, 2013, Monterey, CA, Section F.1.
14. J. Pomeroy, M. Bernardoni, A. Sarua, A. Manoi, D.C. Dumka, D.M. Fanning and M. Kuball, "Achieving the Best Thermal Performance for GaN-on-Diamond," *35th IEEE Compound Semiconductor IC Symposium (CSIC)*, October 13-16 2013, Monterey, CA, Section H.4.
15. M. Tyhach, D. Altman and S. Bernstein, "Analysis and Characterization of Thermal Transport in GaN HEMTs on SiC and Diamond Substrates," submitted to *GOMACT 2014*.
16. D.C. Dumka, T.M. Chou, J.L. Jimenez, D.M. Fanning, D. Francis, F. Faili, F. Ejeckam, M. Bernardoni, J.W. Pomeroy and M. Kuball, "Electrical and Thermal Performance of AlGaN/GaN HEMTs on Diamond Substrate for RF Applications," *35th IEEE Compound Semiconductor IC Symposium (CSIC)*, October 13-16 2013, Monterey, CA, Section F.4.
17. J.A. del Alamo and J. Joh, "GaN HEMT Reliability," *20th European Symposium on the Reliability of Electron Devices, Failure Physics and Analysis*, Vol. 49, Issue 9-11, September-November 2009, pp. 1200-1206.

Channel surfing.



Multichannel Coax Rotary Joint / Slip Ring Assembly

Up to 30 channels.
Use MDL's rotary joint to transfer 3 RF signals and a 30-channel slip ring for flawless DC transmission. We make and assemble both components, so you'll save labor and testing costs. And you're assured of the highest quality and reliability from the leader in high quality cast components and waveguide packages.

You've never been in better hands.
Quality from CAD to crate, quick turnaround, and tight economy is what we're all about. Call an MDL specialist today at 800-383-8057 or do a little surfing of your own and visit us at **mdllab.com**.

RF Rotary Joint	
Two Channels:	*14.4 – 15.4 Ghz*
One Channel:	*9.7 – 15.4 Ghz*
VSWR:	*<2.0:1*
I.L.:	*<2.0dB*
Isolation:	*>60 dB*

Slip Ring Assembly	
Isolated Contacts:	*30*
Voltage:	*20-300 Volts*
Current:	*.1 - 5 Amps*

WAVEGUIDE CAST BENDS & TWISTS
WAVEGUIDE FEED ASSEMBLIES
MONOPULSE COMPARATORS
ROTARY JOINTS
MICROWAVE FILTERS
ROTARY SWITCHES
WAVEGUIDE TO COAX ADAPTERS
WAVEGUIDE PRESSURE WINDOWS
COMMERCIAL WAVEGUIDE ASSEMBLIES

IMS2014 - Tampa Bay, Florida
International Microwave Symposium
IEEE 1–6 June 2014, Tampa Bay, FL MTT–S
Visit MDL at **Booth #1715**

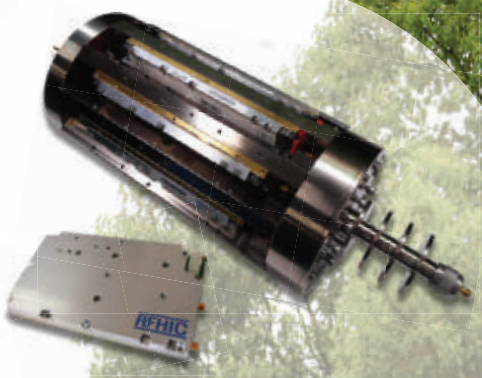
MDL

Microwave Development Laboratories, 135 Crescent Road, Needham Heights, MA 02494
V: 781-292-6680/6684 F: 781-453-8629 E-mail: mdlsales@mdllab.com www.mdllab.com

Think Green

Applications

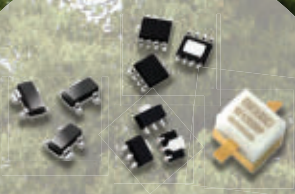
TWT & Magnetron Tube Replacement
Plasma Reactor Source
Microwave Plasma Torch
Waste Disposal
Nano Material Products
Linear Accelerator
Weather Radar
Hydrogen Production
High-energy Transfer



1.5 kW GaN Power Amplifiers
5 kW GaN Power Amplifiers*
(*Under Development)

Applications

Telecom, BTS & RRU
Microwave Oven
Medical Imaging
CATV / FTTH
Wireless Power Transmission
Small Cell Systems
Optical Drive Amplifier
Sat-com Amplifier



0.1W~2W GaAs MMIC
10W~330W GaN Power Transistor*
(* Telecom Tier 1 Only)

RF & MW is our business & passion
Korean Facilities
Tel : 82-31-250-5078 / E-mail : rfsales@rfhic.com
US Facility
Tel : 919-677-8780 / E-mail : sales@rfhicusa.com

Send your inquires to rfsales@rfhic.com

Think RFHIC

GaN

1W~90W peak SMT type Hybrid Amplifiers

Applications

Telecom, BTS & RRU
Satellite Power Amplifier
Marine Radar
Phase Array Radar
Laser & X-ray Drive
Microwave Heating
Microwave Cancer Treatment
Thin Film & Diamond Deposition
Plasma Source

10W~1kW(peak) GaN Pallet & Module

Applications

Small Cell Systems
Point-to-Point Radio
VSAT
Marine Radar
Plasma Etching / Cleaning/ Coating
Ion Sources
Plasma Light
UV Lamps

See us at IMS Booth 1727

RFHIC
www.rfhic.com

MWJ REVIEW BOARD APPROVED

Algorithm Development Platform for Dual-Band Digital Pre-Distortion

Shahin Gheitanchi[1], Christophe Quindroit[2], Patrick Roblin[2], Naveen Naraharisetti[2], Volker Mauer[1] and Mike Fitton[1]
1) Altera Corp., San Jose, CA
2) The Ohio State University, Columbus, OH

Digital predistortion (DPD) is a common and cost-effective method for linearizing the transmitter PA to improve power and efficiency while maintaining linearity.[1] The technique consists of adding a digital block before the PA that adaptively applies distortion with an inverse characteristic of the PA so that the output is linear. To efficiently utilize the available spectrum and provide service for different standards such as WCDMA and LTE, the transmitter must support multiple frequency bands. This presents significant challenges to DPD development.

Wireless communication systems are continuously growing to support more users with higher data rates while using a limited and already saturated radio frequency (RF) spectrum. To take advantage of the spectrum, spectrally efficient modulation schemes based on code division multiple access (CDMA) and orthogonal frequency division multiplexing (OFDM) are commonly used. These schemes have a non-constant envelope signal with a high peak-to-average power ratio (PAPR). This increases transmitter nonlinearities, while the requirements on the RF front end linearity performance are becoming tougher. The power amplifier (PA) plays a key role in the tradeoff between linearity and power efficiency.[2]

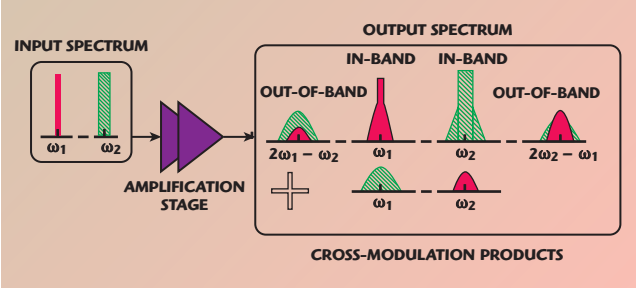


Fig. 1 Dual-band transmission scenario.

SYSTEM DESCRIPTION

In a concurrent multi-band scenario (see ***Figure 1***), the carriers are placed far apart from each other (typically greater than 100 MHz) driving a single amplification stage. Two types of distortion may be observed:

- In-band – Intermodulation products by a carrier in a band and also distortions introduced from other bands which fall in the intended transmission band.
- Out-of-band – All the intermodulation products that fall out of the transmission band that can be reduced using transmit or receive filters.

Due to ADC/DAC limitations, separate transmit and receive paths are necessary for each band, with independent local oscillators (LO). Each has the same bandwidth and sample rate requirement as a single band. A sim-

Z~Communications, Inc.

The World's Largest and Most Trusted Supplier of VCOs & PLLs

RFS Series PLLs *1.5 GHz - 4.5 GHz*

- Fixed Frequency
- Reference Signal Included
- No External Programming

NEW PLL Series!

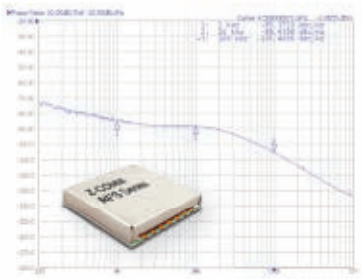
Featured Product:
RFS4500A-LF

Frequency:
4.5 GHz

Phase Noise:
-87 dBc/Hz @ 10kHz offset

Reference Oscillator:
10 MHz (internal)

Package Dimensions:
0.6" x 0.6" x 0.13"



SFS Series PLLs *500 MHz - 15 GHz*

- Fixed Frequency
- No External Programming
- Ultra-low Phase Noise

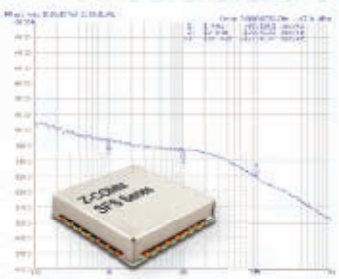
Featured Product:
SFS12000H-LF

Frequency:
12 GHz

Phase Noise:
-103 dBc/Hz @ 10 kHz offset

2nd Harmonic Suppression:
-20 dBc typical

Package Dimensions:
1.0" x 1.0" x 0.22"



DRO Series VCOs *7 GHz - 14 GHz*

- Exceptional Spectral Purity
- Low Power Consumption
- Ultra-fine Tuning Precision

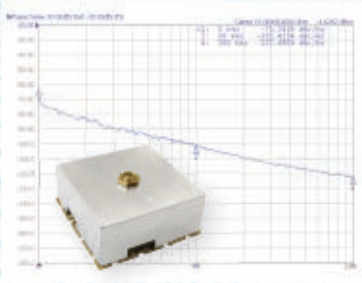
Featured Product:
DRO13000A

Frequency:
13 GHz

Phase Noise:
-102 dBc/Hz @ 10 kHz offset

2nd Harmonic Suppression:
-30 dBc typical

Package Dimensions:
0.91" x 0.91" x 0.51"



USSP Series VCOs *150 MHz - 4 GHz*

- Low Phase Noise
- Ultra-low Power Consumption
- Ultra-compact Size

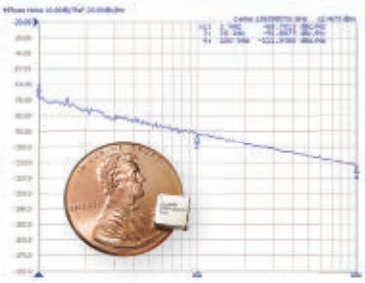
Featured Product:
USSP1570-LF

Frequency:
1540 MHz - 1600 MHz

Phase Noise:
-90 dBc/Hz @ 10 kHz offset

Power Supply:
2.7V @ 7mA

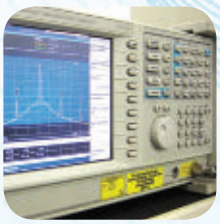
Package Dimensions:
0.2" x 0.2" x 0.6"



With over 800 off-the-shelf products, we carry the right signal source solution for your application.
Visit us at www.zcomm.com for our complete line of VCOs & PLLs. Contact us for custom requirements.

Microwave Radio

Satellite Communications



Test & Measurement

Military Communications

Clock Source

Z-Communications, Inc. • 14118 Stowe Drive, Suite B, Poway, CA 92064 • Phone: (858) 621-2700 • Fax: (858) 486-1927 • Email: sales@zcomm.com

See us at IMS Booth 1227

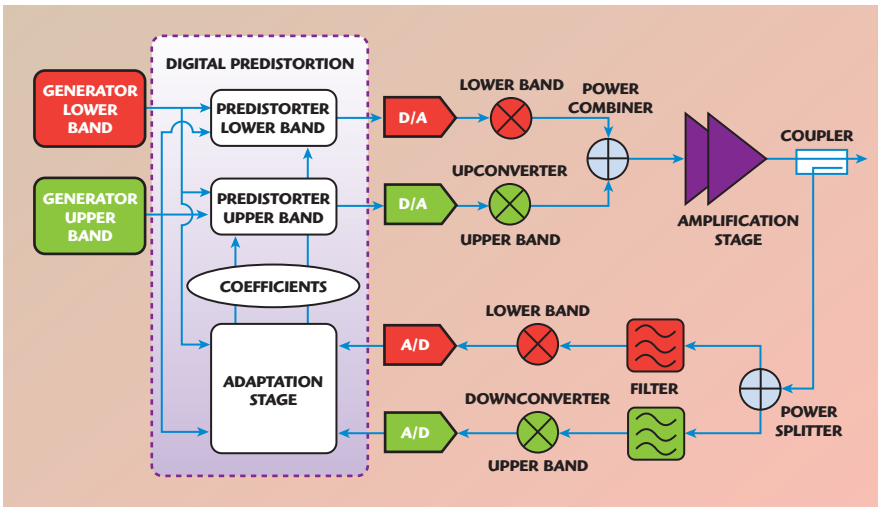


Fig. 2 Dual-band DPD and power amplifier block diagram.

ple dual-band DPD block diagram is shown in ***Figure 2***. It consists of two subsystems: an adaptation stage and a predistorter, or forward path.

The adaptation stage continuously estimates PA characteristics by utilizing samples from the transmitted data (before the DACs) and the observation path (after the ADCs). It employs a PA behavioral model that is described by the Volterra nonlinear model or one of its derivatives.[2] The output is a set of filter coefficients that are passed to the predistorter. The coefficients can be stored in look-up tables for reuse. There are other components such as equalizers, alignment and power control blocks around the adaptation stage that process the samples for estimation.

The predistorter is a set of filters that apply coefficients, generated as a result of estimation, to the transmit data. Predistorter filters run with a sample rate that is at least 3 to 5 times greater than the signal bandwidth to compensate for third and fifth order intermodulation products. In order to maximize the predistortion bandwidth for a given FPGA frequency, polyphase designs can be used.[3]

THEORY

This article focuses on the design of a concurrent dual-band DPD predistorter, also referred to as a frequency selective DPD.[4,5] As mentioned previously, the predistorter must not only reduce in-band distortion (single-band scenario), but must also suppress cross-modulation products that fall into the transmission band. Out-of-band products can be rejected using transmit filters. The structure of the 2D-DPD predistorter is shown in ***Figure 3***.

The Volterra series is a general nonlinear model with memory, but is not useful for practical applications due to its complexity and the large number of coefficients that must be estimated. Instead, the well-used single band memory polynomial model has been extended to the concurrent dual-band scenario by Roblin[4] and Bassam.[5] Both baseband DPD output signals Z_L and, Z_U, respectively, for the lower side band (LSB) and the upper side band (USB) can be expressed as follows:

$$Z_L(n) = \sum_{q=0}^{Q-1}\sum_{k=0}^{K-1}\sum_{j=0}^{k} a_{q,k,j} X_L(n-q)\cdot \left|X_L(n-q)\right|^{2(k-j)} \left|X_u(n-q)\right|^{2j} \quad (1)$$

$$Z_U(n) = \sum_{q=0}^{Q-1}\sum_{k=0}^{K-1}\sum_{j=0}^{k} b_{q,k,j} X_U(n-q)\cdot \left|X_U(n-q)\right|^{2(k-j)} \left|X_L(n-q)\right|^{2j} \quad (2)$$

where X_L and X_U represent both input band signals, and $a_{q,k,j}$ and $b_{q,k,j}$ represent the set of complex coefficients for the LSB and USB respectively. K represents the nonlinearity order and Q is

See us at IMS Booth 1901

WHEN YOU CAN'T AFFORD TO LOSE

choose TELEDYNE STORM cable assemblies

LOW LOSS
TRUE BLUE®

An unmatched combination of low loss, durability, and value

TRUE BLUE® 290

0.260 dB/ft nom @ 18 GHz

TRUE BLUE® 205

0.444 dB/ft nom @ 26.5 GHz

ULTRA LOW LOSS
dB MISER™

The clear choice when loss is the most important consideration

dB MISER™ 300

0.205 dB/ft nom @ 18 GHz

dB MISER™ 210

0.367 dB/ft nom @ 26.5 GHz

See us at IMS Booth 723

TELEDYNE
STORM MICROWAVE
Everywhereyoulook™

630-754-3300
www.teledynestorm.com/mj0514

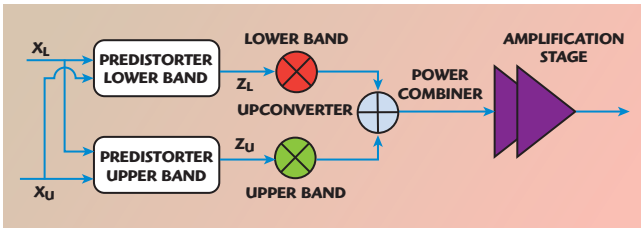


Fig. 3 Concurrent dual-band predistorter block diagram.

the memory depth. From the PA output signals, the least-square algorithm[5] is used to estimate the set of coefficients.

DPD ALGORITHM DEVELOPMENT

The DPD method must meet standard requirements, be resource efficient on target platforms, must support rapid development and be flexible to change. It must also have the following properties:

- Enable the transmission and reception of many different waveforms including standard test patterns and custom carrier aggregation modes.
- Enable the testing of DPD in isolation from other radio head systems such as crest factor reduction.
- Facilitate performance bench marking for various algorithms and enable swapping components of a DPD solution.
- Provide design and hardware modularity.

The following development steps optimize the coexistence of simulation software and flexible hardware in an integrated platform. This ensures that the resulting DPD algorithm can be easily tailored for a specific set of standards, hardware implementation and PAs.

Step 1: Algorithm Simulations

Develop a DPD simulation model using a programming or scripting language such as MATLAB. The purpose is to use flexibility and simplicity of software simulation environments to ensure DPD and related algorithms deliver the expected results and performance.

Step 2: High Level Synthesis Tools

After the algorithm is verified by simulation, decide which parts of the design are to be implemented in hardware. The most common approach is to realize the DPD predistorter filter in hardware on an FPGA and a use processor to run the adaption stage. To ensure that hardware components provide performance similar to software simulations, construct a hardware accurate model using a high level synthesis tool. The tools are often capable of generating RTL for target devices.

Step 3: System Level Integration

Once the hardware model demonstrates acceptable performance compared to software simulation results from Step 1, integrate the RTL into the communication system using standard interfaces and commercial integration tools.

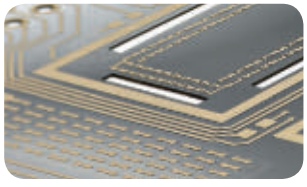
Step 4: System In the Loop (SIL) Verification

Test and verify performance in hardware running jointly with simulation. In SIL verification, a functional block may exist only in software simulation or in hardware, or in both. As the blocks are modified or developed, they can be pushed into hardware and run in conjunction with software simulation for performance measurement and verification.

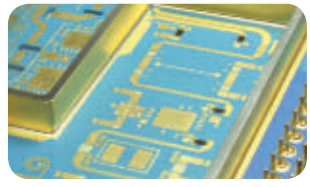
DESIGN EXAMPLE: 2D-DPD PREDISTORTER

MATLAB is used for software simulations and it accommodates algorithms and data processing scripts. It also contains Altera's SIL APIs which enable communication with FPGA boards. For example, data can be written to DDR3 memory or a register value can be read back. A hardware accurate model of a DPD signal processing component is built in Simulink using Altera's DSP Builder Advanced (DSPBA) block sets.[6] DSPBA provides blocks of IPs for fixed and floating point operations[7] and enables verification of components before hardware implementation. MATLAB and DSPBA can communicate and pass parameter values using workspace variables. RTL code is automatically generated from the DSPBA model to

Micro Systems Technologies – engineering for life



DYCONEX



MICRO SYSTEMS ENGINEERING

Interconnect solutions dedicated to the world of RF & microwave microelectronics

- Fine line LTCC substrate technology for hermetic and highly integrated packages
- Multilayer thick film substrates
- Multilayer LCP flex substrates for HF applications up to 110 GHz
- Mixed material prints (LCP/PI/FR4)

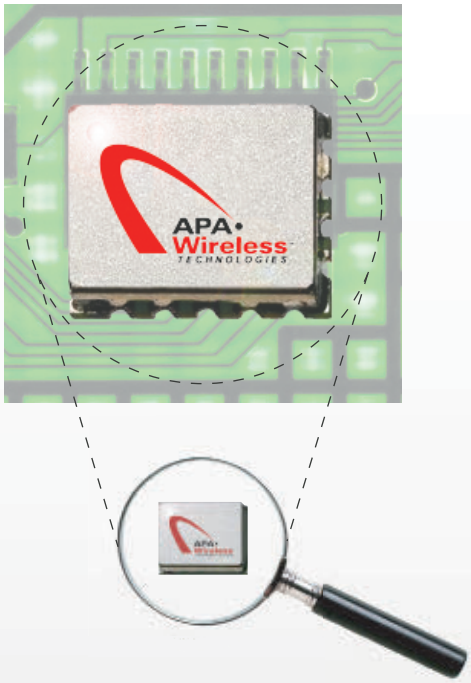
MST
Micro Systems Technologies
engineering for life

Micro Systems Technologies, Neuhofstrasse 4
CH-6341 Baar, Switzerland, Phone +41 (43) 266 11 28
Fax +41 (43) 266 11 11, info@mst.com

www.mst.com

See us at IMS Booth 2213

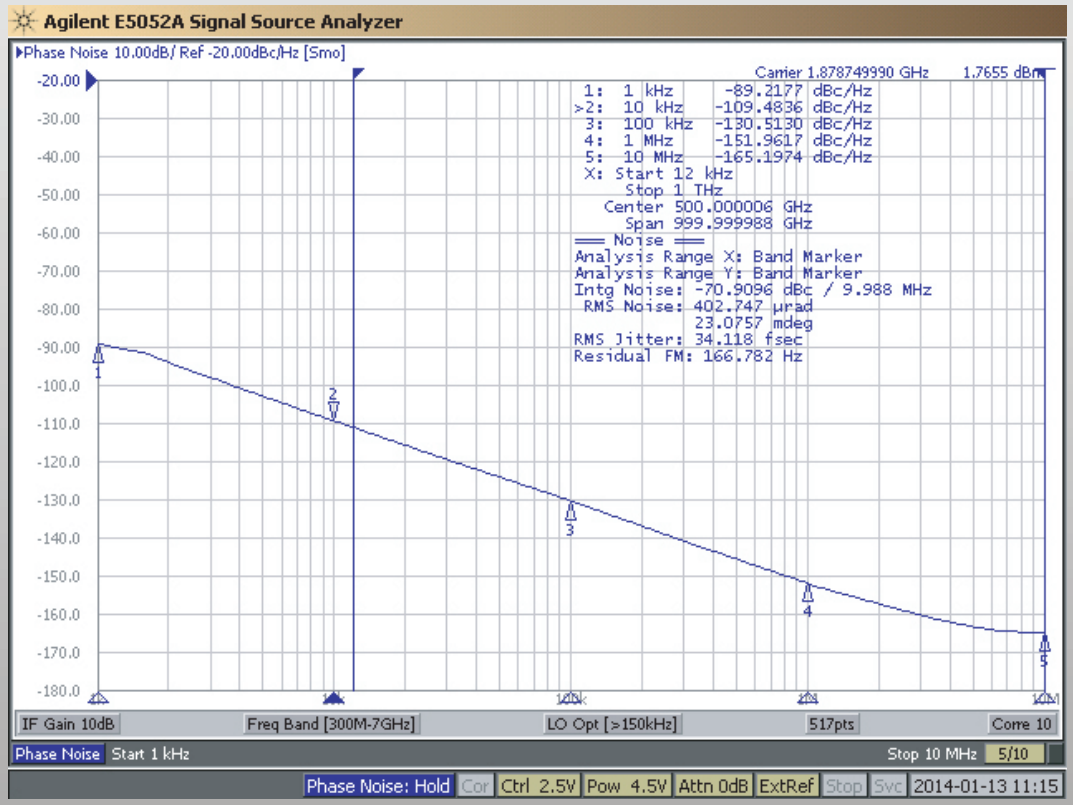
APA Wireless TECHNOLOGIES



Ultra-Low Jitter Clock Source for Gigabit Ethernet and Internet

in a tiny LOW PROFILE *package!*

Need Low Integrated Noise Performance at multiple frequencies? APA's new MULTIBAND CLOCK SOURCE Series have multiple fixed frequencies available in one ***very small and completely sealed*** package. Replace several fixed sources and multiple loops with one source that can switch in multiple frequencies, all under phase lock. In a package slightly bigger than a standard VCO and only ***0.110" high***, this is a completely integrated solution with supply voltages available down to +3V.



VISIT US AT *APAWireless.com*

See us at IMS Booth 201

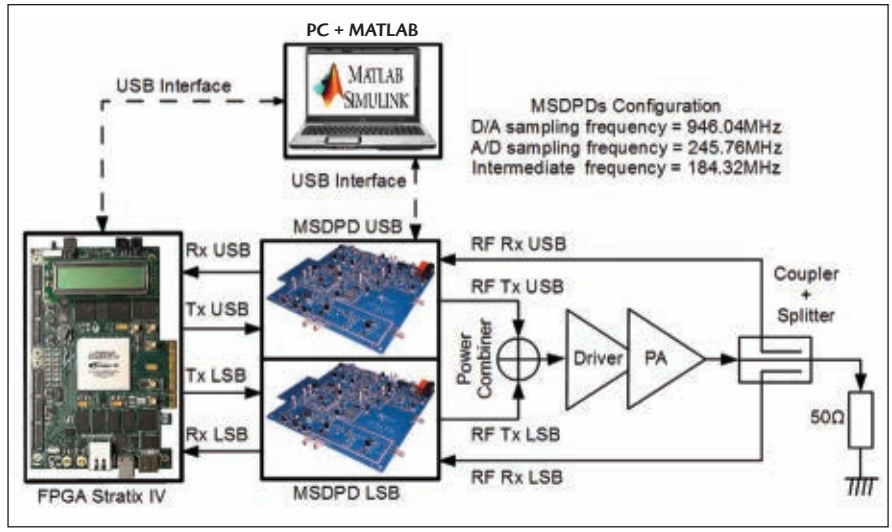


Fig. 4 Dual-band DPD development platform.

TABLE I
INPUT TEST SIGNAL SPECIFICATIONS

	LSB @ 1890 MHz	USB @ 2200 MHz
Signal Type	3-Carrier WCDMA	LTE
Signal Bandwidth	12 MHz	10 MHz
Signal PAPR	8 dB	9 dB

run on an FPGA.

The hardware platform consists of a number of Altera and third-party components as shown in ***Figure 4***. On the digital side, a Stratix IV FPGA development board is used, which consists of DDR3 memory banks and standard USB and HSMC connectors. An analog front end with two LOs is required to support two widely separated bands. For this purpose Analog Devices MSDPD G 1.6 boards[8] are used, where each has an independently programmable LO. Each board has a separate transmit path where the outputs are combined and fed into the PA. On the observation path, the PA output is split between the boards. It is important to ensure the distorting PA is biased correctly and sufficient attenuation is placed at the PA's output for device protection. It should be noted that to saturate a PA, extra power can be provided with a chain of power amplifiers.

PERFORMANCE

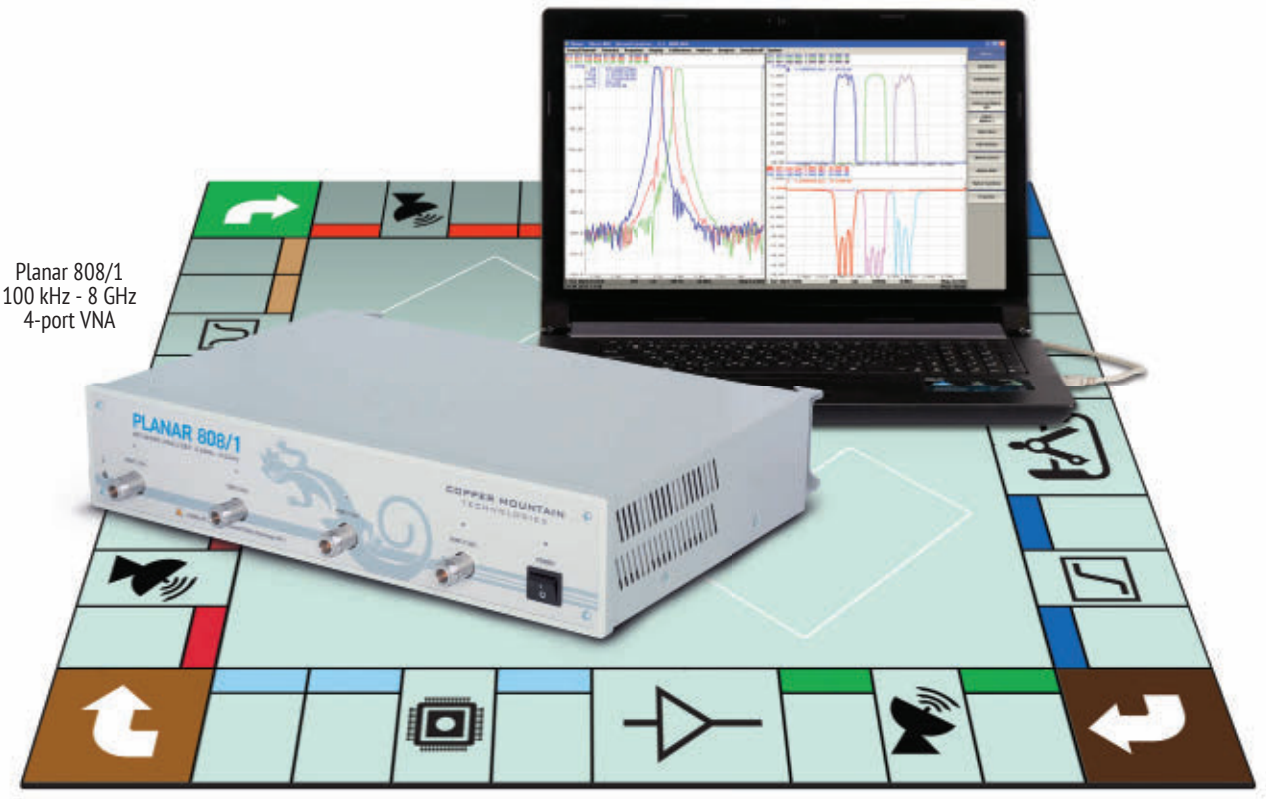
The 2D-DPD predistorters are simulated in MATLAB, verified in DSPBA and then implemented in an FPGA. The system consists of random access memory (RAM), direct memory access (DMA) and the predistorters. Transmit data is loaded from MATLAB to RAM, then played out through the predistorter on the FPGA using DMA. The PA output signal is also captured by RAM using DMA and then is read back to MATLAB. The adaptation stage continuously runs in MATLAB utilizing transmit and captured back data from the PA output. Communication between MATLAB and the FPGA is facilitated by SIL application program interfaces.

On the test bench, the LSB and USB center frequencies are set to 1890 and 2200 MHz, respectively. The amplification stage is composed of a linear driver followed by a broadband 10 W peak output power PA, based on the NXP Semiconductor GaN HEMT CLF1G0060-10 transistor. The signal characteristics are described in ***Table 1***.

Digital down-conversion (DDC), time alignment and coefficients estimation are processed via MATLAB from the recorded PA output data. The training and the validation streams are composed of 8k and 131k samples, respectively. The DPD is implemented using 32-bit fixed point accuracy with a maximum nonlinearity set to K=4 and a maximum memory depth to Q=3. ***Figure 5*** shows both LSB and USB output

Game changer

A VNA that doesn't make you choose between performance and price.



Planar 808/1
100 kHz - 8 GHz
4-port VNA

CMT vector network analyzers eliminate many obstacles that surround traditional analyzers, like the bulky size, outdated computer, and difficult data handling - while maintaining excellent performance. Our VNA software operates on an external PC, which makes data transfer, automation, and system integration easy, so you can **put a lab grade VNA where one hasn't gone before.**

See us at IMS Booth 645

COPPER MOUNTAIN
TECHNOLOGIES

R140 Reflectometer
85 MHz - 14 GHz

TR1300/1
300 kHz - 1.3 GHz

5048
20 kHz - 4.8 GHz

Planar 304/1
100 kHz - 3.2 GHz

Planar 814/1
100 kHz - 8 GHz
Direct receiver access

+1.317.222.5400 | coppermountaintech.com

PICONICS
High-Quality Micro-Electronic Coil Inductors
65+ Ghz Performance
Piconics Conical Inductors
#1 Broadband Choke on the Market
• Best Performance in the Industry
• Single Component Covers Broadband
• Low Insertion Loss
• No Tuning Required
NEW Eq. Circuit Models
Now available through our partnership with Modelithics
Save Time & Cost with Value Added Assemblies
www.PICONICS.com
26 Cummings Rd | Tyngsboro, MA 01879
P: 978.649.7501 | sales@piconics.com
See us at IMS Booth 1714

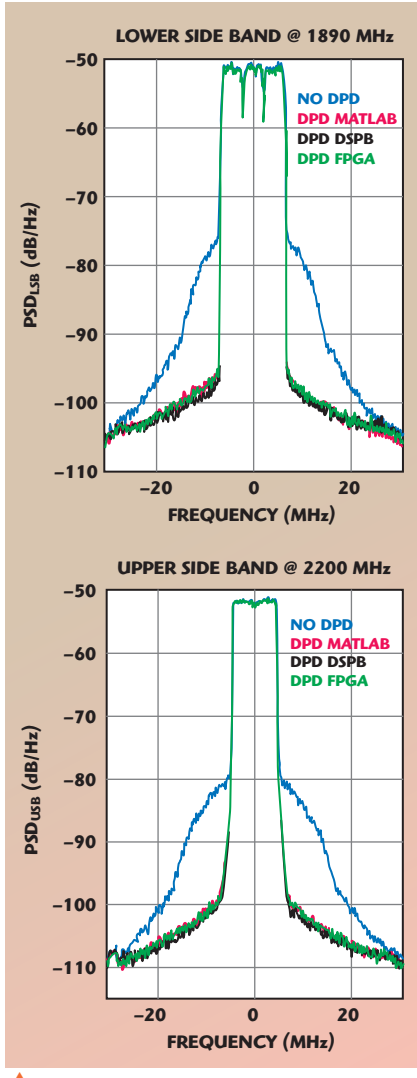


Fig. 5 LSB and USB output spectra.

spectra of the PA with and without DPD for the three methods of implementation. In both bands, spectral regrowth is reduced as predicted by the three methods, which exhibit similar results. ***Table 2*** compares DPD performance in terms of adjacent channel power ratio (ACPR) and normalized mean square error (NMSE) for both bands.

CONCLUSION

Practical challenges for dual-band DPD algorithm development are introduced and four development steps are outlined. The steps are performed using a development platform based on the Altera FPGA and other tools. Using this platform, a 2D-DPD predistorter is implemented on an FPGA. Its performance corresponds closely with MATLAB and Simulink simulations. ■

ACKNOWLEDGMENT

The authors would like to thank Analog Devices and NXP for their donations and technical support.

References

1. F.M. Ghannouchi and O. Hammi, "Behavioral Modeling and Predistortion," *IEEE Microwave Magazine*, Vol. 10, No. 7, December 2009, pp. 52-64.
2. J. Vuolevi and T. Rahkonen, *Distortion in RF Power Amplifiers*, Artech House, Norwood, MA, 2003.
3. "Designing Polyphase DPD Solutions with 28-nm FPGAs," Altera Corporation, January 2012, www.altera.com/literature/wp/wp-01171-polyphase-dpd.pdf.
4. P. Roblin, S.K. Myoung, D. Chaillot, Y.G. Kim, A. Fathimulla, J. Strahler and S. Bibyk, "Frequency-Selective Predistortion Linearization of RF Power Amplifiers," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 56, No. 1, January 2008, pp. 65-76.
5. S.A. Bassam, M. Helaoui and F.M. Ghannouchi, "2-D Digital Predistortion (2-D-DPD) Architecture for Concurrent Dual-Band Transmitters," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 59, No. 10, pp. 2547-2553.
6. www.altera.com/technology/dsp/advanced-blockset/dsp-advanced-blockset.html.
7. www.altera.com/technology/dsp/floating-point/dsp-floating-point.html.
8. www.analog.com/en/content/eb__Mixed_Signal_Digital_Pre-Distortion_sys_board/fca.html.

TABLE II

ACPR AND NMSE FOR THE DIFFERENT IMPLEMENTATIONS

	LSB @ 1890 MHz		USB @ 2200 MHz	
	ACPR ±5 MHz (dBc)	NMSE (dB)	ACPR ±5 MHz (dBc)	NMSE (dB)
No DPD	-39.55/-40.04	-18.84	-34.21/-34.61	-22.59
DPD MATLAB	-48.61/-49.21	-37.36	-50.37/-50.66	-41.71
DPD DSP Builder	-48.71/-49.60	-37.21	-50.87/-50.45	-41.35
DPD FPGA	-48.56/-49.11	-37.49	-50.46/-50.66	-40.84

GET PROTECTED!

Microwave cable assemblies are quite often exposed to a wide range of hostile environments including extreme temperature, abrasion, compressive forces, high pressure fluids, solvents, chemicals, salt water, UV, vibration, and mechanical stress just to name a few. IW offers a wide range of materials and processes designed to protect the integrity of our cable assemblies. These include:

- PEEK braid for high abrasion protection at temperatures up to 260˚C
- Fire resistant aramid Fiber braid
- Interlocked stainless steel armor, crush resistant up to 400 lbs per/inch
- Abrasion resistant PET monomer braid
- Neoprene weather proof jacket
- Polyurethane low smoke, zero halogen
- Pressure tight flexible stainless steel conduit
- Cable assemblies optimized for lowest attenuation loss at frequencies from 11-67GHz
- Standard connectors include SC, Precision N, TNCA (18GHz), SMA, 7MM, 3.5MM, 2.9MM (K), 2.4MM, and 1.85MM (V). Other interfaces available on request

Call us today with your project specs and we'll show you the most reliable way to ***get connected*** *in the industry.*

AS9100:2009 and ISO 9001:2008 certified.

Visit Us At **IMS 2014** Booth 1436

INSULATED WIRE, INC.
203.791.1999
www.iw-microwave.com
sales@iw-microwave.com

Scan code to find out how you can ***get connected***

We're how the microwave industry ***gets connected!***

MWJ REVIEW BOARD APPROVED

Triple-Mode Filter Using a Spherical Dielectric Resonator and Coupling Structures

Nam-Shin Park, Don-Yong Lee, Byung-Chul Kim, Jung-Hee Won, In-Ho Na, Geon-Ho Jang, Young-Ho Cho, Xu-Guang Wang and Sang-Won Yun
Sogang University, Republic of Korea

A triple-mode bandpass/bandstop filter uses a high-Q spherical dielectric resonator that supports triply degenerate $TE_{01\delta}$ modes along three orthogonal axes. Coupling structures based on metallic plates inside the spherical enclosure are also introduced. Due to cross coupling, the proposed bandpass filter (BPF) has an asymmetric response with three controllable transmission zeros, one of which can be located very close to the passband edge to provide an extremely sharp skirt characteristic. In addition, the proposed flexible coupling mechanism allows for realization of a bandstop filter by simply modifying the configuration of the coupling structure. A three-pole single cavity BPF operating at 863 MHz with bandwidth of 14 MHz is designed, simulated and fabricated. Measured results show 0.1 dB insertion loss within the passband and 31 dB rejection 2 MHz away from the lower passband edge.

The dielectric resonator filter is widely used in satellite and mobile communication systems due to its compact size, high performance and superior temperature stability. The $TE_{01\delta}$ mode is the fundamental resonant mode of a dielectric resonator and has been extensively studied for the design of single-mode dielectric loaded cavity bandpass filters (BPF).[1,2] In these designs, the recommended ratio of the dielectric height over diameter is 1:2.2~3.0 for both optimum Q and minimum interference from spurious modes. This puts a constraint on compactness, especially for low frequency applications.

In recent years, wireless communication systems have evolved to have a distributed base transceiver station (BTS) system architecture employing a remote radio head (RRH) and base band unit (BBU).[3] This requires more compact high performance BPFs utilizing dual-mode and multi-mode techniques.[4-9] A typical dual-mode dielectric resonator filter using the $HE_{11\delta}$ degenerate mode was first reported by Fiedziuszko.[4] With proper diameter/length ratio of dielectric resonator, the $HE_{11\delta}$ mode and $TM_{01\delta}$ mode can resonate at the same frequency to form a triple-mode BPF.[5] A triple-mode BPF employing the triply degenerate $TE_{01\delta}$ mode in a cubical dielectric loaded cavity resonator was described by Walker and Hunter.[6] All of these, however, use cylindrical or rectangular dielectric resonators. The spherically shaped dielectric resonator has received less attention. In addition, these designs rely on either the machining of chamfers in dielectric resonator[7,8] or the use of screws[9] to control the coupling between degenerate modes. This increases the complexity of fabrication and tuning.

High Power to High Frequency

Visit us at MTT-S 2014 • Booth 605

Contact us today to find out how TRU
can provide your RF Cable Assembly solutions.

TRU Corporation | Peabody, MA 01960 USA

1 800 262-9878 • (1 800 COAX-TRU)
978 532-0775

trucorporation.com

YES IT'S TRU®

EXPERIENCE. TRU INNOVATION.

In this article, we introduce a triple-mode bandpass/bandstop filter using a high-Q spherical dielectric loaded cavity resonator and new coupling structures located inside the cavity. The coupling structures need no additional space or screws, and have several configurations for generating cross coupling to realize multiple controllable transmission zeros. In addition, one of the transmission zeros can be located very close to the passband edge, producing an extremely sharp rejection characteristic.

A test resonator exhibits a high unloaded Q of 19600 in the 860 MHz band. Fabricated filters, using temperature-stable dielectric material KMW ZT with a dielectric constant of 46,[10] can be reduced in size by 40 percent compared to their single-mode counterparts while providing similar performance.

TRIPLE-MODE DIELECTRIC RESONATOR

It is well known that a dielectric resonator with free-space boundaries can resonate in various modes according to its shape and size. A multi-mode dielectric resonator can support several operating modes resonating at the same frequency, a property that is used to construct multi-mode BPFs. Due to perfect symmetry in all three dimensions, the spherical dielectric resonator is superior to a cylindrical or rectangular resonator and exhibits a very high unloaded Q.

The resonant frequencies of the spherical dielectric resonator can be calculated by solving Maxwell's equations based on r, θ, φ in the spherical coordinate system. The lowest $TE_{01\delta}$ mode is defined by[11,12]

$$H_r = \frac{-2jH\cos(\theta)}{k^2r^2}\left[\frac{\sin(kr)}{kr} - \cos(kr)\right] \quad (1)$$

$$H_\theta = \frac{jH\sin(\theta)}{k^2r^2}\left[\frac{(kr)^2-1}{kr}\sin(kr) + \cos(kr)\right] \quad (2)$$

$$E_\varphi = \frac{H\sin(\theta)}{kr}\left[\frac{\sin(kr)}{kr} - \cos(kr)\right] \quad (3)$$

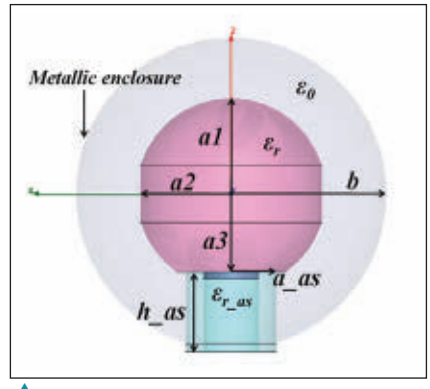
If the radius of the spherical dielectric resonator is a and the outer surface is considered a perfect magnetic boundary, then ka ≈ 2.74,[12] and

$$H_\theta = 0\big|_{r=a} \quad (4)$$

$$\tan(ka) = \frac{ka}{1-(ka)^2} \quad (5)$$

$$f_0 = \frac{1.31\times10^8}{a\sqrt{\varepsilon_r}} \quad (6)$$

From equation 6, the value of a is based on the desired center frequency and the dielectric material. As illustrated in ***Figure 1***, the spherical dielectric resonator is placed at the center of an air-filled spherical metallic enclosure with radius of b = 45 mm on an alumina support with permittivity of ε_{r_as} = 9, height $h_{_as}$ = 20 mm and radius $a_{_as}$ = 13 mm. Due to its symmetry, the dielectric sphere can sustain three orthogonal degenerate modes – $TE_{01\delta X}$, $TE_{01\delta Y}$ and $TE_{01\delta Z}$ – along the x-, y- and z-directions. The sphere's surface along the z-axis is cut a little, so the radius in the xy-plane is reduced from a_1 to a_2 for fine frequency tuning of the $TE_{01\delta Z}$ mode without significantly affecting the other two modes. The bottom of the dielectric sphere is also cut slightly to fix it concentrically, and can be used to finely control the resonant frequencies of the $TE_{01\delta X}$ and $TE_{01\delta Y}$ modes.



▲ *Fig. 1 Spherical dielectric resonator with alumina support in a metallic enclosure.*

Figure 2 is the simulated electric field distribution along the three axes of the dielec-

GaN Manifesto

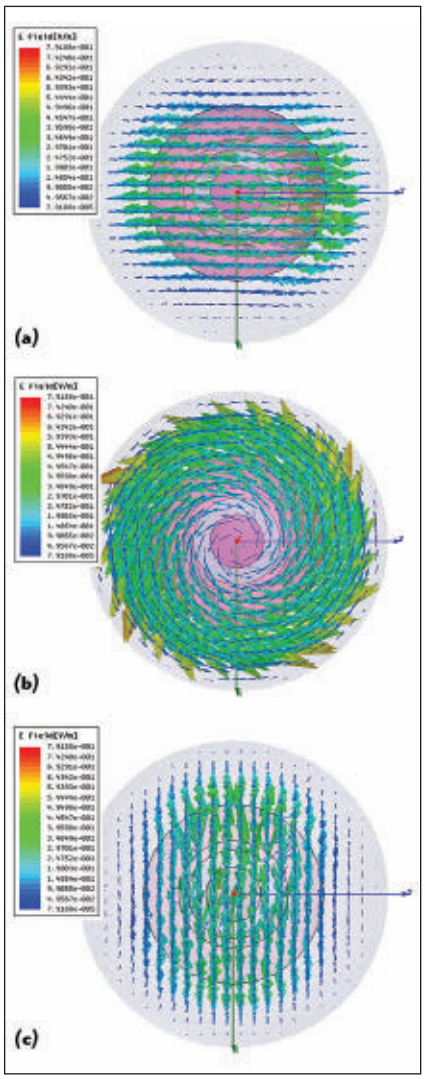
The Path to Mainstream GaN Commercialization in RF and Microwave Applications

MACOM™

Partners from RF to Light

Learn more at www.macom.com/gan

See us at IMS Booth 915



▲ *Fig. 2 Top view of the electric field distribution along the three axes, $TE_{01\delta X}$ at 845.66 MHz. (a), $TE_{01\delta Y}$ at 845.69 MHz (b), $TE_{01\delta Z}$ at 852.76 MHz (c).*

tric sphere with dimensions of a_1 = 29.4 mm, a_2 = 27.3 mm and a_3 = 22.5 mm. These dimensions are refined and optimized using a full-wave simulator to yield the exact center frequency of the triple-mode filters. The corresponding resonant frequencies are f_1 ($TE_{01\delta X}$) = 845.66 MHz, f_2 ($TE_{01\delta Y}$) = 845.69 MHz and f_3 ($TE_{01\delta Z}$) = 852.76 MHz. The dielectric constant of the resonator is 46 and the unloaded Q is 19600.

The dielectric resonator has very high unloaded Q, determined by the material powder and the fabrication process. Another important material property is the temperature coefficient of the resonant frequency. The filters used in high power applications such as base station wireless communication and satellite communication systems are subjected to large temperature variations. In addition, due to the diversity of base station geographic locations, filters must operate various ambient conditions.[13] ***Table 1*** compares the performance of the triple-mode filter described here with filters employing other technologies.

DIELECTRIC RESONATOR FILTER DESIGN

Triple-Mode Bandpass Filter

The concept is verified with a single cavity filter employing the three degenerate $TE_{01\delta}$ modes in the x-, y-

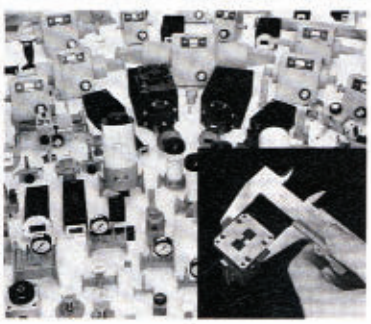
TABLE I

RESONANCE CHARACTERISTICS COMPARISON CHART

	Cavity Filter (TEM Mode)	DR Filter (TM Mode)	DR Filter ($TE_{01\delta}$)	Super Conductor	Proposed Triple Mode
Q Factor	7,500	11,000	19,000	45,000	24,000
Size	●	▲	✖	✖	❊
Weight	▲	▲	✖	✖	❊
Insertion Loss	✖	▲	●	❊	❊
Attenuation	✖	▲	●	❊	●
Reliability	❊	▲	●	✖	●
PIMD	❊	●	●		●
Cost	❊	●	✖	✖	●
Power Handling	●	●	●	✖	●

Frequency: 860 MHz, Cavity size (9 × 90 × 90 mm)
Bad: ✖, Normal: ▲, Good: ●, Very Good: ❊

Waveguide Components
OFF-THE-SHELF OR CUSTOM DESIGNS

• Attenuators • Couplers • Switches • Loads • Terminations • Adapters • Assemblies • Horns • Ferrite Components
We're Ready When You Are... Next Day Delivery Of Catalog Components

From The Largest Inventory Of Waveguide Components In The Industry
RECTANGULAR, MM-WAVE, & DOUBLE-RIDGED COMPONENTS
CUSTOM DESIGNS
Custom designs are a Waveline specialty. If you don't see the product or design in our catalog, we probably have your "special" in our design files. Waveline now offers a complete line of Pin Diode Switches, Attenuators & Phase Shifters. Waveline has the expertise and capabilities to integrate waveguide and solid-state designs for subassemblies.
CALL OR WRITE
waveline
P.O. Box 718, West Caldwell, NJ 07006
(973) 226-9100 Fax: 973-226-1565
E-mail: wavelineinc.com
VISA

Enhanced, Expanded, Perfected.
Powerfilm™ attenuators go further.

Inspired by original designs produced by Aeroflex / KDI decades ago, new Powerfilm surface-mount attenuators from Aeroflex / Inmet are now produced in our new USA facility, and enhanced to include even more attenuation range and power than ever before. Employing a proprietary, highly reliable thick/thin film processing approach, these devices are optimized for your high-power signal conditioning, leveling, gain optimization and matching network challenges.

Frequency Performance up to 18 GHz

Attenuation Ranges up to 20 dB

Power Ranges up to 100 Watts

They're easily designed-in, are readily available, and are priced competitively. Visit our website for detailed specifications.

888-244-6638

www.aeroflex.com/inmet

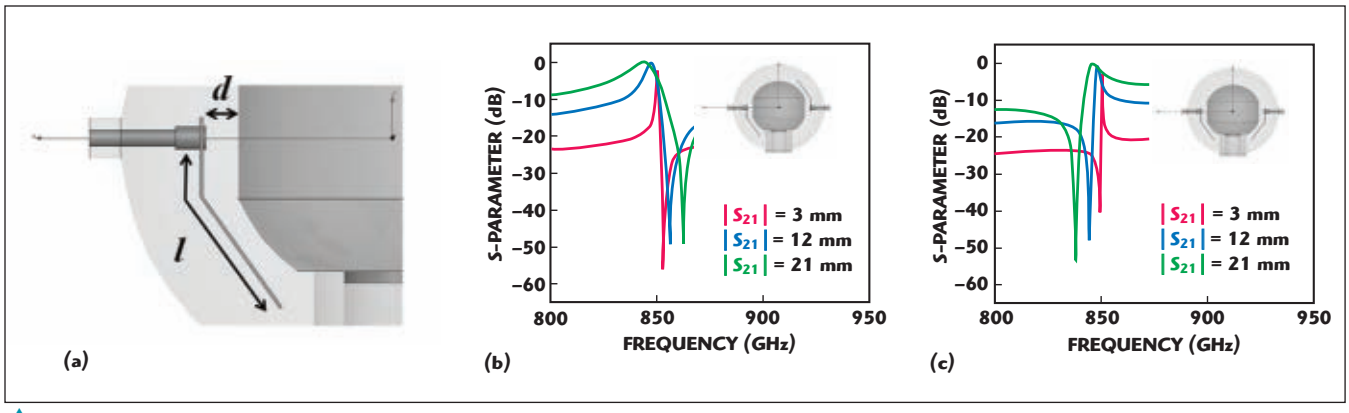
See us at IMS Booth 1623

AEROFLEX
A passion for performance.

Modelithics®

Start designing today with Modelithics Global Models™

Scalable equivalent circuit models and S-parameter data are available at **Modelithics.com**, in the simulator libraries of Agilent's ADS and Genesys software, and in AWR's Microwave Office suite.



▲ *Fig. 3 Schematic of the open-ended input/output coupling structure (a), coupling plates with opposite direction (b), coupling plates with identical direction (c).*

and z-directions, yielding a three-pole filter. The desired center frequency is 863 MHz with 14 MHz bandwidth. The filter is designed using the well-known coupling coefficients/external Q method. The coupling coefficients and external Q are given by the following:[14]

$$K_{i,j} = \frac{FBW}{\sqrt{g_i g_{i+1}}} \quad \text{for } i = 1 \text{ to } n-1 \tag{7}$$

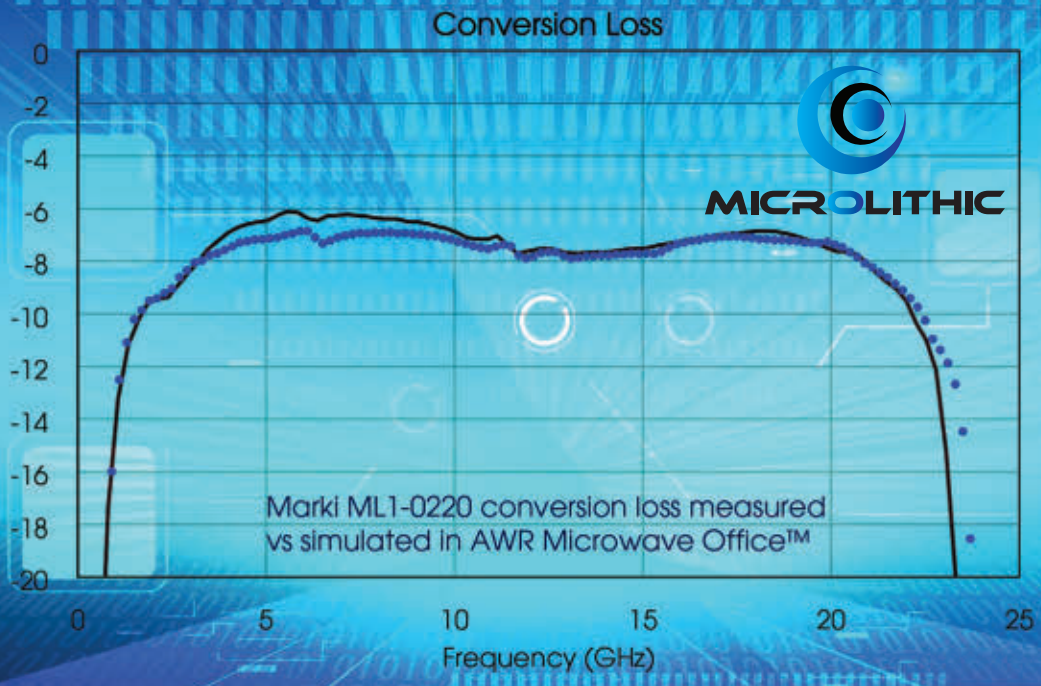
$$Q_1 = \frac{g_0 g_1}{FBW}, \qquad Q_n = \frac{g_n g_{n+1}}{FBW} \tag{8}$$

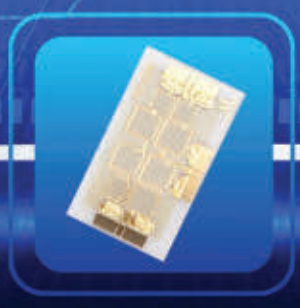
where g_i is the 0.01 dB Chebyshev lowpass prototype element and FBW is the fractional bandwidth.

The input/output structure is designed to provide the required external Q. In general, two kinds of input/output configurations, open-ended and short-ended, are commonly used. ***Figure 3a*** shows the schematic of an open-ended port coupling configuration. In this case, the length l of the coupling plate, as well as the distance d from the dielectric resonator, determine the amount of input/output coupling. When the two coupling plates have opposite directions, as shown in ***Figure 3b***, the transmission zero due to input/output coupling is located above the passband. If the output plate is now reversed in direction, as illustrated in ***Figure 3c***, the transmission zero for the lower stopband can be achieved. The frequency of the transmission zero can be controlled by the plate length l. We use the short-ended configuration, as shown in ***Figure 4a***, because the

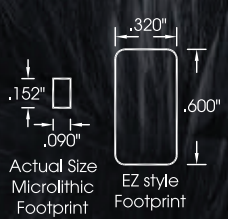
See us at IMS Booth 1115

MIXERS YOU CAN SIMULATE





See us at IMS Booth 634



Marki Microwave offers accurate simulation models for all new Microlithic mixers.
These models can predict isolations and spurious products.
Microlithic mixers feature superior performance with a 14x size reduction.

Marki microwave

Markimicrowave.com/microlithic

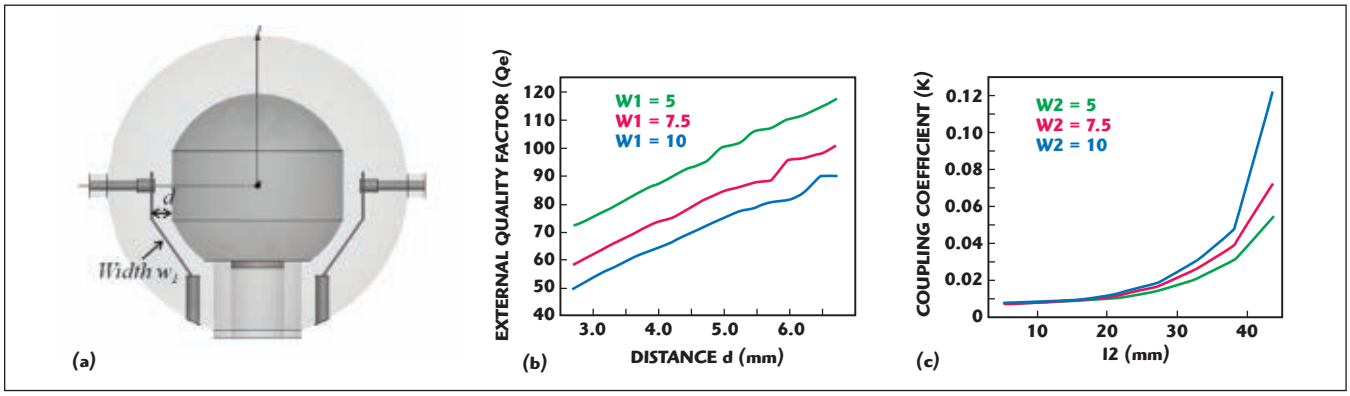


Fig. 4 Schematic of the short-ended input/output coupling structure (a), external Q (b), coupling coefficient K (c).

open-ended structure is difficult to keep fixed and coupling plate angle variation influences coupling strength. In addition, the short-ended configuration is suitable for high power applications like front end unit (FEU) in BTS due to good heat dissipation properties.

Since the short-ended configuration is a fixed structure, the length of the coupling plate cannot be tuned. The required external Q can be achieved by adjusting the plate width (w_1) and distance d. ***Figures 4b*** and ***c*** show external Q and coupling coef-

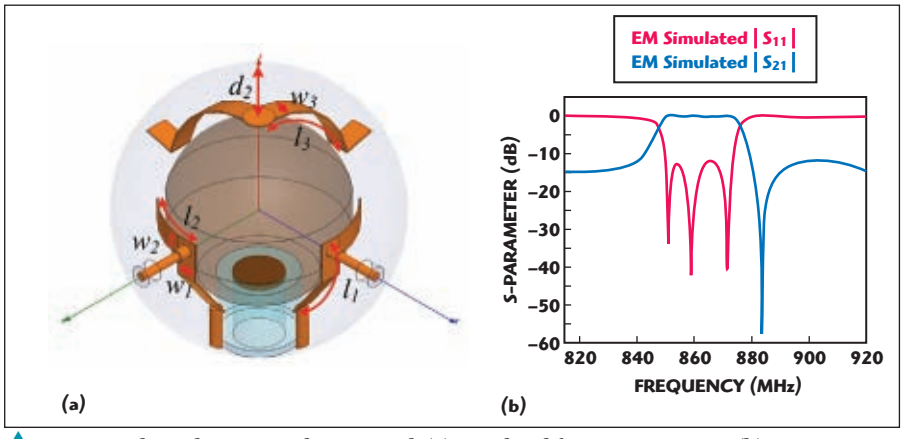


Fig. 5 Triple mode BPF coupling network (a), simulated frequency response (b).

Break on Through With G.T. Microwave

Frequency Translators
BPSK Modulators
Phase Shifters
Attenuators
Switches
QPSK Modulators
Custom-Sub Assemblies
I & Q Vector Modulators

For Leading Edge Ultra-Broadband or Optimized Narrow Band Technology from 20 MHz to 32 GHz Call...

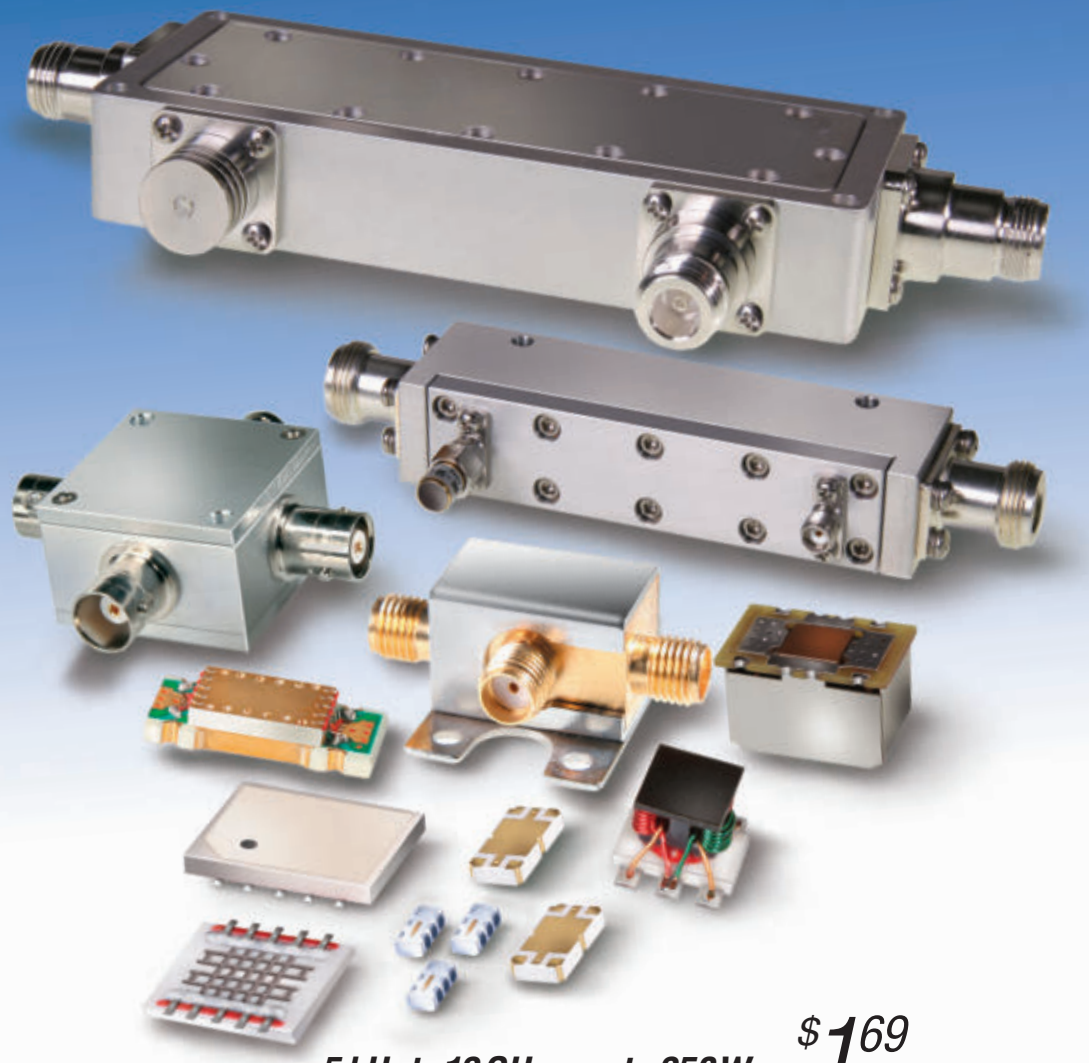
Check out our new website today...
www.gtmicrowave.com

G.T. Microwave Inc.

2 Emery Avenue
Randolph, NJ 07869 USA
973-361-5700 Fax: 973-361-5722
www.gtmicrowave.com
e-mail: sales@gtmicrowave.com

Directional / Bi-Directional

COUPLERS



5 kHz to 12 GHz **up to 250 W** from $1.69 ea. (qty. 1000)

Now! 279 ~~236~~ Looking for couplers or power taps? Mini-Circuits has models in stock, and we're adding even more! Our versatile, low-cost solutions include surface-mount models down to 1 MHz, and highly evolved LTCC designs as small as 0.12 x 0.06", with minimal insertion loss and high directivity. Other SMT models are designed for up to 100W RF power, and selected core-and-wire models feature our exclusive Top Hat™, for faster pick-and-place throughput.

At the other end of the scale, our new connectorized air-line couplers can handle up to 250W and frequencies as high as 12 GHz, with low insertion loss (0.2 dB @ 9 GHz, 1 dB @ 12 GHz) and exceptional coupling flatness! All of our couplers are RoHS compliant. So if you need a 50 or 75 Ω, directional or bi-directional, DC pass or DC block coupler, for military, industrial, or commercial applications, you can probably find it at minicircuits.com, and have it shipped today!

Mini-Circuits®

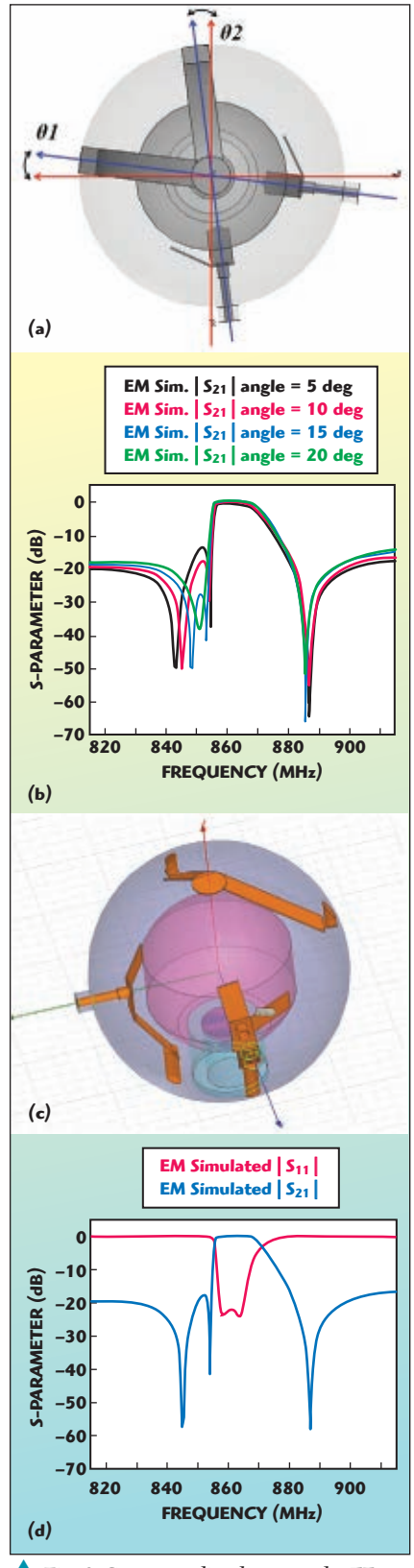
www.minicircuits.com P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com

See us at IMS Booth 823

495 rev C

ficient based on physical parameters d, w_1, w_2 and l_2 (see ***Figure 5***). It can be seen that external Q increases with larger d, resulting in weaker input/output coupling. Beyond a certain value of d, however, the wider the coupling plate, the smaller the external Q.

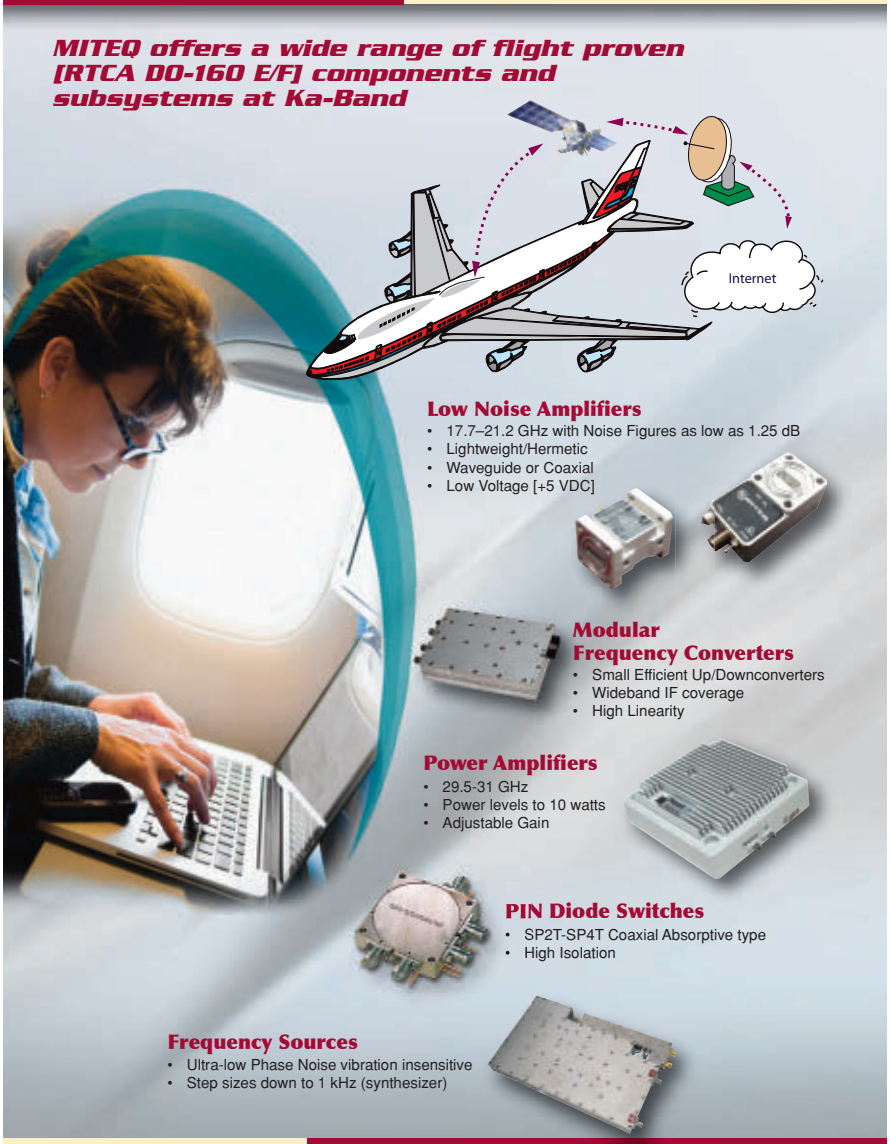
Because each cavity contains three resonances, a controllable coupling scheme is required. Unlike the conventional method, using machining chamfers or screws, a new structure based on metallic coupling plates is introduced in this design. The coupling plates are located inside the cavity, so no additional space is needed. Since all three of the $TE_{01\delta}$ degenerate modes are orthogonal to each other, as shown in Figure 5a, the input/output plates are positioned at 90° to excite the resonance. For coupling between modes $TE_{01\delta X}$ and $TE_{01\delta Z}$, two coupling plates with length of l_2 and width of w_2 are connected to the input/output plates along the xy-plane. The resonant modes $TE_{01\delta Z}$ and $TE_{01\delta Y}$ are coupled using another two coupling plates with length of l_3 and width of w_3. They are con-



▲ *Fig. 6 Cross coupling between the $TE_{01\delta X}$ and $TE_{01\delta Y}$ modes (a), simulated frequency responses for varying θ1= θ2 = θ (b), completed triple-mode BPF model in HFSS (c), simulated frequency response (d).*

Ka-Band Inflight Communication Solutions

MITEQ offers a wide range of flight proven [RTCA DO-160 E/F] components and subsystems at Ka-Band



Low Noise Amplifiers
- 17.7–21.2 GHz with Noise Figures as low as 1.25 dB
- Lightweight/Hermetic
- Waveguide or Coaxial
- Low Voltage [+5 VDC]

Modular Frequency Converters
- Small Efficient Up/Downconverters
- Wideband IF coverage
- High Linearity

Power Amplifiers
- 29.5-31 GHz
- Power levels to 10 watts
- Adjustable Gain

PIN Diode Switches
- SP2T-SP4T Coaxial Absorptive type
- High Isolation

Frequency Sources
- Ultra-low Phase Noise vibration insensitive
- Step sizes down to 1 kHz (synthesizer)

MITEQ www.miteq.com

100 Davids Drive, Hauppauge, NY 11788
Tel: (631) 439-9220 • Fax: (631) 436-7430

See us at IMS Booth 325

Make RF smarter with Freescale.

Design your next high power RF system faster with the new Freescale RF Power Tool system.

Speed your development with:

- Quick setup
- Runs directly from PC or front panel
- 1MHz – 3GHz integrated signal generator
- Flexible pulse modulation, internal, external trigger
- Real time display: VSWR, efficiency, temperature, DC power, voltage, current, and more
- Easy system validation

Use with a range of Freescale reference designs.

Introducing the world's first integrated RF power development system—only from Freescale, the leader in RF power devices.

The global leader in RF power introduces another breakthrough—the Freescale RF power tool system, the industry's first fully integrated RF power application development system-in-a-box. Get all the components needed to design leading-edge RF power applications in a modular portable unit, at a fraction of the cost of a traditional bench setup. Compatible with Freescale RF power evaluation boards and used by our own engineering teams, this innovative new tool simplifies your design process, reduces development time and costs, and gets you to market faster. Next time inspiration strikes, be ready. Visit **freescale.com/RFpowertool**

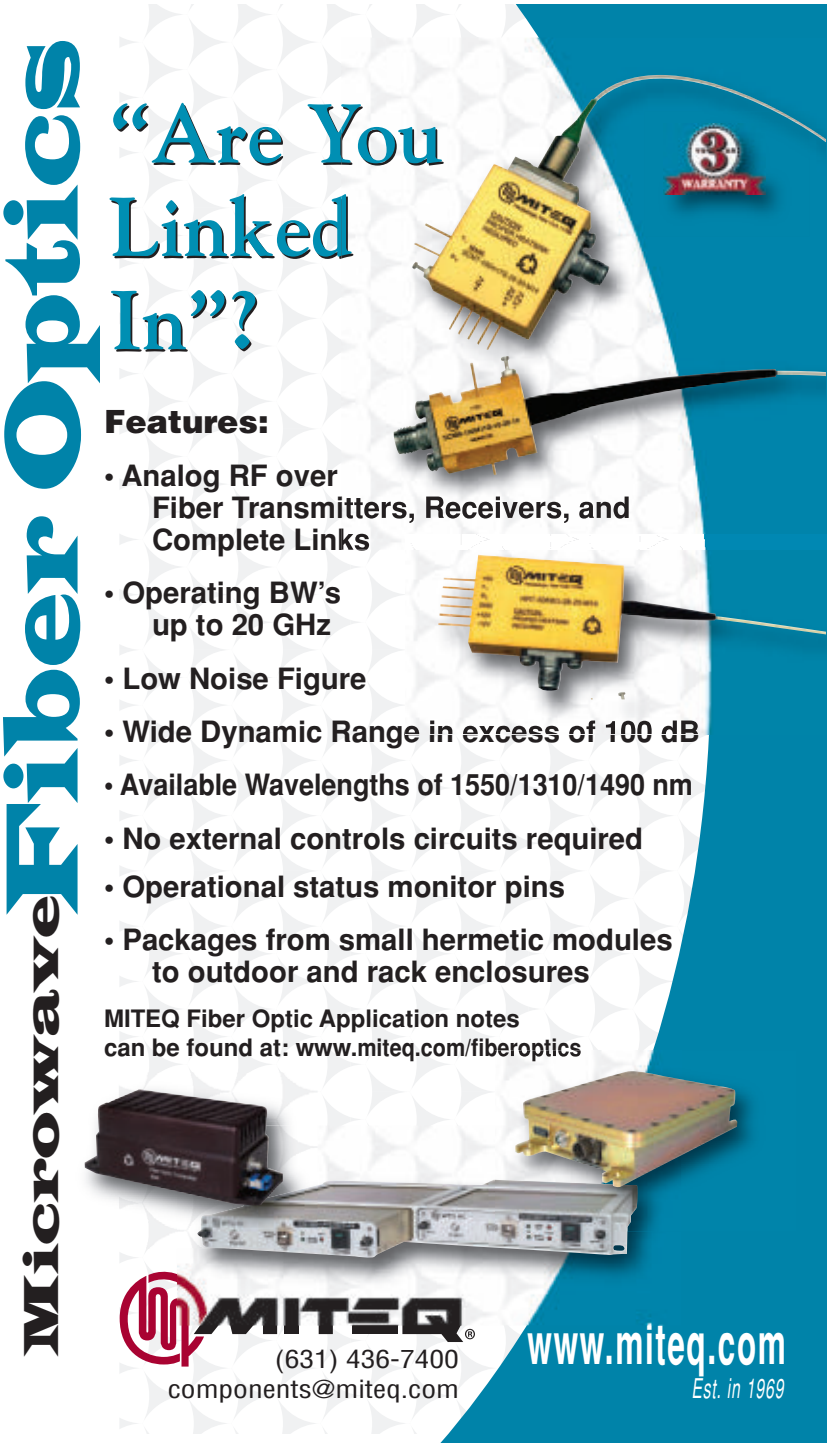
make it freescale™

Freescale and the Freescale logo are trademarks of Freescale Semiconductor, Inc., Reg U.S. Pat. & Tm. Off.
All other product or service names are the property of their respective owners. © 2014 Freescale Semiconductor, Inc.

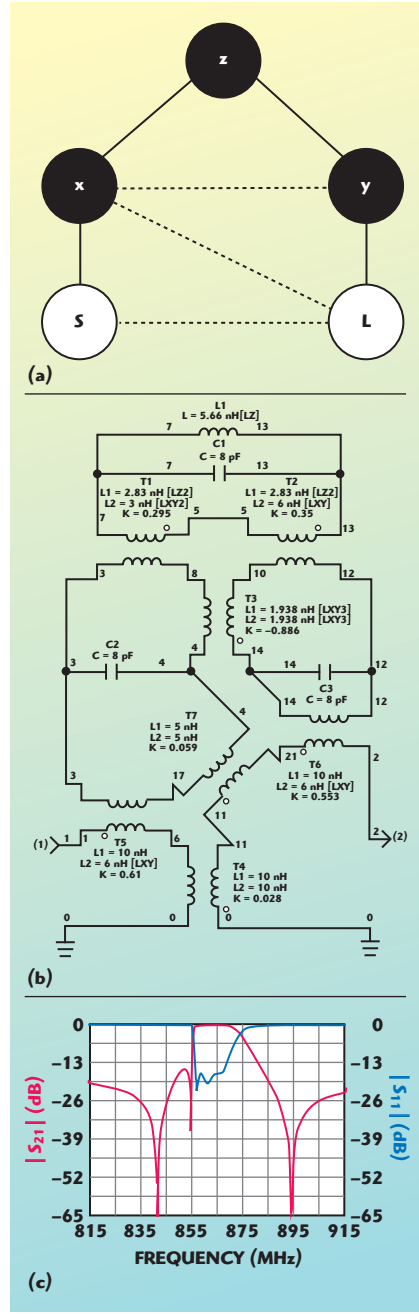
See us at IMS Booth 1315

nected at the top center of the cavity, also separated by 90°. Ninety degree separation is essential to couple the orthogonal modes. Parameter d_2 is the distance between the connecting point and the cavity top. Figure 5b shows the simulated frequency response; a three-pole filter is achieved and there is a transmission zero on the upper stopband due to direct coupling between the source and load.

Introducing a rotation angle (θ) between the two top coupling plates, as depicted in ***Figure 6a***, can improve the left slope performance. ***Figure 6b*** shows how the skirt characteristics are improved as a function of θ. Due to this rotation angle, cross coupling between the $TE_{01\delta X}$ and $TE_{01\delta Y}$ modes is generated, causing another two transmission zeros to appear. This cross coupling can be controlled by θ without significantly affecting direct-coupling. The positions of the transmission zeros can be adjusted while maintaining constant passband bandwidth. In addition, the upper stopband transmission zero is attributed to the input/output cross coupling, so its location also remains nearly constant with varying θ. The simulated results are illustrated in Figure 6b. ***Figure 6c*** shows the completed triple-mode BPF model in HFSS and corresponding frequency responses are given in ***Figure 6d***. Optimized design parameters are d = 3.25 mm, d_2 = 10 mm, w_1 = 7.5 mm, w_2 = 7.5 mm, w_3 = 8 mm, l_2 = 12.5 mm, and l_3 = 45 mm.



See us at IMS Booth 325



▲ *Fig. 7 BPF coupling scheme (a), equivalent circuit with cross coupling (b), simulated frequency response of the equivalent circuit (c).*

Anritsu Since 1895

Vector Network Analysis
Portfolio Brochure

Confidence
on the Cutting Edge.

In the Lab | On the Manufacturing Floor | In the Field

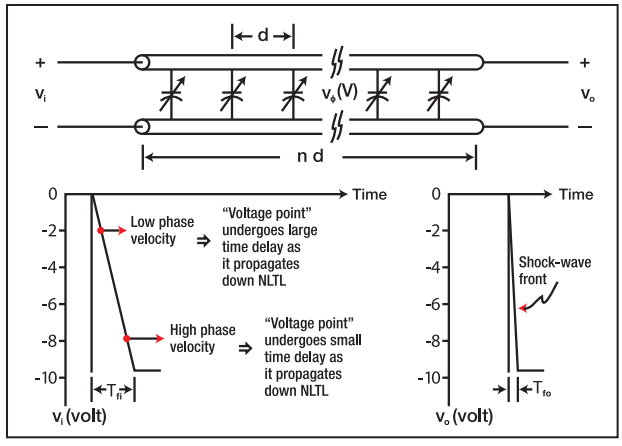
World's first portfolio of VNAs that bring Non-linear Transmission Line (NLTL) technology to every measurement scenario from on-wafer device characterization to R&D testing to manufacturing and field operations.

Anritsu
envision : ensure

In 1965, Anritsu filed the patent that defined the first modern Vector Network Analyzer (VNA). We are proud to continue that tradition of innovation to the present day—with the world's first portfolio of VNAs that bring Non-linear Transmission Line (NLTL) technology to every measurement scenario from on-wafer device characterization to R&D testing to manufacturing and field operations.

By integrating the key components of an NLTL VNA on a single chip, Anritsu's VNAs offer enhanced performance over broad frequency ranges and reduced measurement complexity when compared with existing solutions. These features, combined with the frequency-scalable nature of VNAs' reflectometers, provide users with a unique and compelling solution for their current and future high-frequency measurement needs.

An NLTL is a nonlinear periodic structure that enables the generation of electrical shock waves and solitons. By leveraging these highly nonlinear waves for pulse formation and stimulus generation, Anritsu's sampler-based VNAs provide operation at microwave and millimeter-wave frequencies.



An NLTL is a high-impedance transmission line loaded with varactor diodes at regular intervals. Its ability to compress the fall time of a step-like waveform leads to the formation of an electrical "shock wave" that gets converted into a pulse. Trains of such pulses are used in Anritsu's VNA receivers for the down-conversion of microwave and mm-wave signals into IF frequencies. An NLTL is also used in the generation of microwave and mm-wave VNA source/stimulus signals.

Product family	Application	NLTL-based advantage	Benefit to user
VectorStar™ MS464xB ME7838x	On-wafer device characterization and research and development	Superior conversion efficiency in microwave and mm-wave bands	Achieve high performance over broader frequency ranges – e.g. 109 dB dynamic range at 110 GHz
		Integrated chip design greatly reduces the temperature variations between and across reflectometer	Longer intervals between calibrations, better measurement accuracy and repeatability
		High performance in a very small form factor	Enables direct connection of mm-wave extension module to wafer probe
ShockLine™	Passive component manufacturing	VNA-on-a-chip reduces number of internal VNA components, and enhances reliability	Lower maintenance cost, reduced down time and operating costs
		Improved capability-to-cost ratio enables new applications	Dramatic cost reduction in VNA used for manufacturing test
		Integrated chip design greatly reduces the temperature variations between and across reflectometer	Longer intervals between calibrations, better measurement accuracy and repeatability
Microwave Site Master™	Field measurement	Highest dynamic range and superior accuracy	Unprecedented dynamic range to 110 dB at 40 GHz
		Superior conversion efficiency in microwave bands	More stable and more linear measurements with longer battery life
		VNA-on-a-chip reduces number of discrete parts and connectors	Lower maintenance cost, reduced down time and operating costs

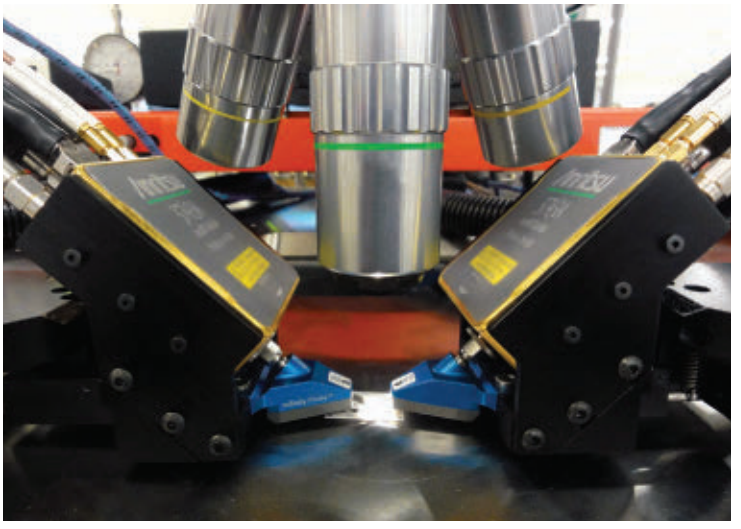
For a more detailed explanation of the operation and benefits of NLTL technology, please see the Anritsu White Paper "Modern Architecture Advances Vector Network Analyzer Performance"

VectorStar® Broadband On-wafer Device Characterization

Don't let expired calibrations spoil your data!

ME7838E: 70 kHz to 110 GHz
ME7838A: 70 kHz to 110 GHz (operational to 125 GHz)
ME7838D: 70 kHz to 145 GHz

The Vector**Star**™ ME7838A Broadband Vector Network Analysis System delivers 109 dB of dynamic range at 110 GHz for high-sensitivity measurements across 70 kHz to 110 GHz (up to 1.1 THz with mm-wave modules) with 0.1 dB and 0.5 degree S_{21} stability over 24 hours. This stable broadband performance means you can make high accuracy measurements all day, with the confidence that your calibration remains rock solid! Spend less time calibrating and more time measuring.



Challenge	VectorStar solution provides:
Maximizing frequency range to develop accurate device models	**Broadest frequency span 70 kHz to 110/125/145 GHz** • Obtain the most thorough and accurate broadband measurements • Accurate low frequency measurements eliminate the time consuming, error-prone concatenation process across the RF, microwave, and millimeter-wave bands
Minimizing accuracy/speed tradeoffs	**Industry-leading performance and speed** • Widest dynamic range of 108 dB at 67 GHz and 109 dB at 110 GHz • Direct-connect to probes further enhances overall system performance • Fastest measurement speed of 110 ms for 401 points at 10 kHz IFBW
Poor stability increases calibration frequency	**Extended test time by reducing calibration frequency** • Compact integrated frequency extension modules provide enhanced stability as compared with old-style hybrid WG/coax modules • S_{21} stability better than 0.1 dB and 0.5 degree over 24 hours • Improved stability allows for a single calibration to be performed once for a four hour session or even once a day, resulting in an increase in measurement test time of over 37% in a single four hour session!
Protecting early prototypes	**Only broadband VNA system with real-time power leveling** • Power sweep control that provides the best power accuracy and stability to power levels as low as –55 dBm • Highly responsive real-time power leveling • Real-time power level control of up to 55 dB enables accurate linear gain and 1 dB compression measurements
Size and weight constraints	**Smallest/lightest mm-wave modules** • Compact, lightweight broadband modules for easy, precise, and economical positioning on a wafer probe station • Direct mounting to probes minimizes cable loss and improves both performance and stability

VectorStar® Research and Development

Solve your toughest design challenges with confidence

MS464xB: 10 MHz to 20, 40, 50 and 70 GHz
Optional low frequency extension to 70 kHz
ME7838x: Broadband systems to 145 GHz
Waveguide band extensions to 1.1 THz

The Vector**Star**™ VNA offers a new performance benchmark for S-parameter measurements of RF, Microwave, and Millimeter wave devices.

In addition to maintaining a peak level of measurement performance, each VectorStar model can be upgraded to a broader frequency range, higher port count, or additional options fitted. Spec the features you need today, then add new ones in the future as required—without fear of obsolescence or the need to learn a new test system.

Challenge	VectorStar solution provides:
Reducing design cost and cycle time	**Hybrid bridge-coupler VNA architecture** • DC extrapolation errors in modeling minimized by use of bridge structure for capture of high quality low frequency S-parameter data • High frequency data quality assured by use of directional couplers • Higher quality measurement data leads to fewer design turns
Locating impedance problems	**Best time domain analysis due to hybrid bridge-coupler design** • Broadest coverage from 70 kHz to 70/145 GHz provides best combination of accurate and hi-resolution low-pass time domain results • Time Domain Analysis provides accurate characterization of impedance profiles due to high quality low frequency S-parameter data • 100,000 points provide best-in-class alias-free range
Achieving sufficient dynamic range when DUT constrains RF drive level	**Only VNA manufacturer using Non-Linear Transmission Line technology (NLTL)** • NLTL technology used in receivers provides lower noise floor at high end frequencies, test port noise floor of -110 dBm at 70 GHz • Use lower drive power and achieve desired dynamic range for low power DUTs • Obtain superior dynamic range when secondary source limits RF drive level
Selecting a VNA for specific application	**Capabilities and options for VectorStar support measurements in the fields of:** • Radar • On-wafer device characterization • Signal integrity • Active and passive components • Antenna measurements • Materials measurements
Protecting investment	**Complete upgradeability within family** • Meet budget targets; buy what is needed now and protect investment by upgrading later • Spread spending across budget years due to ability to add options or upgrade frequency ranges later • Test-set concept permits port-count to be increased when required

SHOCKLINE™ Passive Device Manufacturing

Low cost, high performance to 40 GHz

MS46322A: 2-port Economy VNA family
MS46522A: 2-port Value VNA family
MS46524A: 4-port VNA family

ShockLine™ RF and Microwave VNAs eliminate the need to buy expensive instruments for simple S-parameter measurements. For passive device manufacturers in search of a budget-friendly VNA, ShockLine delivers good performance to 40 GHz at a substantially lower price.

ShockLine offers three families of two and four-port VNAs. Each is based on patented NLTL (ShockLine) technology which simplifies the internal VNA architecture at high frequencies and reduces manufacturing costs, while enhancing accuracy and measurement repeatability.

Challenge	ShockLine™ solution provides:
Minimize test times and maximize throughput	Wide dynamic range shortens test time and increases throughput by optimizing measurement settings in production
Calibration stability	Less frequent calibrations as a direct result of the NLTL receivers' thermal stability
Better measurement accuracy and repeatability	NLTL sampling yields better noise performance than harmonic mixing at higher RF frequencies
Locating and troubleshooting problem areas in devices	Easier and faster testing with time domain lowpass and bandpass mode with time gating capability
Efficient use of rack space	Small form factor (2U) with no display or keypad to conserve space
Protect investment	Upgradable to higher frequency models while reducing switching costs

SiteMaster The Field-ready VNA

The industry standard sets a new benchmark—40 GHz

S820E: 1 MHz to 8/14/20/30/40 GHz

The new Microwave Site Master™ S820E extends Anritsu's leadership with a dozen new benchmarks—including unprecedented dynamic range to 110 dB at 40 GHz for true benchtop performance in the field.

In spite of its compact form factor, Microwave Site Master is a full Vector Network Analyzer in a portable lightweight package. Inside is the same cutting edge NLTL sampler technology as Anritsu's premium benchtop VNA's with 4 complete receivers, and a fully reversing synthesized source with 1Hz frequency resolution. Future software options will enable support for full 2-port S-parameter measurements as well as industry standard S1P and S2P files.

Challenge	Site Master solution provides:
Ever increasing test frequencies	Broadest frequency span from 1 MHz to 8, 14, 20, 30, and 40 GHz
Loss in conversion efficiency at higher frequencies	Best frequency resolution of 1 Hz for maximum frequency flexibility
Microwave testing requires greater dynamic range	Unprecedented dynamic range to 110 dB at 40 GHz for real benchtop performance
Need for accurate measurements the first time	Fastest handheld sweep speed of 650 us/data point for quick field measurements
RF interference in field operations	Highest RF immunity of +17 dBm for operation in harsh RF field environments
Need to quickly isolate cable and antenna problems	Unsurpassed directivity in a handheld for maximum field accuracy
Field battery-operated equipment requires recharging	Longest battery life with four hours of operation for the most field uptime on one charge
Reading measurements under harsh field conditions	Largest and highest resolution display (8.4 inch, 800x600) for maximum readability in all lighting conditions with an intuitive graphical user touchscreen interface
Calibration for all temperature conditions	Full temperature coax calibration kits from -10 ˚C to +55 ˚C for field precision measurement
Maintaining calibration	Widest calibration temperature window of ±10 ˚C requiring less recalibrations
Making fast cable loss measurement over all frequencies	Unique 2-port swept cable loss measurement across the whole frequency range of interest in a quick one-step measurement
Simplifying waveguide calibration	The most pre-loaded waveguide calibration component coefficients in the instrument with ten bands for SSL and SSLT calibrations making it convenient for the customer to quickly make calibrations.

Anritsu Product Line Comparison

Family	VectorStar MS4640B / VectorStar ME7838x	ShockLine MS46522A/MS46524A	ShockLine MS46322A	Microwave Site Master S820E
Applications	Device characterization, research and development	Manufacturing	Manufacturing	Field use
Device under test type	Active, Passive, Non-linear, Frequency translated, Pulsed	Passive only	Passive only	Passive only
Frequency range	10 MHz (70 kHz option) to 20, 40, 50, 70, 110, 145 GHz*	50 KHz to 8.5 GHz	1 MHz to 4, 8, 14, 20, 30, 40 GHz	1 MHz to 8, 14, 20, 30, 40GHz
Number of ports	2 and 4-port	2 and 4-port	2-port	2-port
Dynamic range (@ 10 Hz IFBW)	122 dB (10 MHz to 2.5 GHz) 124 dB (2.5 GHz to 20 GHz) 122 dB (2.5 GHz to 40 GHz) 107 dB (70 GHz) 109 dB (110 GHz) 94 dB (145 GHz)	100 dB (500 KHz to 3 MHz) 110 dB (3 MHz to 6 GHz) 105 dB (6 to 8 GHz) 90 dB typ (8 to 8.5 GHz)	≥ 85 dB (1 MHz to 20 MHz) ≥ 100 dB (20 MHz to 40 GHz)	≥ 85 dB (1 MHz to 20 MHz) ≥ 100 dB (20 MHz to 40 GHz)
Trace noise (rms)	4.5 mdB (500 KHz to 20 GHz) 6 mdB (20 GHz to 67 GHz) 8 mdB (to 70 GHz)	6 mdB (<8 GHz), 100 Hz IFBW	6 mdB 100 Hz IFBW	6 mdB 100 Hz IFBW
Port power	-25 to +10 dBm (<10 MHz) -25 to +12 dBm (.01 to 2.5 GHz) -20 to +13 dBm (2.5 to 20 GHz) -25 to +9 dBm (20 to 40 GHz) -25 to -3 dBm (70 GHz)	-30 to +15 dBm (0.3 to 6 GHz) -30 to +12 dBm (6 to 8 GHz) -30 to +10 dBm (to 8.5 GHz) -30 or 0 dBm (8.5 to 40 GHz)	High State : -3 dBm Low state : -20 dBm	High State : -3 dBm Low state : -20 dBm
Corrected directivity	>50 dB (20 GHz using 36585K AutoCal)	> 42 dB	> 42 dB	> 42 dB
Measurement speed, typical (@widest IFBW)	20 µs/point	70 µs/point	350 µs/point	650 µs/point
Sweep type	Freq: Lin, CW, Segment Power: Lin, log, and constant power sweep or constant power slope over frequency sweep	Freq: Linear, CW, Segment Power: Linear	Linear and CW Frequency Sweep	Linear
Max number of points	100,000	20,000	16,000	130, 259, 517, 1033, 2065
Calibration	SOLT, SSLT, SSST, SOLR, LRL, LRM, A-LRM™, AutoCal, Thru Update	SOLT, SOLR, LRL, LRM, WG, Microstrip	SOLT, WG	SOLT, SSLT (WG)
Embedding, de-embedding	Yes, including multiple networks and extraction utility	Yes, including multiple networks and extraction utility	Yes, including multiple networks and extraction utility	N/A
Built-in bias tee and step attenuator options	Yes	No	No	No
Marker statistics function	Mean, max, min, standard deviation per trace or over a marker region	Mean, max, min, standard deviation per trace or over a marker region	Mean, max, min, standard deviation per trace or over a marker region	Max, min, peak, valley, delta
Pass/fail testing	Yes	Yes	Yes	Yes
Remote control	GPIB, LAN, USB	LAN	LAN	LAN, USB
Programming	SCPI, LabView, LabWindows/CVI, .NET/COM	SCPI, IVI drivers	SCIP, IVI drivers. LabView, LabWindows	SCPI
Major options	Time domain, Rack Mount, Receiver Offset, Dual Source, IF Digitizer, Noise Figure, PulseView™, DifferentialView™, Direct Access Loops, Active Measurement Suite, 70 kHz Low End Extension	Time Domain, Rack Mount	Time Domain, Rack Mount	VNA, full reversing 2-port VNA Time Domain VVM with A/B ratio (options available later in 2014)

* Waveguide extensions available to 1.1 THz

Above data are highlights, please see individual data sheets for full details

Anritsu
envision : ensure

• United States
Anritsu Company
1155 East Collins Boulevard, Suite 100,
Richardson, TX, 75081 U.S.A.
Toll Free: 1-800-267-4878
Phone: +1-972-644-1777
Fax: +1-972-671-1877

• Canada
Anritsu Electronics Ltd.
700 Silver Seven Road, Suite 120,
Kanata, Ontario K2V 1C3, Canada
Phone: +1-613-591-2003
Fax: +1-613-591-1006

• Brazil
Anritsu Electrônica Ltda.
Praça Amadeu Amaral, 27 - 1 Andar
01327-010 - Bela Vista - São Paulo - SP - Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

• Mexico
Anritsu Company, S.A. de C.V.
Av. Ejército Nacional No. 579 Piso 9, Col. Granada
11520 México, D.F., México
Phone: +52-55-1101-2370
Fax: +52-55-5254-3147

• United Kingdom
Anritsu EMEA Ltd.
200 Capability Green, Luton, Bedfordshire LU1 3LU, U.K.
Phone: +44-1582-433280
Fax: +44-1582-731303

• France
Anritsu S.A.
12 avenue du Québec, Bâtiment Iris 1-Silic 612,
91140 VILLEBON SUR YVETTE, France
Phone: +33-1-60-92-15-50
Fax: +33-1-64-46-10-65

• Germany
Anritsu GmbH
Nemetschek Haus, Konrad-Zuse-Platz 1
81829 München, Germany
Phone: +49-89-442308-0
Fax: +49-89-442308-55

• Italy
Anritsu S.r.l.
Via Elio Vittorini 129 00144 Roma, Italy
Phone: +39-6-509-9711
Fax: +39-6-502-2425

• Sweden
Anritsu AB
Kistagången 20B, 164 40 KISTA, Sweden
Phone: +46-8-534-707-00
Fax: +46-8-534-707-30

• Finland
Anritsu AB
Teknobulevardi 3-5, FI-01530 Vantaa, Finland
Phone: +358-20-741-8100
Fax: +358-20-741-8111

• Denmark
Anritsu A/S (Service Assurance)
Anritsu AB (Test & Measurement)
Kay Fiskers Plads 9, 2300 Copenhagen S, Denmark
Phone: +45-7211-2200
Fax: +45-7211-2210

• Russia
Anritsu EMEA Ltd.
Representation Office in Russia
Tverskaya str. 16/2, bld. 1, 7th floor.
Russia, 125009, Moscow
Phone: +7-495-363-1694
Fax: +7-495-935-8962

• United Arab Emirates
Anritsu EMEA Ltd.
Dubai Liaison Office
P O Box 500413 - Dubai Internet City
Al Thuraya Building, Tower 1, Suite 701, 7th Floor
Dubai, United Arab Emirates
Phone: +971-4-3670352
Fax: +971-4-3688460

• Singapore
Anritsu Pte. Ltd.
11 Chang Charn Road, #04-01, Shriro House
Singapore 159640
Phone: +65-6282-2400
Fax: +65-6282-2533

• India
Anritsu India Private Limited
India Branch Office
2nd & 3rd Floor, #837/1, Binnamangla 1st Stage,
Indiranagar, 100ft Road, Bangalore - 560038, India
Phone: +91-80-4058-1300
Fax: +91-80-4058-1301

• P. R. China (Shanghai)
Anritsu (China) Co., Ltd.
27th Floor, Tower A,
New Caohejing International Business Center
No. 391 Gui Ping Road Shanghai, Xu Hui Di District,
Shanghai 200233, P.R. China
Phone: +86-21-6237-0898
Fax: +86-21-6237-0899

• P. R. China (Hong Kong)
Anritsu Company Ltd.
Unit 1006-7, 10/F., Greenfield Tower, Concordia Plaza,
No. 1 Science Museum Road, Tsim Sha Tsui East,
Kowloon, Hong Kong, P. R. China
Phone: +852-2301-4980
Fax: +852-2301-3545

• Japan
Anritsu Corporation
8-5, Tamura-cho, Atsugi-shi,
Kanagawa, 243-0016 Japan
Phone: +81-46-296-1221
Fax: +81-46-296-1238

• Korea
Anritsu Corporation, Ltd.
5FL, 235 Pangyoyeok-ro, Bundang-gu, Seongnam-si,
Gyeonggi-do, 463-400 Korea
Phone: +82-31-696-7750
Fax: +82-31-696-7751

• Australia
Anritsu Pty Ltd.
Unit 21/270 Ferntree Gully Road,
Notting Hill, Victoria 3168, Australia
Phone: +61-3-9558-8177
Fax: +61-3-9558-8255

• Taiwan
Anritsu Company Inc.
7F, No. 316, Sec. 1, Neihu Rd., Taipei 114, Taiwan
Phone: +886-2-8751-1816
Fax: +886-2-8751-1817

Anritsu utilizes recycled paper and environmentally conscious inks and toner.

®Anritsu All trademarks are registered trademarks of their respective owners. Data subject to change without notice.
For the most recent specifications visit: www.anritsu.com

11410-00802A Printed in United States 2014-03

©2014 Anritsu Company. All Rights Reserved.

SIX DAYS ■ THREE CONFERENCES ■ ONE EXHIBITION

Scan page using layar app

EUROPEAN MICROWAVE WEEK 2014
NUOVA FIERA DI ROMA, ROME, ITALY
OCTOBER 5 - 10, 2014

EuMW 2014
CONNECTING THE FUTURE

EUROPEAN MICROWAVE WEEK
ROME, ITALY
5-10 OCTOBER 2014
www.eumweek.com

EUROPE'S PREMIER MICROWAVE, RF, WIRELESS AND RADAR EVENT

EuMW 2014 will be held in the extraordinary and beautiful 'Eternal City' of Rome. Bringing industry, academia and commerce together, European Microwave Week 2014 is a SIX day event, including THREE cutting edge conferences and ONE exciting trade and technology exhibition featuring leading players from across the globe. EuMW 2014 will offer you the unique opportunity to be connected to the future of microwave technology.

The Exhibition (7th – 9th October 2014)

- 8000 sqm of gross exhibition space
- 5,000 key visitors from around the globe
- 1,700 - 2,000 conference delegates
- In excess of 250 international exhibitors (including Asia and US as well as Europe)

The Conferences:

- European Microwave Integrated Circuits Conference (EuMIC) 6th – 7th October 2014
- European Microwave Conference (EuMC) 6th – 9th October 2014
- European Radar Conference (EuRAD) 8th – 10th October 2014
- Plus Workshops and Short Courses (From 5th October 2014)
- In addition EuMW 2014 will include the 'Defence, Security and Space Forum'.

EuMA European Microwave Association

Official Publication: Microwave Journal

Organised by: horizon house

Supported by: IET The Institution of Engineering and Technology

Co-sponsored by: MTT-S

Co-sponsored by: IEEE

EuMIC 2014
The 9th European Microwave Integrated Circuits Conference
Co-sponsored by: ELECTRON DEVICES SOCIETY, GAAS

44TH EUROPEAN MICROWAVE CONFERENCE 2014
The 44th European Microwave Conference
Co-sponsored by: APS

EuRAD 2014
The 11th European Radar Conference
Co-sponsored by: AESS, APS

Interested in exhibiting?

Call +44(0) 20 7596 8742 or visit www.eumweek.com

See us at IMS Booth 720

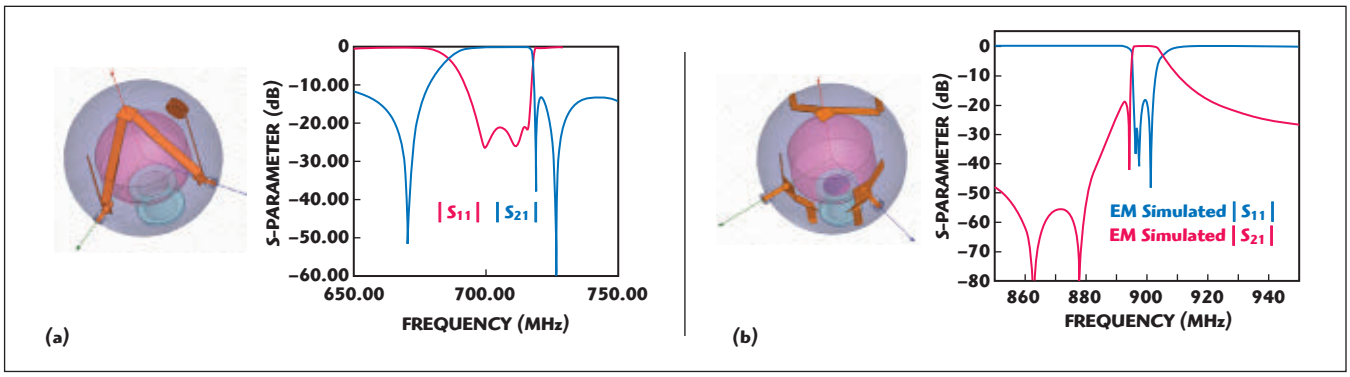


Fig. 8 Various notch designs are possible by rearranging the coupling configuration.

Low Noise Amplifiers
"Need Gain"
3 YEAR WARRANTY
MITEQ has it with Low Noise!
Features:
• Amplifiers from 1 kHz to 65 GHz
• Utilizing GaAs FET/BiPolar/MMIC technologies
• Narrow Band to Ultra-Wideband designs
• Coaxial/Waveguide and Surface Mount Packaging
• Large array of Catalog offerings
• Integrated RF Input limiter protection
• Custom designs are welcomed
MITEQ Amplifier Application notes can be found at:
www.miteq.com/amplifiers
MITEQ®
(631) 436-7400
components@miteq.com
www.miteq.com
Est. in 1969

Equivalent Circuit

Figure 7a shows the coupling scheme. The solid line represents direct coupling, with cross coupling indicated by the dotted line. As described above, the input/output coupling results in one transmission zero above the passband. The other two transmission zeros in the lower stopband are attributed to cross coupling between the $TE_{01\delta X}$ and $TE_{01\delta Y}$ modes. It should be noted that cross coupling between the $TE_{01\delta X}$ mode and load is also characterized. With the effect of this coupling taken into consideration, a sharper slope of the BPF lower stopband can be realized, leading to better agreement between the computed and measured responses. ***Figure 7b*** is the equivalent circuit model of the BPF using L and C lumped elements. The circuit model is simulated using GENESYS, with results shown in ***Figure 7c***.

Various Notch Designs

The coupling mechanism using metallic plates has the advantage of flexibility, which allows for realization of various notch designs. By simply modifying the configuration of the coupling structure, coupling between the three degenerate modes can be arbitrarily controlled, resulting in various stopband characteristics. To demonstrate this property, ***Figure 8a*** and ***b*** are two possible coupling configurations and their corresponding frequency responses, illustrating that the positions of transmission zeros can be freely determined.

Triple-Mode Bandstop Filter

An approach to designing bandstop filters using directly coupled resonators is described by Cameron et al.[15] This method makes the techniques used for bandstop filter design and construction very similar to those used for the BPF. Based on this method, by

See us at IMS Booth 325

SPACEK LABS INC.

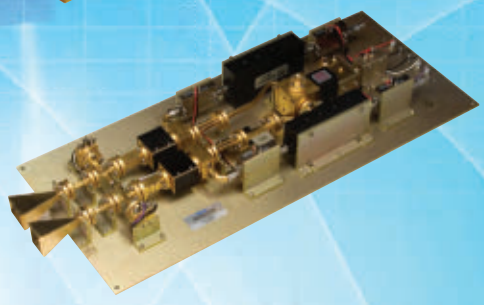
MILLIMETER-WAVE TECHNOLOGY

Serving the Industry for Over 32 Years

Components and Subassemblies from 10 to 110 GHz

Exceeding the Highest Industry Standards for Performance & Quality

MILLIMETER-WAVE COMPONENTS, SUBASSEMBLIES AND SOLUTIONS



For over 32 years, Spacek Labs has been dedicated to providing the highest quality millimeter-wave and microwave components and subassemblies for commercial, military and space applications. From 10 to 110 GHz, we have standard designs or we can design and build for your specific requirements. Give us a call with your needs and we will put together the perfect solution for you!

- Up & Down Converters
- Block Converters
- Power Amplifiers
- Low-Noise Amplifiers
- Frequency Multipliers
- Frequency Sources
- Detectors
- Filters
- Receivers
- Transmitters
- Radiometer Front Ends

ISO 9001:2008 Certified

212 East Gutierrez Street, Santa Barbara CA 93101 | e-mail: sales@spaceklabs.com

www.spaceklabs.com | tel (805) 564-4404 | fax (805) 966-3249

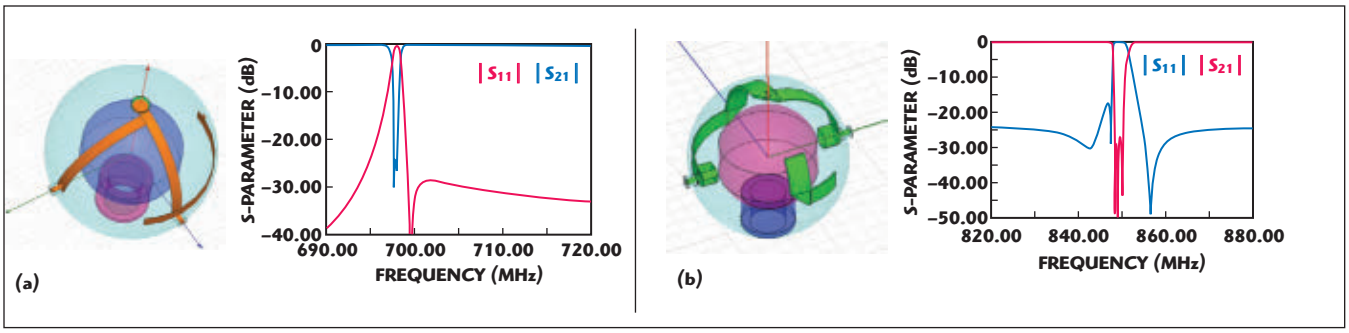
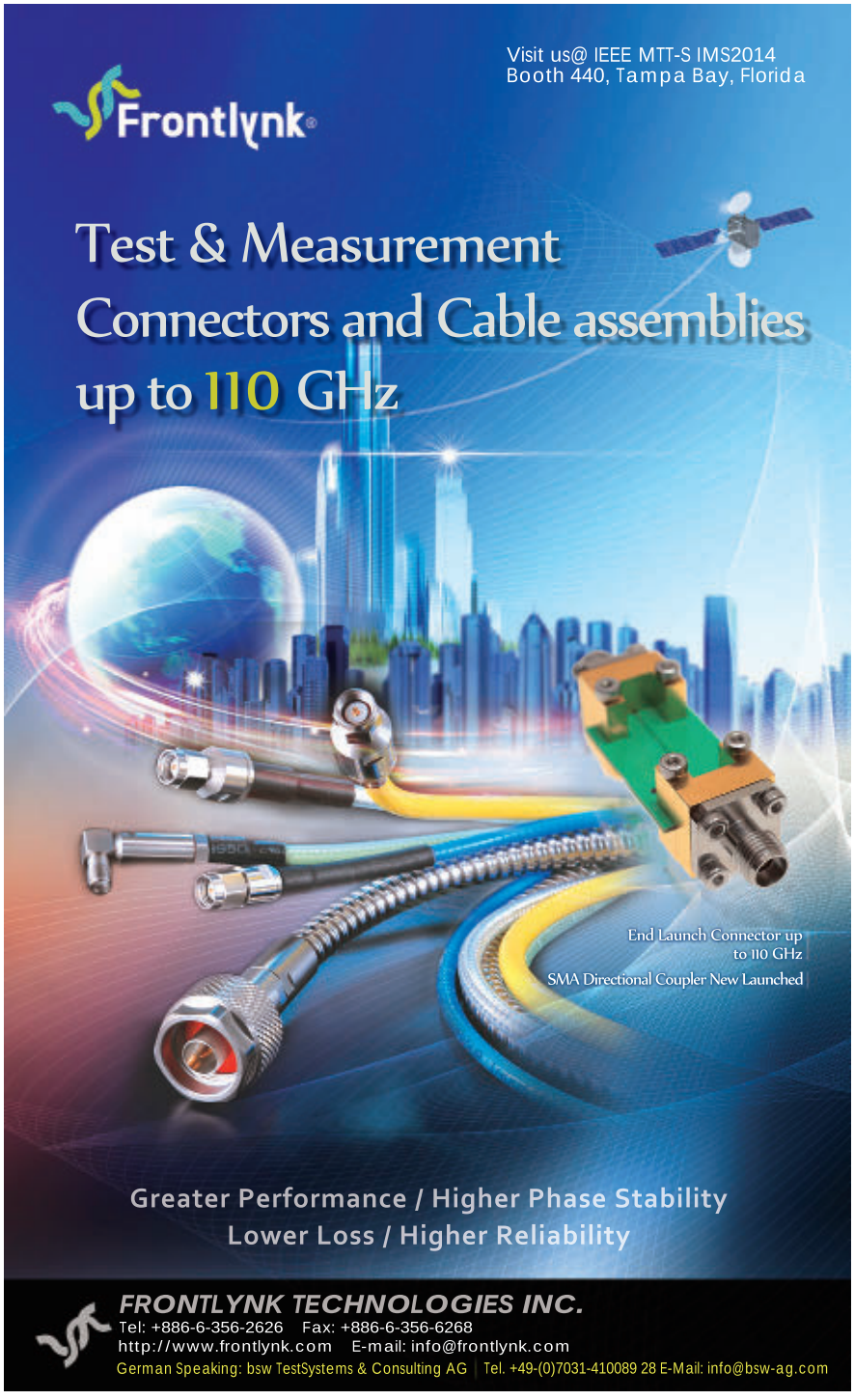


Fig. 9 Bandstop filters and corresponding simulated frequency responses.



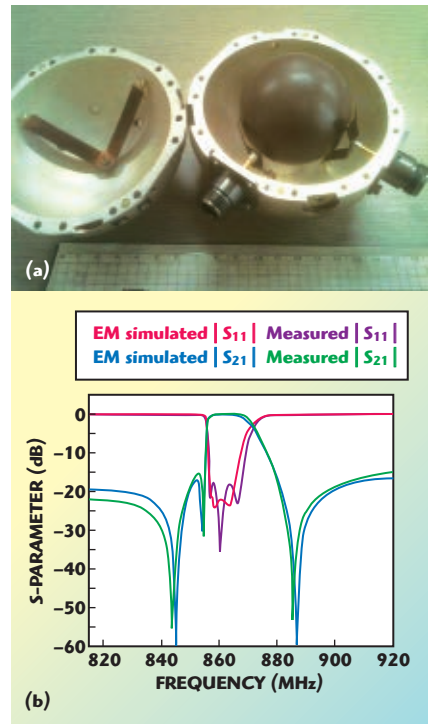


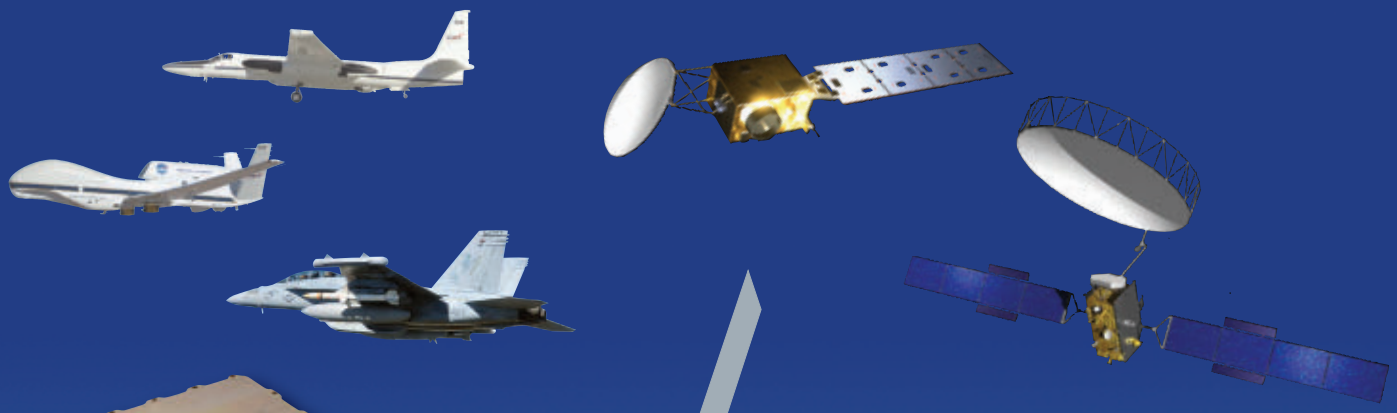
Fig. 10 Fabricated triple-mode BPF (a), measured and simulated frequency responses (b).

simply arranging the coupling plates in other configurations, the triple-mode BPF can be converted to band-stop filter. ***Figures 9a*** and ***b*** show two realizable configurations. Good performance is observed in simulation using HFSS, illustrating another advantage of this coupling structure over approaches using coupling screws or machining chamfers.

EXPERIMENTS

Fabrication and Measurement

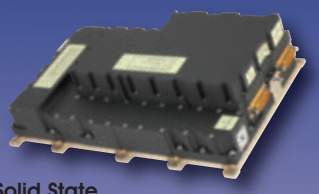
Figure 10a shows the fabricated triple-mode BPF loaded with spherical dielectric resonator. Measurements obtained using an Agilent E5871 VNA are in good agreement with the HFSS simulation results shown in ***Figure 10b***. The BPF exhibits a low insertion loss of 0.1 dB



QUINSTAR
TECHNOLOGY, INC.

94 GHz 30 Watt
Power Amplifier for
Airborne Radar

94 GHz 5 Watt Power
Amplifier Module

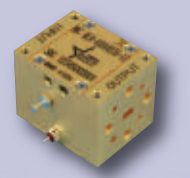


Ka to W-Band Solid State
Power Amplifiers for Space

From Ultra Low-Noise to High Power Amplifiers....

From Ground-Based to Airborne to Space....

Your Best Source for ALL Millimeter-wave Amplifiers



E- and W-band LNA.
Noise Figure As Low
As 3.0 dB

Instrumentation Amplifiers
18 to 120 GHz

Full Waveguide Band
Driver Amplifiers
K Through W-Band

Full Waveguide Band to Ultra Wide Band....

Any Application.. Any Performance... One Supplier...QuinStar

Ka-Band Power Amplifiers
10 to 200 Watt Output Power

QUINSTAR TECHNOLOGY, INC. 310-320-1111 • sales@quinstar.com • www.quinstar.com

See us at IMS Booth 304

and a return loss of nearly 20 dB across the passband. Three transmission zeros generated due to cross coupling are located at 843, 854 and 885 MHz with attenuation of 55, 31 and 53 dB, respectively. Rejection of 31 dB at 2 MHz away from the lower band edge is due to the second transmission zero. This characteristic is very attractive for wireless communication systems where interference from an adjacent channel must be cut-off in the very narrow guard-band, and where co-siting of different services in the same band is needed.

Power Handling Capability

The triple-mode BPF has high power handling capability and can be used in a BTS for CDMA and LTE communication systems. Average power handling of the fabricated BPF is about 100 W, and in experiments, the increase of dielectric resonator temperature is not significant even when the peak power is 1000 W. In addition, the heating-proof effect is also satisfied, so its power handling capability is at the same level as that of existing single $TE_{01\delta}$ mode BPFs.

Spurious

The proposed triple-mode BPF demonstrates nearly the same behavior of the spurious performance when compared with the single $TE_{01\delta}$ mode BPFs, but leads to a significant reduction in size.

CONCLUSION

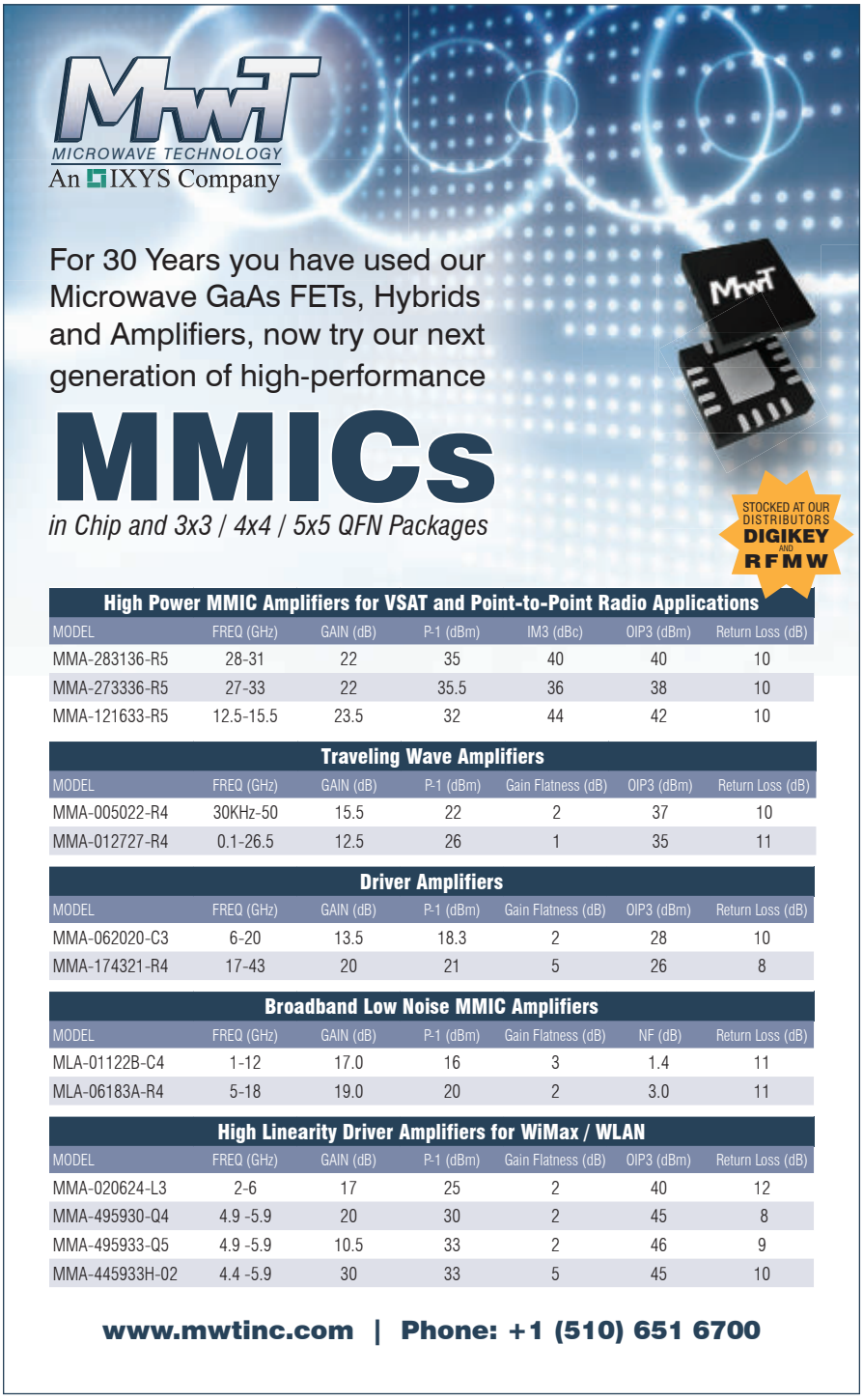
A novel triple-mode high-Q spherical dielectric loaded cavity BPF, based on the three degenerate $TE_{01\delta}$ modes and a new coupling structure, demonstrates low insertion loss and sharp passband skirts due to cross coupling. A triple-mode single cavity BPF in the 860 MHz band provides design verification. It features significant size and mass reduction, and much higher Q when compared with conventional dielectric resonator filters and can be adapted for use in various applications by changing transmission zero positions or by changing its type from bandpass to bandstop. ■

ACKNOWLEDGMENT

This research was supported by the R&D program supervised by the Korea Communications Agency (KCA) (KCA-2012-12-911-01-109).

References

1. J.F. Liang and W.D. Blair, "High-Q TE_{01} Mode DR Filters for PCS Wireless Base Stations," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 46, No. 12, December 1998, pp. 2493-2500.
2. K. Wakino, T. Nishikawa and Y. Ishikawa, "Miniaturization Technologies of Dielectric Resonator Filters for Mobile Communications," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 42, No. 7, July 1994, pp. 1295–1300.
3. A. Ghosh, N. Mangalvedhe, R. Ratasuk, B. Mondal, M. Cudak, E. Visotsky, T.A. Thomas, J.G. Andrews, P. Xia, H.S. Jo, H.S. Dhillon and T.D. Novlan, "Heterogeneous Cellular Networks: From Theory to Practice," *IEEE Communications Magazine*, Vol. 50, No. 6, June 2012, pp. 54-64.
4. S.J. Fiedziuszko, "Dual-Mode Dielectric Resonator Loaded Cavity Filters," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 30, No. 9, September 1982, pp. 1311-1316.
5. W.C. Tang, J. Sferrazza, B. Beggs and D. Siu, "Dielectric Resonator Output Multiplexer for C-Band Satellite Applications," *IEEE MTT-S International Microwave Symposium Digest*, June 1985, pp. 343-345.
6. V. Walker and I.C. Hunter, "Design of Triple Mode TE01δ Resonator Transmission Filters," *IEEE Microwave and Wireless Components Letters*, Vol. 12, No. 6, June 2002, pp. 215-217.
7. I.C. Hunter, J.D. Rhodes and V. Dassonville, "Triple Mode Dielectric Resonator Hybrid Reflection Filters," *IEEE Proceedings on Microwaves, Antennas and Propagation*, Vol. 145, No. 4, August 1998, pp. 337–343.



HUBER+SUHNER
Excellence in Connectivity Solutions

Scan page
using layar app

minibend® series
The truly flexible coaxial cable assemblies

- For use in low profile, internal, point-to-point interconnections
- Replaces semi-rigid cables
- Eliminates the need for predefined custom lengths and bend configurations
- Preassembled and tested high performance
- Cost-effective alternative

HUBER+SUHNER AG 9100 Herisau/Switzerland, hubersuhner.com
HUBER+SUHNER ASTROLAB Warren, NJ/USA, hubersuhner.com

Booth 408

8. H. Salehi, T. Bernhardt, T. Lukkarila and S. Amir, "Analysis, Design and Applications of the Triple-Mode Conductor-Loaded Cavity Filter," *IET Microwaves, Antennas & Propagation*, Vol. 5, No. 10, July 2011, pp. 1136-1142.
9. L.H. Chua and D. Mirshekar-Syahkal, "Analysis and Design of Three Transmission Zeros Bandpass Filter Utilizing Triple-Mode Dielectric Loaded Cubical Cavity," *IEEE MTT-S International Microwave Symposium Digest*, Vol. 2, June 2003, pp. 937-940.
10. Black Hole Filter (Triple Mode Technology. Retrieved November 27, 2013 from KMW RF and Microwave Products Website: www.kmw.co.kr/eng/rf/03_01_00.html.
11. D. Kajfez and P. Guillon, *Dielectric Resonators*, Artech House, Norwood, MA, 1986.
12. C. Hunter, *Theory and Design of Microwave Filters*, IEE, London, UK, 2001.
13. S.J. Fiedziuszko, I.C. Hunter, T. Itoh, Y. Kobayashi, T. Nishikawa, S.N. Stitzer and K. Wakino, "Dielectric Materials, Devices, and Circuits," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 50, No. 3, March 2002, pp. 706-720.
14. J.S.G. Hong and M.J. Lancaster, *Microstrip Filters for RF/Microwave Applications*, Wiley-Interscience, New York, NY, 2001.
15. R.J. Cameron, M. Yu and Y. Wang, "Direct-Coupled Microwave Filters With Single and Dual Stopbands," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 53, No. 11, November 2005, pp. 3288- 3297.

MESA MICROWAVE
CORPORATION
YOUR RELIABLE RF & MW SOURCE

Mesa Microwave has been manufacturing connectors, cable assemblies and components for the RF and Microwave industry since 1995.

Commercial & Military Applications

CONNECTORS & CABLES FROM DC TO 110 GHz
1 MM, K, 2.92,SMA,N,BNC,TNC

•

POWER DIVIDERS, COUPLERS, AMPLIFIERS, ISOLATORS, CIRCULATORS AND SWITCHES FROM DC TO 40 GHz

The Source for Standard & Custom Designs for Unique Applications

Mesa Microwave
480-890-1612

sales@mesamicrowave.com
www.mesamicrowave.com

Nam-Shin Park *received the B.E degree from the Soonchunhayng University, Asan, Korea, in 1994, and is currently working toward the M.S. degree in management of technology at Sogang University, Seoul, Korea. Since 1993, he has been working with the RF UNIT Group, R&D Center, KMW Inc., Hwasung, Korea, as a group manager. His interests include microwave filter, dielectric resonator and filter, high-Q and multiple mode resonator and filter miniaturization.*

Don-Yong Lee *received the B.E degree from the Seoul National University of Science and Technology, Seoul, Korea, in 1998. Since 1997, he has been working with the RF UNIT Group, R&D Center, KMW Inc., Hwasung, Korea, as a principal research engineer. His interests include microwave circuits, cavity and ceramic filters and power handling capability for wireless base station.*

Byung-Chul Kim *received the B.E. degree from the University of Seoul, Seoul, Korea, in 1992, and is currently working toward the M.S. degree in Management of Technology at Sogang University, Seoul, Korea. Since 1997, he has been working with the RF UNIT Group, R&D Center, KMW Inc., Hwasung, Korea, as a principal research engineer. His interests include filter related product and radio communication.*

Jung-Hee Won *received the B.E degree from the Kumoh National Institute of Technology, Gumi, Korea, in 2000. In 2000, he joined the RF UNIT Group, R&D Center, KMW Inc., Hwasung, Korea, where he is currently engaged in research and development on microwave filters and units as a senior research engineer. His research interests include microwave cavity and dielectric filter for wireless base stations and co-siting.*

In-Ho Na *received B.S. and M.S. degrees in electronic engineering from Soonchunhyang University, Asan, Korea, in 2007 and 2009, respectively. In 2012, he joined the strategy business group, R&D Center, KMW Inc., Hwasung, Korea, as an assistant research engineer. His interests include RF components, front end devices and small cell base station.*

Geon-Ho Jang *received B.E. and M.S. degrees in information telecommunication engineering from the University of Incheon, Incheon, Korea, in 2009 and 2011, respectively. In 2011, he joined the RF UNIT Group, R&D Center, KMW Inc., Hwasung, Korea, where he is currently engaged in research and development on microwave filters. His interests include microwave passive components, antennas and metamaterials.*

Young-Ho Cho *received B.Sc and PhD degrees in electronic engineering from Sogang University, Seoul, Korea, in 2005 and 2012, respectively. From September 2012 to March 2013, he was a post-doctoral researcher with Sogang University. He is currently a post-doctoral researcher with the University of California at San Diego (UCSD), La Jolla, CA, USA. His research interests include RF filters, tunable RF components and RF systems.*

Xu-Guang Wang *received the B.Sc. degree in electronic engineering from Qingdao University, Qingdao, China, in 2006, the M.Sc. degree in radio science and engineering from Korea Maritime University, Busan, Korea, in 2008, and PhD degrees in electronic engineering from Sogang University, Seoul, Korea, in 2013, respectively. His research interests include RF/microwave filters, and associated passive and active circuits.*

Sang-Won Yun *received B.Sc. and M.Sc. degrees in electronic engineering from Seoul National University, Seoul, Korea, in 1977 and 1979, respectively, and the PhD degree in electrical engineering from the University of Texas at Austin, Austin, TX, USA, in 1984. Since 1984, he has been a professor with the department of electronic engineering, Sogang University, Seoul, Korea. From October 2009 to September 2011, he was with the Korea Communications Commission (KCC), as a project manager. His research interests include microwave and millimeter-wave devices and circuits.*

When Performance is Critical
Insist on Crystek

Phase Noise Typical @ 100 MHz		
	CVSS-945 Sinewave VCXO	CCPD-575 LVPECL Clock
10 Hz	-85 dBc/Hz	-90 dBc/Hz
100 Hz	-120 dBc/Hz	-120 dBc/Hz
1 kHz	-145 dBc/Hz	-144 dBc/Hz
10 kHz	-162 dBc/Hz	-154 dBc/Hz
100 kHz	-170 dBc/Hz	-158 dBc/Hz
1 MHz	-170 dBc/Hz	-160 dBc/Hz
10 MHz	-170 dBc/Hz	-161 dBc/Hz

The Performance Curve Doesn't Stop Here. Choose Crystek for:

Attenuators

Low-Loss Coaxial Cables

VCOs

VCOs | Crystal Oscillators | RF Cables | Accessories

CRYSTEK MICROWAVE

www.crystek.com

Tel: 800.237.3061 • 239.561.3311

Follow us on Twitter for product updates.

See us at IMS Booth 206

MWJ REVIEW BOARD APPROVED

Ultra-Wideband Double Balanced Mixer Utilizing A Compact Planar Balun

Yongzhen Gao, ZongXin Tang, Biao Zhang and YunQiu Wu
University of Electronic Science and Technology of China, Chengdu, China

A new double balanced mixer (DBM) operating from 3.1 to 10.6 GHz utilizes a compact planar balun. To meet the requirements for ultra-wideband operation and improve return loss, a T-junction formed by side coupled slotlines (SCSL) and microstrip with a wideband microstrip to SCSL transition is employed. The balun's balanced ports are in the form of adjacent microstrip lines located on the same side as the double balanced mixer. This is a practical advantage because it eliminates the crossing of the transmission lines making it more suitable for MIC design. The mixer exhibits a conversion loss of less than 13 dB from DC to 100 MHz IF. Port-to-port isolation is better than 25 dB over the RF and LO bandwidths of 3.1 to 10.6 GHz.

Ultrawideband (UWB) radio technology is becoming more popular for high speed wireless connectivity since the Federal Communications Commission approved the unlicensed operating band from 3.1 to 10.6 GHz in February 2002.[1] The mixer, which provides down-conversion for the receiver and up-conversion for the transmitter, is an important component of a UWB communication system. The double balanced mixer (DBM) is the most attractive choice because of its superior suppression of spurious mixing products, wider dynamic range, excellent local oscillator (LO) noise rejection and good port-to-port isolation.[2] Moreover, the double balanced configuration allows overlapping of radio frequency (RF) and LO frequency bands for efficient expansion of operational bandwidth.

Essential to the operation of a double balanced mixer, the balun converts an unbalanced signal to a balanced one and vice versa. Various types of baluns for wideband performance have been reported over the past decade. Maas[2] introduced a double balanced ring mixer using a nonplanar microstrip to parallel-strip balanced transmission line balun, but it is not convenient for connection with other devices and integration with other circuits. Kim et al.[3] described a planar balun based on a microstrip-to-coplanar stripline (CPS) transition, but it does not prevent the IF from being short-circuited to ground through the microstrip line, it occupies a large circuit area, and it is not suitable for MIC design. Bialkowski and Ogawa[4] reported on an out-of-phase Wilkinson power divider constructed with wideband microstrip-to-slotline transitions, however, the use of only one slotline introduces more insertion loss and has poor return loss, while the balanced ports being on opposite sides makes the connection of diodes inconvenient. By effectively using coupled slot lines, Aikawa and Ogawa[5] introduced a new MIC magic-T, which is useful for the design of the balun.

This article describes a compact planar balun with the balanced ports located on the same side and having a return loss much lower than that reported by Kim et al.[3] A T-junction formed by side coupled slot lines (SCSL) and microstrip accompanied by a wideband microstrip to SCSL transition[6,7] is used to construct a compact UWB planar balun with re-

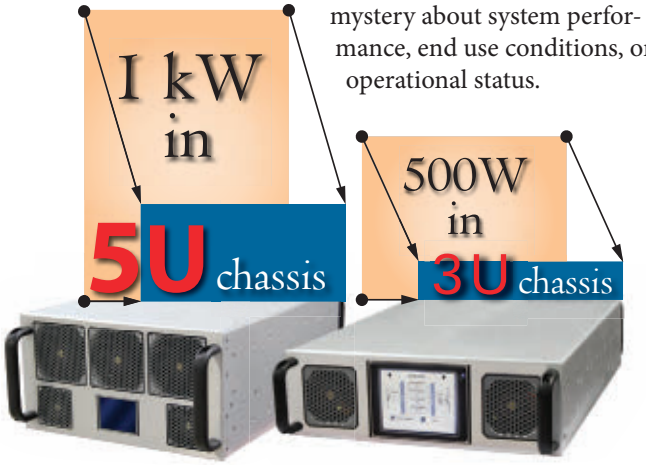
NEXT GENERATION
POWER AMPLIFIERS

What is it that makes these Power Amplifiers NEXT GENERATION Power Amplifiers?

Significant size reduction

Empower RF Systems power amplifier systems sizes reduced by 40-70%

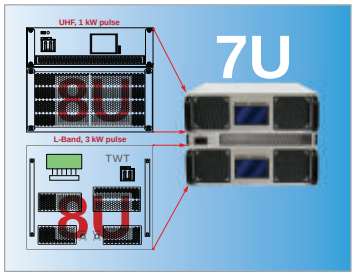
1 kW of broadband output power in a 5U chassis and 500 W of power packaged in a 3U chassis is unprecedented. Specs are guaranteed across full bandwidth and over temperature. Embedded controls and user access that are standard with Empower next generation designs ensure that there is no mystery about system performance, end use conditions, or operational status.



Empower RF Systems is hosting live demonstrations of selected models from the list below at ***IMS 2014, Booth 523.***

→	**SKU 2126**	1 kW	20 - 500	MHz
→	**SKU 2066**	1 kW	500 - 1000	MHz
→	**SKU 2162**	1 kW	20 - 1000	MHz
→	**SKU 2170**	800 W	1000 - 3000	MHz
→	**SKU 2175**	500 W	20 - 1000	MHz

IMS 2014, where the "Size Matters" PA demonstrations are being conducted, lends itself well to validating the exceptional performance of these broadband, power amplifiers. Come see for yourself and consider the possibilities for your application with a *high power amplifier that is 40 to 70% smaller* than what's available in the market. To illustrate the point, consider the advantages of a 7U next generation solution versus legacy systems totaling 16U. A major improvement for an airborne platform, UHF and L-Band pulse amplifiers tied to a shared, 1U power supply.



Amplifier Software

Embedded web server
Real time power amplifier diagnostics
Remote monitoring and control

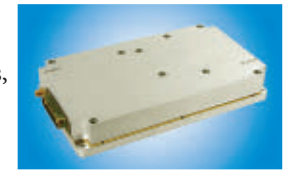
User interface capabilities of Empower Next Generation power amplifiers allow the user to initiate remote management and diagnostics via an embedded web server, enabling network managed site status and control simply by connecting the unit's Ethernet port to a LAN or accessing the unit's IP address. For machine to machine interface (M2M), Empower offers TCP/IP or UDP protocol sockets accessed through the Ethernet port.

The feature rich menu that is available on these high power amplifiers includes real time monitoring, protection and control, sensor driven dynamic adjustments to the amplifier while in operation, remote user access, and a selection of communications protocols that can be enabled by the end user during system set up. Software updates can be delivered via a "direct connect" link, if permitted by the customer, from Empower to the fielded amplifier via the amplifier's embedded web server or updated via a USB drive inserted directly into the back panel of the amplifier. The USB upload process is streamlined for "ease of use" with a self extracting and self loading program.

Scalable output power architecture

Next Generation Building Block Modules

Our advances in RF system design are complimented with advances in RF module design. Integral to our systems designs and also sold as building block modules, Empower's latest PA modules are a "minimal touch" design which incorporate latest devices, circuit topologies and thermal management techniques.



→	**SKU 1163**	125 W	20 - 520	MHz
→	**SKU 1193**	100 W	20 - 1000	MHz
→	**SKU 1199**	100 W	1000 - 3000	MHz
→	**SKU 1191**	100 W	2500 - 6000	MHz

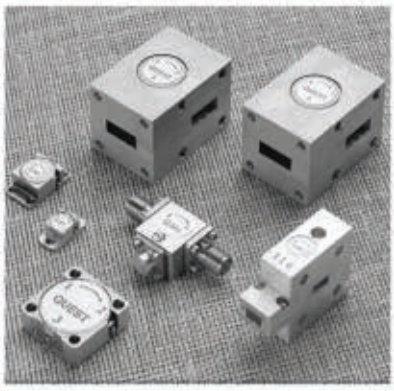
IMS2014 - Tampa Bay, Florida
POWERING THE WAVES

Booth #523

EMPOWER RF SYSTEMS, INC.

www.EmpowerRF.com sales@empowerrf.com Ph. +1 (310) 412 - 8100

CIRCULATORS & ISOLATORS



QUEST for Quality
QUEST for Performance
QUEST for the BEST...
JOIN US

Quality products with quick delivery and competitive prices are our standard

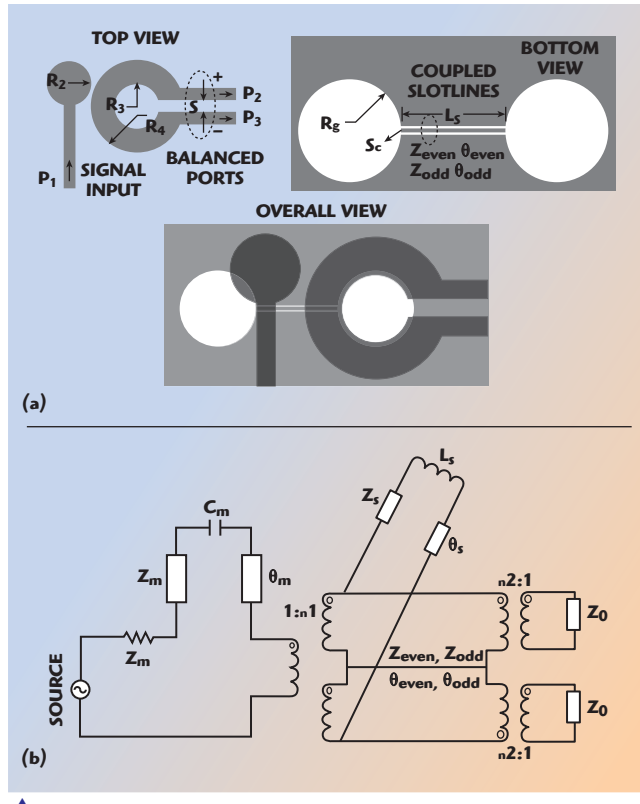
QUEST Microwave Inc.

225 Vineyard Court
Morgan Hill, California 95037

877-QUESTMW (783-7869)
(408) 778-4949 Phone
(408) 778-4950 Fax
circulators@questmw.com e-mail
http://www.questmw.com website

See us at IMS Booth 1505

duced insertion loss. It can easily be made to operate up to millimeter wave frequencies utilizing photolithographic techniques. A DBM based on this balun achieves LO/RF, LO/IF and RF/IF isolation of greater than 25 dB and conversion loss of less than 13 dB over an RF and LO frequency range of 3.1 to 10.6 GHz and an IF band of DC to 100 MHz. The proposed technique has a more convenient circuit layout and provides better performance than a conventional DBM.



▲ *Fig. 1 UWB balun physical configuration (a); equivalent circuit (b).*

ANALYSIS

The planar balun, composed of microstrip lines and SCSLs, is shown in ***Figure 1a***, where the white color represents the substrate and the gray color represents metallization. On the top layer of the printed circuit board (PCB), the unbalanced port is converted from microstrip to SCSL using a wideband microstrip-to-SCSL transition through open ended microstrip and open ended coupled slotlines with a circular disc. The slotlines on the bottom layer are then coupled to microstrip lines and the adjacent balanced microstrip ports are on the same side. Due to the large spacing, the balanced ports are very weakly coupled with each other. The microstrip open circuit circular disc should appear as a short circuit, and the coupled slotline short circuit circular disc should appear as an open circuit at the crossing reference plane. The EM field distribution of the coupled slotlines can be assumed to be composed of even and odd mode excitation.[5] The dispersion and impedance characteristics can be calculated by means of Galerkin's method in a Fourier transform domain first proposed by Itoh and Mittra.[8]

The equivalent circuit of the above transition with the input on the microstrip line is shown in ***Figure 1b***. Ls is the inductance of the shorted coupled slotline. Cm is the capacitance of the open microstrip. Z_{even}, Z_{odd} and Z_m are the coupled slotline and microstrip characteristic impedances, respectively. θ_s and θ_m are the electrical lengths (quarter wavelength at center frequency) of the extended portions (stubs) of the coupled slotline and microstrip, respectively. The transformer ratios are n1 and n2.

Mode conversion is used for analyzing circuit operation. The odd mode and even modes in the coupled slotlines are defined according to Aikawa.[5] They are excited by out-of-phase signals of the same amplitude at ports P2 and P3 or by the signal from port P1. A signal fed to P1 is converted to the even mode of the coupled slotlines and thereafter emerges as 180° out-of-phase signals through the balanced ports P2 and P3, while the even mode signals fed to P2 and P3 cancel each other at the T-junction. Attention should be paid to the entire width of the coupled slotlines, because the line width may induce an undesired even-mode when a signal is fed to port P1. In practice, however, the width Sc is very narrow (0.1 mm for our design considering the fabrication technique).

We Are The
BOSS in SPACE
MICROTECH INC.
FLEXIBLE & RIGID
WAVEGUIDE ASSEMBLIES & PASSIVE
MICROWAVE COMPONENTS
1425 Highland Avenue · Cheshire, CT 06410 USA
Tel 203-272-3234 · Fax 203-271-0352
Email: sales@microtech-inc.com
Visit us at: www.microtech-inc.com
See us at IMS Booth 1604
CHECK OUT OUR NEW WEBSITE FOR
OUR LATEST PRODUCT LISTING

BALUN DESIGN AND VERIFICATION

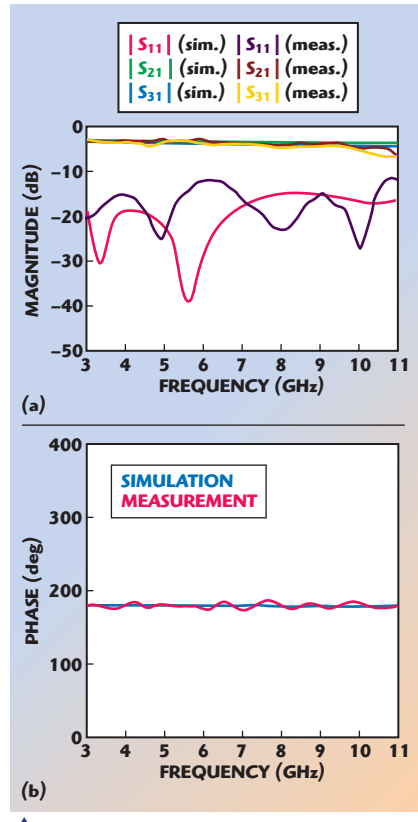
The UWB planar balun design is optimized with the help of 3D EM simulators. The simulated and measured results are shown in ***Figure 2***. The physical dimensions after optimization (see Figure 1) are Ls=4.2 mm, Sc=0.1 mm, S=1mm, Rg=2.1 mm, R2=1.9 mm, R3=1.8 mm and R4=3.9 mm. The simulated results reveal that power is equally divided between the balanced ports, with an insertion loss of less than 0.6 dB and return loss of better than 14.5 dB over the 3 to 11 GHz band. The difference in phase and amplitude between the balanced ports is 180°±1.4° and 0.2 dB over the same band. Due to the microstrip-to-SCSL transition, return loss is better than reported by Bialkowski and Abbosh.[4]

The balun is fabricated on a Rogers substrate with relative permittivity of 3.66, thickness of 0.508 mm, and loss tangent of 0.004 (see ***Figure 3***). It is compact with dimensions of 0.5×0.4λg (where λg is the guided wavelength at the center frequency). For ease of measurement, the balanced ports are expanded with 50 Ω microstrip lines.

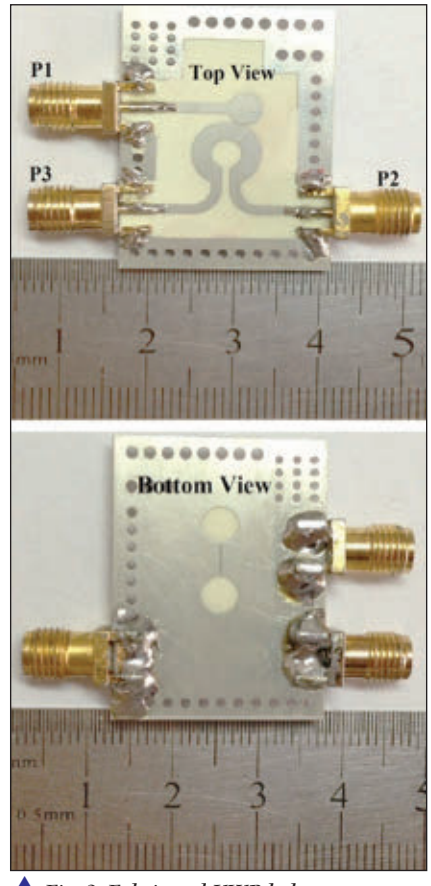
The S-parameters are measured using an HP8756A vector network analyzer employing the through-reflect-line (TRL) calibration technique. The balun is specified to operate from 3 to 11 GHz with a phase difference of the balanced ports equal to 180°±5°, an insertion loss less than 1 dB and a return loss greater than 11 dB. Slight differences between simulation and measurement are attributed to fabrication tolerances. Additional losses are due to connector loss, metal loss and radiation loss. Slight deterioration of insertion loss at the high end of the band is caused by radiation.

IMPLEMENTATION AND EXPERIMENTAL RESULTS

Figure 4 shows the assembled planar double balanced mixer (DBM) designed to operate over the UWB frequency range from 3.1 to 10.6 GHz. The individual components are combined in a harmonic balance simulator to optimize the mixer's performance. Infineon silicon schottky



▲ *Fig. 2 UWB balun simulation versus measurement. S-parameter magnitude (a); phase difference between balanced ports (b).*



▲ *Fig. 3 Fabricated UWB balun.*

GOLDEN MXO
EXTREMELY LOW PHASE NOISE
MULTIPLIED CRYSTAL OSCILLATORS
• 200 MHz to 12 GHz, Fixed
• OCXO & Integrated Multipliers
• Noise Floors to -190 dBc/Hz
• Excellent Spectral Purity
• Very Low Jitter Option
• Phase Lock Options
• Easily Customized
-170.7 dBc/Hz
500 MHz
GMXO-FR
Scan the QR Code to Visit Our New Website!
"Quietly the Best"
Wenzel Associates, Inc.
2215 Kramer Lane, Austin, Texas 78758
512-835-2038 • sales@wenzel.com
www.wenzel.com
Come See Us at IMS 2014 in Tampa, FL - Booth 308

CERNEX&CERNEXWAVE

RF,MICROWAVE&MILLIMETER-WAVE COMPONENTS AND SUB-SYSTEMS UP TO 500GHz

AMPLIFIERS UP 110GHz
FREQUENCY MULTIPLIERS/DIVIDERS
(UP TO 160GHz)

CONVERTERS UP TO 110GHz
ANTENNAS UP TO 220GHz

COUPLERS UP TO 220GHz
FERRITE PRODUCTS
(ISOLATORS/CIRCULATORS)
UP TO 160GHz

FILTERS/DIPLEXERS
SOURCES UP TO 160GHz

SWITCHES UP TO 160GHz
PHASESHIFTERS UP TO 160GHz

TRANSITIONS/ADAPTERS (UP TO 325GHz)
WAVEGUIDE PRODUCTS UP TO 325GHz

TERMINATIONS/LOADS UP TO 160GHz
MIXERS(UP TO 110GHz)

ATTENUATORS(UP TO 160GHz)
DETECTORS(UP TO 160GHz)

LIMITERS(UP TO 160GHz)
BLAS TEE (UP TO 100GHz)

POWER COMBINERS/DIVIDERS EQUALIZERS

CABLES
ASSEMBLIES/CONNECTORS (UP TO 100GHz)
SUB-SYSTEMS (UP TO 100GHz)

FREQUENCY METER

ELECTRO MECH. SWITCH

F.MULTIPLIER

LIMITERS

ADAPTERS

PIN SWITCHES

ROTARY JOINTS

AMPLIFIERS

AMPLIFIERS

AMPLIFIERS

TEST KIT

PLO

ANTENNAS

ANTENNAS

ADAPTERS

ATTENUATORS

CABLES ASSEMBLIES

BIAS TEES

CONVERTER

DETECTORS

POWER COMBINER

TERMINATIONS

WAVEGUIDES

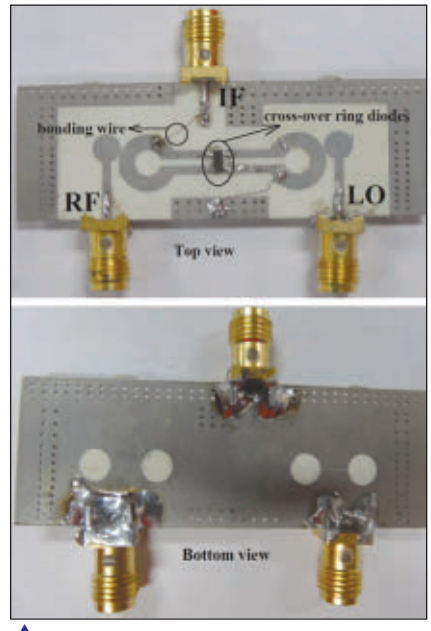
www.cernex.com cernex@cernex.com Add: 766 San Aleso Avenue, Sunnyvale, CA 94085 Tel:(408) 541-9226 Fax: (408) 541-9229
www.cernexwave.com sales@cernexwave.com Add: 1185 Bordeaux Drive, Suite A Sunnyvale, CA 94089 Tel: (408)773-8855 Fax: (408) 773-8858

See us at IMS Booth 1218

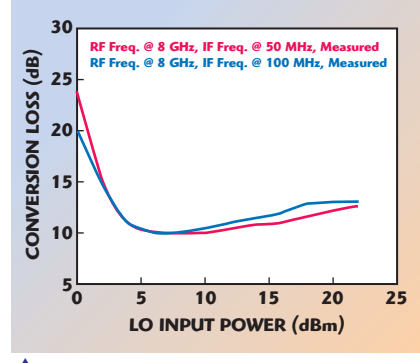
cross-over ring diodes (BAT15-099R) are used. The internal crossover connections make it possible to access the quad from the LO and RF circuit without external crossovers, thus minimizing circuit parasitics. Identical baluns are used for the LO and RF, and their outputs are connected directly to the diode ring. The RF connection points to the quad are virtual grounds for the LO, and vice versa, assuring good LO/RF isolation. Unlike wound transformers, the baluns have no center ground connection that can be used as the IF. The usual technique of using a lone bonding wire interconnection for the IF is adopted so that its inductance effectively isolates the IF from the RF and LO (see Figure 4). The inductance of this interconnection, however, limits the IF bandwidth. Still, this is a simple, low cost, broadband approach.[2]

The DBM is tested using an Agilent 8563EC spectrum analyzer calibrated with an E44198 power meter and E8257D signal generator. Losses of the probes and cables are measured separately and used to calibrate the measured results. Measured conversion loss versus LO power (RF power of -10 dBm) for the down-converter mode is shown in ***Figure 5***. With the RF fixed at 8 GHz and the IF fixed at 100 and 50 MHz, a significant mixing effect at an LO drive level of 8 dBm is evident. For both IF frequencies, conversion loss is less than 11 dB at an LO power of 10 dBm.

Figure 6 plots the conversion loss at a 10 dBm LO drive level for a swept RF response from 3 to 11 GHz and IF frequencies of 50 and 100 MHz. The measured bandwidth is wider than the design goal. The conversion loss is 9 to 13 dB within the operating bandwidth of 3.1 to 10.6 GHz. This broadband performance is due to the high performance of the UWB balun. The



▲ *Fig. 4 Fabricated UWB DBM.*



▲ *Fig. 5 Measured conversion loss versus LO power level with an RF input power of –10 dBm.*

See us at IMS Booth 1201

Vectron
a Knowles company

Helping Customers Innovate, Improve and Grow

Precision Frequency Control and Timing Solutions

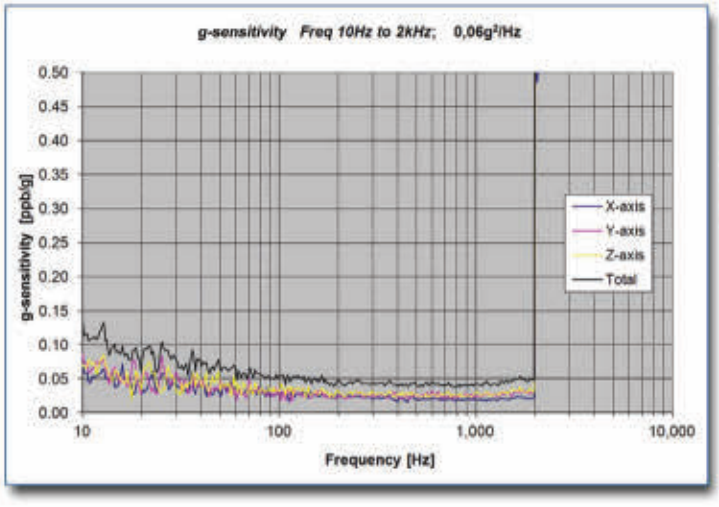
Low g-sensitivity 5x7mm TCXO

The **TX-707** has superior g-sensitivity performance, ideal for Military and harsh environment applications

Features:

- Frequency Range: 10 to 50 MHz
- g-sensitivity: >0.2ppb/g standard
  0.1ppb/g option available
- Temperature Stability: ±1ppm from -40 to 85°C
- Package: 5 x 7 x 2.8 mm

g-sensitivity Performance



Applications:

- Military portable radios
- GPS telemetry
- Test and measurement equipment
- Missile systems

Come Visit Us
Booth# 1305
2014 International Microwave Symposium

OCXO/EMXO | **TCXO** | VCSO | VCXO | Jitter Attenuation | SAW Filter | MEMS/XO | Crystals | Timing Solutions | High-Temp Electronics

Select from **Our Precision Portfolio** that supports your performance requirements, ensuring **Stability, Synchronization and Timing.**

Learn more about Vectron's broad oscillator portfolio

www.vectron.com/products/tcxo/tcxo_index.htm

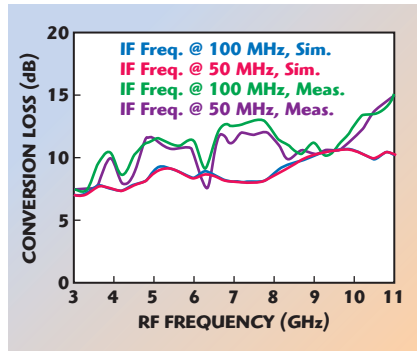
Vectron International - 267 Lowell Road, Suite 102, Hudson NH 03051 - Tel: 1.888.328.7661
www.vectron.com

simulated and measured conversion loss does not precisely match because it is not possible to realize the exact length and shape of the actual bonding wires in the simulation, as well as the additional unbalance caused by the bonding wires.

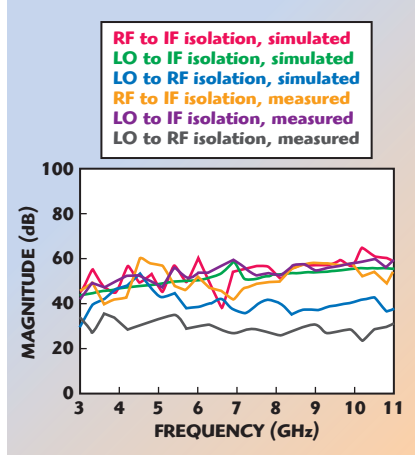
Measured and simulated port-to-port isolation of the DBM for the downconverter mode is shown in ***Figure 7***. The bonding wire isolates both the RF and LO signals from the IF. The LO- and RF-to-IF isolations are greater than 25 and 40 dB, respectively, from 3 to 11 GHz. The LO-to-RF isolation is between 25 and 35 dB within the same swept range.

CONCLUSION

Better performance is achieved in a UWB planar balun composed of microstrip lines, side coupled SCSLs and microstrip-to-SCSL transitions. A compact UWB double balance mixer based on this balun design exhibits a conversion less than 13 dB and high isolation among the three ports. It offers a high performance and cost-effective solution in a compact size for UWB applications. ■



▲ *Fig. 6 Measured conversion loss versus RF frequency (IF frequency = 100 MHz, 50 MHz).*



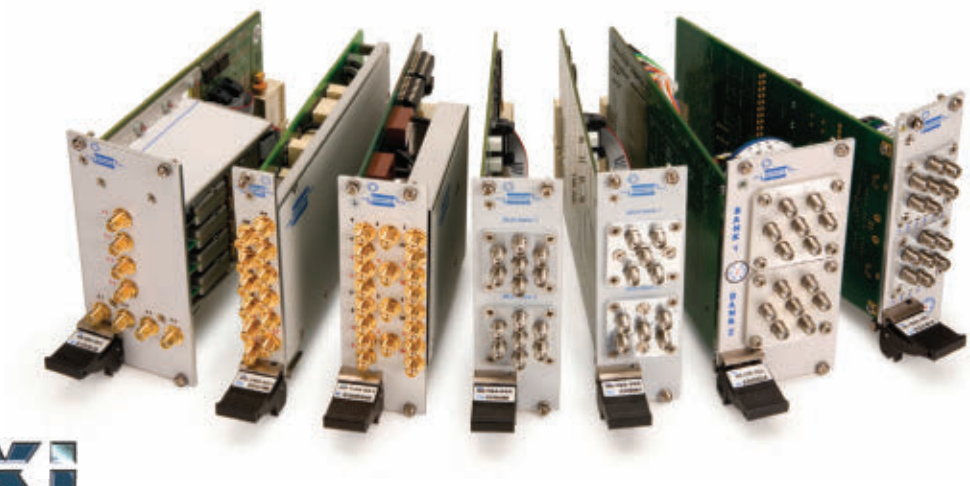
▲ *Fig. 7 Simulated and measured LO/RF, LO/IF and RF/IF isolation as a function of RF frequency from 3 to 11 GHz.*

References

1. "Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems," *FCC, Washington, DC, Technical Report*, ET-Docket 98-153, FCC02-48, adopted February 2002.
2. S.A. Maas, *Microwave Mixers*, 2nd edition, Artech House, Norwood, MA, 1993.
3. Y.G. Kim, D.S. Woo, K.W. Kim and Y.K Cho, "A New Ultra-Wideband Microstrip-to-CPS Transition," *IEEE MTT-S International Microwave Symposium Digest*, Honolulu, HI, June 2007, pp. 1563-1566.
4. M.E. Bialkowski and A.M. Abbosh, "Design of a Compact UWB Out-of-Phase Power Divider," *IEEE Microwave and Wireless Components Letters*, Vol. 17, No. 4, April 2007, pp. 289-291.
5. M. Aikawa and H. Ogawa, "A New MIC Magic-T Using Coupled Slot Lines," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 28, No. 6, June 1980, pp. 523-528.
6. J.B. Knorr, "Slot-Line Transitions," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 22, No. 5, May 1974, pp. 548-554.
7. M.M. Zinieris, R. Sloan and L.E. Davis, "A Broadband Microstrip-to-Slot-Line Transition," *Microwave and Optical Technology Letters*, Vol. 18, No. 5, August 1998, pp. 339-342.
8. T. Itoh and R. Mittra, "Dispersion Characteristics of Slot Lines," *Electronics Letters*, Vol. 7, No. 13, July 1971, pp. 364-365.

RF & Microwave Switching

Diversity • High Density • Expertise



PXI LXI

- DC to 65 GHz
- Key Switching Topologies
- Available in PXI and Ethernet LXI
- 6 GHz Solid State
- 200+ PXI Modules
- Usable in PXI or LXI Chassis

3 Year Warranty

We stand behind our products with a standard three year warranty.

For more information scan this QR Code or go to pickeringtest.com/radio

Visit Pickering at IMS–booth 653

International Microwave Symposium

IEEE 1-6 June 2014, Tampa Bay, FL MTT-S

Switching • Instrumentation • Custom Design • Cables & Connectors

pickeringtest.com

541-471-0700 (West Coast) | 781-897-1710 (East Coast) | ussales@pickeringtest.com

Direct Sales Offices in USA, UK, Sweden, Germany, Czech Republic, France and China

pickering

MWJ REVIEW BOARD APPROVED

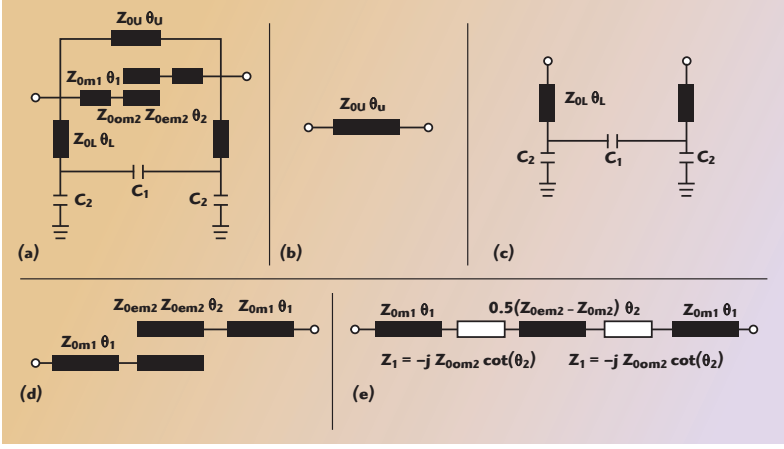
Design of a Compact Wideband Bandstop Filter with Three Transmission Zeros

Ting Lang, Lin Li, Li-Li Yang and Zhi-Hao Zhang
Zhejiang Sci-Tech University, Hangzhou, China

A sharp-rejection wideband bandstop filter (WBSF) is designed in a compact, planar form factor. Three transmission zeros are excited to create a wide stopband response that is easily adjusted by tuning the physical parameters of the structure. The assembled filter demonstrates an 89.5 percent stopband with a rejection of more than 50 dB at both transitions. The circuit area is 0.022λg.[2]

The WBSF is a key enabler for suppressing unwanted signals in broadband wireless systems. Conventional microstrip BSFs[1] consisting of shunt open-circuited stubs are relatively large and have narrow stopbands. Today, however, various methods and structures are available to increase filter rejection in a reduced size. Qian[2] introduces a new compact WBSF with a multilayer embedded capacitor in LTCC. It has a wide bandwidth, but has low rejection levels. Mandal and Sanyal[3] describe a structure consisting of two parallel coupled microstrip line sections in shunt connection, while Shaman and Hong[4] use a cross-coupled configuration. For both of these filters, rejection decreases with wider bandwidth and their 20 dB fractional bandwidths are narrower than desired. To address this, a filter designed with a coupled line and two signal paths, is proposed by Sánchez-Soriano and Torregrosa-Penalva,[5] however, its size can still be decreased. High rejection is achieved by Chiou and Tai[6] with a dual-band BSF using a dual-mode loop resonator and a cross-coupled capacitor. Its 20 dB FBW is over 100 percent, but the exact capacitance is hard to control at high frequencies.

This article describes a new compact WBSF topology in planar microstrip with three transmission zeros in the stopband (see ***Figure 1***). Design equations and parametric curves are provided. The WBSF not only improves rejection and bandwidth, but is also compact and is easy to design, control and fabricate.



▲ *Fig. 1 BSF equivalent circuit model with coupling structure (a); upper section (b); lower section (c); middle section (d); equivalent circuit (e).*

ANALYSIS

Figure 1a is the equivalent circuit model of the bandstop filter (BSF). It can be regarded as an electrical network composed of three parallel parts shown in Figure 1b, c and d, respectively. Figure 1b, the upper section of the BSF, is a transmission line having a characteristic impedance (Z_{0U}) and electrical length (θ_U). The lower section, Figure 1c, is composed of a pi network model consisting of three capacitors C_1 and C_2, and two bilateral transmission lines with characteristic impedance (Z_{0L}) and electrical length (θ_L). The middle section, Figure 1d, consists of a parallel-coupled line with two extended transmission lines. Both extended transmission lines have the same characteristic impedance (Z_{0m1}) and electrical length (θ_1). The parallel-coupled transmission line between them has an odd-mode impedance (Z_{0om2}), an even-mode impedance (Z_{0em2}) and electrical length (θ_2). It is made equal to the structure composed of reactance (Z_1) and a transmission line with impedance $0.5(Z_{0em2}$-$Z_{0om2})$ and electrical length

All in a day's work

ProtoMat® Benchtop PCB Prototyping Machine

What would your day look like tomorrow if you could cut yourself free from the board house and produce true, industrial quality microwave circuits on any substrate right at your desk? LPKF's ProtoMat benchtop prototyping systems are helping thousands of microwave engineers around the world take their development time from days and weeks to minutes and hours. In today's race to market, it's like having a time machine.

www.lpkfusa.com/pcb
1-800-345-LPKF

"You can't beat an LPKF system for prototyping. We do up to three iterations of a design within a day."

Leonard Weber
Agilent

LPKF®
Laser & Electronics

See us at IMS Booth 1108

$0.5\theta_2$. The transformed equivalent circuit is shown in Figure 1e.

Since the configurations in Figures 1b, c and e are all symmetrical, they can be decomposed into even- and odd-mode excitations, as shown in ***Figure 2***.

When excited in the odd-mode, its input admittance is given by

$$Y_{ino1} = -j\frac{\cot\frac{\theta_U}{2}}{Z_{0U}} \quad (1)$$

$$Y_{ino2} = j\frac{Z_{om1} + (Z_{0om2}\cot\theta_2 - 0.5(Z_{0em2} - Z_{0om2})\tan\frac{\theta_2}{2})\tan\theta_1}{Z_{om1}(Z_{0om2}\cot\theta_2 - 0.5(Z_{0em2} - Z_{0om2})\tan\frac{\theta_2}{2} - Z_{om1}\tan\theta_1)} \quad (2)$$

$$Y_{ino3} = j\frac{\omega(C_2 + 2C_1) + \frac{\tan\theta_L}{Z_{0L}}}{1 - \omega(C_2 + 2C_1)Z_{0L}\tan\theta_L} \quad (3)$$

$$Y_{ino} = Y_{ino1} + Y_{ino2} + Y_{ino3} \quad (4)$$

and the input reflection is

$$\Gamma_o = \frac{\frac{1}{Y_{ino}} - Z_0}{\frac{1}{Y_{ino}} + Z_0} \quad (5)$$

where Z_0 is the port impedance.

Similarly, when the circuit is excited in the even-mode, the input admittance is given by

$$Y_{ine1} = j\frac{\tan\frac{\theta_U}{2}}{Z_{0U}} \quad (6)$$

$$Y_{ine2} = j\frac{Z_{om1} + (Z_{0om2}\cot\theta_2 + 0.5(Z_{0em2} - Z_{0om2})\cot\frac{\theta_2}{2})\tan\theta_1}{Z_{om1}(Z_{0om2}\cot\theta_2 + 0.5(Z_{0em2} - Z_{0om2})\cot\frac{\theta_2}{2} - Z_{om1}\tan\theta_1)} \quad (7)$$

$$Y_{ine3} = j\frac{\omega C_2 + \frac{\tan\theta_L}{Z_{0L}}}{1 - \omega C_2 Z_{0L}\tan\theta_L} \quad (8)$$

$$Y_{ine} = Y_{ine1} + Y_{ine2} + Y_{ine3} \quad (9)$$

and the input reflection is

$$\Gamma_e = \frac{\frac{1}{Y_{ine}} - Z_0}{\frac{1}{Y_{ine}} + Z_0} \quad (10)$$

The filter's S-parameters can be derived by (11) and (12).[8,9]

$$S_{11} = \frac{\Gamma_o + \Gamma_e}{2} \quad (11)$$

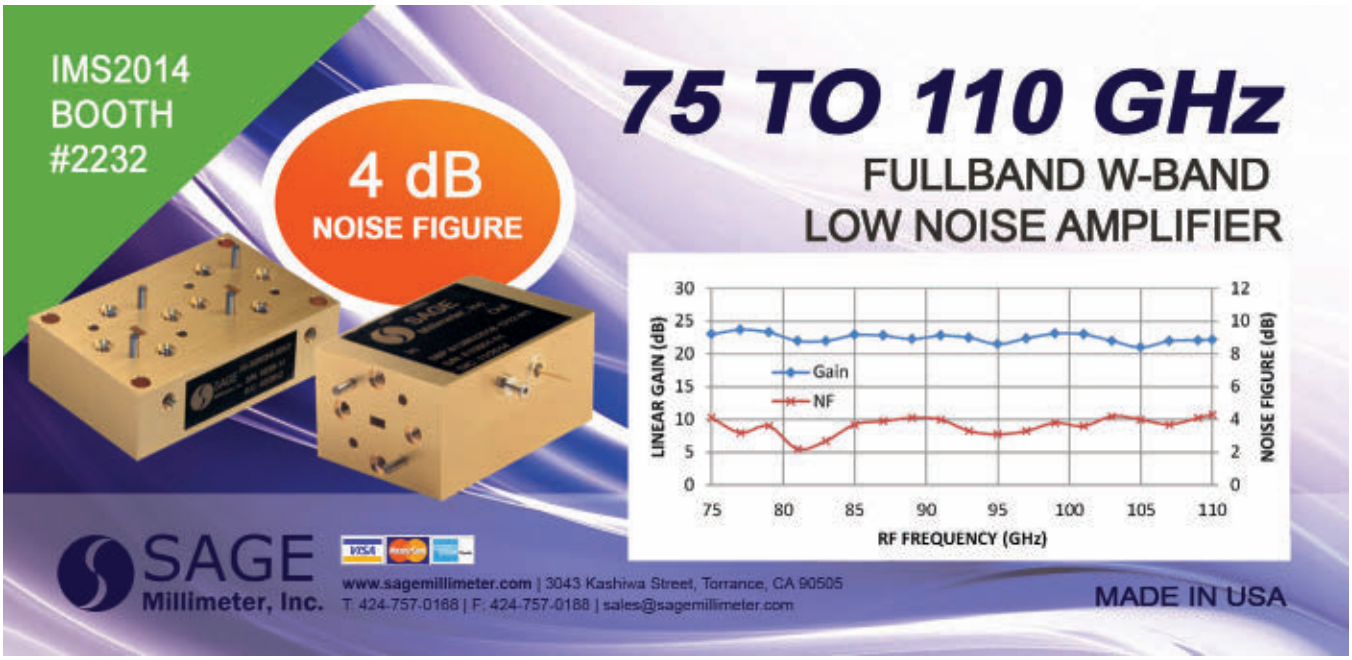
$$S_{21} = \frac{\Gamma_e - \Gamma_o}{2} \quad (12)$$

The condition for stopband transmission zeros is $|S_{21}|=0$, so the transmission zeros can be found by

$$Y_{ine} = Y_{ino} \quad (13)$$

Equation 13 can be solved graphically. ***Figure 3*** depicts equation 13 as frequency functions. The filter's transmission zeros correspond to the intersection points. Because Figure 3 has three intersection points, the filter has three transmission zeros.

Figure 4 illustrates the effect on filter response (S_{21}), including the transmission zero frequencies, due to changes in the intermediate coupling line characteristic impedance (Z_{0om2}). With increasing odd-mode impedance, the first transmission zero remains basically the same, suppression



Yeah, we do that.

Trying to send and receive a small signal among big interferers on your repeater platform?

We should talk.

513.870.4087

mpg POLE ZERO
A DOVER COMPANY

www.polezero.com

See us at IMS Booth 1410

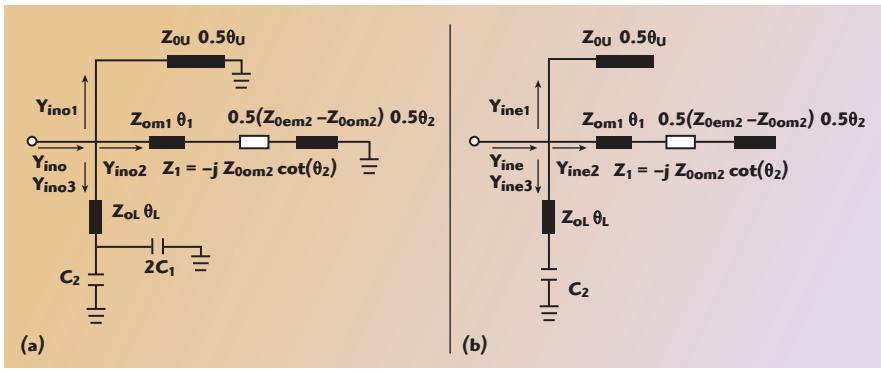


Fig. 2 Equivalent circuit; even-mode (a), odd mode (b).

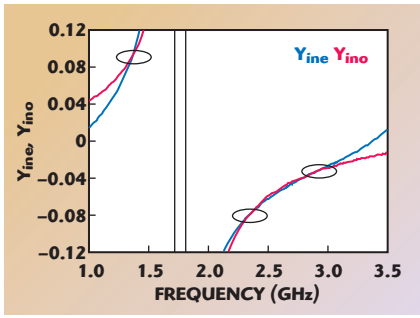


Fig. 3 Even- and odd-mode admittances.

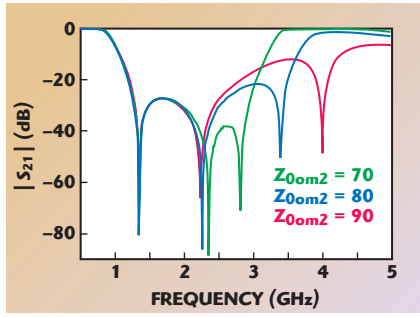


Fig. 4 S_{21} for different values of Z_{0om2}.

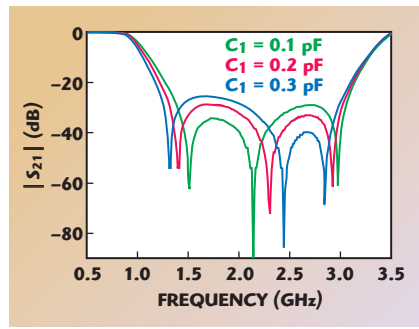
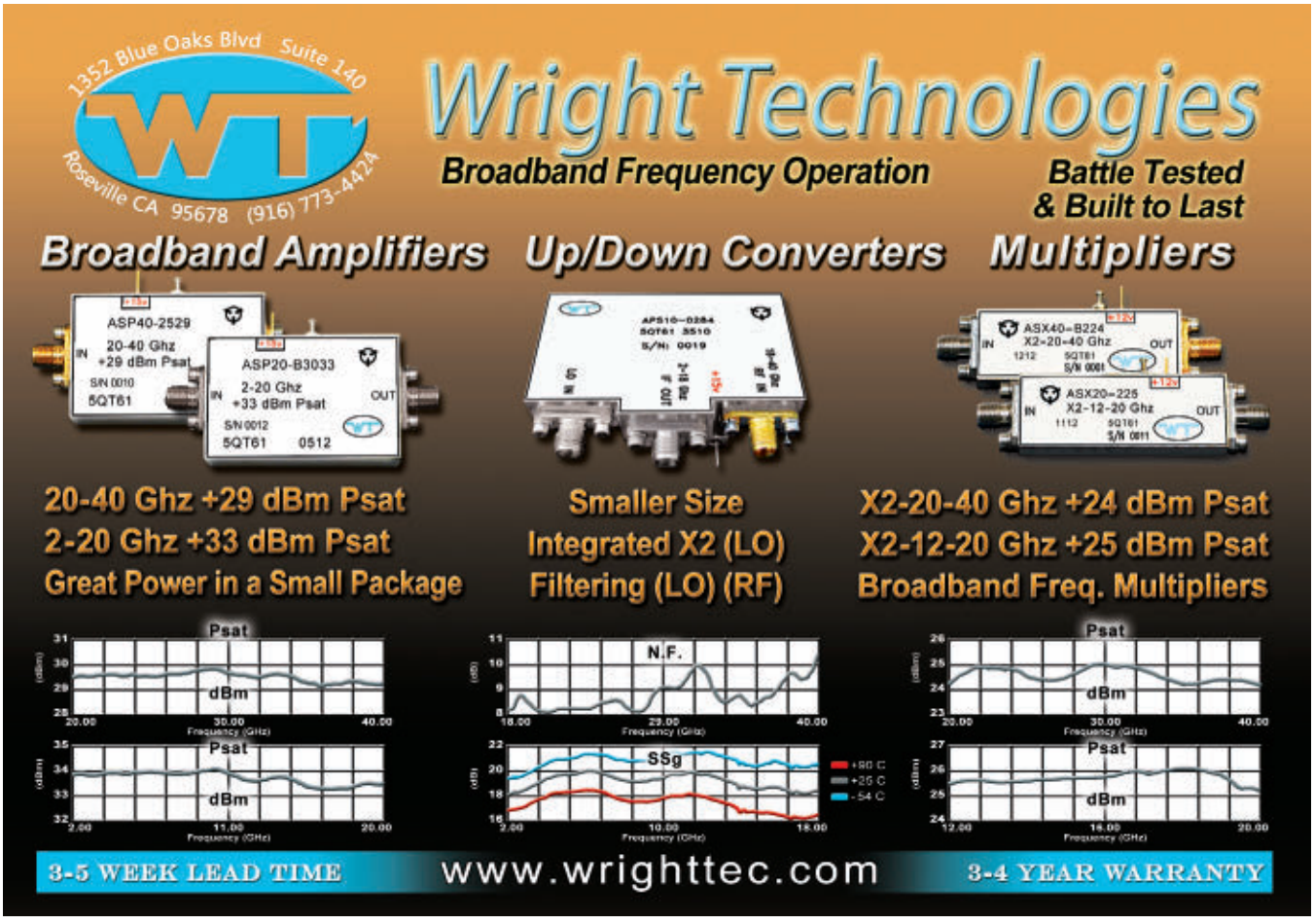


Fig. 5 S_{21} for different values of C_1.

at the second transmission zero decreases slightly, the third transmission zero dramatically shifts higher in frequency, and the bandwidth becomes wider. Suppression at the first zero is unchanged, while suppression at the third zero is reduced. (Z_{0om2} Z_{0em2} = 11,200 Ω^2, C_2 = 4.2 pF, C_1 = 0.24 pF, $Z_{0L} = Z_{om1} = Z_{OU}$ =120Ω, θ_U = 62°, θ_L = 11°, θ_1 = 11, θ_2 = 32°).

Figure 5 shows how S_{21} is influenced by the value of the coupling capacitor C_1. When increased, suppression at the first zero decreases, while rejection at the third zero increases. The frequencies of all three transmission zeros shift. Frequencies at the band extremes shift downward, while the frequency of the middle transmission zero increases. The bandwidth



X/Ku/Ka Band Integrated RADAR Receiver Exciters & Passives

LORCH TRAK

This is not an advertisement; it's an invitation.
Come partner with a business that is helping top-tier radar companies achieve next generation performance, at winning schedules and price points

Come see us in Booth 923

Ultra-Low Phase Noise

- Fast frequency-hopping coherent local oscillators
- Vibration isolation and compensation systems
- Diode-based low-noise multipliers and NLTL comb generators
- Integrated Exciter waveform generation for pulsed, phase coded, and frequency agile systems

Multi-Channel Receivers

- Integrated channelizers for out-of-band interference management
- High instantaneous BW and dynamic range (AGC) for active NF/IP3 control
- Tight channel/channel phase matching for AESA array exciter and multichannel direct array interfaces
- LNA Receiver Folter Protection

Radar Passive Products

- Waveguide Ferrite Duplexers
- Latching Waveguide Switches
- High Power Protection for SSPA's
- Bandpass Filters in Waveguide, Coaxial and SMT Configuration

Rugged Environmental Conditions

- Designed, Manufactured, and Tested to the most rigid environmental standards
- Vibration systems designed to manage MIL-STD-810 and various custom vehicle profiles
- Withstand acceleration and shock for both high-velocity and ground-mobile conditions
- Engineering, Production, and Quality Assurance processes certified to AS-9100C

TRAK Microwave Corporation 4726 Eisenhower Blvd - Tampa, FL 33634 (813) 901-7200 www.trak.com
LORCH 1725 North Salisbury Blvd - Salisbury, MD 21802 (410) 860-5100 www.lorch.com

smiths microwave

remains unchanged. (C_2 = 4.2 pF, Z_{0L} = Z_{om1} = Z_{OU} = 120Ω, Z_{0om2} = 158Ω, Z_{0em2} = 71Ω, θ_U = 62°, θ_L = 11°, θ_1 = 11°, θ_2 = 32°).

Figure 6 shows how S_{21} is influenced by the characteristic impedance of Z_{0U}. With increasing characteristic impedance, suppression at high end of the band increases, leaving suppression at the lower extreme of the band relatively unchanged. The frequency of the second transmission zero increases with increasing Z_{0U}, while the frequency of the third transmission zero decreases. The first transmission zero also decreases, but at a lower rate, therefore, the bandwidth decreases. (Z_{0L} = Z_{om1} = 120 Ω, Z_{0om2} = 158 Ω, Z_{0em2} = 71 Ω, θ_U = 62°, θ_L = 11°, θ_1 = 11°, θ_2 = 32°, C_2 = 4.2 pF, C_1 = 0.24 pF).

From the above observations, adjusting the value of the coupling capacitor (C_1) appears to be the most effective way to control the attenuation poles, because changes to Z_{0om2} and Z_{0U} have a significant effect on only one transmission zero.

FILTER DESIGN AND MEASUREMENTS

Based on the analysis, a WBSF having a 20 dB FBW of 89.5 percent at f_0 = 2 GHz is designed on a 0.5 mm substrate with a relative dielectric constant of 2.65 and loss tangent 0.002 (see ***Figure 7***). The impedance values of the filter are Z_{0U} = Z_{0L} = Z_{om1} = 120 Ω, Z_{0om2} = 158 Ω, Z_{0em2} = 71 Ω, and corresponding electrical lengths are θ_U = 62°, θ_L = 11°, θ_1 = 11°, θ_2 = 32°. The coupled line's corresponding width and separation are both approximately 0.2 mm. In addition, two microstrip patches with an interdigital structure are employed to realize the

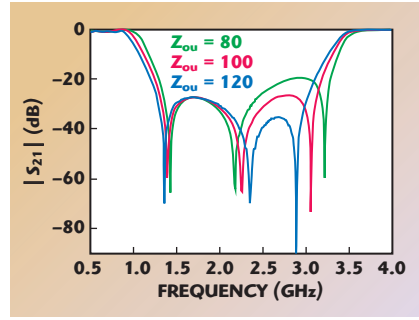
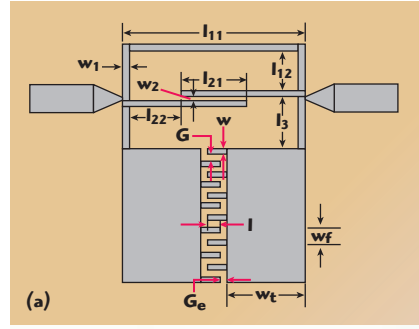


Fig. 6 Computed responses of the WBSF with different Z_{0U}.



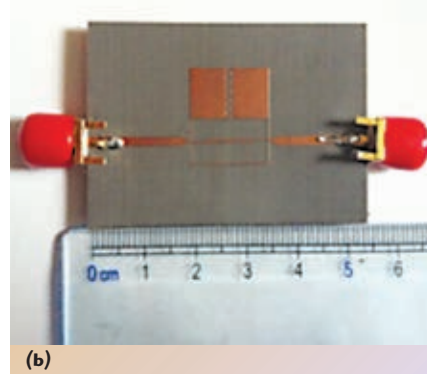
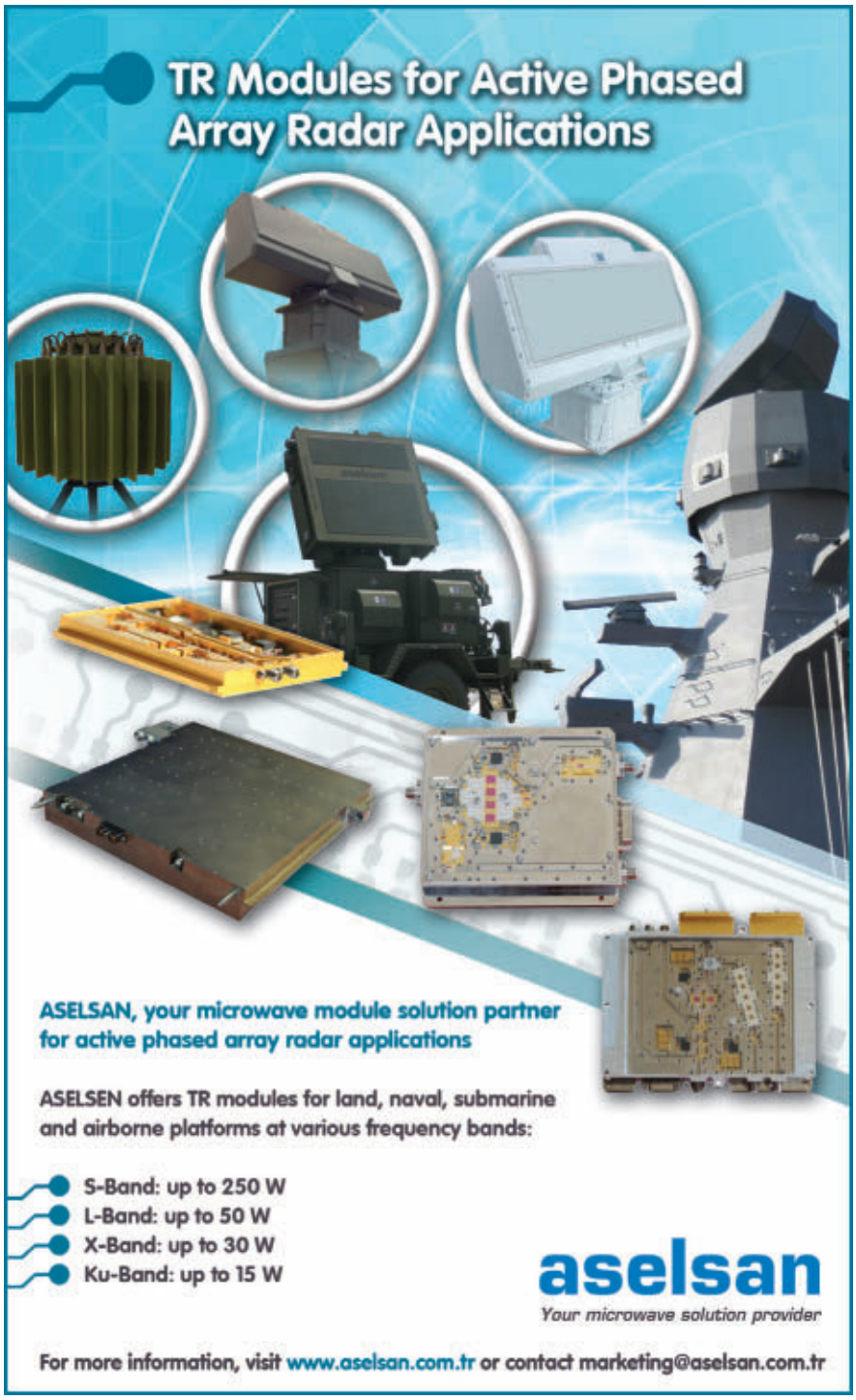
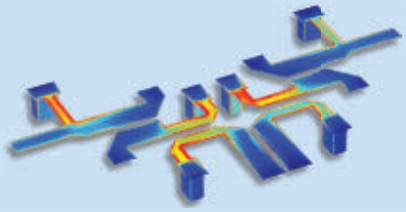
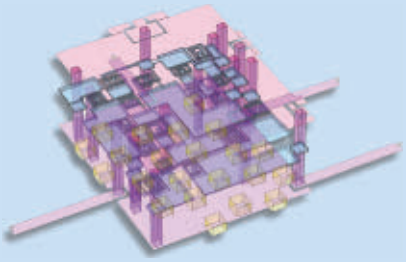


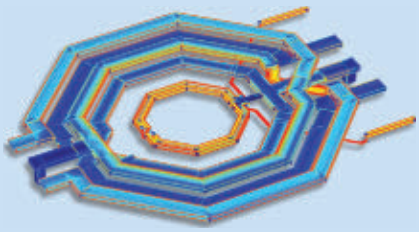
Fig. 7 WBSF layout (a); photograph (b).

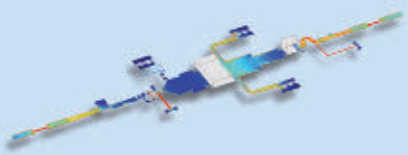


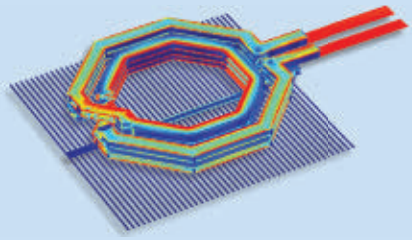
See us at IMS Booth 2126

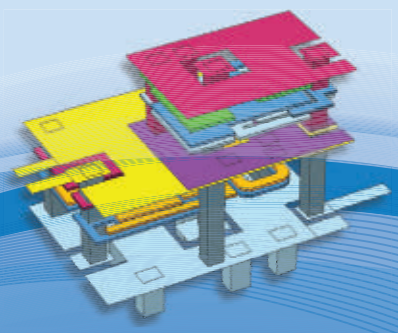












SONNET®

Accurate.
Integrated.
Robust.

EM Software, it's who we are.

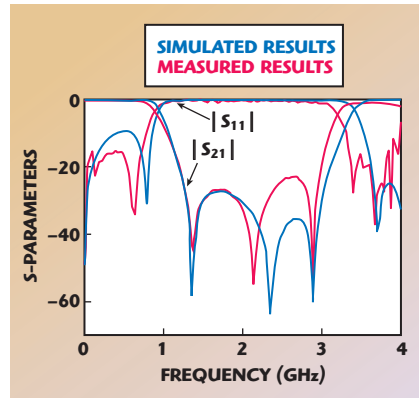
www.sonnetsoftware.com • 1-877-7-SONNET

©2012 Sonnet Software, Inc. All rights reserved. SONNET® is a registered trademark of Sonnet Software, Inc.

See us at IMS Booth 1215

pi network model consisting of three capacitors. C_1 and C_2 are 0.24 pF and 4.2 pF, respectively. Using Agilent's ADS, the dimensions of the interdigital structure are determined to be l = 0.6 mm, w = 0.35 mm, w_t = 7 mm, w_f = 1 mm, G = 0.3 mm and G_e = 0.4 mm. Figure 7(b) is a photograph of the fabricated filter.

The results of simulation (using Ansoft HFSS) and measurement (see ***Figure 8***) show good agreement. The three transmission zeros are located at 1.39 GHz (with a suppression of 46 dB), 2.14 GHz (with a suppression of 55 dB) and 2.89 GHz (with a suppression 53 dB). This provides a wide stopband response with a center frequency of 2 GHz. The lower and upper 3 dB cut-off frequencies are 0.88 and 3.22 GHz, representing a 3 dB FBW of 114.1 percent centered at 2.05 GHz. Rejection is better than 20 dB from 1.20 to 2.99 GHz, corresponding to a 20 dB fractional bandwidth (FBW) of 87.3 percent.



▲ *Fig. 8 Simulation vs. measurement.*

Attenuation rates at the band edges are 67.57 dB/GHz (5 dB at 0.94 and 30 dB GHz at 1.31 GHz) and 78.12 dB/GHz (5 at 3.17 and 30 dB at 2.85 GHz) on the lower and upper side of the stopband, respectively. Furthermore, the filter exhibits good passband performance; the insertion loss is less than 1 dB from DC to 0.76 GHz, and less than 1.1 dB in the upper passband from 3.36 to 3.78 GHz. If the feed lines are not taken in account, the whole filter occupies a compact size of 15.4 × 14.1 mm corresponding to $0.022\lambda_g^2$ ($0.155\lambda_g \times 0.145\lambda_g$), where λ_g is the guided wavelength of a 50 Ω transmission line at the center frequency of 2.05 GHz.

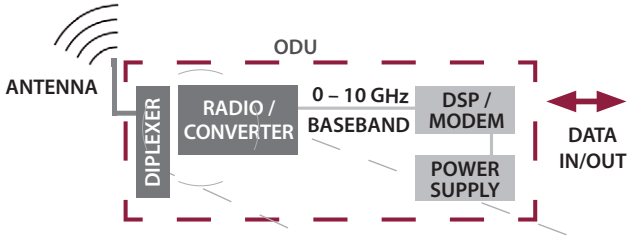
CONCLUSION

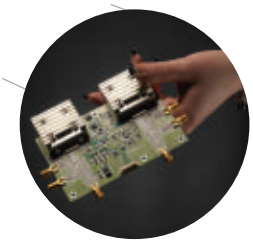
A new type of compact bandstop filter using an interdigital capacitor in the parallel-coupled transmission line section achieves deep rejection and a wide bandstop. With the aid of transmission line modeling and simulation, the parameters of the WBSF are derived. By adjusting the value of transmission line characteristic impedances and the value of the coupling capacitor, the bandwidth and rejection level of the stopband can be easily controlled. The filter produces three stopband transmission zeros and, as a result, provides improved rejection in terms of sharpness and attenuation level. ■

ACKNOWLEDGMENT

The authors wish to acknowledge the support of the National Natural Science Foundation of China under grant (61101052), Zhejiang Provincial Natural Science Foundation under

ATTENTION
all Radio Link Manufacturers!

Want to boost back haul capacity and profit margins – SIMULTANEOUSLY?


Slash time-to-market with Sivers IMA's performance enhancing E and V-band converter platforms. Our flexible platform enables next-generation radio links to provide transfer rates of up to 10 Gb/s - at radically reduced cost!

SIVERSIMA
SIVERS IMA IS AN ISO 9001:2008 CERTIFIED COMPANY
www.siversima.com | info@siversima.com

CERAMIC FILTERS

LOW PASS BANDPASS HIGH PASS

NOW! *Passbands Covering DC to 18 GHz* from 99¢ ea. qty.3000

Over 200 models as small as 0.06 x 0.03"! 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. Supporting a wide range of applications with high stop band rejection and low pass band insertion loss in tiny packages, they're a perfect fit for your system requirements. Visit minicircuits.com for comprehensive data sheets, PCB layouts, free high-accuracy simulation models, and everything you need to choose the model for your needs. Order direct from our web store, and have them in your hands as soon as tomorrow!

Now available in small-quantity reels at *no extra charge:*
Standard counts of 20, 50, 100, 200, 500, 1000 or 3000.
Save time, money, and inventory space!

Wild Card Filter Kits, *KWC-LHP, only* $98

- *Choose any 8 LFCN or HFCN models*
- *Receive 5 of each model*
- *A total of 40 filters for a great value*
- *Order your KWC-LHP Filter Kit TODAY!*

RoHS compliant U.S. Patents 7,760,485 and 6,943,646

Free, High-Accuracy Simulation Models for ADS

Modelithics®

www.modelithics.com/mvp/Mini-Circuits.asp

Mini-Circuits®

www.minicircuits.com P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com

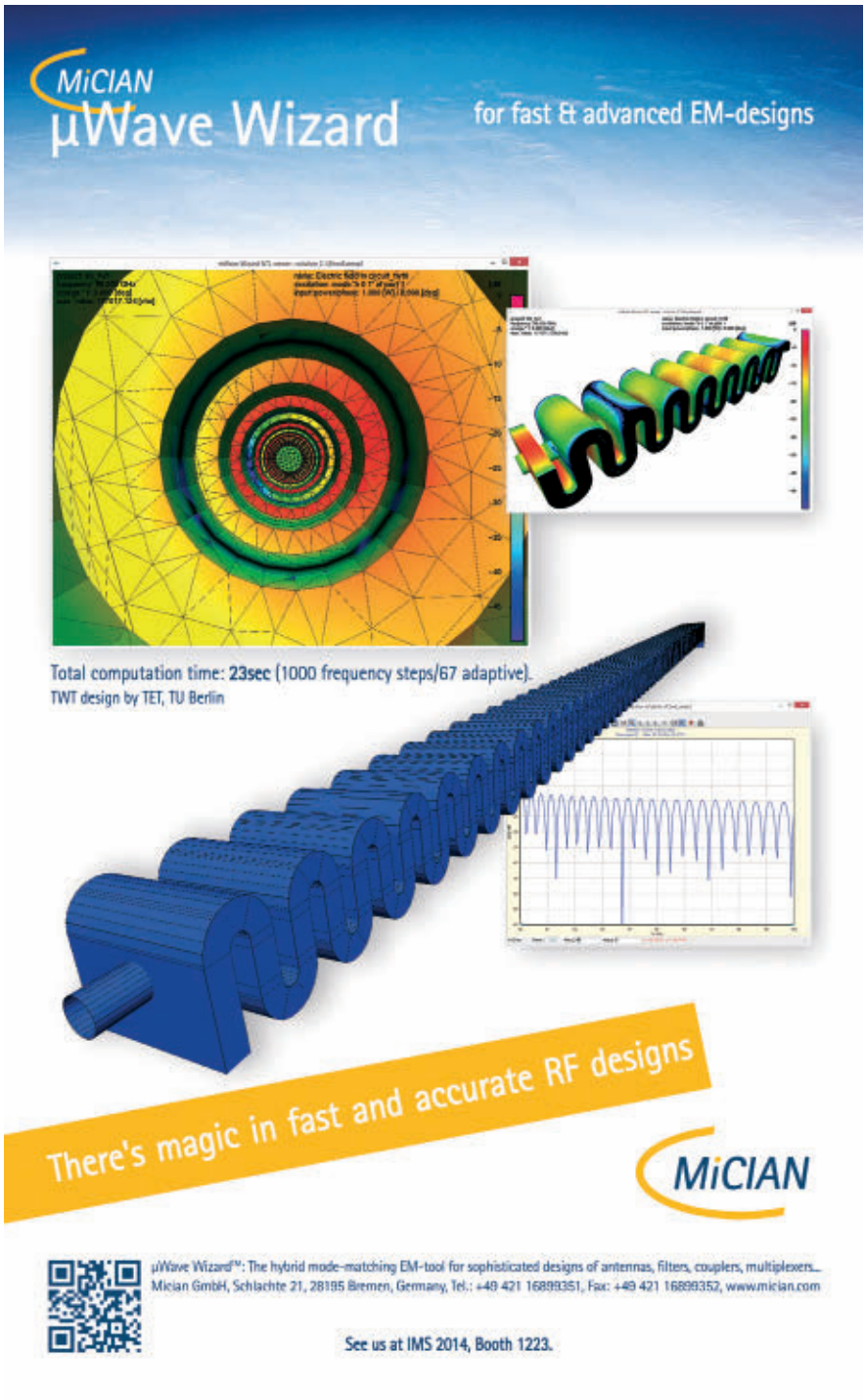
See us at IMS Booth 823

504 Rev E

grant (Y1110297) and the Scientific Research Foundation of Zhejiang Sci-Tech University (1004811-Y).

References

1. G. Matthaei, L. Young and E.M.T. Jones, *Microwave Impedance-Matching Networks and Coupling Structures*, Artech House, Norwood, MA, 1980.
2. K. Qian, "Compact Wideband Bandstop Filter Using Embedded Capacitor," *Microwave and Optical Technology Letters*, Vol. 54, No. 6, June 2012, pp. 1511–1514.
3. M.K. Mandal, K. Divyabramham and S. Sanyal, "Compact, Wideband Bandstop Filters With Sharp Rejection Characteristic," *IEEE Microwave and Wireless Components Letters*, Vol. 18, No. 10, October 2008, pp. 665-667.
4. H. Shaman and J.S. Hong. "Wideband Bandstop Filter with Cross-Coupling," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 55, No. 8, August 2007, pp. 1780-1785.
5. M.A. Sanchez-Soriano, G. Torregrosa-Penalva and E. Bronchalo, "Compact Wideband Bandstop Filter With Four Transmission Zeros," *IEEE Microwave and Wireless Components Letters*, Vol. 20, No. 6, June 2010, pp. 313-315.
6. H.K. Chiou and C.F. Tai, "Dual-Band Microstrip Bandstop Filter Using Dual-Mode Loop Resonator," *Electronics Letters*, Vol. 45, No. 10, May 2009, pp. 507-509.
7. M.K. Mandal and P. Mondal, "Design of Sharp-Rejection, Compact, Wideband Bandstop Filters," *IET Microwaves Antennas & Propagation*, Vol. 2, No. 4, January 2008, pp. 389-393.
8. D.M. Pozar, *Microwave Engineering*, 2nd edition, Wiley, New York, 1998.
9. J.S. Hong and M.J. Lancaster, *Microstrip Filters for RF/Microwave Applications*, Wiley, New York, 2001.



Ting Lang *is currently working toward the electronic and information engineering bachelor's degree at the school of Qixin, Zhejiang Sci-Tech University, China. Her research interests include microwave passive circuit design and its applications.*

Lin Li *received both his bachelor's and master's degrees at Zhejiang University and his PhD at Shanghai Jiaotong University. He is currently an associate professor at Zhejiang Sci-Tech University. His research interests include microwave passive circuit design and its applications.*

Li-Li Yang *is currently working toward the communication engineering bachelor's degree at the school of Qixin, Zhejiang Sci-Tech University. Her research interests include microwave passive circuit design and its applications.*

Zhi-Hao Zhang *is currently working toward the communication engineering bachelor's degree at the school of Qixin, Zhejiang Sci-Tech University. His research interests include microwave passive circuit design and its applications.*

WHEN EVERY CONNECTION COUNTS... COUNT ON DELTA

Visit us at IMS 2014 - Booth # 1114

SMP & **SMPM** connectors from Delta Electronics Mfg. The smart choice for board to board or module to module microwave interconnects. Whether you're increasing package density, reducing weight or improving performance at higher frequencies, Delta has a solution engineered for your critical application.

Download Catalog Here

Engineered:

- ☑ Robust
- ☑ Reliable
- ☑ Cost Effective

DELTA
ELECTRONICS MFG. CORP.
Connect Here.

Get your copy of our **NEW** **SMP/SMPM** catalog, contact Delta today!

AS9100/ISO 9001 ROHS COMPLIANT SOMWBA Woman Owned

(978) 927-1060 • www.deltarf.com

TDR, Meeting Specifications Versus Good Transmission Line Performance

Gordon Vinther
Ardent Concepts Inc., Seabrook, NH

I have spent countless hours and many dollars trying to eliminate impedance mismatches from transmission line interconnections, and I suspect that others may have had similar experiences. Through attempts to minimize reflections at 40+ GHz, I have come across examples where a design that meets a TDR discontinuity specification yields more reflections than one that does not.

My problem is exacerbated by the fact that our company's products are multi-channel RF cable compression mount connectors and cable launch systems that mount to PCBs with hard right angles in the transmission line interfaces. Signals with 20 ps and shorter rise times do not seem to like to make sharp right angle turns. Our customers frequently tell me, "I have a ±10 percent deviation criterion on the impedance of the transmission line and if you cannot hit it, your solution will not meet our requirements."

Through extensive research and optimization of different PCB stack-ups in order to achieve the ±10 percent target, we have learned an interesting thing: there are instances where return loss is worse for a transmission line that meets the ±10 percent specification than for a transmission line that does not. Occasionally, when designing high speed transmission lines, too much emphasis is put on meeting TDR specifications than on achieving a clean signal with fewer reflections and less transmission line insertion loss.

▲ *Fig. 1 Multi-coaxial cable launch connector on a PCB.*

Our customers have an infinite number of different PCB design stack-ups that occasionally change for one reason or another, even after the design is "frozen." It is our responsibility to use whatever tools are necessary to optimize the launches of these cable systems so our customers achieve the data rates they require, often 28 Gbps or higher. At these data rates, the signal resolution often needs to be the third harmonic of the Nyquist Frequency (for 28 Gbps, this can be 42 GHz or higher).

TDR MEASUREMENTS EXAMPLE

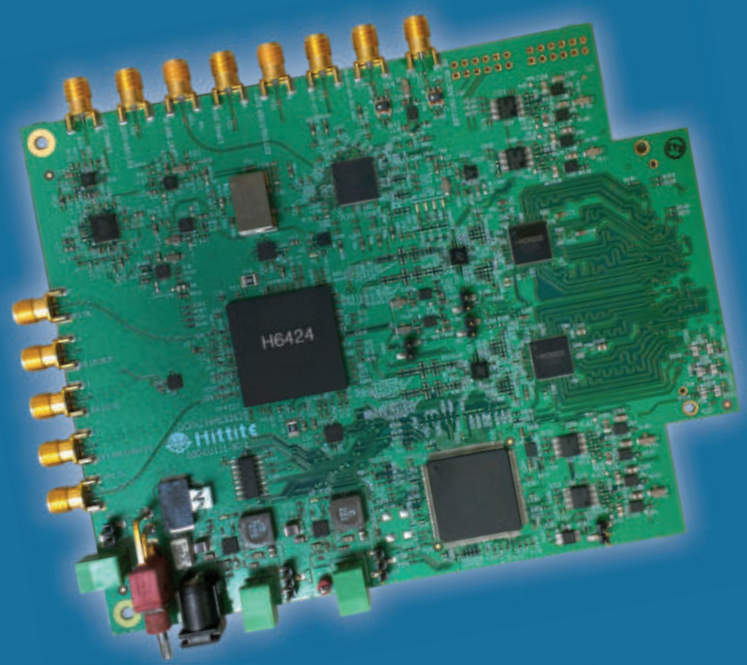
Take, for example, a PCB with a 2.92mm edge launch coaxial connector at one end of a microstrip trace followed by about a 1" trace on a PCB and a right angle transition into a cable connector (see ***Figure 1***). Shown in ***Figure 2*** is a TDR measurement from the edge launch to the cable for two different assemblies, each with their own PCB design but having the same connector design. TDR responses are measured using 20 ps rise time steps for a 10 to 90 percent signal level.

The two curves on this graph, one labeled ×12 and the other labeled ×16, refer to the number of total channels on the two different connectors. As the signal moves through the edge launch on the left of the graph, it encounters a slight inductive response of about 2 ohms on both curves. This inductive response is due to the mismatch on the edge launch connector. For the curve labeled ×16, the signal then goes through a PCB trace that is around 52 ohms for about 0.1 nanoseconds and then it sees a discontinuity at 0.15 ns of about 58 ohms, which is clearly outside the 45 to 55

Dual Direct Conversion Receiver

Highly Integrated, High Performance, Modular Design Supporting Scalable MIMO Architectures

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



HMC8363-DCR Complete, Intergrated, Multi-Carrier GSM Compliant Receiver Solution for 600 MHz to 4000 MHz

Typical Applications

- Multi-Carrier Multi-Standard Cellular Base Stations
- Microwave Point-to-Point
- Adaptive IF Strips
- Test Equipment
- Software Defined Radios

Features

- Arbitrarily Programmable BW: 7 MHz to 100 MHz
  - Unprecedented BW Accuracy: +/- 2.5%
- Integrated DSP
  - Real-time image rejection: > 90 dBc
  - Real-time DC-Offset Compensation
- Fractional LO with Spurious Free Performance
  - < -90 dBc/Hz Spurious
- High Performance ADCs:
  - 80 dBc SFDR, 75 dBFS SNR at 500 MSPS
- 153 dB of Distributed Programmable Gain

Hittite MICROWAVE CORPORATION

2 Elizabeth Drive • Chelmsford, MA 01824
978-250-3343 tel • 978-250-3373 fax
www.hittite.com • adc@hittite.com

Receive the latest product releases - click on "My Subscription"

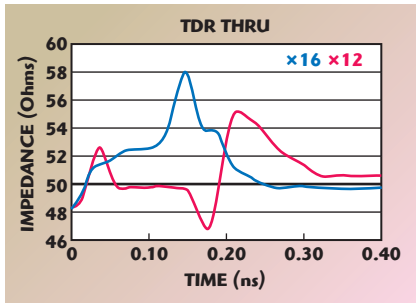
See us at IMS Booth 1841

Download Hittite at the App Store

ohm specification of many transmission line designs.

For the curve labeled ×12, starting on the left, the signal sees the same inductive response from the edge launch but the PCB trace is much closer to 50 ohms. At 0.18 ns, the signal sees a capacitive discontinuity that corresponds to the portion of the PCB trace under the connector, effectively lowering the impedance of that portion to 47 ohms. The signal at that point sees a capture pad that is 0.018" in diameter and is the connector launch pad. The pad size is optimized to be 50 ohms with respect to the surrounding anti pad and the return layer under the microstrip trace. The return layer has a 0.040" hole in it directly under the capture pad. The signal sees the same inductive reactance at the interface part of the cable launch system (about 5 ohms) as seen for the ×16 configuration. After entering the 50 ohm coaxial cable, the impedance becomes uniform.

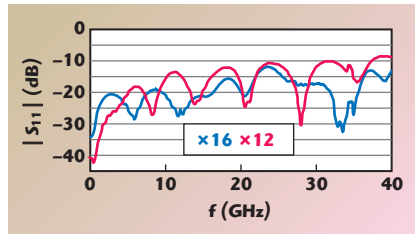
Time differences between the two cases are due to two factors: first the trace lengths are not exactly the same, and second, the dielectrics though they are both Megtron 6 material, are different. This highlights some of the limits of PCB and acid etch technology for extremely fast data rate applications.



▲ *Fig. 2 TDR at 20 ps resolution for a ×12 and a ×16 PCB assembly.*

S-PARAMETER MEASUREMENTS

Looking at these two TDR curves, one might expect to see more variation in S_{11} for the ×16 configuration, having a higher impedance discontinuity, but this is not the case (see ***Figure 3***). We will use S_{11} = -20 dB (VSWR 1.22) and S_{11} = -15 dB (VSWR 1.43) as reference points; S_{11} = -20 dB since it is generally a clear transmission line with a match efficiency of 99 percent; and S_{11} = -15 dB because it is fairly well matched at 96.84 percent efficiency and is still, in most cases, a usable signal. The ×12 transmission line is above -20 dB at about 5 GHz and crosses the -15 dB line at 10 GHz, while the ×16 transmission line with its 58 ohm discontinuity just barely crosses the -20 dB line at 8 GHz but then dips down again and does not really go above -20 dB until above 16 GHz or so. The -15 dB point for the ×16 curve is at 22 GHz.



▲ *Fig. 3 S_{11} through 40 GHz for a ×12 and a ×16 assembly.*

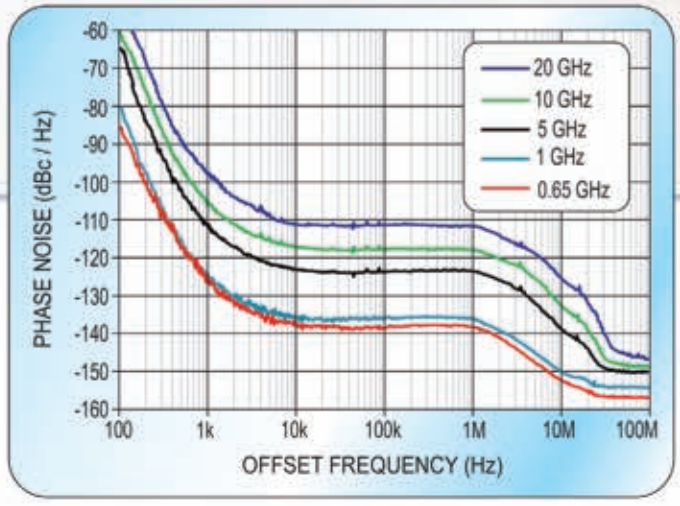
Figure 4 shows the differences between S_{11} for ×16 and ×12. On this

This is the QuickSyn® Lite

The Ultra-Compact, Ultra-Quiet, Ultra-Fast, Ultra-Low Cost Frequency Synthesizer!

Two Models Available:
FSL-0010 10 GHz
FSL-0020 20 GHz

Instrument designers appreciate the popular QuickSyn® Lite frequency synthesizer because its revolutionary phase-refining technology enables fast-switching speeds, low phase noise, and low spurious performance, and with rapid advances in technology resulting in the demand for ever smaller footprints and increasing functionality, the QuickSyn® Lite fits right in!



IMS2014 - Tampa Bay, Florida

We're in the NI booth #633

Wide Coverage
0.65 to 10 GHz or 20 GHz

Fine resolution 0.001 Hz

Fast switching 100 µs

Compact size (4 x 4 x 0.8 in)

Join the QuickSyn® user group on LinkedIn
http://www.linkedin.com/groups/QuickSyn-User-Group-6564266

Phase Matrix, Inc.®
A National Instruments Company

phasematrix.com | 408-610-6810

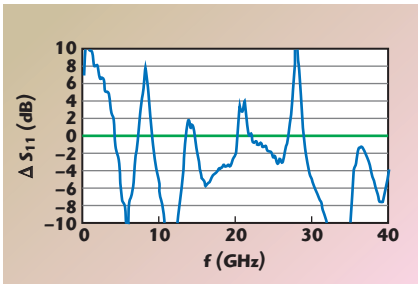


Fig. 4 Differences between S_{11} for a ×16 and a ×12 assembly.

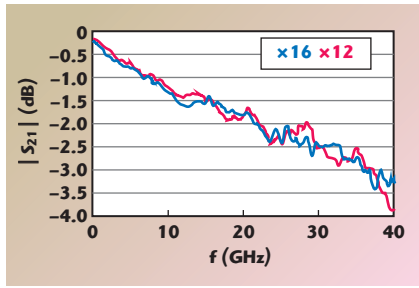


Fig. 5 S_{21} through 40 GHz for a ×12 and a ×16 assembly.

chart, wherever the curve is above zero, S_{11} is lower (better) for ×12 than for ×16. ×12 is lower from 0 to 5 GHz, 7 to 9 GHz, 13 to 15 GHz, 20 to 22 GHz, and 26 to 29 GHz. If one discounts S_{11} measurements below -20 dB, which is a 99 percent perfect signal at 0 to 16 GHz on the ×16 S_{11} curve, then ×12 exhibits a lower S_{11} over a total of only 5 GHz of the entire spectrum to 40 GHz (20 to 22 GHz, and 26 to 29 GHz).

Insertion loss through the interfaces of both transmission lines looks very similar as both have less than 4 dB loss through 40 GHz, which includes 6" of 0.047" diameter coaxial cable attached to the interface (see ***Figure 5***). It is important to note that the S_{21} curves do not start at 0,0 mostly due to the DC resistance of the transmission line, which is about 0.350 ohms. There is less than 0.2 dB of difference through most of the spectrum up to 25+ GHz. The curves start to diverge a bit more at frequencies above 25 GHz, but never by more than 0.5 dB. Note that S_{21} for ×12, the transmission line within the ±10 percent specification, has a noticeable dip after 38 GHz. It remains to be seen if there is a resonance after 40 GHz on the ×12 transmission line.

CONCLUSION

TDR is a good bellwether for determining transmission line performance, but it is not the end all, as illustrated through this example. Time domain measurements are dependent on measurement variables such as rise time. In both the cases described, a rise time above 40 ps would have smoothed the TDR curves out considerably. The use of the time domain with a resolution of, in this case, 20 ps can give indications of trouble spots, but the only real way to obtain an accurate picture of a transmission line performance is to use both time domain measurements and frequency domain measurements, and measure the actual performance. ■

ACKNOWLEDGMENT

Thanks to Gert Hohenwarter from Gatewave Northern for his data and insight.

Making Our Own Waves Since 1985

- Attenuators
- Resistors
- Terminations
- CVD Diamonds
- Diode Detectors

RES-NET MICROWAVE

Thinking at a Higher Frequency

727-530-9555

www.res-netmicrowave.com

Booth 817

IMS Tampa Bay 2014

We don't just sell you what we make, we design what you need.

- Circulators
- Isolators
- Custom Designs
- ISO Registered

NOVA MICROWAVE

Booth 819

IMS Tampa Bay 2014

408-778-2746

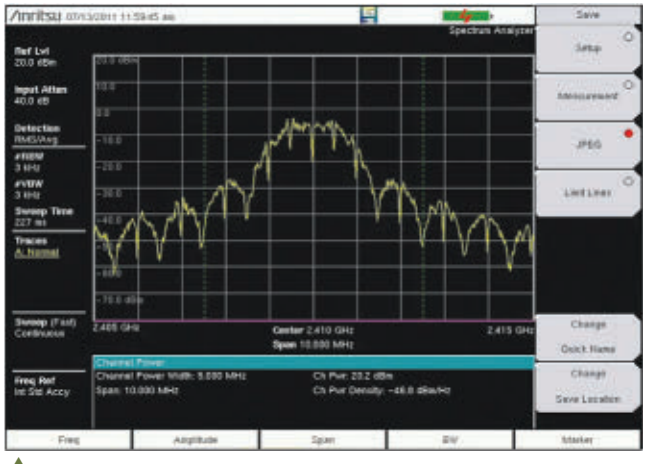
www.novamicro.com

MWJ REVIEW BOARD APPROVED

ZigBee RF Power Measurements in the Field

Boris Aleiner
Petra Solar, South Plainfield, NJ

This article describes a method of performing RF power measurements on ZigBee devices in the field using a portable spectrum analyzer. Because a portable spectrum analyzer is too slow for displaying the whole ZigBee spectrum instantaneously, it is accumulated over time using the analyzer's Max Hold feature. Spectrum analyzer settings are derived that produce measurement results accurate to within 1 dB.



▲ *Fig. 1 ZigBee spectrum.*

The most common and accurate way to measure RF power is to use a power meter; however, traditional power meters measure average power and therefore cannot be used for the measurement of packet-based waveforms (like ZigBee). For this application, a spectrum analyzer can be used. A spectrum analyzer, which measures channel power by capturing a waveform's spectrum, is appropriate for any type (pulsed or non-pulsed) waveform. It should be fast enough to capture the entire spectrum during each burst. A fast measurement instrument, however, is expensive and impractical when power has to be measured in the field (i.e., outside the lab environment).

Handheld spectrum analyzers (used for field measurements) are usually much slower

Now Available to 33GHz!

Micro Lambda's Compact Wideband YIG-based Synthesizers...

Ideal for Main Local Oscillator for Test Equipment, Receivers and VSAT Applications

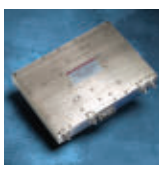
The MLSP-Series of YIG-Based wideband synthesizers provide 1 kHz frequency resolution over the 600 MHz to 20 GHz frequency range. Power levels of +8 to +13 dBm are provided through out the series and full band tuning speed is 6mSec. Compact size will fit a 2 slot PXI chassis.

For more information about the MLSP Series or other products, please contact Micro Lambda Wireless.

See our complete line of frequency synthesizers

MLSL-series
2 to 12 GHZ

MLSN-series
2 to 16 GHz



MLSW-series
0.6 to 16 GHz

MLBS-series
2 to 20 GHz

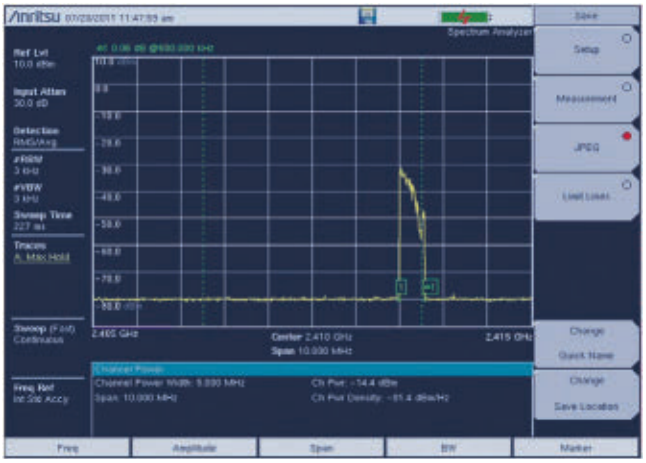
www.microlambdawireless.com

MICRO LAMBDA WIRELESS, INC.

"Look to the leader in YIG-Technology"

See us at IMS Booth 621

46515 Landing Parkway, Fremont CA 94538 • (510) 770-9221 • sales@microlambdawireless.com



▲ *Fig. 2 ZigBee spectrum displayed by a portable spectrum analyzer.*

than lab analyzers. For example, the Anritsu S332E Site Master handheld analyzer has a sweep speed of 1 ms per data point,[1] while the high-end Rohde & Schwarz FSU laboratory spectrum analyzer is capable of doing 80 measurements per second.[2] A consequence of the Anritsu's slower speed is that only a portion of the entire spectrum (600 kHz of the occupied channel bandwidth of 5 MHz) is shown at one time on the spectrum analyzer display. Since channel power is calculated based on the displayed spectrum, a method of displaying the whole spectrum of a pulsed signal on the analyzer's screen is needed.

ACCUMULATION OF DISPLAYED SPECTRUM

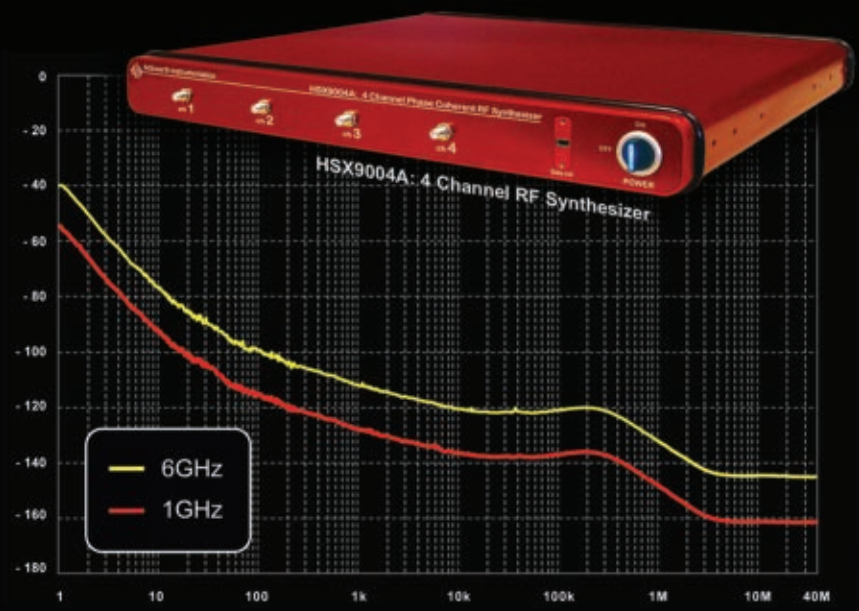
ZigBee radio transmits over short intervals: 1.7 ms every 30 seconds or so. During each burst, one expects to observe the whole ZigBee spectrum, as shown in ***Figure 1***. When measured with Anritsu's S332E, however, the typical spectrum presentation of a ZigBee module's output in the operational mode is shown in ***Figure 2***. This is because its fastest sweep is more than 200 ms, while the length of a typical ZigBee burst is about 2 ms. These bursts are interpreted by the S322E to be a periodic pulse train, represented as a Fourier series by[3]

$$g(t) = \sum_{n=-\infty}^{\infty} c_n \exp\left(\frac{j2\pi nt}{T_0}\right) \quad (1)$$

$$c_n = \frac{TA}{T_0}\,\mathrm{sinc}\left(\frac{nT}{T_0}\right) \quad (2)$$

This is shown graphically in ***Figure 3***, where Figure 3(a) is the time domain representation (Equation 1) and Figure 3(b) is the discrete spectrum amplitude due to the SINC function (Equation 2). Its value is displayed between each of the vertical lines representing conversion from consecutive pulses. If for some reason the pulse train is stopped (or not seen by the spectrum analyzer), the spectral display is also stopped. This occurs when the time it takes for the analyzer to display the spectrum prevents it from catching the next packet in the pulse train. If, after capturing the first two

HSX SERIES
RF SYNTHESIZERS
NEW GENERATION
IMPROVED PURITY
PHASE COHERENT



Frequency Range	10MHz - 6GHz
Frequency Tuning Resolution	0.001Hz
Output Power Range	+18dBm to -110dBm
Pout Tuning Resolution	0.01dB
Phase Noise	
100MHz (10kHz offset)	-155dBc/Hz
1GHz (10kHz offset)	-135dBc/Hz
3GHz (10kHz offset)	-125dBc/Hz
6GHz (10kHz offset)	-119dBc/Hz
Harmonics (+10dBm carrier)	-40dBc (spec)
Sub-Harmonics	-70dBc (spec)
Spurious (non-harmonics)	-80dBc (spec)

SEE IT AT IMS BOOTH 700

holzworth instrumentation
phone: +1.303.325.3473
www.holzworth.com

dynawave®

Single Path to Optimum Performance

We make our own low loss cable
DynaCore®, Low Density PTFE and Phase Stable Technologies

We make our own connectors
standard and custom

We supply the highest performance assemblies *DC to 65 GHz*

Find out more about our complete capabilities and brand new products.

Scan the QR code to instantly access our website to see the most comprehensive line of high performance, low loss bulk cable, connectors and cable assemblies.

Visit us at IMS 2014
June 1-6 Tampa • Booth #1308

www.dynawave.com • 978.469.0555

Dynawave • 135 Ward Hill Ave • PO Box 8224 • Haverhill, MA 01835

20 GHz Modular Signal Sources

- Frequency 50 MHz to 20 GHz
- Power −30 dBm to +10 dBm
- Low phase noise
- 1 Hz tuning resolution
- PXIe, USB, SPI, RS-232
- Available Q3

Visit us at IMS 2014
Booth 548

6 GHz nanoSynth™
SMT Synthesizer Module

Introducing the SC800...

Wideband CW generation in a miniature package

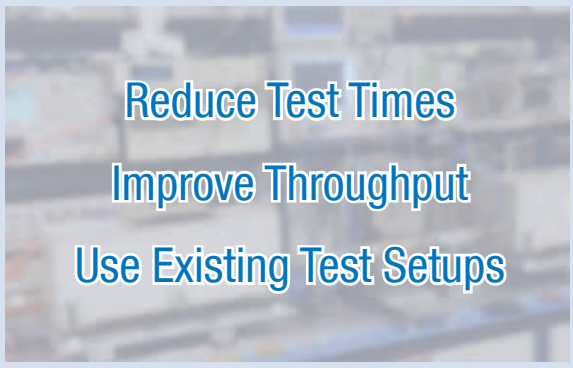
- 25 MHz to 6 GHz
- 1 Hz tuning resolution
- Ultra-compact 2″x 1″ footprint
- Point-to-point radio
- Software defined radio
- Wireless test & measurement
- Available Q3

www.signalcore.com

SignalCore
Preserving Signal Integrity

VITESSE

the new speed in passive load pull...

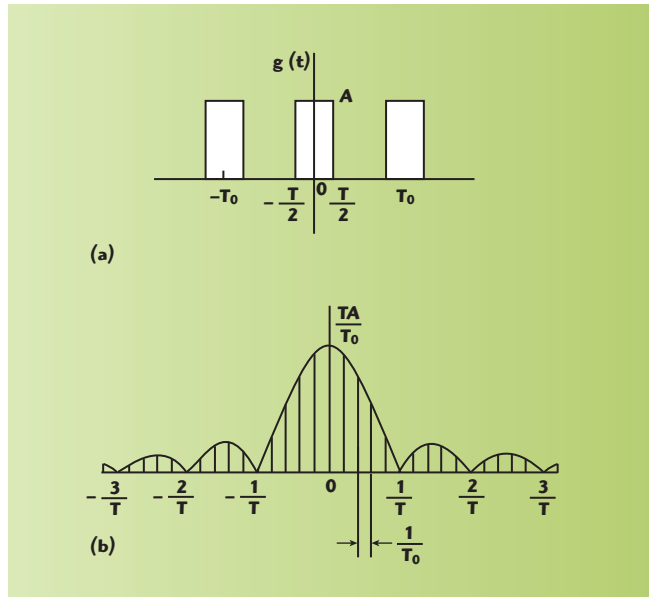


Make 5x improvements in throughput

Come and talk to us at IMS booth #740

www.mesuro.com/vitesse

mesuro
leaders in RF device characterization solutions



▲ *Fig. 3 Fourier conversion of a periodic function – time domain waveform (a), discrete spectrum (b).*

TABLE I

MEASURED OUTPUT POWER AS A FUNCTION OF SPECTRUM ANALYZER RBW

Settings of RBW (kHz)	*Settings of Input RF Power (dBm)*	*Output Power Under Normal Operational Conditions (dBm)*	*Output Power of a Continuous ZigBee Waveform (dBm)*	
		Measured with a Spectrum Analyzer	*Measured with a Power Meter*	*Measured with a Spectrum Analyzer*
1	-8	14	15.5	15
	3	22	22.5	23.5
3	-8	15	15.5	15
	3	23.5	23	23.5
10	-8	17	15.5	15
	3	25.5	22.5	23.5

packets, it loses the rest of the train and has to start anew, then it is displayed as bursts (see Figure 2). Because pulse train acquisitions occur at random times, the bursts appear at random starting frequencies and eventually cover the whole ZigBee spectrum, as in Figure 1. In order to preserve them and accumulate the whole spectrum to obtain a correct measure of channel power, the "Max Hold" trace feature of the S332E is used.

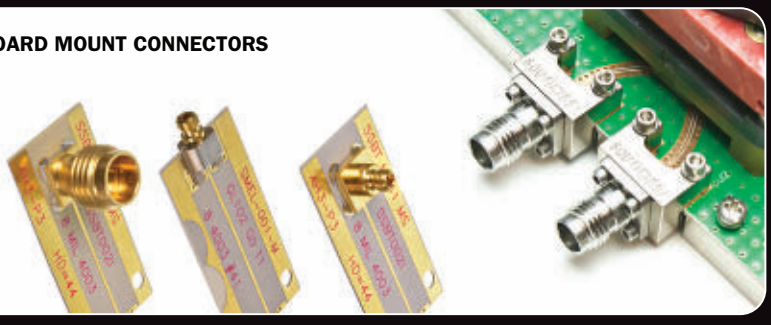
SPECTRUM ANALYZER SETTINGS

Channel power readings depend on the spectrum analyzer settings, including detector type, sweep mode, resolution bandwidth (RBW) and video bandwidth (VBW). These are inter-dependant, so some are chosen as initial settings. Detector type and sweep mode are initial settings. The detector setting is RMS/Avg, because the averaging

THE
PERFORMANCE LEADER
IN MICROWAVE CONNECTORS

SuperSMA, N, TNC, 2.92mm (K), 2.40mm, SSMA, 1.85mm (V), 0.9mm SuperMini

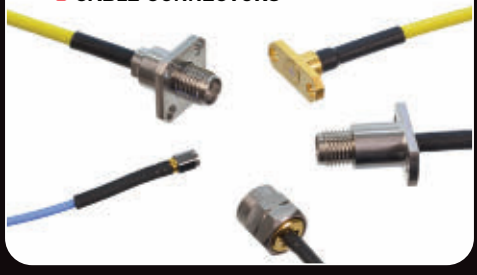
- BOARD MOUNT CONNECTORS



- PANEL MOUNT CONNECTORS

- COAX CONTACTS FOR MULTI-CAVITY CONNECTORS

- CABLE CONNECTORS



- ULTRA-MINIATURE CONNECTORS

- PRECISION ADAPTERS

SOUTHWESTMICROWAVE.COM

TEMPE, ARIZONA, USA | +1 (480) 783-0201

SOUTHWEST MICROWAVE

THE BEST VALUE THROUGH PERFORMANCE:

- LOW VSWR
- LOW INSERTION LOSS
- LOW RF LEAKAGE
- HIGH TEMPERATURE
- MATERIAL TRACEABILITY
- SPACE AND HI-REL
- EXCELLENT REPEATABILITY
- RUGGED AND DURABLE

DFARS COMPLIANT · ISO 9001 COMPLIANT · Pb lead-free · RoHS compliant · REACH Compliant · MATERIAL TRACEABILITY

See us at IMS Booth 543

detector is used specifically for channel power measurements, integrating amplitudes over frequency intervals. Sweep mode is set to "Fast" to allow sufficient time for data capture, enabling good amplitude accuracy and excellent frequency accuracy.

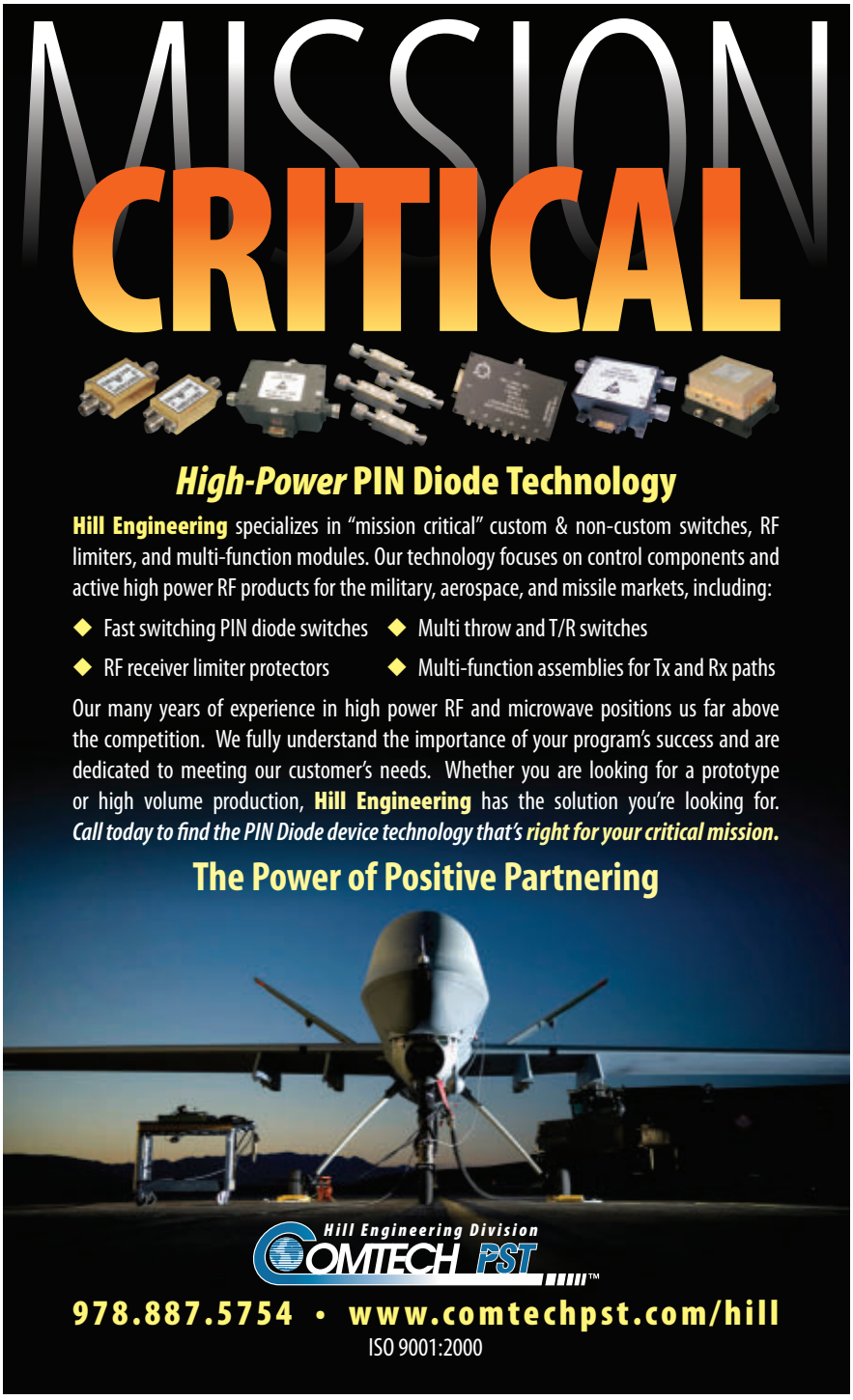
With these initial settings, values for RBW and VBW are derived. The easiest approach is to compare the spectrum analyzer's readings with very accurate readings from an averaging power meter. The power meter, however, does not provide accurate readings for pulsed waveforms. What can be used, in this case, is a special mode of a ZigBee modules' operation designed for regulatory compliance tests. In this mode, the module is not switching between transmit and receive branches, but transmits the ZigBee waveform without intervals, i.e., continuously. The power meter directly reads the waveform's average power and the spectrum analyzer displays the entire ZigBee spectrum. This provides corresponding power readings to calibrate the spectrum analyzer.

To determine the correct RBW and VBW settings, the value of RBW is varied (while the VBW is kept in AUTO). Spectrum analyzer readings of channel power for 500 packets are compared with spectrum analyzer readings of channel power for the continuous ZigBee waveform. These, in turn, are compared with power meter readings (on the same continuous waveform). Results are given in ***Table 1***, showing that all three readings coincide (within the accuracy of the measurements) at 3 kHz RBW.

CONCLUSION

An accurate method of measuring RF power on ZigBee devices in the field is described. A compact handheld spectrum analyzer from Anritsu (model S332E) is used as an instrument to measure channel power. Because the S332E is too slow for displaying the whole ZigBee spectrum instantaneously, the MAX Hold trace feature is used.

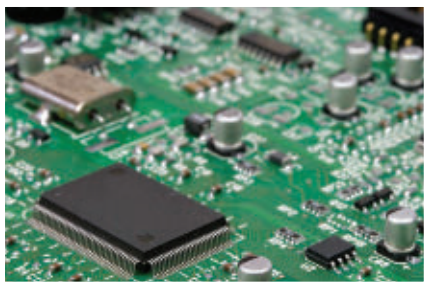
To determine the correct spectrum analyzer settings, RF power measurements with a power meter are performed on a continuous ZigBee waveform and are compared to measurements made using the S322E. To set the RBW, spectrum analyzer power measurements under normal operating conditions are compared to those made on the continuous waveform. With the correct spectrum analyzer settings, all three methods of measurements coincide within the accuracy of the readings (±0.5 dB). ■

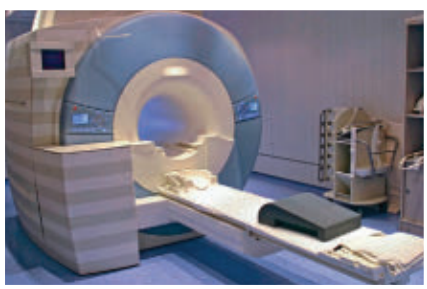


References

1. Anritsu Technical Data Sheet S332E Site Master™ Compact Handheld Cable & Antenna Analyzer with Spectrum Analyzer, www.anritsu.com/en-US/Products-Solutions/Products/S332E.aspx.
2. R&S®FSU Spectrum Analyzer High-end Spectrum Analysis Product Brochure, www.rohde-schwarz.com/en/product/fsu-productstartpage_63493-7993.html.
3. S. Haykin, *Communication Systems*, Second Edition, John Wiley & Sons, 1983.

Microwave Absorbers
For Cavity Suppression and Free Space Applications





CUMING MICROWAVE

Product Lines

C-RAM RF/Microwave Absorbers

NEW! **C-RAM RGD-S-192**; *A thin (0.040'' thick), flexible, highly magnetically loaded silicone absorber for use in cavity resonance suppression between 800 MHz – 18 GHz ; When you can't trade performance for thickness, this absorber is a great choice!*

C-RAM Radar Cross Section Absorbers

C-RAM Anechoic & Free-Space materials

C-RAM Turn-key Anechoic & EMC Chamber Design and Installation

C-STOCK Low Loss Dielectric Materials

Custom Formulations and Custom Fabrication available

Cuming Microwave Corporation is an ISO 9001:2008 and AS9100:2009 global manufacturer of materials that absorb EMI/RFI between 10 MHz – 100 GHz

cumingmicrowave.com
264 Bodwell Street, Avon, MA, USA
508-521-6700 | sales@cumingmicrowave.com

Visit Us at IMS2014 in Tampa, FL at Booth# 1311

Scan page
using layar app

Wireless Prototyping with Software Defined Radio

National Instruments
Austin, TX

Wireless consumers' growing demand for data on mobile devices and increased dependence on applications or "apps" have spurred unprecedented levels of research to design the next generation of wireless systems to increase network capacity while offering new capabilities. The faster a researcher can transition a concept from design to a working prototype, the faster all of us ultimately benefit from faster data at our fingertips and new applications that take advantage of new network capabilities. Researchers are relying more and more on software defined radios (SDR) to compress the time to prototype, and they are becoming integral tools in the design flow. With SDRs, researchers can rapidly prototype custom protocols, analyze concept performance in real-world environments, and iterate. SDRs closely mirror the functionality found in real wireless devices with the added flexibility of broader frequency coverage and reprogrammable baseband processing. The more capable the SDR, the broader the array of research topics that can be explored.

The NI USRP RIO family of software defined radios sets a new standard in price, performance and productivity. NI USRP RIO features a flexible, high performance 2×2 MIMO RF front end with a large reconfigurable Xilinx 7 series FPGA for DSP processing – all in a compact form factor. Tightly integrated NI LabVIEW software support accelerates system design by providing a seamless tool chain that allows researchers to design and deploy algorithms across the FPGA and host processor. Users can balance implementation to match the needs of their application. Designed for rapid prototyping, NI USRP RIO (see ***Figure 1***) is accelerating next-generation wireless research and making users more efficient by enabling them to bridge their software tool flow from design through verification and test.

Fig. 1 The NI USRP RIO joins a complete product line of NI RF technology that features a common NI LabVIEW development framework, spanning from design to test.

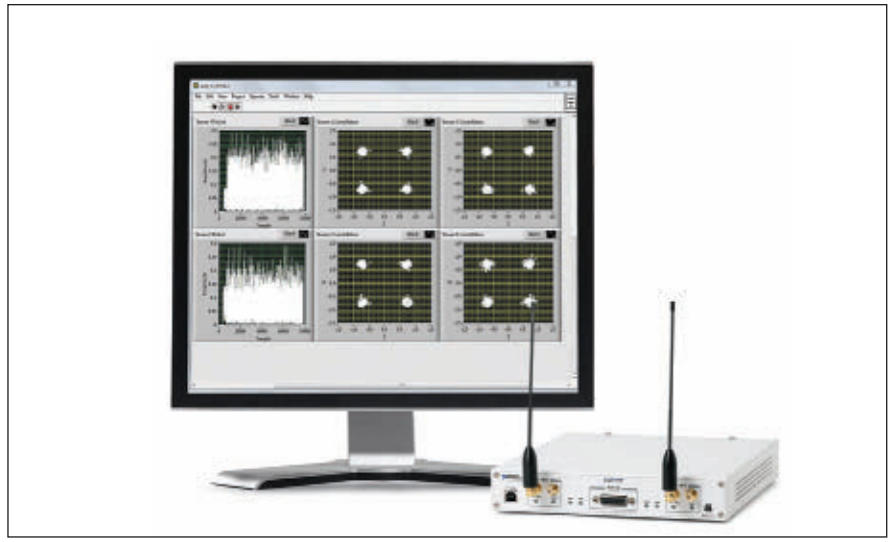
DESIGNED FOR RAPID PROTOTYPING

The integrated hardware and software design flow, termed the NI LabVIEW Reconfigurable I/O (RIO) architecture, allows communications system engineers to

more rapidly prototype their designs. These engineers can now fulfill the role of system architect, baseband DSP designer and high performance FPGA integrator within a common framework for higher bandwidth and lower latency wireless applications. The NI USRP RIO provides two direct conversion RF transceivers with frequency tuning options from 50 MHz to 6 GHz and up to 40 MHz of instantaneous real-time bandwidth. Designers can customize baseband processing in the large DSP-oriented Xilinx Kintex 7 410T FPGA for high performance algorithm implementation that might include channelization or implementation of an entire physical layer of a protocol. NI LabVIEW FPGA software accelerates FPGA design through an open intuitive graphical dataflow representation while allowing native HDL to be integrated inline as needed. NI USRP RIO connects to the host PC over a low-latency PXI Express ×4 connection where LabVIEW, C and m-file script code can be integrated into LabVIEW for host-based processing. Designers can prototype on the latest wireless hardware without the expense of maintaining in-house prototyping platforms as they design next-generation systems.

NEXT-GENERATION WIRELESS RESEARCH

An NI USRP RIO scales from simple monitoring or single-input, single-output (SISO) link applications to high-channel-count multi-antenna research. The NI USRP-294xR devices include a TCXO, while the NI USRP-295xR devices integrate a GPS disciplined OCXO precision clock for improved frequency accuracy and synchronization. Two devices (4 channels) conveniently mount into a single 1U rack with SMA ports on the back for distributing clocks and triggers among multiple devices. The scalability of the platform and productivity gains from LabVIEW allow researchers to make significant contributions across a broad range of applications that include Wi-Fi, LTE, cognitive radio, massive multiple-input, multiple-output (MIMO), spectrum monitoring, Internet of Things (IoT), Global Navigation Space Systems (GNSS), radar, satellite communications and more.



▲ *Fig. 2 With the power of the NI LabVIEW RIO architecture, this SDR will open new avenues into communication system design.*

Prototyping is becoming increasingly important as researchers seek new ways to meet consumers' insatiable need for bandwidth. At Lund University in Sweden, researchers Ove Edfors and Fredrik Tufvesson are working to build one of the first massive MIMO test beds. With more than 100 antennas, this prototype is the largest and most comprehensive of its kind, making it the first test bed to reach this level of magnitude and complexity on the road to 5G.

COMPLETE PLATFORM FROM DESIGN TO TEST

NI USRP RIO joins a complete product line of NI RF technology that features a common NI LabVIEW development framework (see ***Figure 2***). This makes it possible for engineers to collaborate more freely throughout the design process. Design teams benefit from the unified software tool flow, which enables code reuse and collaboration from early stages of design, to characterization, and to manufacturing test. Furthermore, because NI's hardware architecture is similar throughout its RF products, prototypes developed on software defined radio hardware can be deployed on high-performance RF test instrumentation with NIST tractable calibration.

Together, the NI USRP RIO and LabVIEW platform set a new standard for price, performance and productivity, which enhances researchers' ability to prototype next-generation wireless systems. This ultimately makes it possible to meet the growing demand for next-generation wireless technologies.

VENDORVIEW

National Instruments, Austin, TX, www.ni.com/sdr.

See us at IMS Booth 1326

Scan page
using layar app

A High IIP3, 300 MHz to 6 GHz Active Mixer

Linear Technology Corp.
Milpitas, CA

Rarely do active RF mixers break the +30 dBm IIP3 barrier without sacrificing other performance parameters. The Linear Technology LTC5577 is just such an RF mixer. The mixer employs a new active mixer topology to achieve its +30 dBm IIP3. It has a high conversion gain of 0.7 dB, 0 dBm LO drive and wide frequency operation from 300 MHz to 6 GHz. Its active, double balanced design brings the additional benefits of excellent port-to-port isolation, low 2×2 and 3×3 spurious mixing products, and low pseudo-image mixing products that can degrade receiver performance.

The LTC5577 has integrated wideband transformers on its RF and LO inputs that are tuned to 50 ohm single-ended over a wide frequency range. With a fixed external matching circuit, the part operates continuously from 700 MHz to 4.3 GHz with excellent gain flatness. As a result, minimum external components are needed, thereby reducing system cost and solution size. Additionally, its IF output port, usable from 1 MHz to 1.5 GHz, delivers flat conversion gain performance to over 600 MHz bandwidth, supporting LTE and LTE-Advanced base station receivers, as well as other wideband receiver applications.

The mixer also has an integrated LO buffer, requiring only 0 dBm LO drive and tolerating ±6 dB of LO power variation. This eliminates an external high power LO amplifier, which would otherwise require extra power and increased cost. Additionally, a high power LO source in the +17 to +20 dBm range is eliminated, reducing the risk of unintended radiation that may corrupt other parts of the system's RF circuits. As a result, the device saves the cost of RF shielding hardware that would otherwise be necessary. The LTC5577 mixer runs on a single 3.3 V supply with an economized supply current of only 180 mA.

ACTIVE MIXER ARCHITECTURE BENEFITS

The LTC5577's active, double-balanced mixer topology provides other unique benefits. Aside from its high conversion gain and very wide bandwidth, the LTC5577 solves other underlying problems that often challenge designers such as:

Always Thinking.
Always Advancing.

Weatherproof pressurized connectors

Standard or reverse polarity, enhanced TNCs

High-power 7/16s featuring Fluoroloy H

Extreme shock-and-vibration-proof Type Ns

High-flex, 20 GHz eSMAs

SERIES

Every mission. Every maneuver. Today's battlefield is dependent on stable signals. And the connector can make or break them. Proudly serving the U.S. military for more than five decades, San-tron continues to think ahead—now offering a breed of connectors and cable assemblies unlike anything the defense community has seen before. eSeries and other unique models that are smaller, lighter, tighter, tougher. Designed to deliver reliable signals under the harshest conditions. Don't settle for anything less. Visit **Santron.com**.

San-tron

Always Thinking

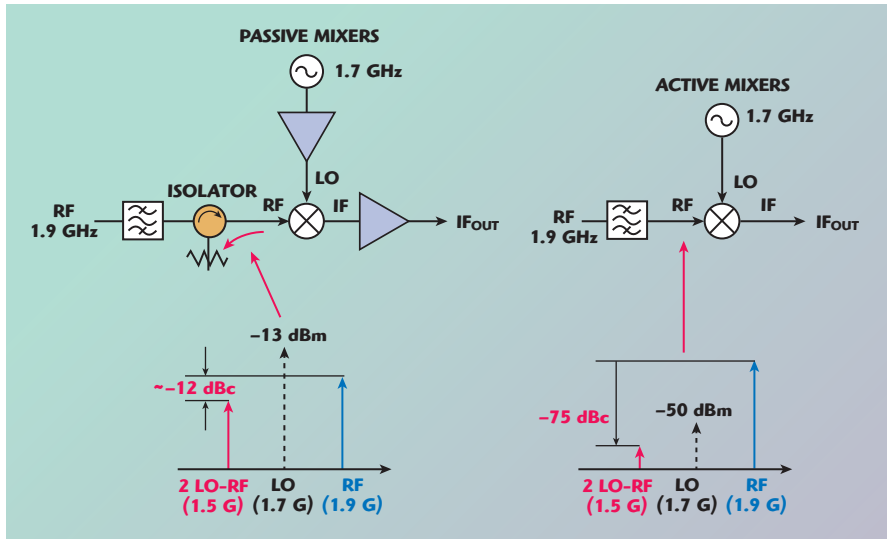
AS9100 REGISTERED
ISO 9001:2008 REGISTERED
DFARS COMPLIANT
ROHS COMPLIANT
ITAR COMPLIANT

See us at IMS Booth #1346

1. Excellent port-to-port isolation
2. Exceptionally low 2×2 and 3×3 spurious products
3. Very low pseudo-image mixing products.

IMPROVED RF ISOLATION

The LTC5577's active mixer topology has an excellent LO to RF leakage of less than –50 dBm, dramatically reducing the undesired LO signal leaking back toward the antenna. This compares favorably to passive mixers that typically have only about 30 dB of isolation, and with a strong LO input level of about +17 dBm results in a much higher –13 dBm LO to RF leakage level. Using the LTC5577 mixer, an external high isolation circulator can be eliminated at the RF input, resulting in a more cost-effective, wideband solution that is space efficient and easy to design.



▲ *Fig. 1 Active mixers reduce LO leakage and the pseudo-image at the mixer's RF input, resulting in improved receiver performance.*

LOW 2×2 AND 3×3 SPURIOUS PRODUCTS

The LTC5577's architecture produces exceptionally low LO and RF harmonic distortion mixing spur products. Its 2×2 (1/2 IF) output distortion spurs measure –79 dBc, while the 3×3 (1/3 IF) spurs are further below at –81 dBc. Such low distortion makes for higher performance in broadband receivers and also improves the distortion correction performance when used in digital predistortion (DPD) receiver applications.

See us at IMS Booth 326

Moreover, the LTC5577's RF input is designed to withstand strong in-band blocking signals with minimal performance degradation. For example, with a +5 dBm input interference signal, its noise figure only degrades from 11.8 to 15.8 dB, compared to other similar class mixers that typically degrade to more than 20 dB. This ensures robust receiver sensitivity in the presence of strong interference.

LOW PSEUDO-IMAGE MIXING PRODUCT

Due to their bi-directional nature and un-buffered RF input, passive mixers have an undesired mixing product present at the RF input, referred to as the "pseudo-image." In the frequency domain, this mixing product is located one IF away from the LO, with a level that is typically 12 dB below the RF input signal level. If not terminated with an isolator or attenuator pad, this mixing product can reflect off the RF input filter and re-enter the mixer, resulting in degraded noise figure at certain frequencies, depending on the electrical length between the filter and mixer. Active mixers like the LTC5577 also have this spur present at the RF input, but at a much lower level, typically –75 dBc. This results in improved receiver sensitivity and simplified RF design by eliminating the need for a circulator or attenuator at the mixer input. ***Figure 1*** illustrates the pseudo-image and LO leakage levels at the RF input for a passive mixer compared to the LTC5577 active mixer.

The new LTC5577 employs an innovative active mixer topology to attain best-in-class 30 dBm IIP3 linearity performance, with 0.7 dB conversion gain and broadband performance range from 300 MHz to 6 GHz. The added benefits of high port-to-port isolation, reduced LO leakage and lower pseudo-image mixing products that challenge many designs. The result is a cost-effective, compact mixer solution that improves receiver performance with low power.

VENDORVIEW

Linear Technology Corp.,
Milpitas, CA
(408) 432-1900,
www.linear.com.

MiCable inc

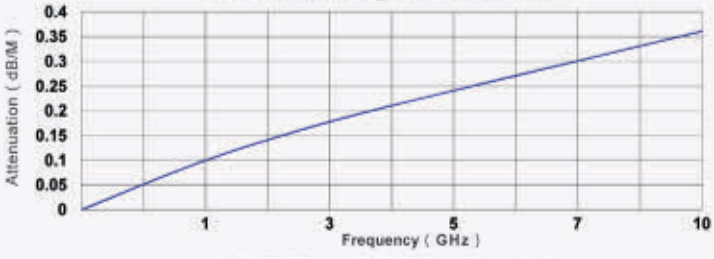
ISO9001:2008 CERTIFIED

A11 Series DC-10GHz Ultra Low Loss, Super High Power Handling Cable Assembly

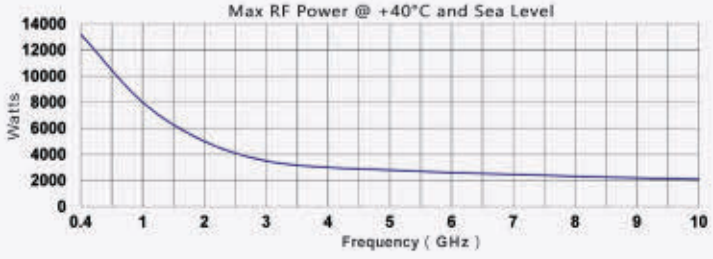
Advantages & Features:

- Frequency up to 10 GHz
- Power handling: 8000 W @ 1 GHz, 2100 W @ 10 GHz
- Cable attenuation: 0.027 dB/ft typ. @ 1GHz, 0.11 dB/ft typ. @ 10 GHz
- *Double shielded with shielding effectiveness < - 90 dB*
- Reinforced passivated stainless steel connectors
- Construction is very robust, employing an advanced strain relief system
- Custom lengths with diversified connectors per request
- Armoring options available

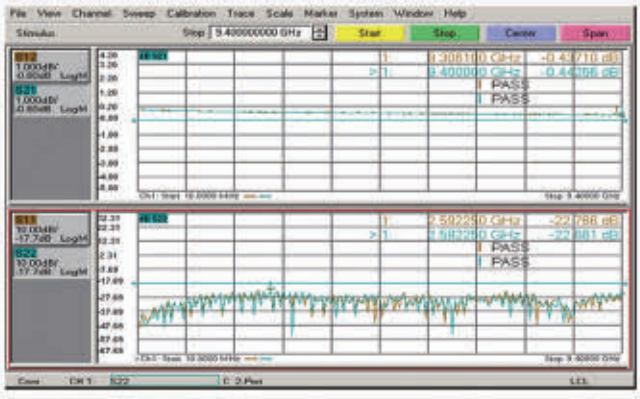
Cable Attenuation @ +25°C and Sea Level



Max RF Power @ +40°C and Sea Level



Test Plot of A11 Cable Assembly, (N M -N M,1meter, DC-9.4GHz)

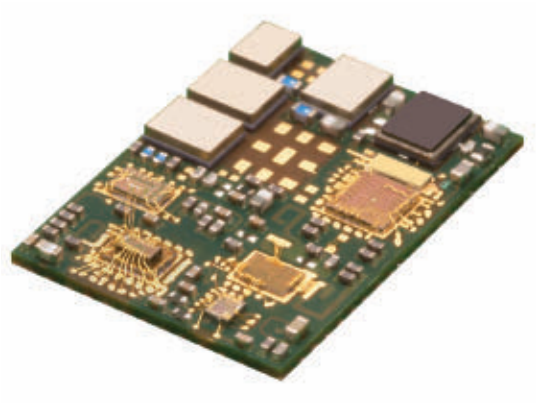


MIcable is your quality fast and low cost solution!

Affiliated with SSi Cable Corp.
MIcable Inc.
Tel: 86 591-87382856
Email: sales@micable.cn
Website: www.micable.cn

USA Distribution Center:
SSI Cable Corporation
Tel: (360)426-5719
Email: bsmith@ssicable.com

See us at IMS Booth 1123



Second-Generation Front End Modules Support Carrier Aggregation

Skyworks Solutions Inc.
Woburn, MA

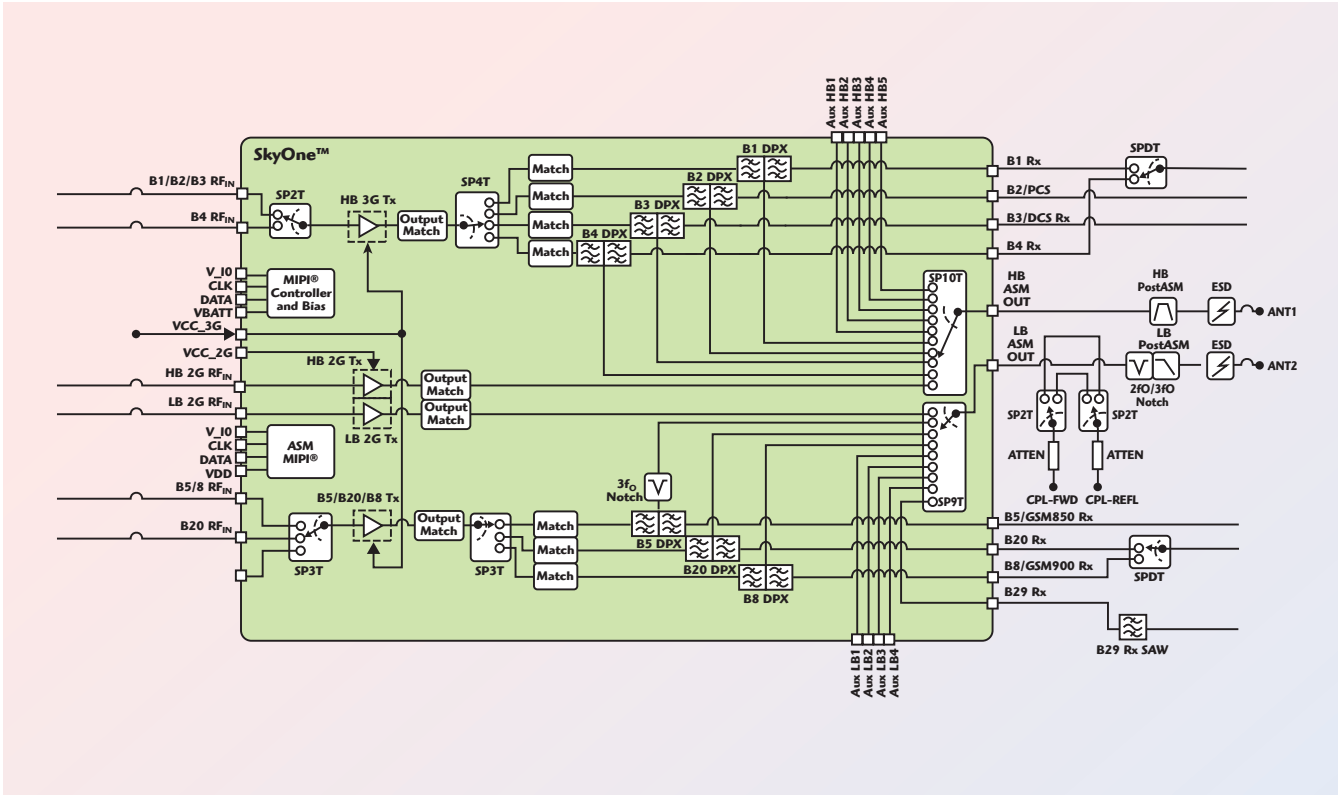
Carrier aggregation (CA) allows mobile service providers to combine spectrum and increase data rate throughput by utilizing two or more bands simultaneously, thereby giving consumers an enriched data experience regardless of location. To meet the demands for smartphones, tablets and datacards requiring wider bandwidths being enabled by carrier aggregation, Skyworks has developed the SkyOne™ family of fully optimized, scalable devices that integrate all of the high performance RF and analog content between the transceiver and antenna into what is claimed to be the industry's smallest footprint. They also provide excellent linearity and power added efficiency for smart RF integration.

The newest front end solutions – the second-generation SkyOne platforms – cover more frequency bands, integrate up to seven duplexers, support carrier aggregation and provide standardized inputs for all leading chipsets that are MIPI® RFFE compatible and address both transmit (Tx) and receive (Rx) switching paths. Skyworks' carrier aggregation switching solutions, which are compliant to tier-one, carrier-driven specifications, are based on silicon-on-insulator wafer process technologies and are available in many different configurations.

SECOND-GENERATION

SkyOne, illustrated in ***Figure 1***, is an 8 × 9 × 0.95 mm module with up to seven duplexers and a dual-pole, 19 throw antenna switch module (ASM) for models supporting carrier aggregation and single pole, 16 throw ASMs for models without a CA requirement. There are multiple variations available depending on regional frequency requirements: the SKY78021, SKY78022, SKY78025 and SKY78026.

SKY78021 is a hybrid, multimode, multiband (MMMB) front end module that supports 2.5G, 3G/4G and CDMA handsets and all standard carrier aggregation frequency band combinations through its integrated dual pole 19 throw switch. This module operates efficiently in EDGE, GPRS, GSM, HSPA, LTE and WCDMA modes.



▲ *Fig. 1 SkyOne™ block diagram.*

SKY78022, SKY78025 and SKY78026 are MMMB FEMs supporting 2.5G, 3G/4G, CDMA and TDD-LTE handsets and operate efficiently in EDGE, GPRS, GSM, HSPA, LTE, TDD-LTE and WCDMA modes. These modules integrate single pole, 16 throw switches with internal IEC protection.

All four SkyOne FEMs consist of a GSM800/EGSM900 PA block, a DCS1800/PCS1900 PA block, separate WCDMA blocks operating in the low and high bands, a logic control block for multiple power control levels, and band enable functions in both cellular and UMTS. RF I/O ports, internally matched to 50 Ω, minimize the need for external components, while extremely low leakage current maximizes handset standby time. The InGaP/GaAs die and passive components are mounted on a multi-layer laminate substrate and the assembly is encapsulated in plastic overmold.

COMPACT ARCHITECTURE

For GSM/EDGE the FEMs' new compact architecture supports the GSM850, EGSM900, DCS1800 and PCS1900 bands, as well as 2.5G Class 12 Enhanced General Packet Radio Service (EGPRS) multi-slot operation and EDGE linear modulation. WCDMA enhanced architecture supports WCDMA/High-Speed Downlink Packet Access (HSDPA) and High-Speed Uplink Packet Access (HSUPA) modulations, covering multiple bands for 3GPP, and operating at different power modes. The modules are fully controllable via a MiPi serial interface.

The SkyOne FEMs meet spectral linearity requirements of LTE modulation with QPSK/16QAM up to 20 MHz bandwidth, including various resource block allocations, with good power-added efficiency. They also meet the spectral linearity requirements of CDMA 2K and EVDO Release A modulation with good power-added efficiency.

THE RECEIVER

For the receiver section GPS and LB/HB WiFi coexistence are designed-in for exceptional support to maintain all radio performance, even in user scenarios of simultaneous use. Optimized low insertion loss Rx paths, matching circuits, and well-grounded guard traces (high Tx-Rx isolation) inside the modules mitigate de-sense problems and enhance sensitivity performance.

The SKY78021 integrated duplexers, Rx SAWs, and a split LB (SP8T)/HB (SP10T) SOI switch support simultaneous downlink carrier aggregation for additional Rx data rate, and provides 2G/3G/4G Rx paths from antenna to LNA port of RFIC. Carrier aggregation requirements for noise and harmonics are designed-in for best de-sense performance. Additionally, the SKY78021 provides four LB and five HB ports. With the SKY78022, SKY78025 and SKY78026, the integrated duplexers, Rx SAWs, and SP16T SOI switch provide 2G/3G/4G Rx paths from the antenna to LNA port of RFIC and all modules provide eight auxiliary ports.

Skyworks has incorporated breakthrough RF switching technology in its newest devices that are enabling early adopters to implement carrier aggregation solutions. SkyOne devices deliver excellent performance, are highly customizable and scalable as well as compatible with all leading chipsets solutions.

VENDORVIEW

Skyworks Solutions Inc.,
Woburn, MA
(781) 376-3000,
www.skyworksinc.com.

Affordable Real-Time Spectrum Analysis

Signal Hound
La Center, WA

Signal Hound's latest innovation is the BB60C spectrum analyzer, an enhanced version of its well-received predecessor, the BB60A. The Signal Hound BB60C has improved SFDR by typically 20 dB, flattened the noise floor by reducing frequency band transitions more than 8 dB, extended the operating temperature down to -40°C and up to +65°C, and expanded the streaming I/Q bandwidth to make it selectable from 250 kHz to 27 MHz. With a price point under $3K, the BB60C is a compelling choice for a broad range of applications.

HARDWARE

The Signal Hound BB60C is a two-stage superheterodyne receiver, using two independent intermediate frequencies (IF). Each IF has a corresponding distributed element notch filter in the RF section, yielding excellent IF rejection. Each RF band also has a distributed element filter buried in the multilayer PCB laminate, specifically engineered to reject that band's image frequencies and reduce LO feedthrough (see ***Figure 1***).

To reduce spurious signals from second-order intermodulation where filtering was not practical, push-pull amplifiers were used in both the preamplifier and mixer stages, effectively canceling even-order mixing products. Direct conversion was used below 20 MHz, avoiding the intermodulation products associated with mixing.

Gain control is achieved in the BB60C using the front end attenuator and preamplifier. The front end was designed to provide good spurious-free dynamic range (SFDR) at any reference level.

The Cypress FX3 USB 3.0 peripheral controller enables the BB60C to continuously stream 80 million 14-bit ADC samples per second to a PC or laptop for processing.

SOFTWARE

The Signal Hound BB60C includes an open-source Windows-based spectrum analyzer software application. The software has traditional controls such as frequency span/center/start/stop, resolution bandwidth, video bandwidth, reference level, configurable traces and markers. Using OpenGL to leverage the GPU acceleration of modern computer graphics, rich display features such as 2D and 3D spectrogram plots and a real-time color persistence display format were added to enhance the user experience and simplify signal identification.

The BB60C ships with a fully documented application programming interface (API) written in C/C++. This provides a tool for users to create their own custom software applications to harness the full capabilities of the BB60C, including record on event trigger, real-time analysis and streaming I/Q data. Program-

Get it airborne with feature-packed hybrid switch matrices.

Is the lack of a lightweight, high power switch matrix keeping your antenna/ sensor system grounded? Aeroflex Signal and Control Solutions (ASCS) can help.

Covering UHF through Ka band, ASCS's broadband and multi-octave solutions are available in nearly limitless I/O configurations. They're housed in your choice of fully hermetic or non-hermetic packaging, and can be engineered to incorporate all your BIT, attenuation, filtering, amplification and conversion requirements.

With decades of hybrid chip and wire and SMT experience, you can count on ASCS to achieve all your insertion loss, gain, signal output and size reduction goals.

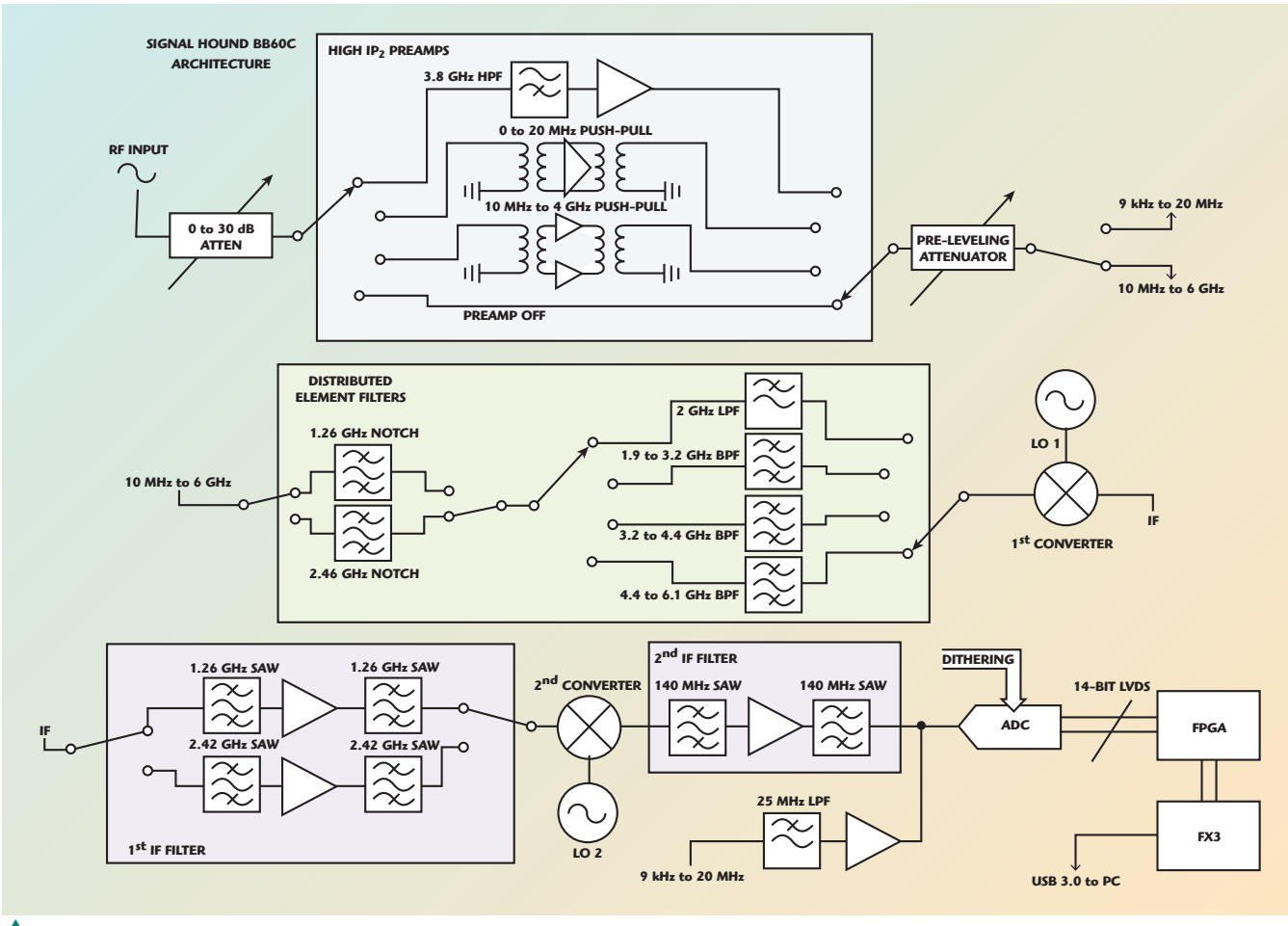
Talk with an application engineer today.

732-460-021 2

www.aeroflex.com/ASCS

See us at IMS Booth 1623

AEROFLEX
A passion for performance.



▲ *Fig. 1 BB60C system architecture.*

mers can either customize the existing open-source application or develop a targeted application from scratch.

The BB60C can be used as an RF recorder by either recording and playing back sweeps, or recording streaming I/Q data directly using the API. The API now features amplitude- and frequency-corrected I/Q data with adjustable sample rates and bandwidth, to support everything from streaming the full 27 MHz of spectrum, to sending a single 250 kHz channel across the Internet.

TABLE I

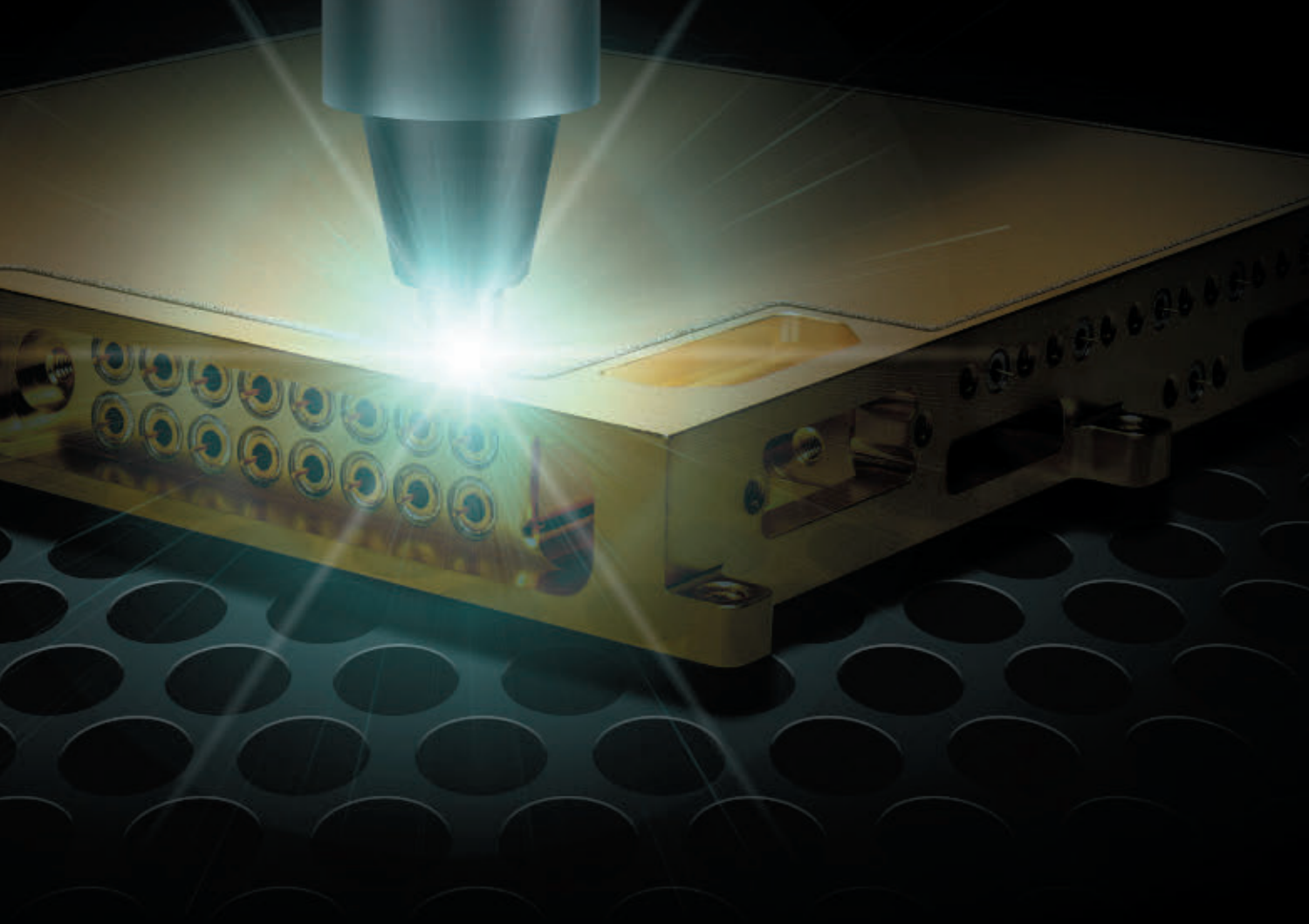
SIGNAL HOUND BB60C ABBREVIATED SPECIFICATIONS (PRELIMINARY)

Frequency Range	9 kHz to 6 GHz
Amplitude Range	+10 dBm to DANL
Amplitude Accuracy	±2.0 dB
Sweep Speed (RBW ≥ 10 kHz)	24 GHz/sec
Streaming Real-Time Bandwidth (Ampl Corrected)	250 kHz to 27 MHz selectable
Displayed Average Noise Level	-159 dBm/Hz + 1 dB/GHz (500 kHz to 6 GHz)
Residual and Spurious Responses	-50 dBc (Ref. Level -50 to +10 dBm, signal 10 dB below ref Level)
SSB Phase Noise	-84 dBc/Hz (1 GHz center freq with 10 kHz offset)
Operating Temperature	0° to +65°C (std.), or -40° to +65°C (option-1)

TRUE REAL-TIME SPECTRUM ANALYSIS

Gapless spectrum coverage, the hallmark of real-time spectrum analysis, is achieved for the entire 27 MHz of Instantaneous Bandwidth (IBW) by using 75 percent overlapping Fast Fourier Transforms (FFT). This means that every digitized sample will be included in 4 FFTs. In this mode, any signal inside the IBW of sufficient amplitude, regardless of duration, will show up in the display. For maximum displayed amplitude, a signal must be present for one entire FFT. For a 631 kHz resolution bandwidth, this works out to about 4 microseconds, but even a 1 microsecond pulse will be attenuated by only 2 to 3 dB.

Advances in Single Instruction Multiple Data (SIMD) instructions have enabled modern processors, such as Intel's Core i7, to perform signal processing at a very high rate, often in excess of 100 GFLOPS. By leveraging Intel's Integrated Performance Primitives, this power has been harnessed with the BB60C. Even when the API is shoving 320 million data points per second into FFTs, or converting streaming IF into amplitude- and frequency-corrected I/Q data, the BB60C only uses a modest fraction of available processor resources. See ***Table 1*** for a summary of the specifications.



The final stage.

Thunderline-Z laser sealing completes the packaging cycle.

One-stop packaging? Case closed. From the #1 name in hermetic feedthroughs and custom RF housings, comes the final stage in the cycle. Thunderline-Z now offers high-powered laser sealing of your hi-rel components and modules. From final lidding to our own innovative surface mount Bell Pin technology, turn to Thunderline-Z to help you create the perfect hermetic package.

Backed by the strength of Emerson and powered by a 500 W vacuum sealed glovebox and a 150 W laser workstation, you can now trust your packages to one source from design through fine and gross leak testing.

It's the final chapter to a hermetic packaging legacy like no other.

THUNDERLINE-Z®

www.thunderlinez.com
603.329.4050

EMERSON™

EMERSON. CONSIDER IT SOLVED™.

In Pursuit of Excellence Through Engineering

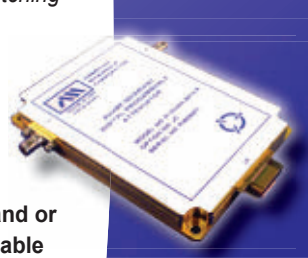
INTEGRATED MICROWAVE ASSEMBLIES AND COMPONENTS

INTEGRATED ASSEMBLIES
- Solid State Switch Based Assemblies
- Switch Matrices on a substrate
- Direction Finding and Beam Forming Networks
- Custom Integration and turn Key systems

SOLID STATE SWITCHES
- DC to 40 GHz
- SPST to SP64T configurations

Any design can be optimized for specific frequency range, insertion loss, isolation, intercept points, switching speed and VSWR.

SOLID STATE VARIABLE ATTENUATORS
- Phase Invariant, Broad Band or Octave Band models available
- Attenuation Ranges 30-120 dB
- 10 MHz to 18 GHz bandwidths available
- Digital, Analog or Current Controlled Variable Attenuators
- Designed to meet MIL Std 202 (additional screening available)



LOG VIDEO AMPLIFIERS
- Standard products – 50 and 70 dB dynamic range SDLVA & DLVA
- CW immunity circuits available for all models

AMERICAN MICROWAVE CORPORATION

MIL 883 CAPABLE - ISO9001:2008 REGISTERED

7309-A GROVE RD | FREDERICK, MARYLAND
PHONE 301.662.4700 | FAX 301.662.4938
AMERICANMIC.COM | SALES@AMERICANMIC.COM

See us at IMS Booth 509

ProductFeature

UNIQUE FEATURES

The Signal Hound BB60C is USB-powered, eliminating the need for external power supplies. This is a convenience for bench-top users, but a must in the field. During manufacture, each BB60C is tested in an environmental temperature chamber. Amplitude readings across frequency, gain and attenuation are measured to generate correction coefficients in 10°C steps, which are then saved in the BB60C flash memory. The API uses this data, along with the BB60C's internal temperature sensor, to compensate amplitude readings for actual operating conditions. This ensures that full accuracy measurements can be taken anywhere from Antarctica to the Sahara. The standard temperature range is built to operate from 0° to +65°C, and the option-1 extended temperature range is built to operate from -40° to +65°C.

In addition to the timebase 10 MHz in/out, the BB60C provides a trigger in/out. The trigger-in mode flags the data sample in the I/Q stream corresponding to the trigger's rising (or falling) edge. The API corrects for the propagation delay through the analog and digital filters, enabling high precision timing, such as time-gated sweeps or GPS time-stamping. The BB60C is built to stock. It generally ships within one day after receiving an order, making it an ideal solution for time-sensitive jobs, when waiting on a manufacturer's standard lead time is not an option.

APPLICATIONS

The Signal Hound BB60C is well suited to several applications due to its real-time analysis capability. Some key examples include intermittent interference hunting, spread spectrum signal analysis, process automation, and remote spectrum monitoring.

Intermittent interference hunting poses several challenges. A traditional spectrum analyzer will only display interference if it occurs within the RBW being measured, making interference difficult to identify and quantify. A real-time spectrum analyzer like the BB60C processes thousands of RBWs simultaneously (in parallel), making the task of interference hunting easy.

Identifying and analyzing frequency hopping spread spectrum signals can pose a challenge for a traditional spectrum analyzer, which will only catch a small fraction of hops. The BB60C's ability to simultaneously stream the entire 902 to 928 MHz ISM band, or sweep from 2400 to 2475 MHz in about 4 ms, greatly simplifies this process.

Production line automation and remote spectrum monitoring can be accomplished over an Ethernet connection with the combination of a BB60C, custom software written using the API, and an Intel vPro enabled PC such as the NUC, model DC53427HYE. Intel vPro technology makes it possible to remotely turn on or off the PC, perform a system recovery if the PC or BB60C crashes, and manage software updates.

Signal Hound,
La Center, WA
(800) 260-TEST or
001-360-263-5006,
sales@signalhound.com,
www.signalhound.com/MWJ.

PRECISION ATTENUATORS

2 W to 100 W

NEW
50 W & 100 W models

NOW from DC up to 40 GHz from $29.95 ea. (1-49)

Customers trust Mini-Circuits BW-family precision fixed attenuators for accuracy, reliability, and repeatability. Now, we've expanded your choices to cover *DC – 40 GHz!* With accurate attenuation from 1 to 50 dB and power handling from 2 up to 100W, these attenuators now bring the same performance you've come to count on to even more applications!

Visit minicircuits.com for free data, curves, quantity pricing, designer kits, and everything you need to find the BW attenuator for your needs. All models are available off-the-shelf for delivery as soon as tomorrow!

RoHS compliant

Mini-Circuits®

www.minicircuits.com P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com

See us at IMS Booth 823

6 in 1 Oscilloscope Instrument

Tektronix
Beaverton, OR

The Tektronix MDO3000 Series of mixed domain oscilloscopes offers the convenience of six integrated instruments in a single compact package, including a spectrum analyzer, logic analyzer, protocol analyzer, arbitrary/function generator and digital voltmeter/frequency counter. With this level of integration, the MDO3000 clears the design bench of costly, specialized equipment and provides the tools needed to test and debug virtually any embedded design, even those involving time and frequency domains. The MDO3000 is highly customizable, enabling designers to select the functionality and performance needed now, and then increase capabilities as their measurement needs change or budgets allow.

With the complexity of modern embedded designs increasing, coupled with the growth of wireless, it has become challenging for many organizations to give designers all the tools they need for efficient debug and troubleshooting. By offering the functionality of six independent instruments without the significant cost of separate units, the MDO3000 lowers capital costs while saving space and improving usability. It also reduces the time engineers have to spend tracking down test instruments from around the lab as the need arises.

Tektronix MDO4000B Series and now the MDO3000 Series are the only oscilloscopes to include a dedicated spectrum analyzer, allowing engineers to access both time and frequency domain analysis in a single instrument. When compared to both standalone oscilloscopes and basic spectrum analyzers in this class, the MDO3000 provides best-in-class performance and features.

INTEGRATION AND VERSATILITY

The MDO3000 Series oscilloscopes provide two or four analog input channels with bandwidth ranging from 100 MHz to 1 GHz, 16 digital channels and one RF input channel matching the bandwidth of the oscilloscope

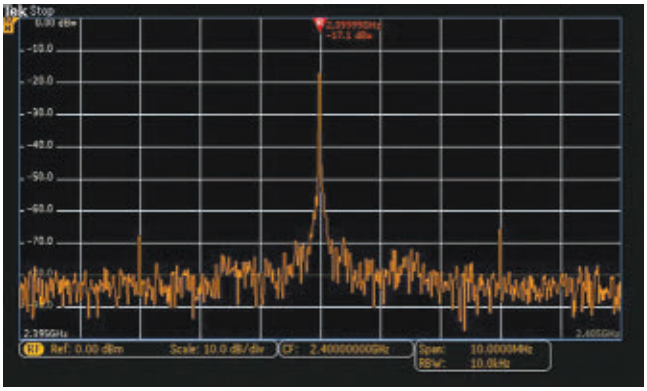


Fig. 1 When using the spectrum analyzer input, the MDO3000 display becomes a full-screen frequency domain view.

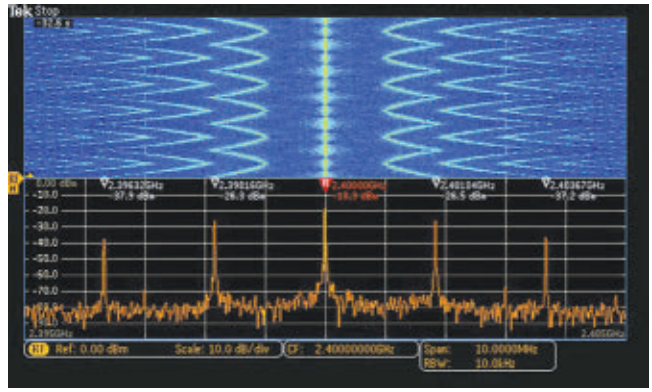


Fig. 2 The MDO3000's spectrogram display illustrates slowly changing RF phenomena such as a signal that has multiple peaks which is being monitored here.

(9 kHz up to analog bandwidth). The RF input frequency on any model can be extended to 3 GHz.

Based on the Tektronix MSO/DPO3000 mixed signal oscilloscope series, the MDO3000 provides extensive debug functionality. With the new FastAcq feature, the MDO3000 oscilloscopes can capture 280,000 waveforms per second to assist in finding infrequent anomalies in a signal. More than 125 available trigger combinations, automated serial and parallel bus analysis, Wave Inspector navigation and automated search controls, and optional automated power measurements round out the feature-set. Also available are optional serial protocol analysis packages including I2C, SPI, RS-232, USB 2.0, CAN, LIN, FlexRay, MIL-STD-1553 and Audio.

The integrated, optional 50 MHz AFG functionality is more than two times faster than competitive offerings with eight times the arbitrary waveform record length. The integrated digital voltmeter (DVM) provides 4-digit AC RMS, DC, or AC+DC RMS voltage measurements, as well as 5-digit frequency measurements. The DVM feature is available free of charge when an MDO3000 product is registered.

The MDO3000 instruments are offered with 3.9 pF passive voltage probing. For higher speed applications, 1 GHz passive voltage probes are offered standard with 1 GHz instruments. These low capacitance probes minimize the impact on devices under test while reducing signal distortion and cleanly passing the signal to the oscilloscope for measurement.

PLATFORM UPGRADES

With the MDO3000 Series, engineers can start with the minimum performance and functional levels they need to accomplish the project at hand with the knowledge that their test platform can be upgraded in the field. Performance upgrades include analog bandwidth of the oscilloscope and input frequency of the spectrum analyzer. Functional upgrades include the addition of digital channels, protocol analysis, arbitrary function generation or digital voltmeter measurements.

SPECTRAL ANALYSIS

When using the spectrum analyzer input, the MDO3000 Series display becomes a full-screen frequency domain view as shown in ***Figure 1***. Key spectral parameters such as center frequency, span, reference level and resolution bandwidth are all adjusted using the dedicated front-panel menus and keypad.

In a traditional spectrum analyzer, it can be a tedious task to turn on and place enough markers to identify all the peaks of interest. The MDO3000 Series improves this process by automatically placing markers on peaks that indicate both the frequency and the amplitude of each peak. The user can adjust the criteria that the oscilloscope uses to automatically find the peaks.

The instrument also includes a spectrogram display as shown in ***Figure 2*** for monitoring slowly changing RF phenomena. The x-axis represents frequency, just like a typical spectrum display. However, the y-axis represents time, and color is used to indicate amplitude. Modern wireless communications vary significantly with time, using sophisticated digital modulation schemes and, often, transmission techniques that involve bursting the output. These modulation schemes can have very wide bandwidth as well. The MDO3000 Series addresses these challenges with up to 3 GHz of capture bandwidth. The spectrum is generated from a single acquisition, thus guaranteeing the user will see targeted events in the frequency domain.

Signal input methods on spectrum analyzers are typically limited to cabled connections or antennas. But with the optional TPA-N-VPI adapter, any active, 50 Ω TekVPI probe can be used with the spectrum analyzer on the MDO3000. This enables additional flexibility when hunting for noise sources and enables easier spectral analysis by using true signal browsing on a spectrum analyzer input. In addition, an optional preamplifier accessory assists in the investigation of lower-amplitude signals. The TPA-N-PRE preamplifier provides 10 dB nominal gain across the 9 kHz to 3 GHz frequency range.

MDO3000 oscilloscopes are available worldwide with prices ranging from $3,350 U.S. MSRP for starter instruments to $18,650 U.S. MSRP providing 1 GHz, 4-channel oscilloscope with AFG, MSO and 3 GHz spectrum analyzer frequency range. Similar standalone instrumentation would cost more than $27,500 U.S. MSRP.

Tektronix,
Beaverton, OR
(800) 833-9200,
www.tek.com/mdo3000.

40 GHz Fixed Attenuators

Mini-Circuits has developed a new family of DC to 40 GHz, 50 ohm precision fixed attenuators ranging from 3 to 20 dB. Each precision attenuator handles up to 2 W of power with a typical VSWR of 1.2. The family consists of the BW-K3-2W44+ with 3 dB attenuation, BW-K6-2W44+ with 6 dB attenuation, BW-K10-2W44+ with 10 dB attenuation and BW-K20-2W44+ with 20 dB attenuation.

All of the attenuators have passivated stainless steel connectors and are RoHS compliant. The operating and storage temperature is -55° to +100°C. All units have 2.92 mm female/male connectors. Typical applications include matching, instrumentation and test setups.

Mini-Circuits offers a wide variety of fixed, programmable and voltage variable attenuators. Its surface mount attenuators come in packages as small as 2 × 2 mm with a full line of hi-rel, hermetically sealed ceramic models for the harshest operating conditions. Coaxial connector attenuator models in the lineup offer excellent accuracy, repeatability and rugged construction for power levels from 2 to 100 W. Mini-Circuits' programmable and voltage variable attenuators provide accurate control with flat performance from DC to 7 GHz over frequency ranges as wide as 4 GHz. All models are available off the shelf for immediate delivery.

VENDORVIEW

Mini-Circuits,
Brooklyn, NY,
sales@minicircuits.com,
www.minicircuits.com.

COST-EFFECTIVE HERMETIC MICRO D CONNECTORS

Standard 9 to 51 pin configurations available or let us design to your custom requirements

SHP SPECIAL HERMETIC PRODUCTS, INC.

Hi-Rel By Design

CONTACT US TODAY
(P) 603-654-2002 (F) 603-654-2533
www.shp-seals.com email: sales@shp-seals.com
CERTIFIED ISO 9001:2008

Visit us at **IMS Booth #650**

BREAK THROUGH MANUFACTURING BARRIERS

We're Not Your Average Outsource

SemiGen understands your gross margin goals so we've taken microwave outsourcing to another level. By creating a direct extension of your manufacturing and supply chain environment our team becomes your team–instantly.

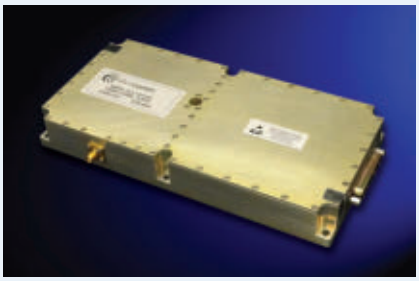
With SemiGen You Get:

- Expert Hybrid Assembly and Wire Bonding
- Complete Testing up to 50 GHz
- Proven Diodes and Passive Components
- Fast Prototyping and Repair Services
- High-mix Automated PCBA
- RF/Digital Design Engineering
- Name-brand Bonding Supplies
- Dedicated Service Plans

Get the edge on the competition by scheduling a free manufacturing consultation today.

SemiGen
Get the Edge

920 Candia Road, Manchester, NH 03109
603-624-8311 | www.SemiGen.net



High Power Pulsed or CW 16 to 18 GHz Amplifier

Aethercomm model number SSPA 16.0-18.0-50 is a high power, broadband, GaN RF amplifier that operates from 16 to 18 GHz. This GaN microwave amplifier operates at a base plate temperature of –40° to +55°C for maximum performance. It is packaged in a modular housing that is 8.50(w)" by 3.50(l)" by 1.38(h)". This amplifier has a typical P3dB of 50 W at room temperature. Noise figure at room temperature is 12 dB typical. It offers a typical power gain of 50 dB with a typical gain flatness of ±1.0 dB. Input and output VSWR is 2.0:1 maximum. Class-AB quiescent current is 6.0 A typical, employing a +26 V DC supply. Second harmonics are less than -40 dBc and spurious emissions are less than -60 dBc.

The SSPA includes an external DC blanking command that enables and disables the module in less than 20.0 µsec. A logic low or open circuit commands the PA OFF. A logic high commands this amplifier ON. Standard features include over/under voltage protection and reverse polarity protection. Input and output RF connectors are SMA female. DC and command voltages are accessible via a DSUB connector.

This is an example of an Aethercomm standard product. Aethercomm designs and manufactures high performance, high power CW or pulsed SSPAs for commercial, military and satellite communications customers.

Aethercomm Inc.,
Carlsbad, CA
(760) 208-6002,
www.aethercomm.com.

See us at IMS Booth 724

REALIZE A CLEAR COMPETITIVE **ADVANTAGE**

NXP has been at the forefront of smart RF and microwave solutions for more than 35 years, that's why we are a trusted leader in 4G base stations. Whatever your challenge, with a broad RF portfolio and collaborative approach, our application experts will help you advance your RF designs to power your competitive advantage.

Visit us at IMS2014, June 3-5 in Tampa, Florida, booth 1733 and discover how we can release your potential.

www.nxp.com/rf

NXP

SECURE CONNECTIONS
FOR A SMARTER WORLD

FEATURED
WHITE PAPERS
The information you need, from industry experts

Accel-RF Instruments Corporation
Assessing the Parameters that Influence Reliability in GaN-based Solid-State Power Amplifier Architectures

Anritsu envision:ensure
Eliminating the Tradeoffs and Limitations of Your Pulse Measurement Test Solution

AR
AR's Complete Product Catalog for EMC & RF Testing

MERCURY SYSTEMS
RF/Microwave Technologies - A Better Alternative In Defense Electronics

RichardsonRFPD An Arrow Company
Wavelex Products Facilitate Both Multi-Octave Bench Testing and Multi-System Testing

ROHDE&SCHWARZ
1MA126: Testing S-parameters on Pulsed Radar Power Amplifier Modules

TEGAM
A new Coaxial Flow Calorimeter for Accurate RF Power Measurements up to 100 Watts and 1 GHz

Check out these new online Technical Papers featured at **MWJournal.com**

Microwave Journal
Frequency Matters.

TechBrief

9.5 to 12.5 GHz Down Converter

Norden has introduced a 10.7 to 12.75 GHz down converter with an IF Band 1 frequency of 950 to 1950 MHz and IF Band 2 frequency of 950 to 2000 MHz. The LO Band 1 frequency is 975 MHz and LO Band 2 frequency is 1075 MHz with an external reference frequency of 10 MHz. It has a noise figure of 0.9 dB maximum and P1dB compression point of 13 dBm. Gain is 60 to 70 dB with a flatness of ±2 dB over the full bandwidth. Third order intercept is -110 dBm and image rejection is -75 dBc. Output VSWR is 1.6:1 and input VSWR is 2:1.

Norden Millimeter has extensive experience in design and manufacturing of frequency converter and custom assemblies products for both the military and commercial markets. They understand that the vast majority of requirements for these types of products involve custom design and packaging per individual customer specifications.

Norden military converters and custom assemblies are used in airborne, shipboard and ground mobile platforms. Military applications include avionics, electronic warfare (including ECM, ESM, ELINT, SIGINT), radar applications, radar environment simulation systems and intelligence, surveillance and reconnaissance (ISR) systems. Norden's commercial converters and custom assemblies are used in microwave communications, astronomy and test equipment.

With experience from VHF to W-Band and in analog, mixed signal and digital technologies, Norden has a wide portfolio of circuit modules, configurations and functionality to meet many different platform needs. Norden utilizes custom building blocks and mixed media construction techniques to meet the most challenging performance and size constraints on the market today.

Norden Millimeter,
Placerville, CA
(530) 642-9123,
www.nordengroup.com.

IMS 2014 Exhibitor List

The following list is complete as of March 24, 2014. Exhibitors in blue have an ad in this issue.

Scan page using layar app

3D Glass Solutions 455
3G Metalworx Inc. 234
A.J. Tuck Co. 1811
A.T. Wall Co. 340
A-Alpha Waveguide Co. 1500
ABF Elettronica Srl 2222
Accel-RF Instruments Corp. 2132
Accurate Circuit Engineering 750
ACEWAVETECH 853
Adamant Kogyo Co. Ltd. 2006
ADMOTECH Co. Ltd 218
AdTech Ceramics 221
Advance Reproductions Corp. 2046
Advanced Circuitry International 1915
Advanced Microwave Components 2017
Advanced Test Equipment Rentals 207
Aeroflex Inc. 1623
Aethercomm Inc. 1125
Agilent Technologies 1133
AI Technology Inc. 1806
AIR-VAC Engineering Co. 348
AKON Inc. 540
Aldetec Inc. 217
Aliner Industries Inc. 1906
AMCAD Engineering 1240
Amcom Communications Inc. 747
American Microwave Corp. 509
American Standard Circuits Inc. 2033
Ametek HCC Electronic Packaging 230
Amphenol Printed Circuits 1947
AmpliTech Inc. 600
AMTI Microwave Circuits 2224
Analog Devices Inc. 415
Anapico Ltd. 2015
Anatech Electronics 239
Anokiwave 149
Anritsu Co. 715
ANSYS Inc. 1433
Anteverta Microwave 1241
APA Wireless Technologies 201
API Technologies 1515
Applied Thin-Film Products (ATP) 526
AR RF/Microwave Instrumentation 1415
ARC Technologies Inc. 1211
Ardent Concepts Inc. 2019
Arlon Tech. Enabling Innovation 1044
Artech House 722
ASB Inc. 1848
Ascotech Elec. Ltd. 1740
Aselsan 2126
Association of Old Crows/Naylor Pub. 2056
ATC 1927
ATE Systems 751
Atlanta Micro Inc. 908
Auriga Microwave 1140
Aurora Software & Testing, SL 643
Avago Technologies 1525
AVX Corp. 1927
AWR Corp 633
Axiom Test Equipment Inc. 1452
B&Z Technologies 1040
Barry Industries Inc. 627
Beijing Aumiwalker Technology Co. Ltd 1949
Besser Associates Inc. 632
Big C: Dino-Lite Scopes 448
BJG Electronics 227
Bliley Technologies Inc. 847
BOCEN Microwave Technology Co. Ltd. 1951
Boeing 745
Boonton 808
Bowei Integrated Circuits Co. Ltd. 247
BRL Test Inc. 1001
BSC Filters Ltd. 1411
C W Swift 938
Cadence Design Systems Inc. 840
California Eastern Laboratories 2116
Cambridge University Press 537
CapeSym Inc. 641
Cascade Microtech Inc. 1132
CEMWorks Inc. 2228
Centellax Inc. 1752
Centerline Technologies LLC 1453
Ceramic Magnetics Inc. 228
Cernex & Cernexwave 1218
Charter Engineering Inc. 309
Chengdu Filter Technology Co. Ltd. 117
Chengdu Hengwei Microwave Electronic Co. 225
Chengdu Kelai Microwave Science & Technology Co. Ltd. 2225
Chengdu Sinoscite Co. Ltd. 2239
Chin Nan Precision Electronics Co. Ltd. 209
Ciao Wireless Inc. 604
Cirexx International Inc. 1807
Coaxial Components Corp. 131
Cobham 1633
Coilcraft Inc. 708
Coining Inc. 1816
Coleman Cable Inc. 1006
Colorado Microcircuits Inc. 2134
COM DEV Ltd. 942
Communications & Power Industries 1639
Compex Corp. 311
Component Distributors Inc. 1543
Connectronics Inc. 229
Copper Mountain Technologies 645
Corning Inc. 1047
Corry Micronics Inc 845
Crane Aerospace & Electronics 332
Crane Polyflon 328
Cree Inc. 433
Crystek Corp. 206
CSI Group 1751
CST of America Inc. 1423
CTS Electronic Components 322
CTT Inc. 429
Cuming Microwave 1311
Custom Cable Assemblies Inc. 848
Custom Interconnects 754
Custom Microwave Components Inc. 2114
Custom MMIC 1844
Custom Systems Integration-CSI 1228, 1229
Daa-Sheen Technology Co. Ltd. 1645
Daisy RS 1602
DAPU Telecom Tech. Co. Ltd. 1908
dBm 1037
Delcross Technologies LLC 850
DELFMEMS 245
Delta Electronics Mfg. Corp. 1114
Delta Microwave Inc. 1109
Delta-Sigma Inc. 342
Design Workshop Technologies Inc. 741
DeWeyl Tool Co. Inc. 320
DFINE Technology Co. Ltd. 550
Diamond Antenna & Microwave Corp. 506
Diamond Microwave Devices Ltd. 1651
Dielectric Laboratories Inc. 1304
DITF Interconnect Technology 1917
DiTom Microwave Inc. 1004
Dong Jin Technology Innovation Co. Ltd. 2129
Dow Key Microwave Corp. 1405
Ducommun Inc. 1124
DuPont Electronic Technologies 1647
Dyconex AG 2213
Dynatronix Inc. 125
Dynawave Inc. 1308
Dyne Tech Co. Ltd 2010
e2v 2120
EADS North America 1145
Eastern Optx 1152
Eclipse Microwave Inc. 1600
Elbit Systems EW & SIGINT-Elisra 1924
ELDUR Corp. 121
Electro Rent Corp. 1147, 1329
ElectroMagneticWorks Inc. 527
Elsevier 248
EM Research Inc. 914
EM Software & Systems - FEKO 307
EMC Technology 923
Emerson Connectivity Solutions 1005
Empower RF Systems 523
EMSCAN 1128
ENS Microwave LLC 952
Epoxy Technology Inc. 240
Erzia Technologies S.L. 654
ET Industries 1909
ETG Eternal Technology Group 1707
ETL Systems 809
ETS-Lindgren 1333
European Microwave Week 720
Evaluation Engineering 1548
Everything RF / Microwaves 101 651
Excalibur Engineering Inc. 2139
Exelis Inc. Electronic Systems 1322
Exelis Inc. – Specialty Applications 1323
Exodus Advanced Communications Corp. 111
EZ Form Cable Corp. 1710
F&K Delvotec Inc. 1552
Farran Technology Ltd. 147
FECOA ELASI 344
Ferrite Microwave Technologies 314
Flann Microwave 215
Flexco Microwave Inc. 1919
Florida RF Labs 923
Florida RS Technology 139
Focus Microwaves Inc. 1432
Fort Wayne Metals 451
Fotofab 210
Freescale Semiconductor 1315
Frontlynk Technologies Inc. 440
FTG Corp. 1941
Gap Wireless 1136
Gel-Pak 2032
Genmix Technology Co. Ltd 1842

IMS 2014 Exhibitor List

Gerotron Communication GmbH 1821
GGB Industries Inc. 1226
GigOptix Inc. 409
Global Communication Semiconductors LLC 1808
GLOBALFOUNDRIES 1339
Gova Advanced Material Technology Co. Ltd 546
Gowanda Electronics 441
Greenray Industries Inc. 223
GS Instruments Co. Ltd. 2035
G-Way Microwave 349
Harbour Industries LLC 1440
HEI Inc. 1904
Herley Industries 1015
Herotek Inc. 1327
Hesse Mechatronics 505
High Frequency Electronics 1605
Hi-Rel Group LLC 345
Hittite Microwave Corp. 1841
Holzworth Instrumentation Inc. 700
Hongke Microwave Communication Co. Ltd 352
HRL Laboratories LLC 749
Huber+Suhner Astrolab Inc. 408
Hughes Circuits Inc. 1943
HYPERLABS Inc. 133
IBM Corp. 1242
IC Chip Packaging 950
IEEE Microwave Magazine 504
IEEE Xplore Digital Library 2004
IHP GmbH 1149
IMST GmbH 1201
Infineon Technologies 804
Innertron Inc. 1825
In-Phase Technologies Inc. 1335
Instruments For Industry, a Teseq Company 500
Insulectro 1746
Integra Technologies Inc. 1506
Integrand Software 2214
Intercept Technology Inc. 1143
International Manufacturing Services Inc. 1224
inTEST Thermal Solutions 2025
Ion Beam Milling Inc. 524
IQD Frequency Products Inc. 224
IQE 107
IROM Tech Inc. 2243
Ironwood Electronics 1829
Isola 533
ISOTEC Corp. 1804
ITEM Media 343
ITF Co. Ltd. 1840
iTherm Technologies 752
IW Insulated Wire Microwave Products Div. 1436
Jebsee Electronics Co. Ltd. 1745
JFW Industries Inc. 1115
Johanson Technology Inc. 1023
JQL Electronics Inc. 212
K&L Microwave Inc. 1404
KCB Solutions 815
Keragis Corp. 909
KEYCOM Corp. 1553
Kingsignal Technology Co. Ltd. 137
Komax Wire 2221
Krytar Inc. 1119
KVG Quartz Crystal Technology GmbH 549
Kyocera America Inc. 1214
L-3 Communications Electron Devices 404
LadyBug Technologies LLC 1805
Laird 2226
Lake Shore Cryotronics Inc. 1352
Lancaster Metal Science Corp. 1751
LanJian Electronics 135
Lark Engineering Co. 211
Laser Processing Technology Inc. 200
Laser Services Inc. 1907
LCF Enterprises 746
Leader Tech. Inc. 2123
Liberty Test Equipment Inc. 1008
LiConn Inc. 453
Linearizer Technology Inc. 318
Lintek Pty Ltd. 1747
Linwave Technology Ltd. 2136
Logus Microwave 338
Lorch Microwave 923
Low Noise Factory 115
LPKF Laser & Electronics 1108
MACOM 915
M2 Global Technology Ltd. 1111
Marcel Electronics International 743
Marki Microwave Inc. 634
Massachusetts Bay Technologies 2121
Materion 1711
MathWorks 2052
Maury Microwave Corp. 1241
MaXentric Technologies LLC 2219
McGraw-Hill Professional 2014
MCV Technologies Inc. 2143
MECA Electronics Inc. 842
Mega Circuit Inc. 1610
MegaPhase 1348
Meggitt Safety Systems Inc. 1426
Mercury Systems 742
Mersen 1717
Mesuro Ltd. 740
METALLIFE Inc. 1950
Metamagnetics Inc. 1902
Metropole Products Inc. 906
Micable Inc. 1123
Mician GmbH 1223
Micro Communications Inc. 2234
Micro Electronic Technology Development Application Corp. 113
Micro Lambda Wireless Inc. 621
Micro Systems Engineering GmbH 2213
MicroApps 1246
Micro-Coax Inc. 425
MicroFab Inc. 1933
Microlease 2141
Micro-Mode 1222
Microsanj 1000
Microsemi Corp. 321
Microtech Inc. 1604
Microtool Inc. 554
Microwave Applications Group 1200
Microwave Communications Labs Inc. 709
Microwave Development Labs Inc. 1715
Microwave Dynamics 904
Microwave Engineering Europe 1900
Microwave Journal 724
Microwave Product Digest 1021
Microwavefilters & TVC S.r.l. 2137
Microwaves & RF 1609
MIG Microwave Innovation Group 2115
Millimeter Wave Products Inc. 2016
Millitech Inc. 923
Mini-Circuits 823
Mini-Systems Inc. 807
MITEQ Inc. 325
Mitsubishi Electric US Inc. 615
MKS Alter Products 2050
Modelithics Inc. 1141
Modular Components National Inc. 511
Molex RF/Microwave Business Unit 508
Momentive Performance Materials 2040
Morion Inc. 216
MOSIS 1449
Mouser Electronics Inc. 1851
MPDevice Co. Ltd. 1910
MPI Corp. 450
MtronPTI 916
Murata Electronics 811
MWI Laboratories 1756
Naeco 1748
NAMICS Technologies Inc. 1549
Nanjing Jiexi Technologies Co. Ltd. 1601
Nano Materials International Corp. 2037
Narda Microwave-East, an L-3 Company 405
Natel EMS 649
National Instruments 633
National Reconnaissance Office 2127
National Research Council Canada - GaN Foundry 119
NEL Frequency Controls Inc. 2021
Netshape Technologies Inc. - MIM 1751
Networks International Corp. (NIC) 1501
NEWKO Precision Proto-Type 1751
Nitronex LLC 1742
Noise XT 1053
Noisecom 808
Norden Millimeter Inc. 648
Northrop Grumman Systems Corp. 1039
Nova Microwave Inc. 819
NSI 851
Nuhertz Technologies LLC 638
Nuvotronics 1349
NuWaves Engineering 1935
NXP Semiconductors 1733
OEwaves Inc. 205
Ohmega Technologies Inc. 249
Omicron Microwave Tech. Co. Ltd. 2133
OML Inc. 2235
OMMIC S.A.S 445
OPHIR RF Inc. 1504
Orbel Corp. 444
Orient Microwave Corp. 1606
P/M Industries Inc. 2220
P1dB Inc. 315
Palomar Technologies 854
Paricon Technologies Corp. 755
ParkerVision Inc. 2051
Passive Plus Inc. 1920
Peopleworks 141
Peregrine Semiconductor Corp. 515
PHARAD LLC. 544
Photonic System Inc. 1741
Pickering Interfaces Inc. 653
Pico Technology 1551
Piconics Inc. 1714
Pimtek Instrument Co. 109
Pivotone Communication Tech. Inc. 1049

IMS 2014 Exhibitor List

PJC Technologies Inc. 1749
Planar Monolithics Industries Inc. 1705
Plextek RF Integration 1809
Pole/Zero Corp. 1410
Polyfet RF Devices 438
Ponn Machine Cutting Co. 805
Precision Connector Inc. 1708
Precision Manufacturing Group 1442
Precision Plating Co. 1751
Precision Process Inc. 1922
Presidio Components Inc. 1205
Presto Engineering Inc. 2044
Q Microwave Inc. 601
Quest Microwave Inc. 1505
Questech Services Corp. 246
Quik-Pak 2032
QuinStar Technology Inc. 304
QWED Sp. z o.o 1648
R&D Altanova 252
R&D Microwaves LLC 153
R&K Company Ltd. 1326
Ranatec Instruments AB 443
Reactel Inc. 1100
RelComm Technologies Inc. 406
Remcom Inc. 1105
Remtec Inc. 204
Resin Systems Corp. 1619
Res-Net Microwave Inc. 817
RF Bay Inc. 129
RF Depot Inc. 905
RF Globalnet *1048*
RF Industries 608
RF Morecom Corea 241
RF Techniques 123
RFcore Co. Ltd. 1928
RFHIC Corp. 1727
Rflight Communication Electronic Co. Ltd 2218
RFMD 833
RFMW Ltd. 315
RFS Ferrocom Ferrite Division 1718
Richardson RFPD 609
Rigol Technologies 2236
RJR Polymers Inc. 1738
RK Technologies LLC 1751
RLC Electronics Inc. 1719
RN2 Technologies 1823
Rogers Corp. 1833
Rohde & Schwarz 1439
Rosenberger North America LLC 1519
Roswin Inc. 1945
S3 Group 551
SAGE Millimeter Inc. 2232
Sainty-Tech Communications Ltd. 2023
Samtec Inc. 951
Sangshin Elecom 315
SANTIER 242
San-tron Inc. 1346
Sawnics Inc. 222
Scientific Microwave Corp. 1038
Selex ES 251
SemiGen Inc. 650
SemiProbe Inc. 2233
SGMC Microwave 939
Shanghai Hexu Microwave Technology Co. Ltd. 145
Shanghai Huaxiang Computer Comm. Eng. 1153
Shenzhen Superlink Connector Co. Ltd. 2042
Shenzhen Yulongtong Electron Co. Ltd. 105
Shoulder Electronics Ltd. 852
Sichuan Keenlion Microwave Tech. Co. Ltd 347
Siddhi Engineers 2238
SignalCore Inc. 548
Signatone 1101
Sinclair Manufacturing Co. 339
SIPAT Co. 350
Skyworks Solutions Inc. 1815
Smiths Microwave 923
SOMACIS 2053
Sonnet Software Inc. 1215
Soontai Tech Co. Ltd 2242
SOURIAU PA&E 1827
Southwest Microwave Inc. 543
SPEAG-Schmid & Partner Engineering AG 1557
Spectra - Mat Inc. 1451
Spectrum Elektrotechnik GmbH 1505
SRI Connector Gage Co. 947
SRI Hermetics 947
SRTechnology Corp. 748
SSI Cable Corp. 1123
State Of The Art Inc. 1205
Statek Corp. 219
Stellar Industries Corp. 843
StratEdge Corp. 539
Sumitomo Electric Device Innovations 333
Suron 351
SV Microwave Inc. 1104
Synergy Microwave Corp. 704, 705
Taconic 305
Tahoe RF Semiconductor Inc. 1706
Tai-Saw Technology Co. Ltd. 1743
TDK-Lambda Americas 1905
Tecdia Inc. 1818
Tech Briefs Media Group *2122*
Techmaster Electronics Inc. 1716
Tektronix Inc. 1923
Teledyne Coax 723
Teledyne LeCroy 723
Teledyne Microelectronics 723
Teledyne Microwave Solutions 723
Teledyne Paradise Datacom 723
Teledyne Relays 723
Teledyne Scientific 723
Teledyne Storm Microwave 723
Teledyne Technologies 723
Telegartner Inc. 1653
Telemakus LLC. 315
TeraProbes Inc. 2237
Terasense Group Inc. 552
Test Equipment Plus Inc. 1550
TestEquipment.com Inc. 2027
TestEquity LLC 948
Testworld Inc. 753
Texas Instruments 2041
Thales Components Corp. 625
The Lindgren Group 1853
The Prince & Izant Companies 1750
The Waveguide Solution Ltd 2125
Ticer Technologies 2231
Times Microwave Systems 1118
TMD Technologies 844
Tooling Dynamics LLC 1751
Top Dog Test 1901
Tosfy Technology Inc. 2216
Toshiba America Electronic Cmpts. Inc. 1723
TowerJazz 1328
TRAK Microwave Corp. 923
Transcom Inc. 2227
Transline Technology Inc. 326
TriQuint 1533
Tronser Inc. 1753
TRU Corp. Inc. 605
TTE Filters LLC 441
T-Tech Inc. 1129
Ulbrich Stainless Steels & Special Metals Inc. 1652
UltraSource Inc. 1422
UMS (United Monolithic Semiconductors) 1204
Unimetal Surface Finishing LLC 353
Universal Semiconductor Technologies 127
UTE Microwave Inc. 1704
Varioprint AG 233
Vaunix Technology Corp. 1353
Vectron International 1305
Venturtec North America 1643
Viking Tech America Corp. 1148
VIMA Co. Ltd. 2124
Viper RF Ltd. 1650
Virginia Diodes Inc. 1341
Vishay Intertechnology Inc. 1446
Voltronics Corp. 1409
W. L. Gore & Associates Inc. 1027
Waka Manufacturing Co. Ltd. 243
Wave-Tech Inc. 449
Weinschel Associates 1814
Wenzel Associates Inc. 308
Werlatone Inc. 1127
West Bond Inc. 1615
WEVERCOMM Co. Ltd. 2034
Wiley 2048
WIN Semiconductors Corp. 839
Windfreak Technologies LLC 1052
WIPL-D D.O.O. 945
Wireless Design & Development *1556*
Wireless Telecom Group 808
X5 Systems Inc. 849
Xian Forstar S&T Co. Ltd. 1850
Xpeedic Technology Inc. 101
Yokowo Co. Ltd. 341
Z-Communications Inc. 1227
ZTEC Instruments 553

IMS 2014
Show Coverage

Catch our exclusive conference information, news, social networking, photos, videos and more at MWJournal.com/IMS2014.

IMS Floorplan

Your Product Guide to the Show Floor

Shaded exhibitors have a product featured in the IMS Product Showcase pages to follow. Look for these products at this year's IMS 2014.

IMS Product Showcase

IMS Cyber Café

Download an electronic version of the IMS Floorplan and new products on display at this year's MTT-S IMS 2014.
www.mwjournal.com/IMS2014Products

Scan page using layar app

Sponsored by: MWJ's IMS Show Daily

These booth numbers are complete as of March 24, 2014.

IMS Product Showcase: Aisles 100-300

The following booth numbers are complete as of March 24, 2014.

Scan page using layar app

Exodus — Booth 111

Pulse Amplifier

Exodus amplifier model AMP4002P is a high power X-Band pulse amplifier covering the 9.1 to 9.5 GHz frequency range at a peak power of 400 W. The AMP4002P is being supplied to an international OEM for a radar application and operates at a duty cycle of 20 percent. It features the following: small form factor rack mounted system, high power GaN transistors, instantaneous bandwidth, suitable for linear pulse applications, built-in protection circuits, and high reliability and ruggedness.

www.exoduscomm.com

Coaxial Components Corp. Booth 131

Phase Adjustable Connector

Coaxicom's innovative phase adjustable connector is now offered with a direct solder solution for RG402, 0.141 semi-rigid and ultra-flex cables. The advanced connector allows for precise manual adjustments to the phase without signal degradation. The 3993 series of phase adjusters deliver a means of phase adjustment over frequency ranges up to 18 GHz. The 3993-2 RF connector has an adjustment range of 180° minimum and a maximum VSWR, with insertion loss of 1.30:1 and 0.42 dB, respectively.

www.coaxicom.com

APA Wireless — Booth 201

Ultra-Low Jitter Clock Source

APA's "Gigabit Series" of programmable clock sources have ultra-low jitter (<30 fsec at 2 GHz, 12 KHz ~ 20 MHz) in a package smaller than your thumb and only 2.9 mm high. Features include low noise (<-165 dBc/Hz) at 10 MHz from the carrier, harmonic filtering and three or more discrete frequencies anywhere in the 100 MHz to 3 GHz range. The outputs can be sine or digital (LVDS, LVPECL, CML, etc.), fully characterized over the industrial temperature range.

www.apawireless.com

JQL Electronics Inc. — Booth 212

Surface Mount Circulator

VENDORVIEW

JQL Electronics Inc. introduced a low PIM surface mount circulator for LTE application. The new surface mount circulator has a compact package with low PIM at -85 dBc. The high power isolator version is also available. JQL offers the low PIM solution to the wireless industry.

www.jqlelectronics.com

Anatech Electronics — Booth 239

Voltage-Tuned Filter

VENDORVIEW

The Anatech Electronics AE225-400VT100 connectorized voltage-tuned filter has a center frequency of 225 to 400 MHz variable via a DC voltage. The unit includes an amplifier that boosts the signal by +19 dB for increased receiver sensitivity. It has a 3 dB bandwidth of 5 percent, analog tuning speed of 200 ns or faster, 70 dB on/off isolation, and -50 dBc spurious rejection. Two models covering 225 to 300 MHz are also available in SMT and connectorized versions.

www.anatechelectronics.com

QuinStar Technology Inc. — Booth 304

Millimeter-Wave Amplifiers

QuinStar Technology has introduced several lines of millimeter-wave amplifiers ranging from ultra-low noise amplifiers (up to 110 GHz), to full waveguide band driver amplifiers covering V-, E- and W-Bands, to very high power amplifiers operating between 25 and 96 GHz with high power output levels and efficiencies. These products are suitable for high reliability applications, including airborne and space-based. The new developed family of pulsed power amplifiers is ideally suited for radars and communications.

www.quinstar.com

Wenzel Associates — Booth 308

OCXO

Wenzel's 10 MHz Streamline II OCXO achieves -146 dBc/Hz at 10 Hz offset. It is a cost effective oscillator in a 2.25" × 2.25" × 1" package with excellent stability for applications in defense, telecom, test instruments and satellite communications. It is available between 5 to 25 MHz with aging ≤ 0.1 ppb per day and temperature stability of ±2 ppb, -20° to 70°C. -40° to +85°C is available. Visit the company's new and improved website for more information.

www.wenzel.com

Charter Engineering Inc. — Booth 309

Terminated RF Switch

CEI model T12P-941518 is a SP12T internally terminated latching switch with indicator circuitry operating from DC to 15 GHz. The ultra low PIM switch features a –160 dBc minimum 3rd order IM. The T12 series is also offered as a failsafe or normally open switch along with various actuator and mounting options. CEI offers a complete line of coaxial RF switches for ATE, matrix and critical switching systems. The low PIM specifications are available with all CEI switches.

www.ceiswitches.com

RFMW Ltd. — Booth 315

Phase Shifter

VENDORVIEW

Laboratory quality USB controlled phase shifters cover L-, S- and C-Bands with over 360 degrees of phase range. 12-bit, 0.25 degree step size offers high resolution. When coupled with a Telemakus digital attenuator, a gain and phase control system can be created. Telemakus test devices represent the latest technology in low cost, transportable test equipment. Each unit's graphical user interface (GUI) is resident in on-board flash memory making them "plug and play" for Windows-based PCs.

www.rfmw.com

CTS Electronic Component Solutions Booth 322

Automotive Quartz Crystals

CTS introduced a series of AEC-Q200 compliant quartz crystals for automotive applications such as remote keyless entry (RKE), audio and video systems, mobile multi-media systems, wireless communication and tire pressure monitoring system (TPMS). The new series offers multiple stability options, operating temperatures extending to +150°C and a selection of small package sizes. Go to the company's website to get more product information or email frequencysales@ctscorp.com.

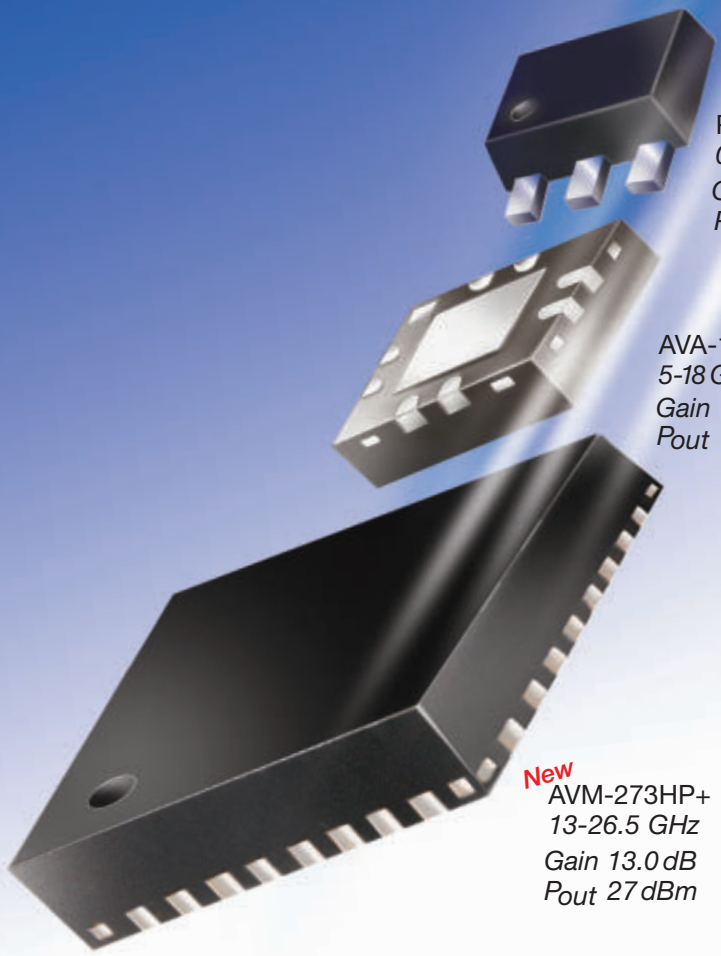
Semiconductor ICs

Expanding its frequency portfolio, CTS now offers high speed ICs with ultra-low phase noise in various input and output types. CTS's buffers & dividers, capacitive tuning, PECL/ECL logic and cable driver are key solutions to the performance of many next generation applications. Visit the company's website to download its comprehensive selection guide or email frequencysales@ctscorp.com for additional details.

www.ctscorp.com

50 MHz to 26.5 GHz

THREE AMPLIFIERS COVER IT ALL !



PHA-1+ $1.99 ea. (qty. 20)
0.05-6 GHz
Gain 13.5 dB
P_{out} 22 dBm

AVA-183A+ $6.95 ea. (qty. 10)
5-18 GHz
Gain 14.0 dB
P_{out} 19 dBm

New
AVM-273HP+ $27.95 ea. (qty. 10)
13-26.5 GHz
Gain 13.0 dB
P_{out} 27 dBm

Mini-Circuits' New AVM-273HP+ wideband, 13 dB gain, unconditionally stable microwave amplifier supports applications from 13 to 26.5 GHz with 0.5W power handling! Gain flatness of ±1.0 dB and 58 dB isolation make this tiny unit an outstanding buffer amplifier in P2P radios, military EW and radar, DBS, VSAT, and more! Its integrated application circuit provides reverse voltage protection, voltage sequencing, and current stabilization, all in one tiny package!

The AVA-183A+ delivers excellent gain flatness (±1.0 dB) from 5 to 18 GHz with 38 dB isolation, and 19 dBm power handling. It is unconditionally stable and an ideal LO driver amplifier. Internal DC blocks, bias tee, and microwave coupling capacitor simplify external circuits, minimizing your design time.

The PHA-1+ + uses E-PHEMT technology to offer ultra-high dynamic range, low noise, and excellent IP3 performance, making it ideal for LTE and TD-SCDMA. Good input and output return loss across almost 7 octaves extend its use to CATV, wireless LANs, and base station infrastructure.

We've got you covered! Visit minicircuits.com for full specs, performance curves, and free data! These models are in stock and ready to ship today!

RoHS compliant

FREE X-Parameters-Based
Non-Linear Simulation Models for ADS

Modelithics®

http://www.modelithics.com/mvp/Mini-Circuits.asp

Mini-Circuits®

www.minicircuits.com P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com

See us at IMS Booth 823

478 rev N

IMS Product Showcase: Aisles 300-400

MITEQ Inc. Booth 325

Compliance Testing Amplifiers

MITEQ's new TTA Series are high performance broadband LNAs specially developed for electromagnetic (EMC) compliance testing. Complete frequency coverage from 1 MHz to 40 GHz is possible with three separate TTA amplifiers. They are enclosed in a small (5.1" × 3.5" × 1.9") lightweight EMI/RFI case and can be used easily in the EMC test setup. A universal wall plug in power supply is included with each TTA which operates from 50 to 60 Hz/100 to 240 VAC. CE approved.

www.miteq.com

Transline Technology Booth 326

PCBs

Transline Technology has been working side-by-side with visionary engineers in the RF/microwave industry for over 20 years to produce innovative printed circuit boards (PCB). TTI

offers rigid, rigid-flex and flex PCB fabrication services as well as photo-chemical metal etching and forming. The company stocks Rogers, Taconic and Arlon materials allowing the company to turn product in as little as 24 hours.

www.translinetech.com

Crane Aerospace & Electronics Microwave Solution Booth 332

Ku-Band Iso-Divider

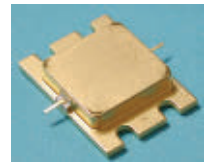
VENDORVIEW

Crane Aerospace & Electronics Microwave Solution announces the new Ku-Band Iso-Divider product line. This unit combines the functions of high performance power dividers with ferrite isolators to provide a high isolation power divider solution. It is designed for satellite receiver redundancy applications, without introducing complex switch-based solutions. Integration of the power divider and isolators into a single package provides enhanced product reliability and improved performance. Learn more at booth 332.

www.craneae.com/mw

Sumitomo Electric Device Innovations Booth 333

GaN IMFET



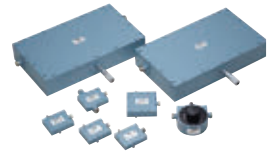
Sumitomo Electric introduced new devices to its line of high power GaN products for X-Band radar applications. The new internally matched device provides 200 W output power in pulsed operation. This device covers frequencies from 8.5 to 10 GHz with excellent efficiency. Please visit Sumitomo's booth 333 for a live demonstration.

www.sei-device.com

Narda Microwave Booth 405

Variable Attenuators

VENDORVIEW



Narda Microwave's expanded variable attenuator product line features nine new models in four distinct categories. The models cover frequencies from 800 MHz to 26.5 GHz. All models feature low VSWR, good environmental performance and low insertion loss. Higher power models can handle up to 500 W average power. Models are available with SMA and Type N connectors. All units are in stock for immediate shipment. For detailed specifications stop by booth 405, or visit the company's website.

www.nardamicrowave.com

RF Relay Store

www.rfrelaystore.com

RF Relay Store.com *is* the answer to your urgent small quantity needs. RelComm Technologies **NOW** offers a huge selection of RF Coaxial Relays with many options available for shipment from **Stock.**

Purchase On-Line with No Hassles - Visa, MC, AMEX

www.rfrelaystore.com

RF Coaxial Relays - DC to 18 GHz
Very Affordable High Performance Building Blocks
Design Enhanced For Mission Critical Communications
Extremely Low Loss from DC to 18 GHz
1P1T, 1P2T, 2P2T, Transfer, Milti-Throw Configurations
PCB Mount, SMA and N-Type Connectorized
Starting at $49.00 each for 5-9 units.
Ship from Stock (Same Day to 36 Hours)

RELCOMM
TECHNOLOGIES, INC.

EXCELLENCE BY DESIGN

RelComm Technologies, Inc. - 610 Beam Street, Salisbury, Maryland 21801
Telephone (410) 749-4488, Fax (410) 860-2327 - www.relcommtech.com

See us at IMS Booth 406

IMS Product Showcase: Aisles 400-500

Relcomm Technologies Inc. Booth 406

1P8T Relay

RelComm Technologies is offering a high power handling, high performance 1P8T relay configured with N type connectors and RF performance to 1 GHz. Power rating is 1200 W continuous over the operating temperature range of -25° to +70°C. The relay measures 3.75" sq. and is less than 3" tall. It is fitted with a standard DB25P header for ease of installation and is fully RoHS compliant. The relay is available in both latching and failsafe configurations and 28 V DC operation.

www.relcommtech.com

HUBER+SUHNER Booth 408

Cable Assemblies

The global Swiss company HUBER+SUHNER develops and manufactures components and system solutions for electrical and optical transportation of data and energy. The company's IMS booth shows products for space & defence, test & measurement applications, as well as its latest antenna innovation – the V- & E-Band Antenna. Furthermore, the company will present HUBER+SUHNER Astrolab's portfolio with special focus on SMPM-T, minibend L, microbend and the high power TVAC cable assembly.

www.hubersuhner.com

BESSER ASSOCIATES
The Worldwide Leader in RF and Wireless Training

Upcoming Courses
for Engineering Professionals

Besser Associates
Web Classroom℠

Web-Classroom Live eLearning
- Power Amplifier ABC's..... Jun 16-20
- GaN Power Amplifiers .....Sep 9-11
- RF Design: Core Concepts ..... Nov 3-7

San Jose, CA
- Digital Signal Processing and Wireless Communications ..... Aug 12-15
- Practical Digital Wireless Signals ..... Aug 18-20
- Applied RF Techniques I..... Aug 18-22
- Introduction to Radar ..... Aug 18-20
- Phase-Locked Loop and Frequency Synthesis Design ..... Aug 21-22
- Cognitive Radios, Networks, and Systems for Digital Communications ..... Aug 21-22
- The Radio Modem: RF Transceiver From Antenna to Bits and Back.....Sep 15-19
- Wireless LANs.....Sep 22-24
- Introduction to Data Converters ..Sep 22-24
- RF and Wireless Made Simple.....Sep 25-26
- Penetration Testing for Network Security.....Sep 25-26
- RF Power Amplifier Techniques using Si, GaAs, and GaN Semiconductors ..... Oct 6-9
- DSP - Understanding Digital Signal Processing..... Oct 8-10
- RF Measurements:Principles & Demonstration..... Oct 27-31
- CMOS RF Circuit Design ..... Oct 27-29
- Hardware DSP: A guide to building DSP Circuits in FPGAs... Nov 17-19
- RF Design: Applied Techniques... Nov 17-21

Register Now!

Download our Schedule Brochure for dates, prices, and course descriptions.

www.besserassociates.com

info@besserassociates.com

See us at IMS Booth 632

CTT Inc. Booth 429

GaN-based SSPAs

A new family of compact, GaN-based solid-state power amplifiers (SSPA) operating in the 7 to 11 GHz frequency range for a wide variety of commercial, industrial and military microwave applications. CTT's latest compact SSPA designs offer as much as 100 W of output power in a compact package. The 7 to 11 GHz segment of X-Band is one of the more "Application Rich" portions of the electromagnetic spectrum.

www.cttinc.com

3D Glass Solutions Booth 455

Photo-Structurable Glass-Ceramic Material

APEX® Glass is a patented photo-structurable glass-ceramic material that is ideally suited for fabricating both low and high volume micro-devices for applications in RF, millimeter wave and IC packaging. Applications include phased array antennas, High-Q structures, glass interposers, inductors and other passive micro-component designs. Engineers can now develop advanced designs in glass with critical dimensions from 30 microns to 1 mm. Value added processes like copper-filled through-vias, redistribution layers and dielectric are available.

www.3dglasssolutions.com

American Microwave Corp. Booth 509

Reflective Switch

VENDORVIEW

AMC introduced a new high power microwave switch. Model SWN-2DR-STD is a SPDT solid state reflective switch capable of operating from 8 to 18 GHz and can handle 40 W of CW power. It has a maximum insertion loss of 2 dB, VSWR of 2.0:1 maximum and an isolation of >40 dB. It has a maximum switching speed of 150 nSec. Switching rate is 500 KHz max. Input and output connectors are SMA (F) and solder pins for TTL and power supplies.

www.americanmicrowavecorp.com

It's about ...

More than just software

itsabout@feko.info
www.feko.info

FEKO
Comprehensive Electromagnetic Solutions

See us at IMS Booth 307

IMS Product Showcase: Aisles 500-600

Peregrine Semiconductor Corp. Booth 515

RF Power Limiters

Peregrine's UltraCMOS® RF power limiters, the first turnkey, monolithic alternative to discrete, PIN-diode limiters, are ideal for test and measurement, land-mobile-radio, wireless infrastructure, military and radar systems. UltraCMOS power limiters outperform GaAs-based limiters in protecting systems from excessive RF power, intentional jammers and ESD events. Visit booth 515 to learn more about UltraCMOS power limiters, including the PE45140 (20 MHz to 2 GHz, 50 W) and the PE45450 (9 KHz to 6 GHz, 50 W).

RF Digital Step Attenuator

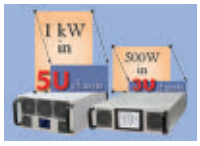
Peregrine's PE4312 is a 6-bit, 50 ohm, RF digital step attenuator (DSA) designed for use in 3G/4G wireless infrastructure, professional portable/mobile radios and other high-performance RF applications. Covering a 31.5 dB attenuation range in 0.5 dB steps, the PE4312 maintains high linearity, low power consumption and a monotonic step response from 1 MHz through 4 GHz. Visit booth 515 to learn more about Peregrine's UltraCMOS® RF digital step attenuators, including the PE4312.

www.psemi.com

Empower RF Systems Booth 523

Broadband High Power Amplifiers

VENDORVIEW



Empower will be showcasing one of five different broadband models from its family of "Size Matters," 1 kW in a 5U chassis or 500 W in a 3U chassis, high power amplifier product platforms. Built with a common architecture that drives consistency in manufacturing and outstanding operational performance, Empower will be conducting live demonstrations of a fully operational unit at the booth and also showcasing additional designs and capabilities.

www.empowerrf.com

Southwest Microwave Booth 543

Board Mount Connector

Southwest Microwave, the world leader in high-performance microwave connectors, will showcase a new 1.85 mm (V) vertical board mount connector at IMS 2014. Built to Southwest Microwave's rigorous quality and performance standards, this connector's footprint is only 0.2" square and is solder-attached to PCB. With board launch structure optimized to 67 GHz, the 1.85 mm vertical board mount connector accommodates top layer microstrip, coplanar or buried layer launch. Visit booth 543.

www.southwestmicrowave.com

SignalCore Booth 548

Signal Source

SignalCore's new, high performance 20 GHz RF/microwave signal source, available in PXIe, USB, SPI and RS-232 platforms, is cost effective, compact and designed for seamless integration. With frequency spanning 50 MHz to 20 GHz (1 Hz resolution), typical amplitude ranging -30 to +10 dBm, and phase noise of -117 dBc/Hz at 10 kHz offset at 10 GHz carrier, this product is ideal for research and development, academic, military and commercial applications.

www.signalcore.com

Ciao Wireless Booth 604

Amplifiers and Assemblies

Ciao Wireless specializes in the design/manufacture of RF and microwave amplifiers/assemblies for both the defense and commercial industries, from 30 kHz to 44 GHz, including the various narrow and ultra-broadband frequencies in between. Ciao offers a complete catalog product line and "custom" designs in order to meet all of your exact microwave amplifier and subsystem needs. Ciao features 1 to 2 week ARO delivery for most catalog and custom parts.

www.ciaowireless.com

TRU Corp. Booth 605

RF Power Transmission

TRU Corp. offers the latest innovation in high power connector design with the MEIA™ series interface. The MEIA interface provides equivalent kW power handling compared to similar EIA connector line sizes but provides a 30 percent smaller and 40 percent lighter form factor with a high efficiency, threaded coupling mechanism. This threaded coupling eliminates issues inherently found in mechanically aligning and fastening a flanged EIA interface with individual bolts.

www.trucorporation.com

Arrow Electronics RF & Power Booth 609

RF & Power Technologies

Please join Arrow's RF & Power business in booth 609 as it hosts a full slate of 15-minute presentations and Q&A sessions featuring the leading innovators and suppliers of RF, wireless and energy technologies. The diverse line-up of presentations covers everything from the latest GaN developments, to military and aerospace applications along with a host of new products from the industry's leading suppliers. For additional presentation details and information on the presenters, please visit Arrow's RF & Power business.

arrow.com/rfpower

Micro Lambda Wireless Inc. Booth 621

Millimeterwave Frequency Synthesizers

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

www.microlambdawireless.com

Besser Associates Booth 632

Wireless Training

BESSER ASSOCIATES

Besser Associates is the worldwide leader in RF and wireless training. Its instruction combines theory with hands-on practice, the latest tools and technology, and the most appropriate training media for individualized, meaningful participant experiences. The company chooses its instructors from the best and brightest in their fields around the world; they carry an average of 20 years of field and applied teaching experience. Courses can also be brought on-site internationally.

www.besserassociates.com

IMS 2014 Show Coverage

Catch our exclusive conference information, news, social networking, photos, videos and more at MWJournal.com/IMS2014.

ATC Ultra-Broadband SMT Capacitor Solutions

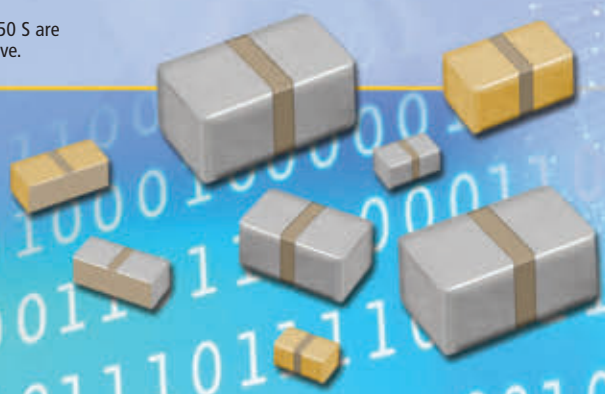
Reliable and Repeatable Ultra-Broadband Performance

ATC's 550 Series family of Ultra-Broadband Capacitors exhibit ultra-low insertion loss and flat frequency response from 16 KHz through 40+ GHz with excellent return loss and voltage ratings to 50 WVDC. They are ideal for use in ultra-broadband DC blocking, coupling, and bypassing for optoelectronics / high speed data, SONET, broadband test equipment and broadband microwave / millimeter-wave based applications. The 550 Series is orientation insensitive* for ease of high speed automated placement.

Attributes

- Surface Mount EIA Case Sizes
- 16 KHz to 40+ GHz Coverage
- Ultra-Low Insertion Loss
- Voltage Ratings to 50 WVDC
- Orientation Insensitive*
- One-Piece Ceramic Construction
- Unit-to-Unit Performance Repeatablity

*550 Z, 550 L, and 550 S are orientation insensitive.



ATC Series	EIA Size	Capacitance	Frequency Range	Insertion Loss	Voltage Rating	Orientation Insensitive
550 Z	0201	10 nF	160 KHz to 40+ GHz	<0.4 dB typ.	10 WVDC	Yes
550 U	0301	100 nF	16 KHz to 40+ GHz	<0.4 dB typ.	6.3 WVDC	No
550 L	0402	100 nF	16 KHz to 40+ GHz	<0.5 dB typ.	16 WVDC	Yes
550 S	0603	100 nF	16 KHz to 40+ GHz	<1 dB typ.	50 WVDC	Yes

AMERICAN TECHNICAL CERAMICS

ATC North America
sales@atceramics.com

ATC Europe
saleseur@atceramics.com

ATC Asia
sales@atceramics-asia.com

THE ENGINEERS' CHOICE®
ISO 9001 REGISTERED

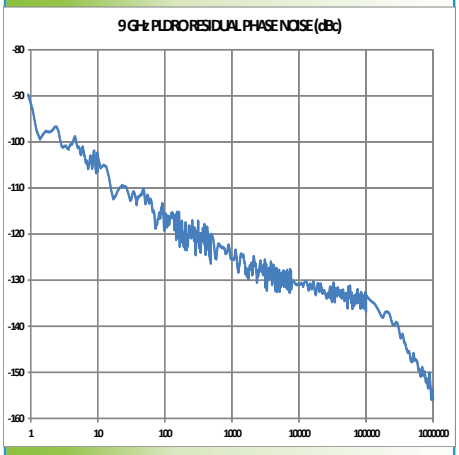
RoHS Compliant

www.atceramics.com

See us at IMS Booth 1927

We have specialized in Low Phase Noise Fixed Frequency Sources since 1998.

A plot of our new quieter PLDRO line.



- Crystal reference phase noise to -130 dBc/Hz @ 100 Hz @ 100 MHz
- Dual loop output frequency resolution +/- 0.001 Hz
- Internal reference stability to +/- 10 ppb
- 5 - 1000 MHz External reference
- Frequency: 10 MHz to 35 GHz
- Power output: +10 to +24 dBm
- Wide operating temperature range: -55º to +85º
- Spurious: < -90 dBc

We welcome your custom requirements.

Nexyn offers the best performance and reliability on the market.

1287 Forgewood Ave.
Sunnyvale, CA 94089
Tel: (408) 962-0895
Fax: (408) 743-5354
sales@nexyn.com

www.nexyn.com

IMS Product Showcase: Aisle 600

AWR Corp. Booth 633

Design Software

VENDORVIEW

Stop by booth 633 at the International Microwave Symposium MTT-S (IMS 2014) in Tampa to see the new features and enhancements in the V11 release of the NI AWR Design Environment. Of special interest are Analyst 3D FEM EM demos showcasing user-configurable PCells (library of parts) and antenna measurement capabilities.

www.awrcorp.com

National Instruments Booth 633

Modular Hardware

VENDORVIEW

National Instruments delivers fast, flexible and accurate RF hardware powered by NI LabVIEW software to keep pace with the ever-changing demands of the wireless industry and growing number of standards. Learn about the advantages of using open software and modular hardware from design to validation to production. To learn more, visit www.ni.com/redefine/?metc=mtyy35.

www.ni.com

Phase Matrix Booth 633

Frequency Synthesizers

See the 10 and 20 GHz QuickSyn® Lite synthesizers in National Instrument's booth 633. These synthesizers were featured as most valuable product in *Microwave Journal*'s February 2014 issue. QuickSyn phase-refining technology enables these synthesizers to cover a wide frequency range, switch between frequencies very quickly, operate quietly, and help instrument designers use space efficiently since their package is compact, only 4" × 4" × 0.8".

www.phasematrix.com

Marki Microwave Booth 634

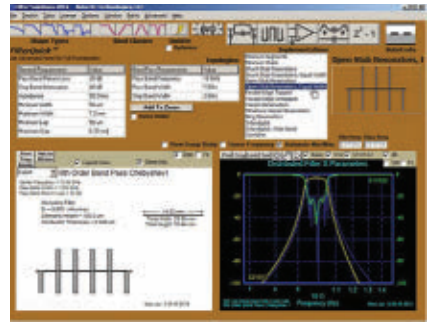
High Performance Doublers

Traditional doublers are limited to octave frequency bands, but Marki Microwave's new microlithic doublers offer high efficiency over multi-octave bandwidths. Additionally, they have superior suppression of fundamental and third harmonic outputs, significantly relaxing filtering requirements. For example, the MLD-1640 offers an 11 dB conversion loss with 33 dB fundamental suppression for outputs from 16 to 40 GHz, ideal for driving millimeter wave mixers.

www.markimicrowave.com

Nuhertz Technologies Booth 638

Filter Synthesis Software



Nuhertz Technologies announces the release of FilterSolutions 2014®. In this release, Nuhertz completes the integration of interconnects to all Microwave Office® library models, adding to the 2013 integration of the Modelithics model libraries. Changes to the program include a new menu item for open stub resonators (for both FilterSolutions and FilterQuick), and schematic notes for lumped elements. FilterSolutions directly integrates with AWR, CST, Modelithics and Sonnet Software, achieving improved modeling accuracies; accounting for electromagnetic effects, and providing tools for system integration.

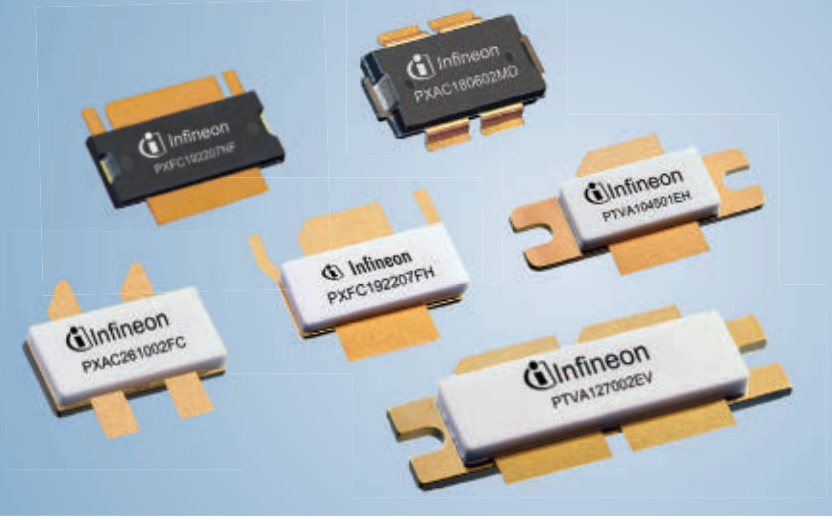
www.nuhertz.com

Copper Mountain Technologies Booth 645

VNA

Copper Mountain Technologies announces the release of Planar 804/1 and S5048 VNA version 3.39 with Point Trigger support. Point Trigger enables tight time synchronization of the analyzer sweep with external events and devices. The VNA can easily be integrated with a DMM to measure an analog auxiliary voltage as the sweep executes. Version 3.39 and VNA simulator 3.39 are available for free download on the company's website. Demo the full line of PC-based VNAs at IMS booth 645.

www.coppermountaintech.com



Product Information

LDMOS RF Power Transistors

For Cellular Infrastructure and Pulsed Applications

Infineon's latest generation of RF Power products enable the design of compact, broadband and efficient RF power amplifiers. Our technology portfolio provides the most advanced solutions for today's multi-carrier, multi-mode communication amplifiers and the most rugged and stable devices in pulsed applications.

- State-of-the-art LDMOS process technology (28V and 50V)
- First to introduce advanced packages with external decoupling leads for high VBW and small footprint in cellular designs
- Thermally efficient packages with copper flanges (plastic, open cavity)
- Internal matching technology for DPD friendliness

Applications:

- Cellular Amplifiers from 450 to 2700MHz
- Commercial Avionics
- L-Band and UHF Band RADAR
- Broadcast
- General Purpose Amplifiers from 500 to 2700MHz

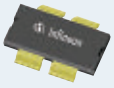
50V LDMOS Product Family For Pulsed Applications (500MHz to 1400MHz)

Product	Operating Frequency (MHz)	Matching	@P_{1dB}			@P_{3dB}			Pulse	VSWR
			P_{OUT} (W)	Gain (dB)	Eff (%)	P_{OUT} (W)	Gain (dB)	Eff (%)		
PTVA030121EA	390 – 450	No	12	25.0	69	14	22.0	73	12µs, 10% DC	13:1
PTVA035002EV	390 – 450	No	400	19.5	65	500	17.5	67	12µs, 10% DC	13:1
PTVA042502EC/FC	470 – 806	I	250	19.5	60	280	18.5	62	12µs, 10% DC	10:1
PTVA047002EV	470 – 806	I	700	20.0	55	800	17.5	57	12µs, 10% DC	10:1
PTVA104501EH	960 – 1215	I/O	450	17.0	57	490	15.0	55	128µs, 10% DC	10:1
PTVA101K02EV	1030 / 1090	I	920	18.0	56	1090	16.0	57	128µs, 10% DC	10:1
PTVA120251EA	500 – 1400	No	30	16.0	56	40	14.0	59	300µs, 10% DC	10:1
PTVA120501EA	1200 – 1400	I	54	16.5	55	63	14.5	57	30 µs, 10% DC	10:1
PTVA123501EC/FC	1200 – 1400	I/O	375	16.0	56	415	14.0	57	300µs, 12% DC	10:1
PTVA127002EV	1200 – 1400	I/O	700	16.0	55	800	14.0	58	300µs, 10% DC	10:1

www.infineon.com/rfpower

New RF Power Transistors

Broadband Doherty Solutions for Cellular Infrastructure

Product	Doherty-in-Package	Operating Frequency [MHz]	P_{1dB} Typ [W]	Gain Typ [dB]	Eff Typ [%]	Supply Voltage Typ [V]	Package Type
PTVA093002TC	Yes	700 – 960	2X50	19	50	50	H-49248H-4
PXAC180602MD	Yes	1800 – 2000	21+28	18	50	28	PG-HB1DSO-4-1 
PXAC201202FC	Yes	1800 – 2200	40+80	16	45	28	H-37248-4
PXAC201602FC	Yes	1800 – 2200	55+85	18.5	49	28	
PTAC240502FC	Yes	2620 – 2690	17+33	14.2	44.2	28	
PXAC261002FC	Yes	2496 – 2690	40+70	15.6	46	28	
PXAC261202FC	Yes	2496 – 2690	60+80	14.3	44.5	28	

Cellular Doherty Reference Designs

60W Symmetric Doherty
1805 – 1880MHz

P_{OUT} = 49.4dBm Avg
Gain = 16dB
Efficiency = 45%

Main & Peak :
PXAC192207FH
H-37288G-4/2

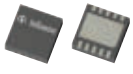
40W Asymmetric Doherty
1805 – 1880MHz

P_{OUT} = 48dBm Avg
Gain = 15dB
Efficiency = 46.5%

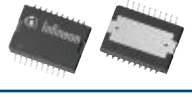
Main : PXFC191507DC
H-49248G-4/2

Peak : PXFC192207FH
H-37288G-4/2

General Purpose Transistors (700MHz – 2200MHz)

Product	Operating Frequency [MHz]	Matching	P_{1dB} Typ [W]	Gain Typ [dB]	Eff Typ [%]	P_{OUT} Avg [W]	Test Signal	Supply Voltage Typ [V]	θJC [°C/W]	Package Type
PTFA220041M	700-2200	None	5	19.0	37.5	4 (PEP)	Two-tone	28	5.50	PG-SON-10 
PTFA220081M	700-2200	None	10	17.0	38.0	8 (PEP)	Two-tone	28	4.20	
PTFA220121M	700-2200	None	15	16.0	37.0	9 (PEP)	Two-tone	28	3.40	

LDMOS Integrated RF Power Amplifiers (700MHz – 2200MHz)

Product	Operating Frequency [MHz]	Matching	P_{1dB} Typ [W]	Gain Typ [dB]	Eff Typ [%]	P_{OUT} Avg [W]	Test Signal	Supply Voltage Typ [V]	θJC [°C/W]	Package Type
PTMA080152M	700-1000	I	20	30	34	8	GSM/EDGE	28	8.5/2.5	PG-DSO-20-63
PTMA080302M	700-1000	I	32	31	36	15	GSM/EDGE	28	6.7/1.7	
PTMA180402M	1800-2200	I	40	30	16	5	CDMA	28	3.6/1.5	
PTMA210152M	1800-2200	I	20	28.5	33	7	WCDMA	28	10.7/2.9	

See our entire portfolio of RF Power Solutions at www.infineon.com/rfpower or contact us at highpowerRF@infineon.com.

© 2014 Infineon Technologies AG.
All Rights Reserved.

EMC Lights the Way!

EMC 2014 SIPI 2014

2014 IEEE International Symposium on Electromagnetic Compatibility

AUGUST 4-8 • RALEIGH, NORTH CAROLINA

IEEE EMC SOCIETY

Registration is Open!

Join your Colleagues in Raleigh, North Carolina

for EMC 2014 and SI/PI 2014. With the new addition of the embedded Signal and Power Integrity Conference this year, we are excited to announce a record number of paper submissions in this subject area!

You Won't Want to Miss:

- Keynote Presentation by **Henry W. Ott – *EMC Past, Present and Future***
- Celebrate the 150th Anniversary of **Maxwell's Equations**. Hear distinguished lecturers and experts in the subtleties of the vector product describe the ongoing importance of those four (or eight) little equations that say, simply, "**I ∇ EMC**."

- Visit the **Exhibit Hall** with hundreds of booths filled with the latest products, equipment and services.
- Attend concurrent **workshops, tutorials and demonstrations** to fire the imagination, and participate in one of the many industry and professional meetings to take your participation to the next level.
- **Global EMC and Signal Integrity (SI) University** brings eighteen hours of instruction on advanced EMC and SI related topics, taught by an international panel of experienced educators.
- Experience the **Southern Hospitality** at numerous formal and informal networking functions. Greet old friends, meet new friends, experts, and colleagues.
- **Companion Club** with fun tours and activities planned for all!

Register Online at **www.emc2014.org**

IMS Product Showcase: Aisles 600-700

Norden — Booth 648

Frequency Multipliers

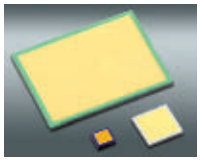
Need to multiply a frequency source, but keep it clean? Norden has produced ×8 frequency multipliers that are -60 dBc clean of the undesired multiples. Norden has vast experience producing frequency multipliers for test equipment systems as well as ELINT, ECM and communication systems. Norden can incorporate attenuation control, output power detectors, temperature compensation and other features if needed.

www.nordengroup.com

SemiGen — Booth 650

Chip Capacitors

VENDORVIEW



SemiGen's chip capacitors are now available from its RF Supply Center. Series 8000 capacitors offer a working voltage of >50 V and capacitance ranges from 2.0 to 600 pF. Series 8100 capacitors offer a working voltage of >100 V and capacitance ranges from 0.1 to 399 pF. These products are available in chip form and offered in custom sizes to fit your applications from 0.1 to 1500 pF. To order visit the company's website.

www.semigen.net

Pickering Interfaces — Booth 653

PXI Microwave Modules

VENDORVIEW

Model 40-780A supports 1 to 4 SPDT relays and is available with frequencies from 12.4 to 65 GHz and 75Ω 2.4 GHz, model 40-782A supports either one or two transfer switches with frequency options of 18, 26.5 and 40 GHz and model 40-781 is a terminated SPDT with 18 GHz frequency range offering one or two relays and can have internal or external terminations. These new modules now include LED indication of when a normally open path is closed.

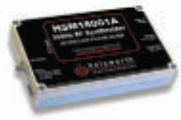
www.pickeringtest.com

Holzworth Instrumentation — Booth 700

RF Synthesizer

VENDORVIEW

The HSM18001A is a highly reliable (>200 kHrs MTBF) signal source with a rugged, compact form factor. This 10 MHz to 20 GHz (0.01 Hz steps) phase coherent signal generator offers low power consumption and industry leading frequency stability. Phase noise at 10 GHz is -114 dBc/Hz (10 kHz offset). Available output power of up to +16 dBm (0.01 dB resolution). Originally designed as a tunable radar LO, the HSM18001A is also an exceptional CW source for benchtop and OEM applications.



www.holzworth.com

Synergy Microwave Corp. — Booths 704, 705

High Power Products

Synergy is displaying high power products that include both surface-mount and connectorized solutions, with power handling capability from 5 through 500 W. These products are designed for minimal power loss and wideband coverage starting from kHz through several GHz in optimized bands. A large selection of power dividers/combiners, couplers and 90 degree hybrids are readily available for your applications in signal distribution, power monitoring and amplifier designs. Some models can operate in non-optimized load conditions, including high load or no load.

DROs

For a low cost, high performance dielectric resonator oscillator, Synergy offers the DRO1024 oscillator operating at 10.24 GHz. Phase noise is -79 dBc/Hz at 1 kHz offset. This comes housed in a connectorized package of 3" × 1.3" × 0.8" or in surface mount at 0.75" square. Other frequencies are available. A complete phase locked subsystem is also available using these DROs locked to a low noise crystal reference for unprecedented noise performance. A demonstration will be available at Synergy's booth.

www.synergymwave.com

Coilcraft Inc. — Booth 708

High-Q Air Core Inductors

Coilcraft's tight tolerance, air core "spring" inductors combine the exceptionally high Q (up to 200 at 400 MHz) of an air wound coil with the convenience of a surface mount package. Available in a wide range of sizes, configurations, inductance values and current ratings, these parts are suitable for a broad spectrum of applications.

www.coilcraft.com

Anritsu Co. — Booth 715

Broadband VNA System

VENDORVIEW

Anritsu Co. establishes a new standard in broadband performance with the introduction of the VectorStar™ ME7838D broadband system that provides industry-best frequency coverage of 70 kHz to 145 GHz in a single sweep using a coaxial test port. Also boasting best-in-class dynamic range, calibration and measurement stability and measurement speed, the VectorStar ME7838D gives design engineers greater confidence when performing on-wafer device characterization at 70 GHz and beyond.

Cable and Antenna Analyzer

Anritsu's Site Master™ S820E microwave cable and antenna analyzer delivers benchtop microwave performance in a compact handheld package. The S820E has the broadest frequency range and resolution, the highest dynamic range and best measurement accuracy. It is rugged, field optimized and includes sweep management capabilities. The S820E provides the highest value with the most standard features. Compliance for use in explosive atmospheres makes it ideal for maintenance of aircraft and naval vessels.

www.anritsu.com

IMS 2014 Show Coverage

Catch our exclusive conference information, news, social networking, photos, videos and more at MWJournal.com/IMS2014.

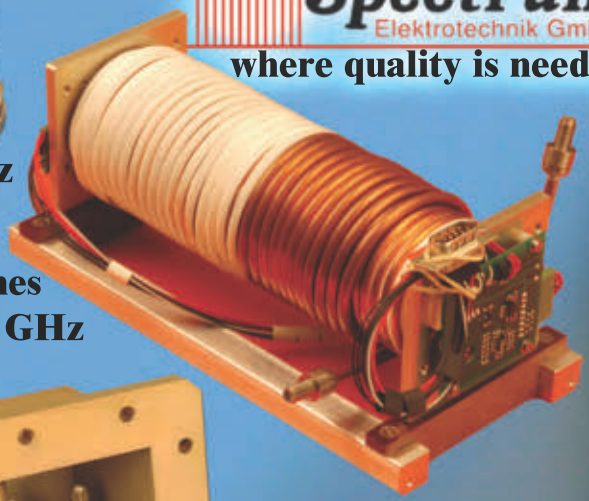
Coaxial Connectors
DC to 71 GHz

and Adapters
DC to 71 GHz

Multiport
Assemblies
DC to 40 GHz

Spectrum
Elektrotechnik GmbH
where quality is needed

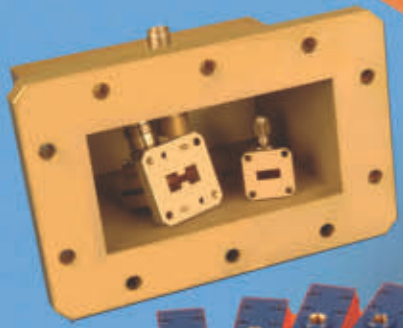
Adapters
DC to 71 GHz



Coaxial
Delay Lines
DC to 40 GHz

TAKE OFF WITH OUR PRODUCTS

Cable Assemblies
DC to 71 GHz



Waveguide to
Coax Adapters

Phase-Adjusters
DC to 63 GHz

Gain Amplitude
Equalizers

Please see us at the IMS

Booth 1505

June 1 to 6

Telephone: +49-89-3548-040
Fax: +49-89-3548-0490
Email: Sales@Spectrum-et.com

www.spectrum-et.com

Universal Microwave Components Corporation

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

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

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

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

www.umcc111.com

IMS Product Showcase: Aisles 700-800

Teledyne Microwave Solutions — Booth 723

ITAR-Free Products

TMS offers a complete suite of ITAR-Free products for Ka-Band systems specifically developed for both legacy and new designs. The up- and downconverters electronically switch between commercial and military Ka-/K-Bands. By combining these converters with the standard SSPA, a full transceiver can be configured to operate over the 29 to 31 GHz transmit band and the 19.2 to 21.2 GHz receive band with just three hermetically sealed modules.

www.teledynemicrowave.com

Teledyne Relays — Booth 723

RF Relay

Teledyne Relays announced its new 121 relay. The RF121 is a high repeatability, SPDT, broadband, magnetic-latching RF relay with performance to 12 GHz. The RF121 is ideal for switchable RF attenuators, RF switch matrices, high frequency spectrum radios, ATE and applications that require dependable high frequency signal fidelity and performance. The RF121 is available in through-hole, surface-mount stub pin (GRF121), and J-lead configurations. The GRF121 has a frequency range of DC to 16 GHz.

www.teledynerelays.com

Teledyne Storm Microwave — Booth 723

Stranded Cable Assembly

Teledyne Storm Microwave introduced a stranded center conductor cable assembly that will benefit both systems and test & measurement applications when requirements call for ease of handling, mechanical reliability and repeatability. Operating to 26.5 GHz, this durable, 7-strand cable offers flex life performance similar to a 19-strand product, as well as excellent connector retention (35 lbs pull). Available in two versions, the standard cable design features lower loss; an RZ version maximizes return to zero electrical performance.

www.teledynestorm.com

Boonton (Wireless Telecom Group) — Booth 808

USB Power Sensor

Visit Boonton and learn more about the 55 Series USB power sensor. See waveform fidelity and trigger stability of an RF pulse on broadband communication signals. Real Time Power Processing™ techniques enable gap-free signal acquisition at 100 K sweeps/sec and reliable capture of all transients, dropouts or interferences. Also see a dual CCDF demonstration for a RF amplifier compression mapping to its system performance, using the 4540 power meter and 55 Series USB power sensor.

www.boonton.com

Noisecom (Wireless Telecom Group) — Booth 808

Noise on Vcc Test Solution

Visit Noisecom and see the JV9000, noise on Vcc test solution. Learn about the impact of noise and spurs on Vcc of a PLL/VCO circuit and how it affects the phase noise performance. JV9000 takes a clean lab power supply and injects noise and spurs into it, driving the Vcc of the DUT. Also see the UFX7000A injecting broadband noise to a broadcast signal demonstrating the immunity of the receiver to noise and interferers.

www.noisecom.com

Res-net Microwave Inc. — Booth 817

CVD Diamonds

Res-net has been in business since 1985 and since that time it has developed a reputation for designing and manufacturing high quality attenuators, resistors and terminations for the RF/microwave industry. More recently they have added CVD diamonds to their product offerings. The frequency range for most of the products is DC to 40 GHz.

www.res-netmicrowave.com

Nova Microwave Inc. — Booth 819

Isolators and Circulators

Nova Microwave is one of the newest additions to the Electro Technik Microwave Group. For the past 18 years Nova Microwave has built a reputation for building high quality isolators and circulators for the RF/microwave markets. They design and manufacture both drop-in and connectorized versions. They now offer custom designs and have just become ISO registered.

www.novamicrowave.com

smiths microwave

Visit us at IMS 2014 Booth 923 and see our family of high performance products.

EMC Technology

Florida RF Labs

millitech

LORCH

TRAK

Mini-Circuits

VENDORVIEW

Booth 823

Test Cable

CBL-50FT-SMSM+ is RoHS compliant with wideband coverage of DC to 18 GHz. It features extra rugged construction with strain relief for longer life; stainless steel SMA-Male connectors for long mating-cycle life; triple shield cable for excellent shielding effectiveness; superior stability of insertion loss, VSWR & phase vs. flexing; and a six-month guarantee. It is useful over the temperature range -55° to 105°C and is flexible for easy connection & bend radius.

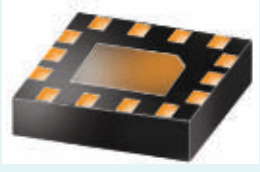
Power Splitter/Combiner

The ZC24PD-222+ is a 24 way-0°, 50 Ω, 650 to 2200 MHz power splitter/combiner. It features wideband, 650 to 2200 MHz; low insertion loss, 1.8 dB typ.; good isolation, 25 dB typ.; good amplitude unbalance, 0.5 dB typ.; and up to 10 W power input as splitter. It is ideal for applications such as UHF, cellular, GPS, communication systems and satellite L-Band.

Monolithic Amplifier

Mini-Circuits' CMA-162LN+ is a E-PHEMT based ultra-low noise MMIC amplifier with a unique combination of low noise and high IP3 making this amplifier ideal for sensitive high dynamic range receiver applications. This design operates on a single 4 V supply. The MMIC amplifier is bonded to a multilayer integrated LTCC substrate and then hermetically sealed under a controlled nitrogen atmosphere with gold-plated covers and eutectic AuSn solder. These amplifiers have been tested to MIL requirements for gross leak, fine leak, thermal shock, vibration, acceleration, mechanical shock and HTOL.

SPDT RF Switch



JSW2-63DR+ is a medium-power reflective SPDT RF switch, with reflective short on output ports in the OFF state. Made using a silicon-on-insulator process, it provides very high IP3 (55 dBm typ.). This switch also has a built-in CMOS driver and negative voltage generator, all packaged in a tiny 2 × 2 mm package, enabling it to operate over wideband and fit into tight spaces.

RF Transformer

Mini-Circuits' TCM2-33WX+ is a 50 Ω surface mount RF transformer. It features wide bandwidth 10 to 3000 MHz, balanced transmission line and excellent return loss. It is aqueous washable. Patent pending. It is ideal for applications such as PCS, wideband push-pull amplifiers and cellular.

Programmable Attenuator

Mini-Circuits' RCDAT-6000-90 is a general purpose programmable RF attenuator supporting frequencies from 1 to 6000 MHz with attenuation from 0 to 90 dB in 0.25 dB steps. Its unique design maintains linear attenuation change per dB, even at the highest attenuation settings. The attenuator is controlled via USB or Ethernet-TCP/IP connections and supports both HTTP and Telnet network protocols. It comes housed in a compact, shielded metal case with SMA(F) input and output ports, a standard Ethernet port, and a USB type Mini-B power and control port. The RCDAT-6000-90 is supplied with the company's easy-to-install, user-friendly GUI software, API objects for Windows® environments, and complete programming instructions for 32 and 64 bit Windows and Linux®1 operating systems.

Bandpass Filter

CBP-1250C+ is a ceramic-coaxial-resonator based bandpass filter in a shielded package fabricated using SMT technology. This filter offers outstanding close in rejection, low insertion loss and high power handling for use in aviation, mobile radio, broadband and fixed wireless.

Power Splitter/Combiner

Mini-Circuits' SEPS-4-272+ is a 4 way-0°, 50 Ω, 690 to 2700 MHz power splitter/combiner. It features an operating temperature of -40° to 85°C; storage temperature of -55° to 100°C; good isolation, 20 dB typ.; good output matching, VSWR 1.1 typ.; and good coplanarity. It has a shielded case and is aqueous washable. It is ideal for applications such as CATV, ISM, wireless communication system, cellular, GPS and PCS.

Slope Equalizer

ZEQ-8-222N+ is a 50 W coaxial slope equalizer. This model offers excellent performance in the "L-Band" frequency range of 950 to 2150 MHz with minimal deviation in the attenuation slope. It features good matching and a connectorized package.

RF Switch Matrix

Mini-Circuits' RC-1SP4T-A18 is a general purpose RF switch matrix controlled via either USB or Ethernet-TCP/IP (supports HTTP and Telnet protocols). The model contains an electromechanical SP4T, absorptive fail-safe RF switch constructed in break-before-make configuration and powered by +24 V DC with switching time of 25 ms typical. The RF switch can be operated remotely using the supplied GUI software or programmed by the user with the included API objects. The RF switch operates over a wide frequency band from DC to 18 GHz, has low insertion loss (0.2 dB typical) and high isolation (85 dB typical) making the switch matrix perfectly suitable for a wide variety of RF applications.

Power Splitter/Combiner

ZFRSC-4-842+ is a 4 way-0°, resistive, 50 Ω, DC to 8400 MHz power splitter/combiner. It features an operating temperature of -55° to 100°C; storage temperature of -55° to 100°C; wideband, DC to 8400 MHz; good VSWR, 1.15:1 typ.; excellent amplitude unbalance, 0.3 dB typ.; and a rugged shielded case. It is ideal for laboratory and test set-up applications.

www.minicircuits.com

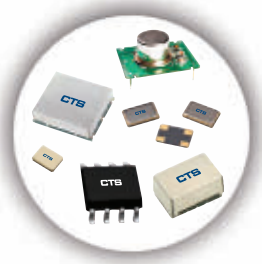
CTS®
ELECTRONIC COMPONENTS

LAUNCHING INNOVATIVE PRODUCTS INTO THE FUTURE

www.ctscorp.com
North America: +1-800-757-6686
International: +1-508-435-6831
Asia: +65-655-17551

IMS2014 - Tampa Bay, Florida
BOOTH #322
POWERING THE WAVE
International Microwave Symposium
IEEE 1-6 June 2014, Tampa Bay, FL MTT-S

FREQUENCY CONTROL PRODUCTS



Timing solutions for used in a broad range of equipment for the medical, defense, aerospace, industrial controls, power management, communications, computer and electronic networking markets.

- Quartz Crystals
- Clock Oscillators
- Timing Modules
- Semiconductor ICs

Scan for Product Information

EMC PRODUCTS

EMC filtering for telecommunications, CATV, telemetry, radar, amplifiers, RF switches and industrial process control equipment. Uses for CTS miniaturized trimmer capacitors include avionic instruments, communications and test equipment.

- Surface Mount Filters
- Feed Through Filters
- Filtered Terminal Blocks
- Variable Trimmer Capacitors
- Coaxial Resonators
- Custom EMI Filter Plate Assemblies
- Ceramic Disc Capacitors

Download Short Form Catalog

CERAMIC COMPONENTS

High performance RF ceramic monoblock band pass filters and duplexers designed for telecommunications infrastructure, satellite communications, avionics, test and guidance systems for both commercial and military use.

- Monoblock Filters
- Monoblock Duplexers
- ClearPlex® Waveguide Filters

Download Selection Guide

THERMAL MANAGEMENT SOLUTIONS

Superior thermal conductivity, convenient attachment methods and wide range of heights and fin types to choose from, CTS' heat sinks, fansinks and rugged circuit card retainers are suitable for electronics and military use.

- Heat Sinks
- Fansinks
- ZIF Circuit Card Retainers

Download Catalog

IMS Product Showcase: Aisles 800-1000

MECA Electronics Inc. Booth 842

Low PIM Loads

VENDORVIEW

MECA's low PIM (-165 dBc typ) loads for DAS applications feature industry leading PIM performance of -160 dBc min all while handling full rated power to 85°C. All of the terminations cover 0.698 to 2.700 GHz frequency bands in 7/16 DIN or Type N connectors. Ideal for IDAS/ODAS, in-building, base station, wireless infrastructure, 4G and AWS applications. VSWR = 1.10:1 (typical). They are made in the USA and come with a 36-month warranty.

www.e-meca.com

Keragis Corp. Booth 909

Wideband Amplifiers

Since 1993 Keragis Corp. has been providing high power, wideband amplifiers for a number of uses including radar subsystems, rack-mounted instruments, phased arrays and tow decoys.

www.keragis.com

MACOM Booth 915

VENDORVIEW

Matched GaN on SiC Power Transistor

The MAGX-001090-600L00 is a gold-metalized, matched GaN on SiC power transistor optimized for pulsed avionics applications, such as secondary surveillance radar in air traffic control systems. The device provides 600 W of output power with a typical 21.4 dB of gain and 63 percent efficiency. The device has very low thermal resistance and best-in-class load mismatch tolerance. In addition, the device has the lowest pulse droop of 0.2 dB and can be used effectively under more demanding Mode-S ELM operating conditions.

Unmatched GaN on SiC Power Transistor

The MAGX-000025-150000 is a gold-metalized unmatched GaN on SiC RF power transistor optimized for a variety of RF power amplifier applications. The device provides 150 W of output power with 18 dB of gain and 58 percent efficiency. The device also boasts very high breakdown voltages, which allows for reliable and stable operation at more extreme load mismatch conditions. The device is offered in a four lead, Gemini package which allows for very broadband match with high performance.

www.macomtech.com

EMC Technology & Florida RF Labs Booth 923

Temperature Variable Attenuator

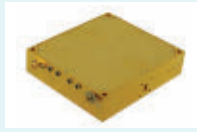
VENDORVIEW

42WTVA series coaxial Thermopad® is another cutting-edge temperature variable attenuator product from Florida RF Labs. Optimized for DC to 20 GHz operation in space and other harsh environments, 42WTVA series is the culmination of Florida RF Labs' extensive experience in passive zero-distortion gain compensation technology. Available in 2 through 6 dB of nominal attenuation, system designers can select from a wide range of compensation options to offset over-temperature gain variations. Samples and technical assistance are available.

www.emc-rflabs.com

Millitech Booth 923

Active Upconverters and Downconverters



Millitech series BUC/BDC are active upconverters and downconverters in a small package. Each BUC/BDC integrates amplifiers, a mixer and a filter to create a high power upconverter or low noise figure downconverter. Combining these components into single packages saves space and weight. An SMA pulse/mute control input is available on all units for control purposes. Custom options are available for gain, output power, noise figure, and other frequencies.

www.millitech.com

TRAK Microwave Corp. Booth 923

Ka SSPA

TRAK's low-cost all SMT Ka SSPA design is ultra-rugged and can be combined in 2, 3, 4 or 6 brick configurations for a wide range of flexible power options from 10 to 50 W. The wideband design uses no open die and utilizes sealed parts withstanding demanding airborne altitude and moisture environments. High RF linearity allows efficient operation with integrated DC/DC converter managed by TRAK DPS™ algorithm, which can be augmented with a band hopping BUC supporting worldwide Ka operation.

www.trak.com

Emerson Network Power Connectivity Solutions Booth 1005

SMPM Connectors

Emerson Network Power Connectivity Solutions now offers the Johnson line of SMPM connectors. The sub-miniature, push-on style micro interfaces are primarily distinguished by their size (about 35 percent smaller than the SMP connector) and their robust RF performance from DC-level frequencies up to 65 GHz. This makes the design appealing for security and defense systems, radar and closely-spaced, high-density wireless communication nodes.

www.emersonconnectivity.com

Thunderline-Z Inc. Booth 1005

Capacitive Feedthru

Thunderline-Z, a leader in production of glass to metal seals, hermetic packages and laser services, will be showing several new products at MTT. On display will be a downsized capacitive feedthru, an RF thread-in feedthru and new, low cost multipin headers. See these products on display at booth 1005.

www.emerson.com

KRATOS General Microwave Booth 1015

X- and Ku-Band SSPAs

KRATOS General Microwave presents X- and Ku-Band solid state power amplifiers. These GaN-based SSPAs offer up to 400 W of output power in up to 1000 MHz bandwidth. Units offer graceful power output degradation, ultra quiet switching power supply, fast on/off response and have built-in test capability. They offer high performance and are cost effective alternatives to electron tube devices. Their robust design, high reliability and small size make them ideally suited to replace TWTs in demanding airborne radar, missile and communication systems.

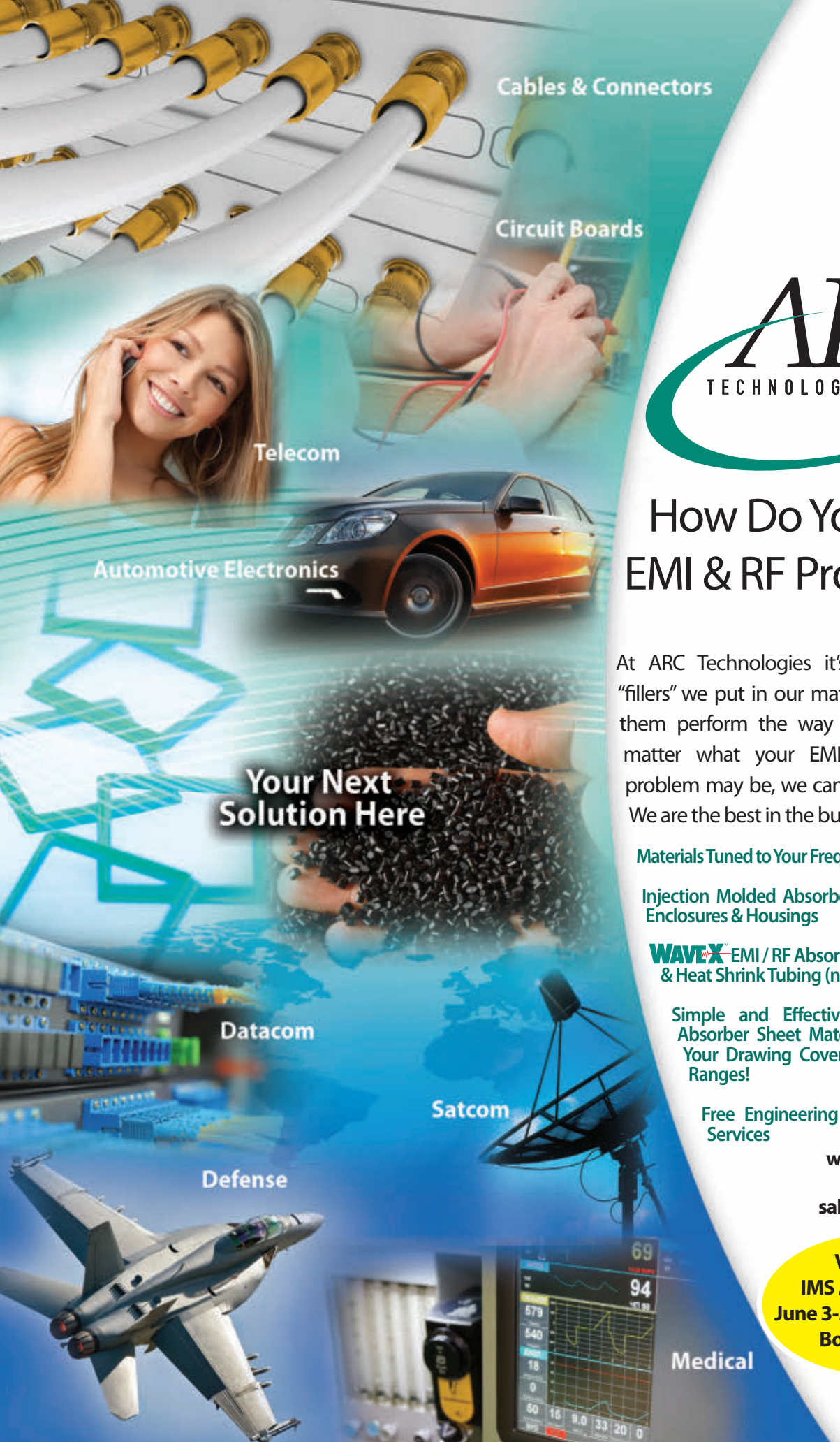
www.kratosepd.com

dBm Corp. Inc. Booth 1037

RF Link Emulator

dBm will demonstrate its high performance UHF/VHF radio and satellite RF link impairments emulator. This product offers full duplex RF link emulation with bandwidths up to 250 MHz and a powerful suite of tests for radio, UAV, satellite and mobile transceiver testing. Variable delay, Doppler, Multipath link emulation, additive white Gaussian noise and other link impairments can be emulated in real time.

www.dbmcorp.com



ARC TECHNOLOGIES, INC.

How Do You Solve EMI & RF Problems?

At ARC Technologies it's all about the "fillers" we put in our materials that make them perform the way they do. So no matter what your EMI or RF related problem may be, we can offer a solution. We are the best in the business.

- Materials Tuned to Your Frequency Specification
- Injection Molded Absorber for Lids, Covers, Enclosures & Housings
- WAVEX EMI / RF Absorbing Cable Coating & Heat Shrink Tubing (new)
- Simple and Effective Cut EMI / RF Absorber Sheet Material Converted To Your Drawing Covering All Frequency Ranges!
- Free Engineering and Consultation Services

www.arc-tech.com
978-388-2993
sales@arc-tech.com

Visit us at
IMS / MTT-S 2014
June 3-5 Tampa Bay, FL
Booth #1211

IMS Product Showcase: Aisles 1000-1100

B&Z Technologies Booth 1040

LNAs

Due to an increased demand by its customers requiring urgent delivery of state-of-the-art amplifiers, B&Z Tech has started a new trend with quick delivery of 'in stock' units operating from 10 MHz to 50 GHz. B&Z Tech has selected units based on the most common amplifier specification requests from their customers and put them in stock for quick delivery. Typically these units can be shipped within 3-5 days to domestic customers and in 7-10 days to international customers.

www.bnztech.com

Pivotone Booth 1049

Quadruplexer

Pivotone introduced a new quadruplexer: LTE700 / AMPS / PCS / AWS. It covers the: 698 to 790 MHz, 824 to 896 MHz, 1850 to 1990 MHz, 1710 to 1755, and 2110 to 2155 MHz bands. This high-performance part is designed for multi-band, co-located sites. Although it is relatively small in size, it has low insertion loss and allows for DC and AISG issue 2.0 passthru on selected ports. This quadruplexer is available to mount on the wall or poles. It is suitable for outdoor and indoor applications.

www.pivotone.com

Reactel Inc. Booth 1100

Small Form Factor Filters

VENDORVIEW

Reactel will feature a line of small form factor filters that are suitable for densely populated boards, portable systems or any application where size is at a premium. These units are available in discrete component, ceramic, cavity or combline designs. With profiles as low as 1/8", these units pack all of the performance of their larger counterparts into a much smaller package. They are available across a frequency range of 100 MHz to 40 GHz with bandwidths of 5 to 100 percent and are available in 4-12 sections.

www.reactel.com

SV Microwave Booth 1104

RF Interconnect System

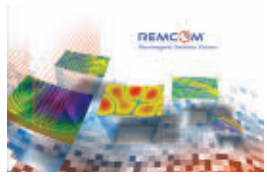
The new FeatherMate RF interconnect system from SV Microwave combines a high density (0.095" center-to-center spacing) 40+ GHz multiport concept with a zero disengagement force mating mechanism. Direct connection to board trace, solder-free board mounts and small diameter coax cable connectors are a few of the configurations available. Applications include test boards and anywhere a high density, low-force connection is needed. Get more bandwidth and signal density in your application without worrying about destructive demating forces with SV Microwave's FeatherMate.

www.svmicrowave.com

Remcom Inc. Booth 1105

EM Simulation Software

XFdtd is a full wave 3D electromagnetic solver that simplifies the analysis of complex EM problems and leads the market in FDTD-based modeling and simulation. XFdtd is ideal for solving the largest and most complex EM problems at the fastest speeds. Using MPI technology with XStream GPU acceleration and unlimited memory support allows massive simulations with a virtually unlimited number of cells. Other key features include XACT Accurate Cell Technology, CAD Merge, XTend Script Library, and External Queue Integration (EQI).



www.remcom.com

LPKF Laser & Electronics Booth 1108

PCB Prototyping System

The LPKF ProtoMat D104 is a rapid PCB prototyping system that features both mechanical tools and a UV laser beam. By combining mechanical and laser processing, a wide range of applications are possible. The laser can be used to etch fine line circuit traces on high frequency materials and ceramics, while milling and drilling tools can be used to route boards and drill vias and through-holes.

www.lpkfusa.com

Delta Electronics Booth 1114

Coaxial Interconnect System

Delta Electronics Manufacturing Corp.'s new MHF/U.FL series data sheet details the company's latest ultra miniature coaxial interconnect system that operates from DC to 6 GHz. This connector interface was developed for applications in small form factor wireless mobile electronic devices. In addition to information on applications, materials, finishes and typical electrical performances, full detail is provided on how to specify a MHF/U.FL cable assembly or "pigtail" assembly, including compatible coaxial cables and alternate end interfaces. Specifications are also provided on the surface mount receptacle.

www.deltarf.com

JFW Industries Inc. Booth 1115

Low PIM Attenuator

JFW is proud to introduce its latest innovation in RF fixed attenuation. The 50FLP-XXX-100 fixed attenuator boasts a maximum passive intermodulation (PIM) reading of -155 dBc (-165 dBc typical). It covers 698 to 2700 MHz and is available in 5, 6, 10, 20 and 30 dB values. The 50FLP series handles up to 100 W of RF power (average) while maintaining an accuracy of ±0.75 dB and a typical VSWR of 1.3:1.

www.jfwindustries.com

Times Microwave Systems Booth 1118

Coaxial Cable Assembly

The Times SPP-LLPL 50 ohm low loss plenum rated/UL listed coaxial cable assembly family has been expanded beyond the popular SPP-250-LLPL 1/4" cable to now include SPP-375-LLPL 3/8" and SPP-500-LLPL 1/2" cables for even lower loss. Superior in electrical performance to other copper cable assemblies, SPP-LLPL cables are the perfect in-building solution for PIM-sensitive installations and system interconnects. Meeting the fire resistance requirements of UL 910 for plenum rated applications, the new sizes are ideal for installations where lower loss is needed.

www.timesmicrowave.com

KRYTAR Inc. Booth 1119

Directional Coupler

Model 181230 offers superior performance over the 12.4 to 18 GHz frequency range, delivers 30 dB (±1.0 dB) of Nominal Coupling and Frequency Sensitivity of ±0.7 dB. Directivity is >15 dB with insertion loss of <0.6 dB across the full frequency range including coupled power. Maximum VSWR at any port is 1.35, input power rating is 20 W average and 3 KW peak. Operating temperature is -54° to +85°C.

www.krytar.com

MIcable Inc. Booth 1123

Cable Assemblies

C04 series are highly reliable and cost-effective cable assemblies, ideal for broadband tests and various connections. The triple-shielded cable has rugged construction employing an advanced strain relief system and is equipped with reinforced stainless steel connectors. They are tough enough to be qualified for over 20,000 flex cycles without changes in electrical performance up to 26.5 GHz. They are available in custom lengths with SMA or N type connectors.

www.micable.cn

Two big functions.
One tiny footprint.

We've combined the perfect switch and the perfect limiter into one high-power, moisture-sealed, SMT unit.
It operates from your 5 V, 30 V and -5 V supplies and includes a fully integrated DC bias network.

- **Frequency range: 2 to 4 GHz**
- **Avg. Tx Power Handling: 125 W CW**
- **Voltage Rating: > 500 V**
- **Insertion Loss: 0.85 dB**
- **VSWR: 1.6:1**
- **Size: 8 mm x 5 mm x 2.5 mm**

It is designed to minimize small-signal insertion loss and provide excellent Tx input return loss under large signal conditions. It's the perfect alternative to MMIC solutions and comes MIL-STD ready.

Visit our website for the complete datasheet or contact us to discuss your L-, S-, or C-band application.

603-641-3800
www.aeroflex.com/metelics
See us at IMS Booth 1623

AEROFLEX
A passion for performance.

IMS Product Showcase: Aisles 1100-1300

WERLATONE Booth 1127

Absorptive Filters

VENDORVIEW

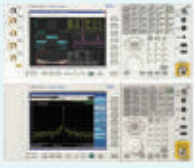
WERLATONE® introduced its new line of high power absorptive filters. Its non-reflective designs are internally terminated, preventing out-of-band signals from generating undesirable intermodulation products. Its Mismatch Tolerant® design greatly reduces the dependency of the system on the length of interconnecting cable between a power amplifier and antenna. This absorptive filter approach eliminates the instability of power amplifiers at out-of-band frequencies, and eliminates potential damage to power amplifiers due to reflection of high power out-of-band energies.

www.werlatone.com

Agilent Technologies Booth 1133

VENDORVIEW

Signal Analyzers



Agilent's MXA/EXA signal analyzers are ideal for wireless communications and general-purpose testing. Latest enhancements include: Noise Floor Extension (NFE) for MXA — up to 9 dB sensitivity improvement over models without NFE; atomic frequency reference option — 100× improvement in long-term frequency stability; MXA extended frequency coverage — up to 110 GHz with Agilent smart mixers; up to 1.1 THz with VDI's frequency extender; and fast power option — up to 4× speed improvement in adjacent channel power ratio and band density measurements.

Handheld Analyzers

Agilent FieldFox handheld combination analyzers are the ideal tool for radar installation and maintenance (I&M). Until now the only choice for radar I&M was to use expensive, lab-grade instruments that make time-consuming measurements. FieldFox offers an easier, more cost-effective way to complete your testing, with all the accuracy and functionality you require in an all-in-one solution. Go to www.agilent.com/find/fieldfoxradar to learn techniques for precision radar performance in the field; download an application note, watch a video or watch an on-demand webcast.

www.agilent.com

State of the Art Inc. Booth 1205

Chip Resistors

State of the Art Inc. has recently extended its S failure rate level to all of its MIL-PRF-55342 chip resistor products. Failure rate level S is the lowest (0.001 percent/1000 hours) failure rate available. These precision thin film chip resistors now join the company's semi-precision thick film chip resistors that were first qualified to S level in 1987. State of the Art Inc. products have been used in mission-critical military and space applications since the 1970s.

www.resistor.com

Sonnet Software Inc. Booth 1215

Passive Device Design EM Simulation

Blink is the first multi-solver passive device modeling suite that operates entirely from within the Cadence Virtuoso environment. Integrated Circuit (IC) designers can focus their efforts on speed and accuracy with Blink's two full-wave EM solvers, where they can choose from Sonnet's traditional shielded method-of-moments (MoM) solver and the new fast solver. Designers can now easily model new and unique passive devices within their normal Cadence Virtuoso based IC design flow to achieve first pass Silicon success.

www.sonnetsoftware.com

Cernex Inc. Booth 1218

Up/Down Converter Subsystem

VENDORVIEW

Cernex introduced a 64 GHz switch up/down converter subsystem. Up link features RF: 58.54 to 64.54 GHz, IF: 1 to 7 GHz, Gain: >12 dB, flatness: 4 dB typ., OP1dB: 13 dBm typ, 12 dBm min, OIP3: 35 dBm typ @ 0 dBm at RF/IF output (guaranteed but not tested). Down link features: RF: 58.54 to 64.54 GHz, IF: 1 to 7 GHz, Gain: >12 dB, flatness: 4 dB typ, NF: 6 dB typ, 7 dB max, OP1dB: >0 dBm, max input power: -10 dBm, OIP3: 35 dBm typ @ 0 dBm at RF/IF output (guaranteed but not tested).

www.cernex.com

Z-Communications Inc. Booth 1227

Fixed Frequency Synthesizer

The SFS10625E-LF is a single frequency PLL solution that is pre-programmed to operate at 10.625 GHz. This fixed frequency device utilizes ceramic resonator topology to achieve integrated RMS noise performance of better than 0.4° while consuming less than 500 mW of power. It is designed to deliver +3 dBm of output power into a 50 Ω load and is available in a package measuring 1.0" × 1.0" × 0.22".

www.zcomm.com

Maury Microwave Booth 1241

Measurement and Modeling Solutions

Maury Microwave will be demonstrating state-of-the-art measurement and modeling solutions including: a patent-pending noise parameter system, a pulsed IV/RF and compact modeling solution, a hybrid-active load pull solution based on the PNA-X, a patented mixed-signal active load pull system capable of up to 1000 impedance/power measurements per minute and 240 MHz of instantaneous impedance control, and Maury's patent-pending LXI™-certified automated impedance tuners. Visit Maury for demos at IMS.

Color-Coded Interconnects

ColorConnect™ Precision Adapters and Stability™ and Utility™ cable assemblies are the first commercially available products to offer clear indications of compatibility and intermatability. ColorConnect™ makes it a simple matter to avoid and eliminate damaged equipment, degraded equipment reliability, degraded performance and lengthy maintenance times due to improper mating (and attempted mating) of incompatible adapters. ColorConnect™, Stability™ and Utility™ are available in 1.85mm, 2.4mm, 2.92mm, 3.5mm, N-Type and SMA.

www.maurymw.com

Cuming Microwave Booth 1311

Microwave Absorber

Cuming Microwave announces a new microwave absorber for use in cavity resonance suppression between 800 MHz and 18 GHz. C-RAM RGD-S-192, a thin, flexible, highly magnetically loaded silicone absorber used in applications where performance cannot be traded for a thicker material. C-RAM RGD-S-192 is standard at 0.040" (1.01 mm) thick and is ideal for suppressing waves within cavities of microwave modules and other electronics where physical space is limited. Available in 12" × 12" sheets, other thicknesses, PSA, and custom configurations. Samples are available.

www.cumingmicrowave.com

Freescale Semiconductor Booth 1315

Mobile Radio Solution

Freescale's AFT05MS006N is a 6 W device for handheld mobile radio applications. With this latest addition to its flagship Airfast RF power solutions portfolio, Freescale is the only supplier capable of supporting all power levels of relevance to the mobile radio space, from 5 W handheld units to 75 W mobile radios and base stations. The device is

MINIATURE FOOTPRINT

ULTRA WIDE BANDWIDTH VCO

Perfect for portable radios and T & M equipment

0.3" x 0.3" x 0.1"

Model	Frequency Range (MHz)	Tuning Voltage (VDC)	DC Bias VDC @ I [Typ.]	Phase Noise @ 10 kHz (dBc/Hz) [Typ.]
DCO4351-8	430 - 510	0.3 - 3	+8 @ 27 mA	-105
DCO50100-5	500 - 1000	0.5 - 15	+5 @ 28 mA	-100
DCO5260-3	525 - 600	0 - 3	+3 @ 12 mA	-105
DCO6080-3	600 - 800	0 - 3	+3 @ 12 mA	-105
DCO7075-3	700 - 750	0 - 3	+3 @ 10 mA	-108
DCO8087-5	800 - 870	0.5 - 5	+5 @ 22 mA	-111
DCO80100-3	800 - 1000	0 - 3	+3 @ 12 mA	-105
DCO80100-5	800 - 1000	0.5 - 8	+5 @ 21 mA	-111
DCO8190-5	810 - 900	0.5 - 16	+5 @ 28 mA	-118
DCO100200-5	1000 - 2000	0.5 - 24	+5 @ 30 mA	-95
DCO1198-8	1195 - 1205	0.5 - 8	+8 @ 24 mA	-115
DCO143158-8	1430 - 1515	0.3 - 3	+8 @ 17 mA	-105
DCO170340-5	1700 - 3400	0.5 - 24	+5 @ 24 mA	-90
DCO200400-5	2000 - 4000	0.5 - 18	+5 @ 38 mA	-90
DCO230245-5	2300 - 2450	0.5 - 20	+5 @ 29 mA	-102
DCO300600-5	3000 - 6000	0.3 - 16	+5 @ 12 mA	-78
DCO400660-5	4000 - 6600	0.5 - 11	+5 @ 29 mA	-75
DCO400800-5	4000 - 8000	0.3 - 15	+5 @ 17 mA	-78
DCO432493-3	4325 - 4950	0.5 - 11	+3 @ 18 mA	-87
DCO432493-5	4325 - 5000	0.5 - 12	+5 @ 17 mA	-88
DCO473542-3	4650 - 5420	0.3 - 22	+3 @ 18 mA	-88
DCO473542-5	4730 - 5420	0.5 - 22	+5 @ 20 mA	-88
DCO490517-3	4900 - 5400	0.3 - 10	+3 @ 14 mA	-83
DCO490517-5	4900 - 5175	0.5 - 5	+5 @ 17 mA	-88
DCO495550-5	4950 - 5500	0.5 - 12	+5 @ 17 mA	-83
DCO579582-5	5725 - 5880	0.5 - 10	+5 @ 16 mA	-90
DCO608634-3	6080 - 6340	0.5 - 5	+3 @ 22 mA	-86
DCO608634-5	6080 - 6340	0.5 - 5	+5 @ 16 mA	-85
DCO615712-5	6150 - 7120	0.5 - 12	+5 @ 18 mA	-85
DCO680700-5	6760 - 7000	0.5 - 5	+5 @ 28 mA	-88
DXO810900-5	8100 - 8925	0.5 - 15	+5 @ 26 mA	-82
DXO880920-5	8800 - 9200	0.5 - 15	+5 @ 22 mA	-80
DXO900965-5	9000 - 9650	0.5 - 12	+5 @ 22 mA	-80
DXO10021022-5	9700 - 10225	0.5 - 15	+5 @ 21 mA	-78
DXO10701095-5	10700 - 10950	0.5 - 15	+5 @ 21 mA	-82
DXO11441200-5	11440 - 12000	0.5 - 15	+5 @ 24 mA	-82
DXO11751220-5	11750 - 12200	0.5 - 15	+5 @ 24 mA	-80
DXO13901400-5	13900 - 14000	0.5 - 8	+5 @ 18 mA	-77
DXO14851515-5	14850 - 15150	0.5 - 15	+5 @ 25 mA	-74

Patented Technology

SYNERGY® MICROWAVE CORPORATION

Phone: (973) 881-8800 | Fax: (973) 881-8361

E-mail: sales@synergymwave.com | Web: www.synergymwave.com

Mail: 201 McLean Boulevard, Paterson, NJ 07504

See us at IMS Booths 704 & 705

The Signal Source Noise Control & Signal Processing Experts.

ideal for handheld applications while also broadly applicable as a driver in higher powered mobile radio solutions.
www.freescale.com

Herotek Inc. Booth 1327

Low Signal Detectors

Herotek has introduced a new series of detectors for very low signals for direct measurement of microwave signals down to -80 dBm over 1 to 40 GHz. The DTA182670A operates from 18 to 26 GHz with very high sensitivity of 100 mV/mW, TSS of -70 dBm, stable and quite low I/F noise operation, and extremely fast pulse response (1 nsec rise time typical). Its max input VSWR is 2:1, it is hermetically sealed for military application and it has removable connectors for MIC assembly.
www.herotek.com

Virginia Diodes Inc. Booth 1341

VNA Extension Modules

VDI's smaller form factor vector network analyzer extension modules are now in production. While retaining industry leading test port power and dynamic range, the modules have been reduced to ¼ the volume of previous modules, the power supply has been simplified, and the cooling fans have been eliminated. Key applications include probe stations and antenna ranges. Miniature modules are currently available for WR15, WR12 and WR10 waveguide bands with higher frequency modules under development.
www.vadiodes.com

San-tron Booth 1346

Low-PIM Mini-DINs

VENDORVIEW

San-tron has added high performance 4.1/9.5 mini-DIN connectors and adapters to its growing line of low-PIM SRX products. The new mini-DINs feature low PIM of -160 dBc and < 1.10 VSWR up to 7 GHz, and complement San-tron's low-PIM cable assemblies. Suited for wireless and cellular applications, they meet critical requirements for attenuation, VSWR, and intermodulation strength, and can stand up to extreme environments. Get a quote today at the company's website.
www.santron.com

K&L Microwave Booth 1404

Lowpass Filters

Using a proprietary design approach, K&L Microwave has been able to significantly reduce the size required for high power cleanup lowpass filters. A series of these parts has been designed and put into volume production, providing cutoff frequencies as low as 3 MHz, a shape factor of 1.22:1 and handling 1000 W CW. The approach utilized allows the size of these filters to be remarkably small at 4.5"L × 1.8"W × 1.25"H. Discuss your custom requirement at booth 1404.
www.klmicrowave.com

Dow-Key Microwave Booth 1405

Switches and Switching Systems

VENDORVIEW

Dow-Key Microwave manufactures and custom designs switches and switching systems for the commercial, military and space industries. Its products include broadband RF coaxial and

waveguide switches operating from DC to 70 GHz, electromechanical and solid state switch matrices and fiber-optic switching systems. Visit the company at booth 1405 to learn more about its new low PIM switches, Reliant Switch™, next generation matrices and custom matrix solutions.
www.dowkey.com

AR RF/Microwave Instrumentation Booth 1415

SSPA

VENDORVIEW

Model 50HM1G6AB-47 is a compact, wideband, 50 W Class AB solid state hybrid power

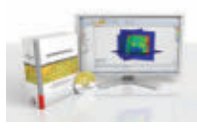
amplifier module that instantaneously covers 1 to 6 GHz. It operates from a single DC voltage and provides 48 dB of typical gain with excellent gain flatness, noise figure and low intermodulation distortion for military and wireless applications.
www.arworld.us

CST of America Inc. Booth 1423

3D Electromagnetic Simulation Software

VENDORVIEW

CST STUDIO SUITE® is a package of tools for simulating and optimizing devices across the electromagnetic spectrum – helping to address



design challenges in application areas such as microwaves, RF and optical, EDA, EMC/EMI and particle dynamics. The integrated design environment gives users access to the entire range of solver technology, while system assembly and modeling facilitates multi-physics and co-simulation. CST STUDIO SUITE can offer product to market advantages such as shorter development cycles and optimization.
www.cst.com

Insulated Wire Inc. Booth 1436

Customized Composite Cables

Insulated Wire (IW) announced the expansion of its capabilities to produce customized composite cables featuring low smoke/zero halogen polyurethane jackets. IW's composite cables provide a myriad of options. Components can include individually shielded and jacketed signal transmission cables, power cables, microwave cables and fiber optic. Depending on the application, cables can be optimized to address issues such as hydrostatic pressure, tensile loads, concentrated compression points, etc. Overall shielding can be provided with ferrous or non-ferrous materials.
www.insulatedwire.com

Rohde & Schwarz GmbH & Co. KG Booth 1439

VENDORVIEW

Switch Matrix

Rohde & Schwarz has developed the R&S ZN-Z84 switch matrix, an up to 48-port solution for testing multiport components. The matrix can be controlled and operated directly from an R&S ZNB network analyzer. The matrix covers the frequency range from 10 MHz to 8.5 GHz, and the base model is equipped with six test ports. When needed, the number of test ports can be increased in groups of six to provide a total of 24 ports.

Signal and Spectrum Analyzer

Rohde & Schwarz has expanded the analysis bandwidth for its R&S FSW high-end signal and spectrum analyzers to 500 MHz. The new hardware option is now available for all analyzers of the R&S FSW family and can therefore be used for measurements in a frequency range up to 67 GHz. This enables completely new applications in research and development. The analyzer is especially well-suited for sophisticated measurement tasks in radar or satellite applications as well as for tests on fast wireless connections such as WLAN or beyond 4G (5G).
www.rohde-schwarz.com

Microwave Journal

Frequency Matters.

www.mwjournal.com/freqmatters

Scan page using layar app

Catch up on the latest industry news with the bi-weekly video update

Frequency Matters

from

Microwave Journal

Sponsored By Mini-Circuits® ISO 9001 ISO 14001 AS9100 Agilent Technologies

See us at IMS Booth 724

IMS Product Showcase: Aisle 1500

Networks International Booth 1501

Miniature Filters

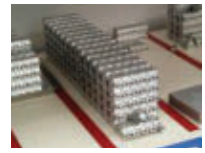
NIC's engineering expertise in hi-reliability RF products includes a specialty in miniature filters that range in frequency from 20 MHz to 7 GHz. These low profile (0.15") LC and ceramic filters can be customized to meet passband requirements from 1 to 100 percent and meet a wide range of environmental requirements as well. Whether your challenge is a small form factor, high power or cost, NIC's unique products showcase a variety of creative solutions for all of your radar and communications needs.

www.nickc.com

Quest Microwave Booth 1505

Ferrite Devices

Quest Microwave provides a broad range of ferrite devices for the global microwave electronics marketplace. Standard and custom designs are available for both commercial and military applications. With over 60 years of combined experience, the company's engineering staff can design and develop ferrite devices for virtually any application. They are there to provide you with a world class microwave components solution.



www.questmw.com

Spectrum Elektrotechnik GmbH Booth 1505

Multiport Designs

Spectrum Elektrotechnik GmbH is currently developing a circular multiport connector using the size 13 dimensions of MIL-DTL 38999 series, containing nine coaxial low loss cables with outer diameter of 2.3 mm (0.091") and operating to 18 GHz, as well as a circular multiport connector containing 19 coaxial cables of same cable type in the size 25 shell MIL-DTL 3899. In parallel, development has been started for several rectangular multiport connectors. Spectrum's Multiport family is continuously increasing.

www.spectrum-et.com

Rosenberger of North America LLC Booth 1519

Push-On Products

Rosenberger has responded to the market demand for higher density on boards and frequencies to 100 GHz, by introducing its new series of push-on products called WSMP™. This product line provides lower weight and is 45 percent smaller in size than SMPM. The WSMP product family is supported by custom cable assemblies, test adapters and custom designs. See Rosenberger at booth 1519.

www.rosenbergerna.com

TriQuint Semiconductor Inc. Booth 1533

RF Power Transistors

TriQuint's T1G4020036-FS/-FL are 2 × 120 W (peak P3dB) discrete GaN on SiC HEMTs that operate from DC to 3.5 GHz constructed with TriQuint's TQGaN25HV process and offer an operating voltage of 36 V. The 4-leaded "Gemini" style package offers two independent 120 W RF paths that enable flexibility when designers are choosing amplifier architectures. The transistors are available in both eared and earless versions and offer a 60 percent reduction in PCB board area versus comparable LDMOS power.

www.triquint.com

EDI
CON
2015
Electronic Design Innovation Conference
电子设计创新会议
Connecting Engineers and Industry
April 2015
Beijing, China
北京
Scan page
using layar app
Exhibition Spaces Available
www.EDICONCHINA.com
See us at IMS Booth 724

IMS Product Showcase: Aisles 1500-1600

Test Equipment Plus — Booth 1550

Real-time Spectrum Analyzer

Signal Hound BB60A is a real-time spectrum analyzer/RF recorder that captures and displays RF events as short as 1 µs. It is operational from 9 kHz to 6 GHz. Signal Hound streams 80 million samples per second of RF data to a PC via USB 3.0 — enabling real-time spectrum analysis of any 20 MHz segment of spectrum. The BB60A comes with a compiled API for writing custom software. It sells for $2,479 USD.

www.testequipmentplus.com

Pico Technology — Booth 1551

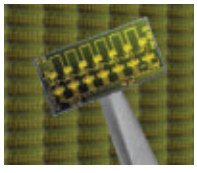
Sampling Oscilloscopes

Pico Technology is the world leader in PC-based oscilloscopes, with 23 years of experience and a wealth of engineering talent; Pico Technology's products offer a modern and cost effective alternative to traditional, and often costly, bench top test and measurement equipment. With PicoSample software that offers clock and signal characterization, mask testing, TDR/TDT and histogram analysis – please drop by booth 1551 at IMS Tampa Bay.

www.picotech.com

Eclipse Microwave — Booth 1600

Driver Amplifier

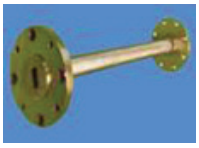


Eclipse Microwave's EMD1211-D is a GaAs MMIC general purpose driver amplifier. This power amplifier device is well suited for applications that require a typical output power of +30 dBm at 10 GHz, while requiring only 300 mA from a +12 V supply. Gain flatness is less than 2 dB from DC to 20 GHz. The EMD1211-D is available in die form, has excellent RF/thermal properties and is ideal for commercial and industrial applications.

www.eclipsemicrowave.com

Microtech Inc. — Booth 1604

Millimeter Seamless Waveguide

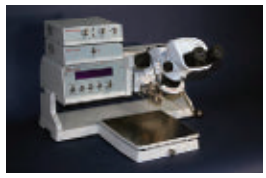


Millimeter Seamless waveguide is available in both standard and custom designed configurations, spanning frequencies from 26.5 to 110 GHz. It provides a convenient way to bridge two fixed assemblies or allow for movement within a system. The interior is silver-plated for minimal insertion loss.

www.microtech-inc.com

West-Bond Inc. — Booth 1615

Wire Bonders



Introducing the most flexible, complete wire bonders system available today…7KE and 4KE Series wire bonders: Bonding at 45 degree feed for tail control, 90 degree for ribbon and deep access and ball bonding without changing heads. Wedge bonding Au, Al, Cu; ball bonding Au, Cu; automatic, semiautomatic, and manual all ESD protected. Ultrasonic, thermosonic, and thermocompression wire/ribbon bonders; eutectic and epoxy die bonders, insulated wire bonders and pull testers.

www.westbond.com

Aeroflex/Inmet — Booth 1623

Temperature Compensating Attenuators

Aeroflex/Inmet introduced the TCAF-X-N05 series of temperature compensated chip attenuators. Operating DC to 12.4 GHz and capable of 2 W average power, these surface mount attenuators are used in place of standard chip attenuators to combine level setting or buffering functionality with negative temperature compensation without the need for bias or control voltages. Designs for 2, 3 and 4 dB attenuation values with a temperature coefficient of -0.005 dB/dB/°C are available for evaluation. For samples or typical data, contact inmet-sales@aeroflex.com.

www.aeroflex-inmet.com

Aeroflex / Metelics — Booth 1623

GaAs Comb Generators

Aeroflex / Metelics' new 4 nonlinear-transmission-line (NLTL) GaAs comb generators offers superior phase noise performance up to -18 dBc/Hz better than an SRD, usable harmonics out to 50 GHz and it is available in SMT or connectorized packages. Applications for these devices include radar and surveillance receivers and feature 10 to 18 dBc/Hz lower phase noise than Si step recovery diode (SRD) comb generators. They offer phase noise as low as -135 dBc/Hz at 100 Hz offset from the 12 GHz harmonic.

High Power Limiters

The RoHS-compliant LM Series of surface mount limiter modules provide exceptional broadband performance (20 to 8,000 MHz) in a low profile (8 × 5 × 2.5 mm) outline suitable for high peak and average power receiver protector applications. These products feature high peak power operation (+60 dBm, 25 µs pulse width, 5 percent duty cycle); high CW power handling (125 W CW); and low insertion loss (0.3 dB) and low flat leakage power (+20 dBm).

www.aeroflex.com/metelics

Aeroflex Signal & Control Solutions — Booth 1623

Frequency Synthesizer

Aeroflex Signal & Control Solutions' new model 2600 synthesizer represents the latest in frequency generation solutions from Aeroflex. The 2600 series is developed around stable direct analog and direct digital frequency synthesis with no VCOs or sensitive PLLs. Features include: Broad frequency range with options up to 40 GHz, fully phase coherent, 1 Hz resolution as standard, 250 nS switch speed (fully settled, true hopping rate), and ultra-low phase noise.

www.aeroflex.com/ascs

Aeroflex / Weinschel — Booth 1623

Programmable Attenuator Units

VENDORVIEW

Aeroflex / Weinschel's Model 8320/8321 Series represent a new streamlined approach in programmable attenuation for bench test and subsystem applications. Standard designs house and control various Aeroflex / Weinschel programmable attenuator models (3200-XE, 3400, 150T, and 4200 Series) via front panel controls, Ethernet, USB and Serial communications interfaces. A GPIB (IEEE-488) interface is also available as an option. Labview-based attenuator control center software (ACCS) is included.

www.aeroflex.com/weinschel

eLEARNING center

Presented by: Microwave Journal

May Short Course Webinars

Technical Education Training
The Design of a 100 W, X-Band GaN PA Module
Presented by: Agilent Technologies EEsof/Cree
Live webcast: 5/7/14

Technical Education Training
Advanced Safety Systems in Automotive Designs
Presented by: Isola
Live webcast: 5/8/14

Technical Education Training
Antenna Measurements in Under 1 Second Using Very-Near-Field Technology
Presented by: EMSCAN
Live webcast: 5/14/14

Technical Education Training
Practical Antenna Design for Advanced Wireless Products
Presented by: AWR
Live webcast: 5/15/14

RF/Microwave Training
Mixers and Frequency Conversion
Sponsored by: Mini-Circuits
Live webcast: 5/20/14

Technical Education Training
Overview of FEKO Suite 7.0
Presented by: EM Software & Systems
Live webcast: 5/21/14

Agilent in Wireless Communications
IEEE 802.11ad (WiGig) PHY and Measurement Challenges
Live webcast: 5/22/14

Past Webinars On Demand

Technical Education Training Series
- Learn How to Select the Right RF Product Solution to Improve Overall Radar Performance
- Current Induced in Si RFIC Substrates by Spiral Inductors and Patterned Ground Shields
- Overcome LTE-A and 802.11ac Manufacturing Test Challenges with Agilent's New EXM
- Analysis of FMCW Radar Signals in Automotive Applications
- Learn to Make Power Amplifier Tests Faster!
- Overcome LTE-A UE Design Test Challenges with Agilent's New UXM
- Design and Simulation of Modern Radar Systems
- PCB Material Selection for High Speed Digital Design
- Improve Overall System Performance with New TriQuint GaN Products
- Freescale and Scintera: The Small Cell Transmitter Solution Provider
- What Have You Been Missing in Your Pulsed Network Analyzer Measurements?
- Interference 101

RF and Microwave Education Series
Presented by: Agilent Technologies
- EMC Back to Basics

Agilent in Aerospace/Defense Series
- Effectively Maintain Mission Critical Communication Systems
- Understanding Low Phase Noise Signals

CST Webinar Series
- New Features for MW, RF and Optical Simulation in CST STUDIO SUITE 2014
- Train Signaling System Interference Estimation by CST MWS
- Simulating Dielectric and Conductor Loss Components Including the Influence of Trace Edge and Surface Roughness Topography
- Traveling Wave Tube Design with Simulation
- EMC Simulation in the Design Flow of Modern Electronics
- Wireless Power Transfer and Microwave Energy Harvesting

Innovations in EDA/Signal Generation & Analysis Series
Presented by: Agilent EEsof EDA/Agilent Technologies
- ADS 2014: New Technologies, New Capabilities & Impressive Productivity Improvements
- Non-Standard Connection Characterization with ATE Systems
- How to Improve PA Performance and Reliability Using Electro-Thermal Analysis
- Tolerance Analysis for Planar Microwave Circuits

Agilent in LTE/Wireless Communications Series
- E-Band Wireless Backhaul: System Design and Test Challenges
- Carrier Aggregation: Fundamentals and Type of Deployments

FieldFox Handheld Analyzers Series
Presented by: Agilent Technologies
- Techniques for Precise Cable and Antenna Measurements in the Field
- Precision Validation of Radar System Performance in the Field

Register to attend at mwjournal.com/webinars

Scan page using layar app

ASB
Advanced Semiconductor Business

CATV Push-Pull MMICs
5~1200 MHz

ASL912, ASL920

Output 110 dBμV @ PAL-99
117 dBμV @ CENELEC-42
Gain 13, 19 dB
Vd 10 V
Id 620, 630 mA

AWB51D2, AWB51D7, AWB51D9

Output 107~109 dBμV @ PAL-99
Gain 14, 18, 22 dB
Vd 8 V
Id 340 ~ 370 mA

AWB31D2, AWB31D7, AWB31D9

Output 101~105 dBμV @ PAL-99
Gain 12, 17, 19 dB
Vd 5 V
Id 210 ~ 220 mA

Optical Receiver
Gain Adjustable

Frequency 50 ~ 1200 MHz
Optical Input −8 ~ +2 dBm
Output Power 82 ~ 87 dBμV

QFN24(4x4mm)

Voltage Attenuation Control Included

TIA VAC Amp

Part Number	Vd/Id (V/mA)	Gain @ Vc (dB)	Output (dBμV)	CSO (dBc)	CTB (dBc)
ASA303A	5 / 245	33~3 @ 0~2.92 V	82[1], 84[2]	66[1], 72[2]	66[1, 3]
ASA306B	5 / 270	36~16 @ 0~4.4 V	87[2]	64[4], 62[2]	67[4], 62[2]

1) PAL 98 ch (81 dBμV 60 ch + 71 dBμV 38 ch)
2) CENELEC 42 ch (81 dBμV 42 ch)
3) 553.25 MHz of NTSC 79 ch in the optical input range of -7 ~ +2 dBm
4) Optical Input = -7 dBm
5) Optical Input = +2 dBm

www.asb.co.kr

See us at IMS Booth 1848

IMS Product Showcase: Aisles 1600-1700

Communications & Power Industries
Booth 1639

X-Band SSPA

CPI's VXS3614 solid state power amplifier (SSPA) is designed to provide a very reliable, air-cooled amplifier for mobile radar requirements. The VSX3614 SSPA covers the 8.8 to 9.6 GHz frequency band with a duty cycle of 10 percent. Gallium Nitride transistors are utilized for optimum size, weight and efficiency. The 900 W SSPAs can be readily power combined using waveguide combiners for power levels from 1.5 to 6 kW.

www.cpii.com/bmd

UTE Microwave Inc.
Booth 1704

High Power Circulator

High power circulator CT-1842-D is suitable for applications in radar, medical, scientific and broadcast applications. The 2 KW average power unit has a 52 min. bandwidth at customer selected center frequencies in the range of 80 to 720 MHz. Specifications are 20 dB min. isolation, 0.3 dB loss, 1.25 VSWR max. Size is 9" square. DIN l/16 connectors are standard. Other options are available. Peak power units are also available.

www.utemicrowave.com

Planar Monolithics Industries Inc.
Booth 1705

Frequency Synthesizer

VENDORVIEW

PMI Model No. PFS-618-CD-1 is a high speed frequency synthesizer that operates over the frequency range of 6 to 18 GHz having 100 kHz steps with an output power of +10 dBm minimum and an accurate to within ±1 MHz maximum and settles within 1 usec maximum. This model features low SSB noise and a low spurious output of -55 dBc maximum. Harmonics are kept below -30 dBc. Frequency modulation has a bandwidth of DC to 10 MHz with ±400 MHz minimum at 100 MHz/V.

www.pmi-rf.com

EZ Form Cable Corp.
Booth 1710

Standard Flexible Cable Assemblies

EZ Form Cable Corp. has introduced flexible cable assemblies that replace the need for custom 0.086 semi-rigid cable assemblies with special lengths and bends. EZ Mini-Flex 405 cable assemblies are complete and fully tested and are available in a variety of standard lengths. Assemblies utilize solderless crimp SMA plugs that eliminate solder concerns and facilitate low profile applications. Availability: From stock to 10 working days.

Non-Magnetic Connectors

EZ Form has launched a line of virtually non-magnetic connectors and cables addressing new markets, such as quantum computing. The EZ Form connectors are void of ferrous material and contain no nickel plating. They meet a permeability of less than 1.01 mu. The typical measured magnetic field of these specialized EZ Form connectors is below 0.2 mGauss, which is about 500 times less magnetic than standard SMA connectors. Also, non-magnetic cable assemblies can be ordered complete.

www.ezform.com

Piconics Inc.
Booth 1714

Inductor Engineering Kits

Piconics is pleased to announce its new broadband conical inductor engineering kits. Piconics broadband conical inductors are the highest performing broadband inductors on the market. They are the only solution for broadband biasing up to and beyond 65 GHz. Now you can have a variety of conicals at your fingertips to optimize your designs. Visit the company website to get your kit today.

www.piconics.com

Microwave Development Laboratories
Booth 1715

Waveguide Tapers

Microwave Development Laboratories, the world leader in waveguide components and assemblies, introduces custom made waveguide tapers. Using a rapid prototype printer, customers can order transitions between different waveguide sizes. The length of the taper is optimized for best electrical (VSWR) performance. Flange configurations are fully customizable to meet customers' requirements. Quick delivery turnaround is available from MDL.

www.mdllab.com

Scan page using layar app

10 Things You May NOT Know About Tampa

1. The name Tampa is believed to come from the Calusa phrase "Sticks of Fire" because of severe lightning.
2. Tampa is known as "Cigar City". In 1929, the factory at Ybor City rolled approximately 500 million stogies!
3. Although we all know how hot it can get in Florida, the temperature in Tampa has never hit 100 degrees.
4. Tampa's number one export? Phosphate.
5. It took the Tampa Bay Buccaneers 25 years to return a kickoff for a touchdown.
6. Babe Ruth hit his longest home run during an exhibition game in Tampa – it sailed 587 feet.
7. The world's first scheduled passenger flight flew from St. Pete to Tampa in 1914.
8. Tampa is home to the world's longest continuous sidewalk, Bayshore Boulevard. It's 4.5 miles long!
9. In the 1980s, Tampa was considered the death metal capital of the music world.
10. The Cuban sandwich was invented in Tampa.

10 Things You May NOT Know About Microwave Journal

1. Celebrates its 56th year of publishing in 2014.
2. The magazine is distributed in more than 60 countries.
3. The Chinese edition reaches 10,000 qualified engineers.
4. Our mobile app has more than 5,000 users.
5. Augmented Reality is available in every 2014 issue.
6. Our LinkedIn Group has more than 22,000 members.
7. EDICON China drew more than 2,000 attendees in Beijing.
8. Parent company Horizon House manages the European Microwave Week exhibition.
9. Sponsors the Cyber Café at IMS.
10. Gives away the "MTT-Shirt" at our booth every year.

Microwave Journal

Frequency Matters.

Stop by Booth 724 to find out more and to pick up your MTT-Shirt

rflight®
RFLIGHT COMMUNICATION ELECTRONIC CO.,LTD.

To be The best & The number one!

HIGH POWER WIDEBAND SOLID STATE AMPLIFIER

Model	Frequency (GHz)	Output Power Min(dBm)
NTWPA-00000104100	0.00001~0.4	50
NTWPA-00000010011000	0.00001~0.01	60
NTWPA-00000010013000	0.00001~0.01	65
NTWPA-00000010015000	0.00001~0.01	67
NTWPA-001011000	0.01~0.1	60
NTWPA-001013000	0.01~0.1	65
NTWPA-001015000	0.01~0.1	67
NTWPA-008031000	0.08~0.3	60
NTWPA-008032000	0.08~0.3	63
NTWPA-0310700	0.3~1.0	58
NTWPA-03101000	0.3~1.0	60
NTWPA-00305100	0.03~0.512	50
NTWPA-00305200	0.03~0.512	53
NTWPA-000110100	0.001~1.0	50
NTWPA-00810100	0.08~1.0	50
NTWPA-00810200	0.08~1.0	53
NTWPA-0510100	0.5~1.0	50
NTWPA-0510200	0.5~1.0	53
NTWPA--0510500	0.5~1.0	57
NTWPA--05101000	0.5~1.0	60
NTWPA-0710100	0.7~1.0	50
NTWPA-0710200	0.7~1.0	53
NTWPA-0710500	0.7~1.0	57
NTWPA-1822100	1.8~2.2	50
NTWPA-1822200	1.8~2.2	53
NTWPA-1822500	1.8~2.2	57
NTWPA-2327100	2.3~2.7	50
NTWPA-2327200	2.3~2.7	53
NTWPA-2327500	2.3~2.7	57
NTWPA-0822100	0.8~2.2	50
NTWPA-0822200	0.8~2.2	53
NTWPA-0822500	0.8~2.2	57
NTWPA-0727100	0.7~2.7	50
NTWPA-0727200	0.7~2.7	53
NTWPA-2560100	2.5~6.0	50
NTWPA-2560200	2.5~6.0	53
NTWPA-2060100	2.0~6.0	50

Add: #20 Linhuai Street,Jiangning Development Zone Nanjing,China
Postcode: 211106
Tel: (+86-25)84471786-807
Fax: (+86-25)84471786-800
Website: www.rflight.cn
E-mail: sales@rflight.cn

See us at IMS Booth 2218

IMS Product Showcase: Aisles 1700-1900

RLC Electronics — Booth 1719

Cavity Filters

RLC Electronics' cavity filters are fixed tuned filters that feature sharp stop band rejection, high Q, small size and low insertion loss. These filters are centered in Ka-Band (26.5 to 40 GHz), with rejection carrying up to 50 GHz. The type of filter selected is usually determined by the percentage 3 dB bandwidth desired (which ranges from 0.2 to 67 percent of fc). Units are constructed to operate over the most severe military environmental conditions.

www.rlcelectronics.com

Skyworks Solutions Inc. — Booth 1815

High Linearity LNAs

VENDORVIEW

Skyworks introduced two high linearity LNAs with active bias for cellular infrastructure applications such as tower mounted amplifiers, remote radio units, repeaters and base stations, plus commercial and military devices. The single stage, GaAs, PHEMT SKY67150-396LF (300 to 2200 MHz) and SKY67153-396LF (700 to 3800 MHz) offer industry-leading low noise figure and excellent return loss in a small QFN package. On-die active bias design ensures consistent performance over process and temperature variation. Excellent thermal characteristics allow high performance operation at temperatures ≤105°C.

www.skyworksinc.com

Rogers Corp. — Booth 1833

Dk Materials

VENDORVIEW

John Coonrod from COONROD'S CORNER will teach you everything you need to know about Design Dk, the benefits of high Dk materials, the RO4000 product family, interpreting high frequency circuit material data sheets and why you should consider PIM when designing a PCB antenna in just 5 short minutes. Visit Rogers Corp.'s technology support hub today to watch his videos, use the microwave impedance calculator, various conversion tools and more! Register for your free account: rogerscorp.com/techub

www.rogerscorp.com

Hittite Microwave Corp. — Booth 1841

IF Transceiver Chipset

VENDORVIEW

To reduce the complexity of traditional microwave radios, Hittite Microwave has developed highly integrated IF transmitter, HMC1116LP5ME and IF receiver, HMC1117LP6JE chips which feature high linearity and low noise figure, among many other attractive features. The receiver chip allows the use of either integrated 14, 28 and 56 MHz channel filters, or external channel filters. Housed in compact, 5 × 5 mm (Tx) and 6 × 6 mm (Rx) QFN plastic packages, these chips enable radio designers to achieve significant size, performance and cost improvements.

www.hittite.com

Custom MMIC — Booth 1844

SP4T Switch

VENDORVIEW

Custom MMIC's latest addition to its growing product portfolio is the CMD203C4, a broadband, high isolation, non-reflective GaAs SP4T switch housed in a leadless 4 × 4 mm surface mount package. Covering DC to 20 GHz, this switch features low insertion loss of 2 dB and high isolation of 46 dB at 10 GHz. The SP4T is also available in die form with part number CMD203. Get a quote today at the company's website.

www.custommmic.com

Top Dog Test — Booth 1901

Test Equipment

Top Dog Test specializes in the sale, rental, leasing, purchase, repair, calibration and liquidation of test equipment which includes oscilloscopes, spectrum analyzers, network analyzers, function generators, logic analyzers and telecommunication test equipment. Find equipment on Top Dog's site or call the company's qualified technicians for professional assistance at (510) 324.3001. They will help you decide on what specific model or product will best meet your needs and budget.

www.topdogtest.com

Your best protection against mediocre ideas.

We don't pretend to be all things to all people. We stick with what we know: RF and Microwave technology. If you're in need of fresh ideas and good thinking, call us. You'll work with Jaime Leger, who promises to show up in a coat and tie and not stand on your desk.

sln
Good thinking.

Sheppard Leger Nowak, Inc.
2.0 Marketing Communications
Social Media
Public Relations
Trade Show Support
www.slnadv.com
leger@slnadv.com
401.276.0233

MICRO-ADS

ES MICROWAVE LLC.
Since 1985 we have offered our custom design filters and sub-assemblies in combline, interdigital and suspended-substrate technologies.
Broadband
Suspended-Substrate
Filters, Diplexers, Triplexers, Quadruplexers, Quintuplexers, Sextuplexers...
DC-40 GHz Filters
Multiplexers &
Switch Filter Banks
ES Microwave, LLC
8031 Cessna Avenue, Gaithersburg, MD 20879
P: 301-519-9407 F: 301-519-9418
www.esmicrowave.com

KR Electronics
www.krfilters.com
ISO 9001:2008 Certified
Custom & Standard Filters
40+ Years of Military & Commercial Applications
Bandpass, Anti-Aliasing, Highpass, Video Filters, Diplexers, Delay Equalized, Surface Mount
Lowpass, Notch, Root Cosine, Equalizers, Linear Phase, Absorptive, Matched
KR Electronics, Inc.
Avenel, NJ
www.krfilters.com
sales@krfilters.com
Phone 732.636.1900
Fax 732.636.1982

Frequency SYNTHESIZERS
Model SLSM5, your best choice for a high performance synthesizer when price / performance is an issue.
- Frequency Bands to 32 GHz
- Frequency Steps 1 kHz
- Low spurious
- Phase Noise @ 10 GHz -90dBc/Hz @ 10 kHz
- 10 MHz Ext. or Int. Reference (±0.5 PPM)
- Control via RS-485, Multi Drop
- Non Volatile Memory
- Miniature Assembly (2.5" X 2.5" X 0.6")
Low cost custom designs are our specialty
Luff RESEARCH
Web: www.luffresearch.com
Tel: (516) 358-2880 Fax: (516) 358-2757
Email: sales@luffresearch.com

IMS Product Showcase: Aisles 1900-2200

American Technical Ceramics — Booth 1927

Surface Mount Inductor

ATC's 506WLS ultra-broadband surface mount inductor is engineered with a powdered iron (ferrite) core and RoHS compliant terminations. This product provides reliable and repeatable ultra-broadband performance from

400 KHz to 40+ GHz. It exhibits ultra low insertion loss, flat frequency response and provides an excellent match over multiple octaves of frequency spectrum. The 506 WLS is ideal for high speed optical data systems and many other ultra-broadband applications. Inductance values from 0.47 to 10.7 µH.

www.atceramics.com.

Ardent Concepts — Booth 2019

Multi-Coax Cable Assemblies

Ardent Concepts has released several new versions of the patented Terminate-R™ 40 GHz+ multi-coax cable assemblies for high speed digital and RF test applications. Now available in 8, 12, 16 and 24 channel configurations with SMK or SMV connectors, Terminate-R is a compression mount solution which provides the highest density cable termination in the smallest footprint with no solder-down parts. Samples are available.

www.ardentconcepts.com

Custom Microwave Components Inc. — Booth 2114

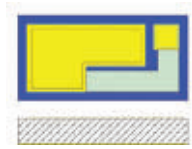
Switch Matrices

CMCI1080 is a 24×12 solid-state non-blocking switch matrix covering 0.7 to 3 GHz with 70 dB cross-channel isolation. Each output is 70 dB adjustable in 0.5 dB increments. It is a 6U/17"D rack mount unit, operates at up to 1 W RF power and requires less than 20 W prime power. The matrix is networkable with secure access. It is controlled through the front panel touch screen locally and/or a browser remotely. An intuitive GUI with practically zero training time makes it plug-n-play.

www.customwave.com

Massachusetts Bay Technologies — Booth 2121

Capacitor/Resistor Chip



Massachusetts Bay Technologies (MBT) is proud to announce its integrated, thin film, capacitor/resistor chip. The silicon based chip has the advantage of a small 0402, 1.0 × 0.50 mm footprint. They are available in several circuit configurations with resistive values from 47 to 150 ohms and capacitive values from 10 to 100 pF. They were initially designed to assist engineers that have size requirements in their circuits and/or are interested in reducing assemble part count. Custom values are available upon request.

www.massbaytech.com

Accel-RF — Booth 2132

Measurement Equipment

Accel-RF is the world-leader in supplying equipment for performing measured long-term reliability assessment on compound-semiconductors. To keep up with the shift in GaN from "research novelty" to "market reality," Accel is expanding its product line with the introduction of an 80-channel RF biased burn-in system. The Automated Multi-Channel RF-Biased Burn-In Test System is a turnkey system for mitigating the risks of product failures in the field.

www.accelrf.com

SAGE Millimeter Inc. — Booth 2232

Omni-Directional Antenna

VENDORVIEW

Model SAO-5836230230-15-S1 is a V-Band vertically polarized omni-directional antenna with center frequency at 60 GHz and ±2 GHz operation bandwidth. The antenna is designed for close-in wireless communication applications. The antenna has 30 degree vertical beamwidth with a typical of 2 dBi gain. The RF connector of the antenna is WR-15 waveguide with UG385/U Flange, and the diameter of the antenna is 4".

www.sagemillimeter.com

OML Inc. — Booth 2235

IMD Measurements

OML introduced the industry's first direct connect solution for mm-wave Intermodulation Distortion (IMD) measurements. Fitted to characterize mm-wave devices for S-parameters and gain compression, IMD is an industry standard technique revealing the linearity of an amplifier using a two-tone measurement. Compatible with modern network analyzers such as Agilent, Anritsu and R&S, OML offers mechanical compatibility with existing probe stations, including the flexibility to upgrade existing VNA modules with IMD capabilities.

www.omlinc.com

MICRO-ADS

LOGUS
Since 1961
HIGH-REL
Waveguide Switches
WR10 thru WR975
Ground · Sea
Air · Space
Ultralight
VALUE · QUALITY · FAST DELIVERY
LOGUS.com p: 561-842-3550 f: 561-842-2196

See us at IMS Booth 338

AST Advanced Switch Technology
MICROWAVE SWITCHES FOR THE TELECOM INDUSTRY
WAVEGUIDE SWITCHES - COAXIAL SWITCHES - DUAL SWITCHES
WE ARE THE WAVEGUIDE & COAXIAL SWITCH EXPERTS
YOUR #1 SOURCE FOR MICROWAVE SWITCHES
QUALITY, SERVICE & QUICK DELIVERIES UNMATCHED IN THE INDUSTRY
Celebrating 1992 - 2012 20 YEARS
754 Fortune Crescent, Kingston, ON, K7P 2T3, Canada
Tel: 613 384 3939 - Fax: 613 384 5026
e-mail: info@astswitch.com
WWW.ASTSWITCH.COM

RF Amplifiers, Isolators and Circulators from 20MHz to 40GHz

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

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

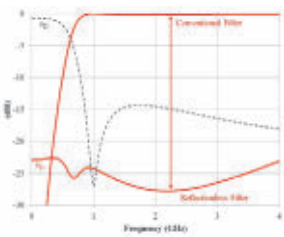
Wenteq Microwave Corporation
138 W Pomona Ave, Monrovia, CA 91016
Phone: (626) 305-6666, Fax: (626) 602-3101
Email: sales@wenteq.com, Website: www.wenteq.com

LOW NOISE AMPLIFIERS
WWW.SATELLINK.COM
ISO 9001 CERT.
CE mark
NOISE TEMPERATURE (°K)
NOISE FIGURE (dB)
FREQUENCY (GHz)
UNCOOLED 23°C TE COOLED
32nd
SATELLINK, INC.
3525 MILLER PARK DR.
GARLAND, TX 75042
CALL (972)487-1434
FAX (972)487-1204

1x1mm MMIC Cascadable Absorptive Reflectionless Filters

- 3rd-order Inverse Chebyshev response with excellent impedance match in pass-band, stop-band and transition band
- Ideal for RF/Microwave systems operating from DC to 40 GHz
- Standard low-pass and high-pass designs cover 500 MHz - 24 GHz plus custom frequencies available upon request

- Absorbs spurious signals
- Reduces cross-channel coupling
- Greater amplitude, phase stability and linearity
- Better out-of-band termination of mixers and amplifiers



National Radio Astronomy Observatory
1180 Boxwood Estate Rd, Charlottesville, VA 22903
434-296-0236 tto@nrao.edu
More detail & datasheet:
www.nrao.edu/new/tt/reflectionless-filters

KERAGIS

Since 1993, Keragis Corporation has been providing high power, wide-band amplifiers for a number of applications including radar subsystems, rack-mounted instruments, phased arrays and tow decoys.

See us at IMS Booth 909
www.keragis.com

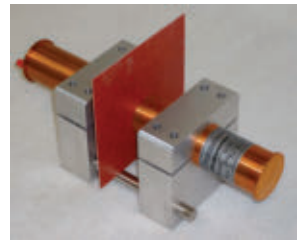
New for 2014
Microwave Journal
Frequency Matters.
Classified
Help Wanted
Find Reps, Engineers and Used Equipment.
Post your listing on the new MWJ classified section.
www.mwjournal.com/classifieds

See us at IMS Booth 724

SECTOR MICROWAVE INDUSTRIES, INC.

* DPDT
* TYPE N, SMA, BNC, TNC
* MANUAL OVERRIDE
* DC THROUGH 23 GHZ.
(631) 242-2300 FAX (631) 242-8158
www.sectormicrowave.com

CIRCUIT BOARD TESTERS
● Std Sizes ● No Contact ● Easy Prep
Models 125HC, 08, 06, 03 from ~0.4 to ~12 GHz
● Usable from -50 to +150° C



ε, tan δ - Cavity™ sfwr
Thin Sheets, Substrates, Resins, Foams
www.damaskosinc.com
(610)358-0200 fax(610)558-1019

Filter Synthesis Using Genesys S/Filter

Randall W. Rhea

Filter Synthesis Using Genesys S/Filter covers the design of practical lumped element, distributed and resonator based filters from the perspective of transmission zeros. While the book is of some interest to all filter designers, it is written for users of the systhesis program Genesys S/Filter from the Agilent EEsof EDA division of Agilent Technologies. The focus is common filter design problems and how to use direct synthesis to solve those problems.

S/Filter includes tools beyond direct synthesis, including a wide variety of both exact and approximate equivalent network transforms, methods for selecting the most desirable out of potentially thousands of synthesized alternatives, and a transform history record that simplifies design attempts requiring iteration. Very few software programs are based on direct synthesis, and the additional features of S/Filter make it a uniquely effective tool for filter design. This book does not cover synthesis theory, modeling, tuning, standard values, tolerance or Q of elements and their effects on filter performance.

This book is a practical guide to using Genesys software for microwave and RF filter design and synthesis. The book covers the application of S/Filter features for solving important and common filter problems so is useful to the practicing engineer. Both lumped element and distributed filters are discussed, with extensions to dielectric and quartz crystal resonators. The book is a good practical guide to this specific area of filter design but would be of less interest to those not directly involved in this area of expertise.

Artech House will be attending IMS 2014 in Tampa, FL and giving away a limited number of signed books as a promotion. Visit the Artech booth number 722 and enter for a chance to win autographed copies of this book and see other RF/microwave titles with special discounts for the show.

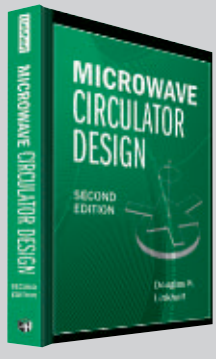
To order this book, contact:

Artech House
685 Canton St., Norwood, MA 02062
(800) 225-9977
or
16 Sussex St., London, SW1V 4RW, UK
+44 (0) 20 7596 8750
330 pages, $129
ISBN: 978-1-60807-802-8

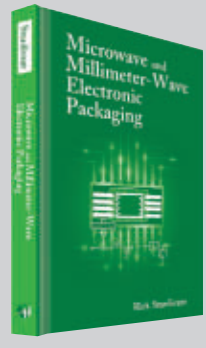
ARTECH HOUSE

Maximize Your Microwave Know-How!

Filter Synthesis Using Genesys S/Filter
Randall W. Rhea
Hardcover. 327 pp. 2014
ISBN: 978-1-60807-802-8
$129/£89



Microwave Circulator Design, Second Edition
Douglas K. Linkhart
Hardcover. 378 pp. 2014
ISBN: 978-1-60807-583-6
$149/£99



Microwave and Millimeter-Wave Electronic Packaging
Rick Sturdivant
Hardcover. 280 pp. 2013
ISBN: 978-1-60807-697-0
$149/£99

US: **Call** 1-800-225-9977 (in the U.S. or Canada), or 1-781-769-9750, ext. 4030
Fax to: 1-781-769-6334
E-mail to: artech@ArtechHouse.com

UK: **Call** +44 (0)20 7596 8750
Fax to: +44 (0)20 7630-0166
E-mail to: artech-uk@ArtechHouse.com

For complete descriptions and to order, visit
ArtechHouse.com

All orders plus shipping/handling and applicable taxes.

ARTECH HOUSE
BOSTON | LONDON

685 Canton Street, Norwood, MA 02062 USA
16 Sussex Street, London SW1V 4RW UK

See us at IMS Booth 722

IMS2014 - Tampa Bay, Florida

Powering The Waves

For more information please visit:

HTTP://IMS2014.MTT.ORG

IEEE MTT-S

IMS2014 POWERING THE WAVES

CONFERENCE DATES: ***1- 6 JUNE 2014!***

IT'S MORE COSTLY NOT TO GO...

IMS is the single annual opportunity to get the entire pulse of our industry in just one week. Attending IMS2014 enables you to see what is new, improve your technical knowledge and meet your colleagues, partners and vendors face-to-face in one efficient trip. It is the one event where you can connect with key people and learn about the technology advances you need to make informed decisions.

Innovations and Emerging Technologies Benefits:

IMS2014 offers Focus Sessions which highlight emerging new technical topics that are gaining importance and may be of significant interest to the microwave and wireless community.

Technical & Knowledge Benefits:

IMS2014 offers technical sessions, interactive forums, plenary and panel sessions, workshops, short courses, application seminars, and a wide variety of other technical activities.

Networking Benefits:

Microwave Week has countless opportunities to connect with other members of our growing community. No other event in the industry offers access to as many technical experts, and product representatives, or provides as good a forum to exchange ideas and meet the people who truly move our industry forward.

Exhibit Benefits:

Over 550 Exhibitors represent the state-of-the-art when it comes to materials, devices, components, subsystems and services as well as design and simulation software and test and measurement equipment. Whatever you are looking to acquire, you will find the industry leaders ready and willing to answer your purchasing and technical questions.

With all these benefits of attending, it is hard to imagine a more productive way than spending one week with us!

JOIN THE CONVERSATION: #IMS2014

AdvertisingIndex

Advertisers in blue are enabled with the layar app

Advertiser	Page No.
3D Glass Solutions	38
Accel-RF Instruments Corporation	34
Advanced Switch Technology	267
Aeroflex / Inmet, Inc.	155
Aeroflex / Metelics, Inc.	9, 253
Aeroflex / Signal & Control Solutions	217
Aeroflex / Weinschel, Inc.	17
Agile Microwave Technology Inc.	20
Agilent Technologies, Inc.	25
American Microwave Corporation	60, 220
American Technical Ceramics	241
AnaPico AG	180
Anaren Microwave	101
Anatech Electronics, Inc.	117
Anokiwave, Inc.	98-99
Anritsu Company	13
APA Wireless Technologies	145
AR RF/Microwave Instrumentation	37
ARC Technologies, Inc.	251
Ardent Concepts, Inc.	74
Arrow Electronics RF & Power	21
Artech House	268
ASB, Inc.	262
ASELSAN	188
AWR	11
B&Z Technologies, LLC	22-23
Besser Associates	238
Bonding Source	107
Boonton Electronics (a Wireless Telecom Group Company)	COV 2
Broadband Wireless	118
Cernex, Inc.	177
Charter Engineering, Inc.	196
Ciao Wireless, Inc.	72
Coaxial Components Corp.	146
Coilcraft	15
Compex Corporation	134
COMSOL, Inc	33
Comtech PST Corp.	40
Comtech PST Corp. (Hill Engineering Division)	206
Copper Mountain Technologies	147
CPI Beverly Microwave Division	103
Crane Aerospace & Electronics	90
Crystek Microwave	171
CST of America, Inc.	31
CTS Electronic Components	133, 249
CTT Inc.	70-71
Cuming Microwave Corporation	207
Custom Microwave Components, Inc.	96
Custom MMIC	116
Damaskos Inc.	267
dBm Corp.	100
Delta Electronics Mfg. Corp.	193
Dow-Key Microwave Corporation	54
Dyconex AG	144
Dynawave Incorporated	203
Eastern Wireless TeleComm, Inc.	113
Eclipse Microwave	28, 30
EDI CON 2015	259
EMC Technology Inc.	67
Emerson Network Power	115
Empower RF Systems, Inc.	173
ERZIA Technologies S.L.	102
ES Microwave, LLC	266
EuMW 2014	163
Exodus Advanced Communications, Corp.	126
EZ Form Cable Corporation	84-85
FEKO	239
Florida RF Labs Inc	67
Freescale Semiconductor, Inc.	161
Frontlynk Technologies Inc.	166
G.T. Microwave Inc.	158
Herotek, Inc.	132
Hittite Microwave Corporation	195
Holzworth Instrumentation	46, 202
Huber + Suhner AG	169
IEEE International Symposium on Electromagnetic Compatibility 2014	243
IEEE MTT-S International Microwave Symposium 2014	269
IMST GmbH	178
International Manufacturing Services, Inc.	128
IW Inc. (Insulated Wire)	149
JFW Industries, Inc.	156
JQL Electronics Inc.	6
K&L Microwave, Inc.	7
Keragis Corporation	267
KR Electronics, Inc.	266
Kratos General Microwave	198
Krytar	236
Linear Technology Corporation	29
Logus Microwave Corporation	267
LPKF Laser & Electronics	183
Luff Research, Inc.	266
MACOM	45, 153
Marki Microwave, Inc.	157
Massachusetts Bay Technologies, Inc.	108
Maury Microwave Corporation	122-123
MCV Microwave	152
MECA Electronics, Inc.	3
Mercury Systems, Inc.	129
Mesa Microwave Corporation	170
Mesuro Ltd.	204
MIcable Inc.	213
MiCIAN GmbH	192
Micro Lambda Wireless, Inc.	201
Micro Systems Technologies	144
MicroTech Inc.	175
MicroWave Technology, Inc.	168
Microwave Development Laboratories	137
Microwave Journal	226, 228, 257, 261, 263, 267, 273
Millitech	110
Mini-Circuits	4-5, 18, 79, 80, 93, 159, 191, 221, 235, 271
MITEQ Inc.	160, 162, 164
Narda Microwave-East, an L3 Communications Co.	127
National Instruments	35
National Radio Astronomy Observatory	267
Networks International Corporation	39
Nexyn Corporation	242

NOW

USB & ETHERNET
RF SWITCH MATRIX

Efficiency for your test setup. Economy for your budget.

New Feature!
Switch Cycle Counting

DC to 18 GHz *from* $385 *ea.*

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

Our easy-to-install, easy-to-use GUI will have you up and running in minutes for step-by-step control, full automation, or remote operation. They're fully compatible with most third-party lab software,† adding capabilities and efficiency to existing setups with ease! Visit minicircuits.com today for technical specifications, performance data, quantity pricing, and real time availability – or call us to discuss your custom programming needs – and think how much time and money you can save!

USB Control Switch Matrices

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

NEW USB and Ethernet Control Switch Matrices

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

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

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

Mini-Circuits®

www.minicircuits.com P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com

See us at IMS Booth 823

Advertising Index

Advertisers in blue are enabled with the layar app

Advertiser	Page No.
NoiseWave Corp.	8
Norden Millimeter Inc.	36
Nova Microwave, Inc.	199
Nuhertz Technologies	82
NXP Semiconductors, Inc.	227
OML Inc.	95
Pasternack Enterprises, Inc.	121
Peregrine Semiconductor Corp.	42-43
Phase Matrix, Inc.	197
Phonon Corporation	130
Pickering Interfaces Inc.	181
Pico Technology	92
Piconics	148
Pivotone Communication Technologies, Inc.	55
Planar Monolithics Industries, Inc.	75
Pletronics, Inc.	136
Pole/Zero Corporation	185
Presidio Components	131
Pulsar Microwave Corporation	78
Quest Microwave Inc.	174
QuinStar Technology, Inc.	167
R&K Company Limited	209
Reactel, Incorporated	49
RelComm Technologies, Inc.	237
Remcom	89
Res-Net Microwave Inc.	199
RF-Lambda	111
RFHIC	138-139
Rflight Communication Electronic Corporation	264
RFMW, Ltd.	97
RLC Electronics, Inc.	27
Rogers Corporation	41
Rohde & Schwarz GmbH	53, COV 3
Rosenberger	119
Sage Millimeter, Inc.	106, 184
Santron Inc.	211
Satellink, Inc.	267
Sector Microwave Industries, Inc.	267
SemiGen	225
SenarioTek, Inc.	59
SignalCore, Inc.	204
Signal Hound	91
Sivers IMA AB	190
Skyworks Solutions, Inc.	63
SLN Advertising	265
Smiths Microwave	247
Sonnet Software, Inc.	189
Southwest Microwave Inc.	205
Spacek Labs Inc.	165
Special Hermetic Products, Inc.	224
Spectrum Elektrotechnik GmbH	245
Stanford Research Systems	57
State of the Art, Inc.	56
Strand Marketing, Inc.	258
Sumitomo Electric USA Inc.	125
SV Microwave, Inc.	105
Synergy Microwave Corporation	87, 255
Teledyne Coax Switches	61
Teledyne Microwave Solutions	83
Teledyne Relays	61
Teledyne Storm Microwave	143
Thunderline-Z	219
Times Microwave Systems	135
Top Dog Test	142
TRAK Microwave Corporation	187
Transline Technology	212
TRU Corporation	151
United Monolithic Semiconductors	76
Universal Microwave Components Corporation	246
UTE Microwave Inc.	109
Vectron International	179
Virginia Diodes, Inc.	51
W.L. Gore & Associates, Inc.	65
Waveline Inc.	154
Weinschel Associates	32, 120
Wenteq Microwave Corporation	267
Wenzel Associates, Inc.	176
Werlatone, Inc.	COV 4
West Bond Inc.	112
WIN Semiconductors Corp.	47
Wright Technologies	186
Z-Communications, Inc.	141

Sales Representatives

Microwave Journal
Frequency Matters.

Eastern and Central Time Zones
Chuck Boyd
Northeast Reg. Sales Mgr.
(New England, New York, Eastern Canada)
685 Canton Street
Norwood, MA 02062
Tel: (781) 619-1942
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
Brian Landy
Western Reg. Sales Mgr.
(CA, AZ, OR, WA, ID, NV, UT, NM, CO, WY, MT, ND, SD, NE & Western Canada)
144 Segre Place
Santa Cruz, CA 95060
Tel: (831) 426-4143
FAX: (831) 515-5444
blandy@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)
WMS.Werbe- und Media Service
Brigitte Beranek
Gerhart-Hauptmann-Street 33,
D-72574 Bad Urach
Germany
Tel: +49 7125 407 31 18
FAX: +49 7125 407 31 08
bberanek@horizonhouse.com

Israel
Liat Heiblum
Oreet International Media
15 Kineret Street
51201 Bene-Berak, Israel
Tel: +972 3 570 6527
FAX: +972 3 570 6526
liat@oreet-marcom.com

Korea
Young-Seoh Chinn
JES Media International
2nd Floor, ANA Bldg.
257-1, Myungil-Dong
Kangdong-Gu
Seoul, 134-070 Korea
Tel: +82 2 481-3411
FAX: +82 2 481-3414
yschinn@horizonhouse.com

Japan
Katsuhiro Ishii
Ace Media Service Inc.
12-6, 4-Chome,
Nishiiko, Adachi-Ku
Tokyo 121-0824, Japan
Tel: +81 3 5691 3335
FAX: +81 3 5691 3336
amskatsu@dream.com

China
Michael Tsui
ACT International
Tel: 86-755-25988571
Tel: 86-21-62511200
FAX: 86-10-58607751
michaelT@actintl.com.hk

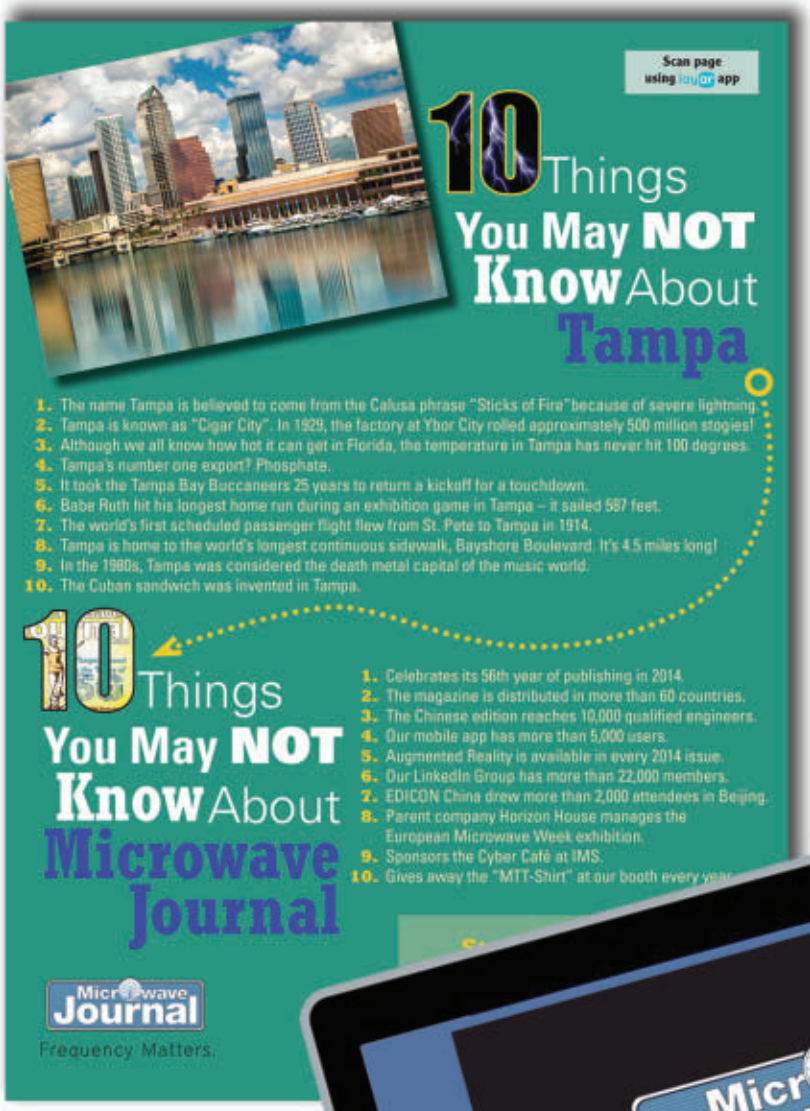
Hong Kong
Mark Mak
ACT International
Tel: 852-28386298
markm@actintl.com.hk

Ed Kiessling
Traffic Manager/Inside Sales
685 Canton Street
Norwood, MA 02062
Tel: (781) 619-1963
FAX: (781) 769-6178
ekiessling@mwjournal.com

Microwave Journal Brings Print to Life

Scan page using layar app

Our print pages are brought to life with the Augmented Reality app Layar. Readers can scan pages to view embedded videos, links to more information or post on social media sites.



See us at IMS Booth 724

HOW IT WORKS

STEP 1

Download the free Layar app from the iTunes (iOS) or Google Play (Android) store.

STEP 2

Launch the app to view enhanced content on any page with the layar logo.

STEP 3

Frame the entire page in the screen and tap to experience enhancements (tap screen again for full screen view).

Microwave**Journal's**

STEM Works

IMS [eye-em-ess]

IMS is an annual technical professional conference specializing in RF/microwave theory and applications that combines multiple technical conferences and a commercial exhibition. IMS represents the largest gathering of RF/microwave professionals in the world and is organized and sponsored by the IEEE Microwave Theory and Techniques Society (MTT-S). IMS, also known as "Microwave Week," has evolved from the annual meeting of the MTT-S and occurs annually in various locations throughout North America, based on a bidding process within the MTT-S and its administrative committee. IMS also hosts the IEEE RFIC Symposium and the Automated RF Techniques Group (ARFTG) Conference.

1952 The first technical meeting of the Professional Group on Microwave Theory and Techniques (PGMTT) was the Symposium on Microwave Circuitry held in the Western Union Auditorium in New York City on November 7, 1952, with 210 attendees and the submission of 12 papers.

1964 The first annual symposium (a term adopted in 1958) to include "International" in its title.

1976 *Microwave Journal* publishes its first MTT-S Symposium and exhibition (May) issue, includes status report on MW technology by Dr. Frank Brand. Held in Cherry Hill, NJ, the technical program featured 24 sessions and the very first exhibition, which included 38 vendors.

1981 MTT-S is held in Los Angeles. *Microwave Journal* editor Joseph White writes the very first "Attending the Conference." Event includes symposia from MTT, AP-S and URSI. Special panel titled "Impact of Gallium Arsenide ICs on MW Systems" is held. Exhibition has grown to 153 exhibitors. K&L introduces its iconic "it's in the bag" giveaway.

1989 Steering committee chairman Chuck Swift welcomes Long Beach IMS attendees with his event theme "Symposium by the Sea," composing and performing (with cast) in his "One Penny Opera" homage to the IMS and Microwave Week at the Chairman's dinner.

1996 San Francisco MTT-S includes 460 technical papers available in technical digest and augmented with first-time CD-ROM (available at no extra cost).

2000 Agilent Technologies (formerly Hewlett-Packard) makes its debut at IMS. The new $8 billion company composed of HP's non-computing products divisions, included scientific instruments, semiconductors, optical networking devices and electronic test equipment for telecom and wireless R&D and production.

2006 IMS San Francisco hits attendance high watermark with general chair John Barr reporting 3000 technical attendees and over 12,000 overall attendees. In addition to over 1000 presenters, the event featured 546 exhibitors and 12 industry sponsors.

STEM Works recognizes

MTT-S®

for its support of science education.

Baseband & RF
MIMO & Fading
Rohde & Schwarz SMW 200A

Please visit us at
IMS 2014
in Tampa Bay,
booth 1439

The new vector signal generator for wideband communications systems
Unique generator with baseband, signal calculation, fading, MIMO, AWGN and RF generation in a single box. Two paths up to 6 GHz. Full modularity. Convenient touch operation for confident control of the most complex signals. In 3G and 4G scenarios as well as in aerospace & defense applications.

- 160 MHz I/Q modulation bandwidth with internal baseband
- All key MIMO modes, including 3x3, 4x4 and 8x2
- All key communications standards
- Comprehensive help for efficient working
- Outstanding modulation and RF characteristics

R&S®SMW 200A. The fine art of signal generation.

www.rohde-schwarz.com/ad/smw-mr

Watch the video

ROHDE&SCHWARZ

WERLATONE®

Mismatch Tolerant®

HIGH POWER COMBINERS

BIG STUFF!

- Power Levels to 20 kW CW
- Low Insertion Loss
- Isolated and Non-Isolated Designs
- Rack Mount, Drawer Mount, Radial Type
- Coherent and Non-Coherent Combining

Scan page using layar app

Product Search
For current designs

Request a quote
For custom specs

Werlatone®, Inc.
17 Jon Barrett Road
Patterson, NY 12563
T 845.278.2220
F 845.278.3440
www.werlatone.com

A few of our Customer driven designs.

Model	Type	Frequency (MHz)	Power (W CW)	Insertion Loss (dB)	Isolation (dB)	Size (Inches)
D8265	2-Way	1-50	5,000	0.3	20	15.5 x 15 x 5.25
D2075	2-Way	1.5-30	6,000	0.2	20	15.5 x 11.75 x 5.25
D8969	2-Way	1.5-30	12,500	0.2	20	17 x 17 x 8
D6139	4-Way	1.5-32	5,000	0.25	20	13 x 11 x 5
D6774	4-Way	1.5-32	20,000	0.3	20	21 x 17.25 x 11
D6846	6-Way	1.5-30	4,000	0.35	20	3U, 19" Rack
D8421	8-Way	1.5-30	12,000	0.3	20	22.5 x 19.5 x 8.75
D7685	4-Way	2-100	2,500	0.5	20	14.75 x 13 x 7
D2786	4-Way	20-150	4,000	0.5	20	18 x 17 x 5
D6078	2-Way	100-500	2,000	0.25	20	13 x 7 x 2.25
H7521	2-Way (180°)	200-400	2,500	0.3	20	15 x 10 x 2
D7502	2-Way	400-1000	2,500	0.25	NI*	9.38 x 3.12 x 1.25

*NI = No Isolating Terminations

Mismatch Tolerant® is a registered trademark of **Werlatone, Inc.**

Directional Couplers | 0° Combiners/Dividers | 90° Hybrid Couplers | 180° Hybrid Combiners | Absorptive Filters

Semiconductors • First Response • Medical • In-Building • Military Comm and EW

See us at IMS Booth 1127

2014-15

Product Selection Guide

Choose TriQuint's Innovative RF Solutions

TriQuint
Reach Further · Reach Faster™

TriQuint
Reach Further • Reach Faster™

Welcome to Our 2014-15 Product Selection Guide

ABOUT TRIQUINT 3
NEW PRODUCTS 4
GUIDE BY APPLICATION
- Defense & Aerospace
  - Comms 10
  - Electronic Warfare 17
  - GaN 20
  - Navigation 22
  - Radar 28
  - Space 33
- Mobile Devices
  - 2G GSM/GPRS/EDGE 38
  - 3G CDMA/EVDO 39
  - 3G WCDMA/WGPRS/WEDGE 39
  - 4G LTE 41
  - Advanced Filters 42
  - GPS 42
  - WLAN/Bluetooth® 43
- Network Infrastructure
  - Automotive Radar 44
  - Automotive Telematics 45
  - Base Station 46
  - BWA 54
  - Cable/FTTH 56
  - GPS 58
  - Multi-Market Standard Products 59
  - Optical 63
  - Point-to-Point Radio 65
  - VSAT 70
  - WLAN/Bluetooth® 74

GUIDE BY PRODUCT TYPE
- Duplexers 77
- IF Filters 78
- RF Filters 82

CUSTOMER SUPPORT 86

This guide contains a subset of the total selection of the 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.

Our guide lists over 750 standard products and highlights more than 140 newly released and announced products, showcased in our New Products section.

Products are organized by key market applications and product types (filter & duplexer offerings only). We've also incorporated block diagrams identifying TriQuint product functionality with blue symbols and TriQuint integrated product functions in green blocks to indicate where TriQuint solutions exist.

We invite you to visit our website at triquint.com to obtain full product specifications. TriQuint's online resource section offers additional insights for simplifying RF connectivity through a growing collection of technical resources. While visiting our website, click on 'Newsletter Signup' to receive TriQuint's quarterly e-newsletter and new product announcements.

TriQuint also offers convenient online product purchasing. Visit the online store at http://store.triquint.com to see the latest products, samples and evaluation boards available across a variety of mobile device, network infrastructure and defense applications. TriQuint products are also available through our worldwide sales, representative and distribution networks.

About TriQuint

TriQuint's innovative, high-performance solutions are Accelerating the Next Generation of RF.

Committed to innovation and speed, TriQuint designs, develops and manufactures advanced RF solutions. We reach further, with solutions that boost performance and extend range while reducing size, cost and bill of materials. We reach faster, utilizing our broad technology portfolio to simplify complex RF challenges and enable our customers a better time to market. Customers count on TriQuint to solve their toughest RF challenges, today and tomorrow.

TriQuint's advanced research and extensive government grants have bolstered our technology portfolio. In the last three decades we've pioneered and refined industry-leading power and filter processes, including gallium arsenide (GaAs), gallium nitride (GaN), surface acoustic wave (SAW), and bulk acoustic wave (BAW) technologies. TriQuint uniquely integrates many of the world's most advanced RF solutions to deliver solid customer value. These solutions can enable quicker design turns, streamlined manufacturing and lower overall system costs. TriQuint high-efficiency solutions can extend battery life in mobile devices and can reduce electrical consumption in networks, defense and aerospace systems.

Our product portfolio of power, control and acoustic filter technologies serves the world's leading communications and defense companies. Customers can access our award-winning RF solutions through standard products like those in this catalog and custom designs fabricated in our advanced foundries. TriQuint also offers in-house assembly services that can place die-level devices into single and multi-chip packages.

TriQuint was founded on RF innovation which continues today through our advanced technology programs that are setting new benchmarks in high-performance GaN solutions. Our acoustic filter technologies embrace the latest temperature compensation techniques and wafer level packaging. We are well positioned to serve the growing needs of wireless, fiber optic, telecom, CATV and defense / aerospace manufacturers around the world.

Key advantages of GaAs, GaN, SAW and BAW technologies:

- GaAs can operate efficiently at higher breakdown voltages compared to silicon-based semiconductor technologies while generating less noise in frequencies in excess of 250 MHz. GaAs offers high efficiency, linearity and good wideband performance.
- GaN offers greater power handling and density than GaAs across a wider frequency range. Intrinsic GaN technology advantages enable unprecedented performance, or at a given power level, a solution using fewer or smaller devices. GaN offers excellent efficiency, linearity and noise figures, plus greater wideband capability.
- SAW filter technology offers excellent performance and economy through 2.5 GHz. Our temperature-compensated SAW products expand this versatile technology's capabilities to meet more demanding performance requirements for new and emerging applications.
- BAW filters offer superior low-loss and strong ESD performance as well as greater resistance to temperature effects from 2.5 to 6 GHz and beyond. BAW is ideal for the toughest interference challenges, such as LTE and co-existence filter requirements, as well as mission-critical defense and aerospace applications where precise performance is most valued.

Attenuators

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Bits	Control Voltage (V)	Package Style
TGL6425-SCC	0.5 - 18.5 GHz Digital Attenuator	Digital	0.5 to 18	4	15.5	20	5	0, -5	Die

CATV Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style	Applications
TAT8857A1H	CATV Infrastructure Power Doubler	40 to 1000	21 to 27	31	52	4	24	350	SOIC-16W	Infrastructure
TAT6281	50 - 1000 MHz FTTH Integrated Variable Gain Receiver	50 to 1000	33	–	–	–	5	300	6 x 6 mm	Receiver
TAT7427B-T1	75 Ohm, 50 - 1000 MHz Single Ended RF Amp	50 to 1000	18.5	–	39	2.5	8	145	SOT-89	Single Ended Home Amplifier
TAT7430B-T1	75 Ohm, 50 - 1000 MHz Single Ended RF Amplifier	50 to 1000	22	22	41	2	5 to 8	190	SOT-89	Single Ended Home Amplifier
TAT8858A1H	CATV Infrastructure Push Pull Amp	50 to 1000	27 to 34	28	44	3	24	270	SOIC-16W	Infrastructure
TAT9988	GaN CATV MMIC Power Doubler	50 to 1200	24	–	53	3.5	24	445	5 x 7 mm	Infrastructure
TAT7461-x	75 Ohm, 50 - 1,000 MHz Single Ended RF Amplifier	50 to 1,000	16	24	39	2.5	5	115	SOT-89	Single Ended Home Amplifier

CATV Hybrid Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	RF Output / Tilt (dBmV / dB)	CSO (dBc)	CTB (dBc)	Voltage (V)	Current (mA)	Package Style	Applications
TAT8884HO	CATV High Output GaAs Power Doubler Hybrid	50 to 1,000	25.7	50 / 13.5	-75	-74	24	440	SOT115J	Power Doubler
TAT8888	CATV High Output GaN Power Doubler Hybrid	50 to 1,000	24	61 / 18	-65	-65	24	440	SOT115J	Power Doubler

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
T1G2028536-FL	285 W, 36 V DC - 2 GHz, GaN RF Power Transistor	DC to 2	19	–	54.2	–	54	36	576	NI-780
T1G2028536-FS	285 W, 36 V DC - 2 GHz, GaN RF Power Transistor	DC to 2	19	–	54.2	–	54	36	576	NI-780
T1G3000532-SM	5 W, 32 V, DC - 3 GHz GaN RF Power Transistor	DC to 3	16	–	37	–	50	32	25	5 x 5 mm
T1G4004532-FL	45 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	19	–	46.4	–	52	32	220	NI-360
T1G4004532-FS	45 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	19	–	46.4	–	52	32	220	NI-360
T1G4012036-FL	120 W Peak, 24 W Average Power, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	50.8	–	52	36	360	NI-360
T1G4012036-FS	120 W Peak, 24 W Average Power, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	50.8	–	52	36	360	NI-360
T1G4020036-FL	2 x 120 W, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	54	–	52	36	520	NI-650
T1G4020036-FS	2 x 120 W, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	54	–	52	36	520	NI-650

Discrete Transistors (Cont.)

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
T1G6001032-SM	10 W, 32 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	19	–	40	–	54	32	50	5 x 5 mm
T2G6001528-SG	15 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15.5	–	42.3	–	70	28	100	NI-200
TGA2601-SM	800 - 3000 MHz High IP3 Dual pHEMT	0.8 to 3	19 to 24	23	–	0.7	–	4	100	4 x 4 mm

Driver Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
TQP3301	8 W Linear Amplifier	400 to 2,700	17.4	40	52	4.7	5	500	4 x 5
TGA3500-SM	Wide Band Driver Amplifier	2,000 to 12,000	34	21	29	3	5	200	QFN 8 x 8 mm

Duplexers

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
TQQ1013	Band 13 LTE SE/SE Duplexer	SAW	777 to 787, 746 to 756	–	2.4	SE/SE	2.5 x 2
TQQ2504	B4, B25 LTE SE/SE Duplexer	SAW/BAW	1,850 to 1,915	65	2	SE/SE	3.6 x 2 x 0.9
TQM976027	B7 BAW Duplexer	BAW	2,500 to 2,570, 2,620 to 2,690	70	9	SE/SE	2 x 1.6

Frequency Converters/Mixers

Part	Description	RF (GHz)	IF (GHz)	LO (GHz)	Gain (dB)	Output IP3 (dBm)	NF (dB)	Output P1dB (dBm)	LO Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGC2610-SM	Ku-Band Downconverter	10 to 15.4	DC to 4	6 to 19	14	16	1.5	7	0 to 8	4	160	5 x 5 mm
TGC4405	17 - 27 GHz Upconverter	17 to 27	0.5 to 3	8 to 13	13	–	–	–	2 to 5	5	425	Die
TGC4405-SM	17 - 27 GHz Packaged Upconverter	17 to 27	0.5 to 3	8 to 13	13	28	–	–	2	5	425	4 x 4 mm
TGC4546-SM	37 - 46 GHz Upconverter	37 to 46	DC to 3.5	8.35 to 11.5	12	26	18.5	21	2 to 8	5	430	5 x 5 mm
TGC4671	71 - 86 GHz Sub-Harmonic Image Reject Mixer	71 to 86	DC to 7	31 to 42	-12	–	–	–	15	–	–	Die

Gain Block Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package (mm)
TQL9047	High Linearity Gain Block with Shutdown Function	50 to 4,000	14.5	21.2	35.5	1.6	5	70	2 x 2
TQL9048	High Linearity Gain Block with Shutdown Function	50 to 4,000	14.5	22	40.5	1.7	5	130	2 x 2

Limiters

Part	Description	Frequency (GHz)	Insertion Loss (dB)	Flat Leakage (dBm)	Package Style
TGL2205	S and C-Band 100 W VPIN Limiter	1 to 6	< 0.5	–	Die
TGL2206	S-Band 100 W VPIN Limiter	2 to 4.5	< 0.5	–	Die
TGL2207	S and C-Band 100 W VPIN Limiter	2 to 5	< 0.5	–	Die
TGL2208-SM	2 - 20 GHz Dual-Stage VPIN Limiter	2 to 20	< 1	< 18	QFN 3 x 3 mm 14L

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
TQL9042	Ultra Low Noise, High Linearity LNA with Bypass Function	0.5 to 2	0.42	19	36	23	5	70	3 x 3 mm
TQL9043	Ultra Low Noise, High Linearity LNA with Bypass Function	1.5 to 4	0.6	17.5	33	19.4	5	80	3 x 3 mm
TQL9044	Ultra Low Noise, High Linearity LNA with Bypass Function	1.5 to 4	0.6	19.4	34.5	20.4	5	70	3 x 3 mm
TGA2611	2 - 6 GHz GaN LNA	2 to 6	1	25	32	22	10	110	Die
TGA2611-SM	2 - 6 GHz GaN LNA	2 to 6	1.2	25	32	22	10	100	4 x 4 mm Overmold QFN
TGA2567-SM	2 - 20 GHz LNA Amplifier	2 to 20	2	17	29	19	5	100	QFN 4 x 4 mm 24L
TGA2613	S-Band High-Linearity LNA	2.5 to 4	2.5	12.5	29	29	6	320	Die
TGA2614	S-Band High Gain LNA	2.7 to 3.8	0.9	18	33	20	6	110	Die
TGA2614-SM	S-Band High Gain LNA	2.7 to 3.8	1.2	17	33	19	6	120	QFN 5 x 5 mm 32L
TGM2543-SM	4 - 20 GHz Limiter/ Low Noise Amplifier	4 to 20	2	17	28	21	5	100	7 x 7 mm
TGA2612	6 - 12 GHz GaN LNA	6 to 12	1.8	22	29	20	10	100	Die

Modulator Drivers

Part	Description	Frequency (GHz)	Vpp (V)	Gain (dB)	3 dB Bandwidth (GHz)	Voltage (V)	Current (mA)	Package (mm)
TGA4195-SM	11.3 Gb/s EML Driver, Diff In/Diff Out	DC to 10	6	26	8	3.3	0.65	4 x 4
TGA4840-SM	28 Gb/s CFP2 Modulator Driver	DC to 25	1 to 2	9	25	3.3	50	4 x 3
TGA4892-SL	200 Gb/s 16 QAM Linear Dual Driver, SE In/SE Out	DC to 27	3 to 5	24	25	5 to 7	500	13 x 10.6
TGA4893-SL	200 Gb/s 16 QAM Linear Dual Driver, Diff In/SE Out	DC to 30	4 to 5	24	25	5	500	16.1 x 10.6
TGA4894-SL	100 Gb/s Linear Dual Driver, SE In/SE Out	DC to 30	5 to 8	33	25	5 to 7	650	16.1 x 10.6
TGA4947-MOD	Quad Channel 100 Gb/s Modulator Driver	DC to 35	3 to 9	27	32	5 to 6	1,100	45 x 33.4

Multi-Mode, Multi-Band Power Amplifier (MMPA) Modules

Part	Description	Bands	Features	Package (mm)
TQP9051	TRIUMF™ ET/APT-MIPI MMPA	GSM850/900, DCS/PCS & WCDMA & LTE B1, B2, B3, B4, B5, B8, B26	High/Low Power Modes	5 x 7 x 1
TQP9059	TRIUMF™ Advanced ET/APT-MIPI MMPA	GSM850/900, DCS/PCS & WCDMA & LTE B1, B2, B3, B4, B5, B8, B17, B20, B26	High/Low Power Modes	5 x 7 x 1
TQP9059S	TRIUMF™ Advanced ET/APT-MIPI MMPA	GSM850/900, DCS/PCS & WCDMA & LTE B1, B2, B3, B4, B5, B8, B20, B26	High/Low Power Modes	5 x 7 x 1
TQP9058H	TRIUMF™ Quad Band GSM-EDGE & Penta Band W/CDMA/HSPA+/LTE	GSM 850/900, DCS/PCS, & WCDMA & LTE B1, B2, B3/4, B5, B8	High/Low Power Modes	7 x 5 x 1

Oscillators

Part	Description	Frequency (GHz)	Power (dBm)	Phase Noise (dBc/Hz)	Voltage (V)	Current (mA)	Package Style
TGV2204-FC	19 GHz VCO with Prescaler	18.5 to 19.5	7	-105 @ 1 MHz	5	158	Die

Phase Shifters

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	RMS Amplitude Error (dB)	RMS Phase Error (Degrees)	Bits	Control Voltage (V)	Package Style
TGP2105	6 - 18 GHz 6-Bit Digital Phase Shifter (+Vc)	Digital	6 to 18	< 10	0.45	4	6	0, 5	Die

Phase Shifters (Cont.)

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	RMS Amplitude Error (dB)	RMS Phase Error (Degrees)	Bits	Control Voltage (V)	Package Style
TGP2105-SM	6 - 18 GHz 6-Bit Digital Phase Shifter (+Vc)	Digital	6 to 18	< 10	0.45	4	6	0, 5	QFN 5 x 5 mm 32L
TGP2107	6 - 18 GHz 6-Bit Digital Phase Shifter (-Vc)	Digital	6 to 18	< 10	0.55	5	6	-5, 0	Die
TGP2107-SM	6 - 18 GHz 6-Bit Digital Phase Shifter (-Vc)	Digital	6 to 18	< 10	0.55	5	6	-5, 0	QFN 5 x 5 mm 32L

Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA2237	0.03 - 2.5 GHz 10 W GaN Power Amplifier	0.03 to 2.5	40	19	–	> 52	30	360
TGA2237-SM	0.03 - 2.5 GHz 10 W GaN Power Amplifier	0.03 to 2.5	40	19	–	> 50	30	360
TGA2216-SM	0.1 - 3 GHz 12 W GaN Power Amplifier	0.1 to 3	40.5	21	–	> 40	40	360
TGA2216	0.1 - 3 GHz 12 W GaN Power Amplifier	0.1 to 3	41	22	–	> 40	48	360
TGA2578	2 - 6 GHz 30 W Power Amplifier	2 to 6	45	27	–	40	28	400
TGA2573-2-TS	2 - 18 GHz, 10 W GaN Amplifier on Carrier	2 to 18	40	10	–	20	30	500
TGA2576-2-FL	2.5 - 6 GHz 40 W GaN Power Amplifier	2.5 to 6	46.5	29	–	36	30	1550
TGA2576-FS	2.5 - 6 GHz 40 W GaN Power Amplifier	2.5 to 6	46.5	29	–	35	30	1550
TGA2583	2.7 - 3.7 GHz 10 W GaN Power Amplifier	2.7 to 3.7	40	33	–	54	25	175
TGA2583	2.7 - 3.7 GHz 10 W GaN Power Amplifier	2.7 to 3.7	40	33	–	54	25	175
TGA2583-SM	2.7 - 3.7 GHz 10 W GaN Power Amplifier	2.7 to 3.7	41	33	–	> 50	25	175
TGA2585	2.7 - 3.7 GHz 18 W GaN Power Amplifier	2.7 to 3.7	42.8	33	–	54	28	225
TGA2585-SM	2.7 - 3.7 GHz 18 W GaN Power Amplifier	2.7 to 3.7	42.8	32	–	> 50	28	225
TGA2813	3.1 - 3.6 GHz 100 W GaN Power Amplifier	3.1 to 3.6	50.7	22	–	55	30	150
TGA2814	3.1 - 3.6 GHz 80 W GaN Power Amplifier	3.1 to 3.6	49.5	22	–	56	30	125
TGA2590	6 - 12 GHz 30 W GaN Power Amplifier	6 to 12	45	29	–	28	25	1100
TGA2501-GSG	2.8 W 6 -18 GHz Power Amplifier	6 to 18	34.5	26	–	20	8	1200
TGA2517-GSG	14 W X-Band Power Amplifier	7.5 to 11.5	41.6	30	–	28	12	3000
TGA2586-FL	7.9 - 8.4 GHz 50 W GaN Power Amplifier	7.9 to 8.4	47	14	–	36	24	2240
TGA2622	9 - 10 GHz 40 W GaN Power Amplifier	9 to 10	46	32	–	> 46	28	290
TGA2624	9 - 10 GHz 18 W GaN Power Amplifier	9 to 10	42.5	35	–	40	28	365
TGA2312-FL	X-Band 60 W GaN Power Amplifier	9 to 10	48	13	–	38	24	2400
TGA2704-SM	8 W, 9 - 11 GHz Power Amplifier	9 to 11	39	21	–	–	9	1050
TGA2710-SM	8 W, 9.5 - 11.5 GHz Power Amplifier	9.5 to 11.5	39	22	–	–	9	1050
TGA2623	10 - 11 GHz 35 W GaN Power Amplifier	10 to 11	45.5	35	–	> 47	28	290
TGA2625	10 - 11 GHz 18 W GaN Power Amplifier	10 to 11	42.5	34	–	40	28	365
TGA2565-SM	11-17 GHz Medium Power Amplifier	11 to 17	27	27	–	–	6	210
TGA2536-FL	5 W Ku-Band Power Amplifier	13.5 to 16	37	25	–	20	8	2600
TGA2559-FL	4 W Ku-Band Power Amplifier	14 to 16	36	24	–	30	6	1000
TGA2572-2-FL	16 W Ku-Band GaN Power Amplifier	14 to 16	42	25	–	20	30	2000
TGA4536-SM	K-Band Power Amplifier	24.2 to 26.5	34	18	7	20	6	1430
TGA4544-SM	K-Band Power Amplifier	26 to 31	31.5	23	5	–	6	1100
TGA2594	27 - 31 GHz 5 W GaN Power Amplifier	27 to 31	37	23	–	28	20	140
TGA2595	27.5 - 31 GHz 9 W Power Amplifier	27.5 to 31	39.5	23	–	24	20	280
TGA4537-SM	K-Band Power Amplifier	29 to 35	32	18	6	15	6	1100
TGA2575-TS	Ka-Band 3 W Power Amplifier On Carrier	32 to 38	35.5	19	–	22	6	2100

Power Amplifier Modules

Part	Description	Standards	Bands	Pout (dBm)	Gain (dB)	PAE (%)	Package (mm)
TGA2450-SM	2100 MHz 2.5 W Small Cell PA Module	W-CDMA, LTE	1, 4, 10	42.5	35	35	20 x 20
TGP2451-SM	1900 MHz 2.5 W Small Cell PA Module	W-CDMA, LTE	2, 25, 36	43	35	38	20 x 20
TGP2453-SM	1800 MHz 2.5 W Small Cell PA Module	W-CDMA, LTE	3, 9	43	34	35	20 x 20

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
857193	725.5 MHz SAW Band 28 Uplink Filter	SAW	725.5	45	4	SE/SE	3 x 3
857217	742.5 MHz SAW Filter	SAW	742.5	27	2.5	SE/SE	3 x 3
857216	1,030 MHz SAW Filter	SAW	1,030	10	2.3	SE/SE	3 x 3
857215	1,090 MHz SAW Filter	SAW	1,090	10	2.6	SE/SE	3 x 3
880272	1,227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	30	2.25	SE/SE	3.26 x 1.6
880366	1,227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	12	1.5	SE/SE	3.26 x 1.6
880098	1,575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	20	4 Max	SE/SE	3.71 x 2.57
880404	1,575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	35	1.5	SE/SE	3.71 x 2.57
857207	1,585.66 MHz SAW Filter	SAW	1,585.66	41	1.45	SE/BAL	1.4 x 1.2
856815	1,650.75 MHz SAW Filter	SAW	1,650.75	48.5	2.5	SE/SE	3 x 3
TQQ7303	1,747.5 MHz BAW Band 3 Uplink Filter	BAW	1,747.5	75	3.5	SE/SE	3 x 3
TQQ0302	Band 3 Uplink RF Filter	BAW	1,747.5	75	3.5	SE/SE	3 x 3
TQQ0303	Band 3 Downlink RF Filter	BAW	1,842.5	75	5	SE/SE	3 x 3
885069	2,350 MHz BAW Band 40 Filter	BAW	2,350	100	3	SE/SE	1.4 x 1.2
885062	2440 MHz BAW Filter - ISM Passband for WLAN/LTE Coexistence	BAW	2,440	82	1.6	SE/SE	1.4 x 1.2
885071	2440 MHz BAW Filter - ISM Passband for WLAN/LTE Coexistence	BAW	2,440	82	1.6	SE/SE	1.4 x 1.2
885070	2436 MHz BAW Filter - ISM Passband for WiFi Bandedge and LTE Coexistence	BAW	2,436	72	0.7	SE/SE	1.7x1.3
TQQ7307	2,535 MHz BAW Band 7 Uplink Filter	BAW	2,535	70	3.5	SE/SE	3 x 3
TQQ0041	B41 Rx BAW Filter	BAW	2,580	196	3.5	SE/SE	2 x 2
885026	B38 Tx/Rx Filter	BAW	2,595	50	1.4	SE/SE	1.4 x 1.2
885043	B38/B40 Tx Diplexed BAW Filter	BAW	2,595, 2,350	100	3.5	SE/SE	1.7 x 1.3

Spatium™ Amplifiers

Part	Description	Frequency (GHz)	Psat (W)	Power Gain (dB)	Small Signal Gain (dB)	Power (dBm)	PAE (%)	Voltage (V)	ECCN	Package (mm)
KU250W-1416	14.4 - 16 GHz 250 W Ku-Band GaN Spatium™ Solid-State Power Amplifier	14.4 to 16	250	22	25	54	20	30	ITAR	176 x 61 x 61
KA150W-2730	27 - 30 GHz 150 W Spatium™ Solid-State Power Amplifier	27 to 30	150	15	22	52	28	20	3A001 .b.4.b	104 x 74 x 61
KA130W-2730	27- 30 GHz 130 W Ka-Band GaN SSPA	27 to 30	130	14	> 20	51.14	> 15	20	3A001 b.4.b	104 x 74 x 61
KA130W-3031	30 - 31 GHz 130 W Ka-Band GaN SSPA	30 to 31	130	14	> 20	51.14	> 15	20	3A001 b.4.b	104 x 74 x 61

Spatium™ Bench Top Amplifiers

Part	Description	Frequency (GHz)	Psat (W)	Power Gain (dB)	Small Signal Gain (dB)	Power (dBm)	PAE (%)	Voltage (V)	ECCN	Package (mm)
RM022020	2 - 20 GHz 20 W Spatium™ Bench Top Power Amplifier	2 to 20	15	43	45	41.7	8	90 to 264	3A001.b.4.b	482 x 236 x 145

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
TQP4M0013	High Isolation Absorptive SPST Switch	0.1 to 4	0.55	50	35	3.3	0.08	2 x 2 mm
TQC0015	High Isolation Absorptive SPDT Switch	0.1 to 6	0.5	60	33	3.3	0.1	4 x 4
TGS2354	0.5 - 6 GHz 40 W GaN SPDT Switch	0.5 to 6	< 1	40	> 25	0, -40	< 1	Die
TGS2354-SM	0.5 - 6 GHz 40 W GaN SPDT Switch	0.5 to 6	< 1	40	> 25	0, -40	< 1	4 x 4 mm QFN
TGS2355	0.5 - 6 GHz 80 W GaN SPDT Switch	0.5 to 6	< 1.25	> 80	> 40	0, -40	< 1	Die
TGS2352-2-SM	0.5 - 12 GHz High Power SPDT Reflective Switch	0.5 to 12	< 1	-35	20	0 to -40	–	QFN

Switches (Cont.)

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGS2353-2-SM	0.5 - 18 GHz High Power SPDT Reflective Switch	0.5 to 18	< 1.5	-30	10	0 to -40	–	QFN
TGS4307	77 GHz Transceiver Switch	70 to 85	2.5	40	–	1.3	40	Die

Transimpedance Amplifiers

Part	Description	Bandwidth (GHz)	Differential Transimpedance Gain (ohm)	Differential Output Vpp (mV)	Equivalent Input Noise (pA/rtHz)	Voltage (V)	Current (mA)
TGA4871	4-Channel 28 Gb/s Limiting TIA	30	6000	600	15	3.3	300
TGA4872	Dual 32 Gb/s Linear Transimpedance Amplifier with AGC	30	7000	200 to 900	20	3.3	175
TGA4874	Quad 32 Gb/s Linear Transimpedance Amplifier with AGC + Optional SPI Control	30	7000	200 to 900	20	3.3	350
TGA4866	44.6 Gb/s Limiting Transimpedance Amplifier	40	2,800	600	15	3.3	75

Transmit Modules

Part	Description	Bands	Features	Package (mm)
TQF9089	QUANTUM Tx™ Quad-Band WCDMA/ LTE/GPRS SP8T Transmit Module	QDE + QB	Integrated QB GSM/GPRS & 4 WCDMA Antenna Switch Ports, Low Rx Insertion Loss	6 x 5 x 1

Variable Gain Amplifiers

Part	Description	Frequency (MHz)	Attenuation Range (dB)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package (mm)
TQC9305	Digital Variable Gain Amplifier with Shutdown Mode	700 to 3,600	31.5	13	23	39.7	3.1	5	130	5 x 5
TGA4541-SM	Ka-Band Variable Gain Driver Amplifier	28,000 to 31,000	30	32	23	31	_	5	330	6 x 6

WLAN Front End Modules

Part	Description	Frequency (GHz)	802.11 Standards	Typ Pout 1.78% EVM (dBm)	Typ Pout 3.0% EVM (dBm)	Tx Gain (dB)	Rx Gain (dB)	Rx NF (dB)	Nom Bias Voltage (V)	Current (mA)	Package (mm)
TQF7062	802.11a/n/ac Power Amplifier, LNA with Bypass, SP2T Switch	4.9 to 5.925	a/n/ac	19	20.5	36	13	2.5	3.6	290	2.5 x 2.5 x 0.4
TQP5523	5 GHz WLAN 802.11a/n/ac Power Amplifier (+22dBm)	4.9 to 5.925	a/n/ac	22	24	32	–	–	3.3, 5	315	4 x 4 x 0.85
TQP5525	5 GHz WLAN 802.11a/n/ac Power Amplifier (+24dBm)	4.9 to 5.925	a/n/ac	24	26	32	–	–	3.3, 5	550	4 x 4 x 0.85
TQL1600	5 GHz WLAN Switch / LNA Front End Module	5.15 to 5.875	a/n/ac	–	–	–	13	2.5	3.3, 5	8	2.5 x 2.5 x 0.45

Many listings in this product guide support both commercial and defense applications. The tables in this section are a partial listing of devices suitable for specific defense/aerospace applications. We have included product solutions based on RF GaN technology in this section. Although located here for easy reference, GaN products have wide-ranging applications across many commercial markets. Products listed throughout this guide may be specially screened to meet unique customer requirements including 100% electrical screening and visual inspection to either MILSTD-883 Class B or Class S. Please contact TriQuint with your requirements: **info-defense@triquint.com.**

Attenuators

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Bits	Control Voltage (V)	Package Style
TGL4203-SM	DC - 30 GHz Wideband Analog Attenuator	Analog	DC to 30	1.5	16	20	6	-1 to 0	Die
TGL4201-00	Wideband Fixed 0 dB Attenuator	Analog	DC to 50	0	–	20	–	Passive	Die
TGL4201-02	Wideband Fixed 2 dB Attenuator	Analog	DC to 50	2	–	20	–	Passive	Die
TGL4201-03	Wideband Fixed 3 dB Attenuator	Analog	DC to 50	3	–	20	–	Passive	Die
TGL4201-06	Wideband Fixed 6 dB Attenuator	Analog	DC to 50	6	–	20	–	Passive	Die
TGL4201-10	Wideband Fixed 10 dB Attenuator	Analog	DC to 50	10	–	20	–	Passive	Die
TGL4203	50 GHz Wideband Analog Attenuator	Analog	DC to 50	2	17	15	–	-1 to 0	Die
TQP4M9071	Parallel Controlled 6 Bit, 31.5 dB Digital Step Attenuator	Digital	0 to 4	1.6	31.5	30	6	5	4 x 4 mm
TQP4M9072	Serial Controlled 6 Bit, 31.5 dB Digital Step Attenuator	Digital	0 to 4	1.6	31.5	30	6	5	4 x 4 mm
TQP4M9083	High Linearity Serial Controlled 7 Bit, 31.75 dB Digital Step Attenuator	Digital	0.4 to 3.5	1.5	31.75	30	7	5	4 x 4 mm

CATV Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package (mm)	Applications
TGA2803-SM	CATV TIA / Gain Block	40 to 1,000	20	28	45	1.5	8	350	4 x 4	Receiver
TGA2806-SM	CATV Linear Amplifier	40 to 1,000	20	28	45	1.7	8	380	5 x 5	General Purpose Dual

Diplexers

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
*890086***	1176.45 / 1575.42 MHz High Attenuation SAW Diplexer	SAW	1,176.45, 1,575.42	20.46	3.5	SE/SE	5 x 5
*890087***	1176.45 / 1575.42 MHz Low Loss SAW Diplexer	SAW	1,176.45, 1,575.42	20.46	0.9	SE/SE	5 x 5
*890084***	1227.6 / 1575.42 MHz High Attenuation SAW Diplexer	SAW	1,227.6, 1,575.42	20.46	3.5	SE/SE	5 x 5
*890085***	1227.6 / 1575.42 MHz Low Loss SAW Diplexer	SAW	1,227.6, 1,575.42	20.46	0.9	SE/SE	5 x 5

NOTES: *** = Preview***

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
*T1G2028536-FL***	285 W, 36 V DC - 2 GHz, GaN RF Power Transistor	DC to 2	19	–	54.2	–	54	36	576	NI-780
*T1G2028536-FS***	285 W, 36 V DC - 2 GHz, GaN RF Power Transistor	DC to 2	19	–	54.2	–	54	36	576	NI-780
*T1G3000532-SM***	5 W, 32 V, DC - 3 GHz GaN RF Power Transistor	DC to 3	16	–	37	–	50	32	25	5 x 5 mm
*T1G4012036-FL***	120 W Peak, 24 W Average Power, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	50.8	–	52	36	360	NI-360
*T1G4012036-FS***	120 W Peak, 24 W Average Power, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	50.8	–	52	36	360	NI-360

Discrete Transistors (Cont.)

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
*T1G4020036-FL***	2x120 W, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	54	–	52	36	520	NI-650
*T1G4020036-FS***	2x120 W, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	54	–	52	36	520	NI-650
*T1G4004532-FL***	45 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	19	–	46.4	–	52	32	220	NI-360
*T1G4004532-FS***	45 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	19	–	46.4	–	52	32	220	NI-360
T2G4003532-FS	30 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16.5	–	44.5	–	49	32	150	NI-360
T2G4003532-FL	30 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16.5	–	44.5	–	49	32	150	NI-360
T2G4005528-FS	55 W, 28 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	15	–	47.2	–	> 50	28	200	NI-360
TGF2021-04-SD	DC - 4 GHz Packaged Power pHEMT	DC to 4	16	26.5	–	0.6	–	5	150	SOT-89
*T1G6001032-SM***	10 W, 32 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	19	–	40	–	54	32	50	5 x 5 mm
*T2G6001528-SG***	15 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15.5	–	42.3	–	70	28	100	NI-200
T2G6000528-Q3	7 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15.5	–	39.5	–	50	28	50	NI-200
T2G6001528-Q3	18 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15	–	42.5	–	> 50	28	50	NI-200
T2G6003028-FL	30 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	14	–	45	–	50	28	200	NI-200
T2G6003028-FS	30 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	14	–	45	–	50	28	200	NI-200
TGF2021-01	X-Band Discrete Power pHEMT	DC to 12	11	–	> 30	–	59	8 to 12	75 to 125	Die
TGF2021-02	X-Band Discrete Power pHEMT	DC to 12	11	–	> 33	–	59	8 to 12	150 to 250	Die
TGF2021-04	X-Band Discrete Power pHEMT	DC to 12	11	–	> 36	–	59	8 to 12	300 to 500	Die
TGF2021-08	X-Band Discrete Power pHEMT	DC to 12	11	–	> 39	–	59	8 to 12	600 to 1,000	Die
TGF2021-12	X-Band Discrete Power pHEMT	DC to 12	11	–	> 42	–	58	8 to 12	900 to 1,500	Die
TGF2023-2-01	6 W Discrete Power GaN on SiC HEMT	DC to 18	18	–	38	–	71.6	12 to 32	25 to 125	Die
TGF2023-2-02	12 W Discrete Power GaN on SiC HEMT	DC to 18	21	–	40.1	–	73.3	12 to 32	50 to 250	Die
TGF2023-2-05	25 W Discrete Power GaN on SiC HEMT	DC to 18	18	–	43	–	78.3	12 to 32	100 to 500	Die
TGF2023-2-10	50 W Discrete Power GaN on SiC HEMT	DC to 18	19.8	–	47.3	–	69.5	12 to 32	200 to 1,000	Die
TGF2023-2-20	90 W Discrete Power GaN on SiC HEMT	DC to 18	19.2	–	50.5	–	70.5	12 to 32	400 to 2,000	Die
TGF2018	180 um Discrete GaAs pHEMT	DC to 20	14	–	22	1	55	8	29	Die
TGF2022-06	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 28	–	58	8 to 12	45 to 75	Die
TGF2022-12	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 31	–	58	8 to 12	90 to 150	Die
TGF2022-24	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 34	–	58	8 to 12	180 to 300	Die
TGF2022-48	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 37	–	58	8 to 12	360 to 600	Die
TGF2022-60	Ku-Band Discrete Power pHEMT	DC to 20	12	–	> 38	–	57	8 to 12	448 to 752	Die
TGF2025	250 um Discrete GaAs pHEMT	DC to 20	14	–	25	0.9	58	8	41	Die
TGF2040	400 um Discrete GaAs pHEMT	DC to 20	13	–	26	1.1	55	8	65	Die
TGF2060	600 um Discrete GaAs pHEMT	DC to 20	12	–	28	1.4	55	8	97	Die
TGF2080	800 um Discrete GaAs pHEMT	DC to 20	11.5	–	29.5	–	56	8	129	Die
TGF2120	1200 um Discrete GaAs pHEMT	DC to 20	11	31	–	–	57	8	194	Die
TGF2160	1600 um Discrete GaAs pHEMT	DC to 20	10.4	32.5	–	–	63	8	258	Die
TGF4350	0.3 mm, 0.25-µm mmW pHEMT 2MI	DC to 22	13 @ 10 GHz	–	16	0.8 @ 10 GHz	–	3	15	Die

NOTES: *** = Preview***

Driver Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
*TGA3500-SM***	Wide Band Driver Amplifier	2,000 to 12,000	34	21	29	3	5	200	QFN 8 x 8 mm

NOTES: *** = Preview***

Frequency Converters/Mixers

Part	Description	RF (GHz)	IF (GHz)	LO (GHz)	Gain (dB)	Output IP3 (dBm)	NF (dB)	Output P1dB (dBm)	LO Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGC4403	8 - 15 GHz Doubler with Amplifier	16 to 30	8 to 15	–	20	–	–	20	–	5	150	Die
TGC4403-SM	8 - 15 GHz Packaged Doubler with Amplifier	16 to 30	8 to 15	–	18	–	–	20	–	5	150	4 x 4 mm
TGC4402	17 - 27 GHz Upconverting Mixer	17 to 27	0.5 to 3	14 to 28	-9	10	9	–	17	-0.9	–	Die
*TGC4405-SM**	17 - 27 GHz Packaged Upconverter	17 to 27	0.5 to 3	8 to 13	13	28	–	–	2	5	425	4 x 4 mm
TGC4610-SM	K-Band Downconverter	17 to 27	DC to 4	6.5 to 15.5	15	18	2.5	–	5.5	3	228	5 x 5 mm
TGC4402-SM	18 - 26 GHz Packaged Upconverting Mixer	18 to 26	0.5 to 3	16 to 26	-9	10	9	–	19	-0.9	–	4 x 4 mm
TGC1430F	Doubler	20 to 40	–	–	-12	–	–	–	–	–	–	Die
TGC4407-SM	Ka-Band Upconverter	21.5 to 32.5	DC to 7	11 to 16	-9	4	9	-5	0 to 7.5	5	65	3 x 3 mm
TGC4406-SM	28 - 34 GHz Packaged Doubler with Amplifier	28 to 34	14 to 17	–	15	–	–	20	–	5	150	4 x 4 mm
*TGC4546-SM**	37 - 46 GHz Upconverter	37 to 46	DC to 3.5	8.35 to 11.5	12	26	18.5	21	2 to 8	5	430	5 x 5 mm

NOTES: ** = New*

Lange Couplers

Part	Description	Frequency (GHz)	Insertion Loss (dB)	Package Style
TGB2001	Lange Coupler	12 to 21	< 0.25	Die
TGB4001	Lange Coupler	18 to 32	< 0.25	Die
TGB4002	Lange Coupler	27 to 45	< 0.25	Die

Limiters

Part	Description	Frequency (GHz)	Insertion Loss (dB)	Flat Leakage (dBm)	Package Style
*TGL2205***	S and C-Band 100 W VPIN Limiter	1 to 6	< 0.5	–	Die
*TGL2206***	S-Band 100 W VPIN Limiter	2 to 4.5	< 0.5	–	Die
*TGL2207***	S and C-Band 100 W VPIN Limiter	2 to 5	< 0.5	–	Die
*TGL2208-SM**	2 - 20 GHz Dual-Stage VPIN Limiter	2 to 20	< 1	< 18	QFN 3 x 3 mm 14L

NOTES: ** = New, ** = Preview*

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
TQP3M9036	Ultra Low Noise, High Linearity LNA	0.4 to 2	0.45	19	35	20	5	65	2 x 2 mm
TQP3M9008	High Linearity Low Noise Gain Block	0.05 to 4	1.3	20.6	35.5	20	5	85	SOT-89
TQP3M9009	High Linearity Low Noise Gain Block	0.05 to 4	1.3	21.8	39.5	22	5	125	SOT-89
TQP3M9018	High Linearity Low Noise Gain Block	0.05 to 4	1.3	20.5	36	20	5	85	3 x 3 mm
TQP3M9019	High Linearity Low Noise Gain Block	0.05 to 4	1.3	22	39.5	22	5	125	3 x 3 mm
TQP3M9037	Ultra Low Noise, High Linearity LNA	1.5 to 4	0.4	20	35	20	5	65	2 x 2 mm
TQP3M9028	High Linearity Low Noise Gain Block	50 to 4,000	14.7	20.7	40	2	5	85	SOT-89
TQP3M9038	High Linearity LNA Gain Block	50 to 4,000	14.9	21.6	39.5	2	5	85	3 x 3 mm
*TQL9047**	High Linearity Gain Block with Shutdown Function	50 to 4,000	14.5	21.2	35.5	1.6	5	70	2 x 2 mm
*TQL9048**	High Linearity Gain Block with Shutdown Function	50 to 4,000	14.5	22	40.5	1.7	5	130	2 x 2 mm
*TGA2611***	2 - 6 GHz GaN LNA	2 to 6	1	25	32	22	10	110	Die
*TGA2611-SM***	2 - 6 GHz GaN LNA	2 to 6	1.2	25	32	22	10	100	4 x 4 mm Overmold QFN
TGA2525	2 - 18 GHz Low Noise Amplifier with AGC	2 to 18	2	17	29	22	5	75	Die
TGA2513-SM	Wideband Low Noise Amplifier	2 to 20	2.5	17	–	16	5	75	4 x 4 mm

Low Noise Amplifiers (Cont.)

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
TGA2526	2 - 20 GHz Low Noise Amplifier with AGC	2 to 20	2.5	17.5	29	22	5	100	Die
TGA2567-SM*	2 - 20 GHz LNA Amplifier	2 to 20	2	17	29	19	5	100	QFN 4 x 4 mm 24L
TGA2513	Wideband Low Noise Amplifier	2 to 23	2	17	–	16	5	75	Die
TGA2613	S-Band High-Linearity LNA	2.5 to 4	2.5	12.5	29	29	6	320	Die
TGA2614	S-Band High Gain LNA	2.7 to 3.8	0.9	18	33	20	6	110	Die
TGA2614-SM	S-Band High Gain LNA	2.7 to 3.8	1.2	17	33	19	6	120	QFN 5 x 5 mm 32L
TGA2512-1-SM	4 - 14 GHz Balanced Low Noise Amplifier	4 to 14	2.3	25	16	12	5	160	4 x 4 mm
TGA2512-2-SM	4 - 14 GHz Balanced Low Noise Amplifier	4 to 14	2.3	25	24	12	5	160	4 x 4 mm
TGA2512	X-Band Low Noise Amplifier	5 to 15	1.4	27	24	13	5	160	Die
TGA2612	6 - 12 GHz GaN LNA	6 to 12	1.8	22	29	20	10	100	Die
TGA2511	X-Band Low Noise Amplifier	6 to 14	1.3	20	24	12	5	160	Die
TGA4506	K-Band Low Noise Amplifier	20 to 27	2.2	21	–	12	3.5	60	Die
TGA4507	Ka-Band Low Noise Amplifier	28 to 36	2.3	22	–	12	3	60	Die
TGA4508	Ka-Band Low Noise Amplifier	30 to 42	2.8	21	–	14	3	40	Die
TGA4600	60 GHz Low Noise Amplifier	57 to 65	4	13	–	–	3	41	Die

NOTES: **** = New, ** = Preview***

Modulator Drivers

Part	Description	Frequency (GHz)	Vpp (V)	Gain (dB)	3 dB Bandwidth (GHz)	Voltage (V)	Current (mA)	Package Style
TGA4832	DC - 35 GHz Wideband Amplifier	DC to 35	4	12	35	5	135	Die
TGA4830	CFP Low Power Driver	DC to 40	2.5	13	40	5	50	Die
TGA4803	DC to > 50 GHz Medium Power Amplifier with AGC	DC to 50+	3.5	8	> 50	6.5	100	Die

Oscillators

Part	Description	Frequency (GHz)	Power (dBm)	Phase Noise (dBc/Hz)	Voltage (V)	Current (mA)	Package (mm)
TGV2561-SM	8.9 - 9.8 GHz VCO with Divide by 2	8.9 to 9.8	16	-114 @ 100 kHz	5	195	5 x 5
TGV2562-SM	9.5 - 10.3 GHz VCO with Divide by 2	9.5 to 10.3	15	-113 @ 100 kHz	5	195	5 x 5
TGV2563-SM	9.7 - 10.8 GHz VCO with Divide by 2	9.7 to 10.8	11	-111 @ 100 kHz	5	175	5 x 5
TGV2564-SM	10.3 - 11.1 GHz VCO with Divide by 2	10.3 to 11.1	10	-111 @ 100 kHz	5	175	5 x 5
TGV2539-SM	10.7 - 11.5 GHz VCO with Divide by 2	10.7 to 11.5	10	-111 @ 100 kHz	5	185	5 x 5
TGV2565-SM	11.3 - 12.3 GHz VCO with Divide by 2	11.3 to 12.3	11	-111 @ 100 kHz	5	180	5 x 5
TGV2584-SM	12.6 - 13.8 GHz VCO with Divide by 2	12.6 to 13.8	10	-110 @ 100 kHz	5	180	5 x 5
TGV2566-SM	13.4 - 14.4 GHz VCO with Divide by 2	13.4 to 14.4	9	-110 @ 100 kHz	5	175	5 x 5

Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA2237	0.03 - 2.5 GHz 10 W GaN Power Amplifier	0.03 to 2.5	40	19	–	> 52	30	360
TGA2237-SM	0.03 - 2.5 GHz 10 W GaN Power Amplifier	0.03 to 2.5	40	19	–	> 50	30	360
TGA2216	0.1 - 3.0 GHz 12 W GaN Power Amplifier	0.1 to 3	41	22	–	> 40	48	360
TGA2216-SM	0.1 - 3.0 GHz 12 W GaN Power Amplifier	0.1 to 3	40.5	21	–	> 40	40	360
TGA2578	2-6 GHz 30 W Power Amplifier	2 to 6	45	27	–	40	28	400
TGA2576-2-FL	2.5 - 6 GHz 40 W GaN Power Amplifier	2.5 to 6	46.5	29	–	36	30	1,550
TGA2583-SM	2.7 - 3.7 GHz 10 W GaN Power Amplifier	2.7 to 3.7	41	33	–	> 50	25	175
TGA2585-SM	2.7 - 3.7 GHz 18 W GaN Power Amplifier	2.7 to 3.7	42.8	32	–	> 50	28	225
TGA2706-SM	2 W C-Band Packaged Power Amplifier	5.5 to 8.5	34	31	7	–	6	1,260
TGA2701-SM	3 W C-Band Packaged Power Amplifier	5.9 to 8.5	35	18	–	37	6	1,000
TGA2701	7 - 8.5 GHz High Power Amplifier	7 to 8.5	37	21	–	> 40	5 to 7	1,050

Power Amplifiers (Cont.)

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA2586-FL	7.9 - 8.4 GHz 50 W GaN Power Amplifier	7.9 to 8.4	47	14	–	36	24	2,240
TGA2700	X-Band Driver Amplifier	8 to 13	30	25	–		9	300
TGA2622*	9 - 10 GHz 40 W GaN Power Amplifier	9 to 10	46	32	–	> 46	28	290
TGA2624*	9 - 10 GHz 18 W GaN Power Amplifier	9 to 10	42.5	35	–	40	28	365
***TGA2312-FL**	X-Band 60 W GaN Power Amplifier	9 to 10	48	13	–	38	24	2,400
TGA2704	9 - 10.5 GHz High Power Amplifier	9 to 10.5	38	20	–	> 40	7 to 9	1,050
TGA2704-SM*	8 W, 9 - 11 GHz Power Amplifier	9 to 11	39	21	–	–	9	1,050
TGA2710-SM*	8 W, 9.5 - 11.5 GHz Power Amplifier	9.5 to 11.5	39	22	–	–	9	1,050
TGA2623*	10 - 11 GHz 35 W GaN Power Amplifier	10 to 11	45.5	35	–	> 47	28	290
TGA2625*	10 - 11 GHz 18 W GaN Power Amplifier	10 to 11	42.5	34	–	40	28	365
TGA2535-SM	X-Band Power Amplifier	10 to 12	34.5	25	–	30	6	1,300
TGA2710	10.5 - 12 GHz High Power Amplifier	10.5 to 12	38	19	–	> 40	7 to 9	1,050
TGA2524-SM	Ku-Band Power Amplifier	12 to 16	26.5	23	7	–	5	320
TGA2533-SM	Ku-Band Power Amplifier	12.5 to 15.5	34.5	27	–	–	6	1,300
TGA2510	2 W Ku-Band Power Amplifier	12.5 to 17	34	26	–	–	7.5	650
TGA2510-TS	2 W Ku-Band Power Amplifier	12.5 to 17	34	26	–	–	7.5	650
TGA2533	Ku-Band Power Amplifier	12.7 to 15.4	35	28	6	–	6	1,300
TGA2514-FL	6.5 W Ku-Band Power Amplifier	13 to 16	38	24	–	–	8	2,600
TGA2505	Ku-Band High Power Amplifier	13 to 17	34	25	–	–	7	640
TGA2902-1-SCC-SG	2 W Packaged Amplifier	13 to 17	34	26	–	–	7.5	650
TGA2514	6.5 W Ku-Band Power Amplifier	13 to 18	38	24	–	–	8	2,600
TGA2536-FL*	5 W Ku-Band Power Amplifier	13.5 to 16	37	25	–	20	8	2,600
TGA2579-2-FL	20 W Ku-Band GaN Power Amplifier	14 to 15.35	43	35	–	27	25	1,000
TGA2559-FL*	4 W Ku-Band Power Amplifier	14 to 16	36	24	–	30	6	1,000
TGA2572-2-FL*	16 W Ku-Band GaN Power Amplifier	14 to 16	42	25	–	20	30	2,000
TGA2521-SM	17 - 24 GHz Linear Driver Amplifier	17 to 24	25	20	5	–	5	320
TGA2522-SM	17 - 24 GHz Power Amplifier	17 to 24	28	17	–	–	5	712
TGA4531	K-Band High Linearity Power Amplifier	17 to 24	32	23	6	–	7	720
TGA4502-SCC	Ka-Band High Power Amplifier	17 to 27	29	22	–	–	7	760
TGA4030-SM	17 - 37 GHz Medium Power Amplifier/Multiplier	17 to 37	19	20	–	–	5	140
TGA4031-SM	17 - 40 GHz Medium Power Amplifier/Multiplier	17 to 40	19	22	–	–	5	140
TGA4040	17 - 43 GHz Medium Power Amplifier/Multiplier	17 to 43	22	25	–	–	5	140
TGA4532	K-Band Power Amplifier	17.5 to 20	32.5	23	6	–	6	900
TGA4532-SM	K-Band Power Amplifier	17.7 to 19.7	32.5	23	7	–	6	900
TGA4022	K-Band High Power Amplifier	18 to 23	32.5	26	–	–	7	840
TGA1135B-SCC	K-Band High Power Amplifier	18 to 27	30	14	–	–	5 to 7	540
TGA1073G-SCC	K-Band Medium Power Amplifier	19 to 27	25	22	–	–	5 to 7	220
TGA4036	19 - 38 GHz Medium Power Amplifier	19 to 38	22	20	–	–	5	160
TGA4533-SM	K-Band Power Amplifier	21.2 to 23.6	32	22	6	–	6	880
***TGA4536-SM**	K-Band Power Amplifier	24.2 to 26.5	34	18	7	20	6	1,430
TGA4902-SM	Ka-Band Packaged Medium Power Amplifier	25 to 35	25	18	–	–	6	220
TGA1073A-SCC	Ka-Band Medium Power Amplifier	26 to 35	25	19	–	–	5 to 7	220
TGA2594*	27 - 31 GHz 5 W GaN Power Amplifier	27 to 31	37	23	–	28	20	140
TGA1073B-SCC	Ka-Band High Power Amplifier	27 to 32	28.5	25	–	–	6 to 8	420
TGA4903-SM	Ka-Band Medium Power Amplifier	27 to 32	24	15	–	–	5	170
TGA2595*	27.5 - 31 GHz 9 W Power Amplifier	27.5 to 31	39.5	23	–	24	20	280
TGA4539-SM	1 W Ka-Band Power Amplifier	28 to 30	30.5	20	–	–	6	420
TGA4512-SM	Ka-Band Driver Amplifier	28 to 32	17	14.5	7.5	–	6	80
TGA4537-SM*	K-Band Power Amplifier	29 to 35	32	18	6	15	6	1,100
TGA4510	29 - 37 GHz Driver Amplifier	29 to 37	16	16	–	–	6	60
TGA4516	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050
TGA4516-TS	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050
TGA4514	2 W Ka-Band Power Amplifier	31 to 35	33.5	19	–	–	6 to 7	1,150

Power Amplifiers (Cont.)

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA4517	Ka-Band Power Amplifier	31 to 37	35	15	–	–	6	2,000
TGA2575	3 W Ka-Band Power Amplifier	32 to 38	35.5	19	–	22	6	2,100
*TGA2575-TS***	Ka-Band 3 W Power Amplifier On Carrier	32 to 38	35.5	19	–	22	6	2,100
TGA4521	32 - 45 GHz Wideband Driver Amplifier	32 to 45	24	15	–	–	6	200
TGA1141	Ka-Band High Power Amplifier	33 to 36	31	17	–	–	6 to 7	880
TGA4522	33 - 47 GHz Wideband Driver Amplifier	33 to 47	27	14	–	–	6	400
TGA1073C-SCC	Ka-Band High Power Amplifier	36 to 40	26	15	–	–	5 to 7	240
TGA1171-SCC	Ka-Band High Power Amplifier	36 to 40	30	14	–	–	6 to 7	500
TGA4538	37 - 40 GHz Power Amplifier	37 to 40	29.5	24	–	–	5	600
TGA4542	37 - 40 GHz Power Amplifier	37 to 40	32.4	26	–	18	6	900
TGA4043	Q-Band Power Amplifier	40 to 45	29	10	–	–	7	500
TGA4543	40.5 - 43.5 GHz Power Amplifier	40.5 to 43.5	30	23	–	–	6	900
TGA4042	Q-Band Driver Amplifier	41 to 45	18	14	–	–	6	168
TGA4046	2 W Q-Band High Power Amplifier	41 to 46	33	16	–	–	6	2,000

NOTES: ** = New, ** = Preview*

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856980	70 MHz IF SAW Filter	SAW	70	2.5	9	SE/SE	13.3 x 6.5
856980	70 MHz IF SAW Filter	SAW	70	2.5	9	SE/SE	13.3 x 6.5
857174	70 MHz SAW Filter	SAW	70	4.9	25.5 Max	SE/SE	19 x 6.5
857175	70 MHz SAW Filter	SAW	70	5.7	21	SE/SE	19 x 6.5
857176	140 MHz SAW Filter	SAW	140	28.5	19.75	SE/SE	9 x 7.01
857177	140 MHz SAW Filter	SAW	140	1.5	23.5	SE/SE	19 x 6.5
857191	810 MHz SAW Filter	SAW	810	5	4.6	SE/SE	3 x 3
857162	1000 MHz Non Dispersive SAW Delay Line	SAW	1,000	700	30	SE/SE	25.4 x 12.7
857163	1000 MHz Non Dispersive SAW Delay Line	SAW	1,000	430	23.3	SE/SE	25.4 x 12.7
857164	1000 MHz Non Dispersive SAW Delay Line	SAW	1,000	353.5	21.25	SE/SE	25.4 x 12.7
857169	1000 MHz Non Dispersive SAW Delay Line	SAW	1,000	705	35.3	SE/SE	25.4 x 12.7
880367	1030 MHz SSR/IFF BAW Filter	BAW	1,030	14	3	SE/SE	3.71 x 2.57
857179	1090 MHz SAW Filter	SAW	1,090	10	5.6	BAL/BAL	3.8 x 3.8
880374	1090 MHz SSR/IFF BAW Filter	BAW	1,090	16	3	SE/SE	3.71 x 2.57
880364	1176 MHz GPS L5 BAW Filter	BAW	1,176	30	2.5	SE/SE	3.26 x 1.6
880060	1227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	25	1.8	SE/SE	3.26 x 1.6
*880272**	1227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	30	2.25	SE/SE	3.26 x 1.6
880368	1280 MHz L-Band BAW Filter	BAW	1,280	19	4	SE/SE	3.71 x 2.57
880094	1575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	30	1.8	SE/SE	3.26 x 1.6
880273	1575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	40	2.35	SE/SE	3.26 x 1.6
880126	2106 MHz RF BAW Filter	BAW	2,106	35	4 Max	SE/SE	3.26 x 1.6
880148	2324 MHz RF BAW Filter	BAW	2,324	38	3	SE/SE	3.71 x 2.57
880157	2560 MHz S-Band BAW Filter	BAW	2,560	30	3.8	SE/SE	3.71 x 2.57

NOTES: ** = New*

Spatium™ Amplifiers

Part	Description	Frequency (GHz)	Psat (W)	Power Gain (dB)	Small Signal Gain (dB)	Power (dBm)	PAE (%)	Voltage (V)	ECCN	Package (mm)
*KU250W-1416**	14.4 - 16 GHz 250 W Ku-Band GaN Spatium™ Solid-State Power Amplifier	14.4 to 16	250	22	25	54	20	30	ITAR	176 x 61 x 61
*KA150W-2730**	27 - 30 GHz 150 W Spatium™ Solid-State Power Amplifier	27 to 30	150	15	22	52	28	20	3A001.b.4.b	104 x 74 x 61
*KA130W-2730**	27- 30 GHz 130 W Ka-Band GaN SSPA	27 to 30	130	14	> 20	51.14	> 15	20	3A001b.4.b	104 x 74 x 61
*KA130W-3031**	30 - 31 GHz 130 W Ka-Band GaN SSPA	30 to 31	130	14	> 20	51.14	> 15	20	3A001b.4.b	104 x 74 x 61

NOTES: ** = New*

Spatium™ Bench Top Amplifiers

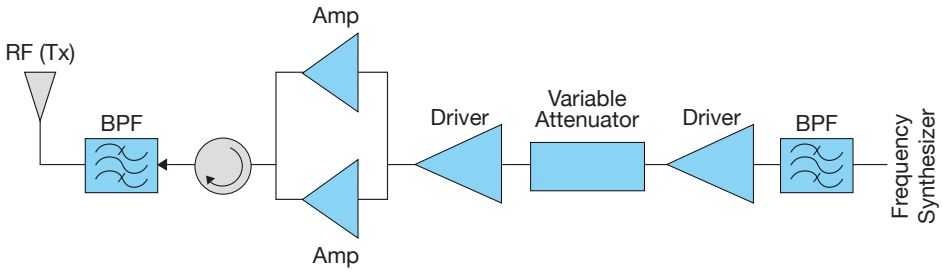
Part	Description	Frequency (GHz)	Psat (W)	Power Gain (dB)	Small Signal Gain (dB)	Power (dBm)	PAE (%)	Prime Power (VAC)	ECCN	Package (mm)
*RM022020**	2 - 20 GHz 20 W Spatium™ Bench Top Power Amplifier	2 to 20	15	43	45	41.7	8	90 to 264	3A001.b.4.b	482 x 236 x 145

NOTES: ** = New*

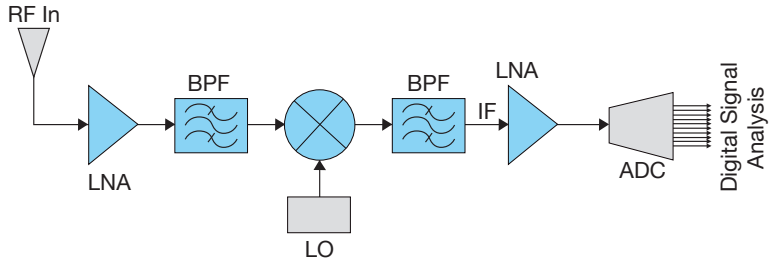
Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGS2303	SP3T VPIN	0.2 to 20	0.5	35	–	–	10	Die
TGS2304-SCC	SP4T VPIN	0.2 to 20	0.6	38	23	–	10	Die
*TGS2354***	0.5 - 6 GHz 40 W GaN SPDT Switch	0.5 to 6	< 1	40	> 25	0, -40	< 1	Die
*TGS2354-SM***	0.5 - 6 GHz 40 W GaN SPDT Switch	0.5 to 6	< 1	40	> 25	0, -40	< 1	4 x 4 mm QFN
*TGS2355***	0.5 - 6 GHz 80 W GaN SPDT Switch	0.5 to 6	< 1.25	> 80	> 40	0, -40	< 1	Die
*TGS2352-2-SM***	0.5 to 12 GHz High Power SPDT Reflective Switch	0.5 to 12	< 1	-35	20	0 to -40	–	QFN
*TGS2353-2-SM***	0.5 to 18 GHz High Power SPDT Reflective Switch	0.5 to 18	< 1.5	-30	10	0 to -40	–	QFN
TGS2313	4 - 18 GHz VPIN SP3T Switch	4 to 18	1	35	20	2.7, -2.7	20	Die
TGS2302	4 - 20 GHz VPIN SPDT Switch	4 to 20	0.9	35	20	2.7, -2.7	20	Die
TGS4302	High Power Ka-Band SPDT Switch	27 to 46	0.9	27	> 33	5, -5	20	Die
TGS4304	High Power Ka-Band Absorptive SPDT Switch	32 to 40	0.9	35	> 33	5, -5	30	Die

NOTES: *** = Preview*



Signal Jammer



Digital Receiver

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
T1G2028536-FL**	285 W, 36 V DC - 2 GHz, GaN RF Power Transistor	DC to 2	19	–	54.2	–	54	36	576	NI-780
T1G2028536-FS**	285 W, 36 V DC - 2 GHz, GaN RF Power Transistor	DC to 2	19	–	54.2	–	54	36	576	NI-780
T1G3000532-SM**	5 W, 32 V, DC - 3 GHz GaN RF Power Transistor	DC to 3	16	–	37	–	50	32	25	5 x 5 mm
T1G4012036-FL**	120 W Peak, 24 W Average Power, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	50.8	–	52	36	360	NI-360
T1G4012036-FS**	120 W Peak, 24 W Average Power, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	50.8	–	52	36	360	NI-360
T1G4020036-FL**	2 x 120 W, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	54	–	52	36	520	NI-650
T1G4020036-FS**	2 x 120 W, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	54	–	52	36	520	NI-650
T1G4004532-FL**	45 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	19	–	46.4	–	52	32	220	NI-360
T1G4004532-FS**	45 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	19	–	46.4	–	52	32	220	NI-360
T2G4003532-FL	30 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16.5	–	44.5	–	49	32	150	NI-360
T2G4003532-FS	30 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16.5	–	44.5	–	49	32	150	NI-360
TGF2021-04-SD	DC - 4 GHz Packaged Power pHEMT	DC to 4	16	26.5	–	0.6	–	5	150	SOT-89
T1G6001032-SM**	10 W, 32 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	19	–	40		54	32	50	5 x 5 mm
T2G6001528-SG**	15 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15.5	–	42.3	–	70	28	100	NI-200
T2G6000528-Q3	7 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15.5	–	39.5	–	50	28	50	NI-200
T2G6001528-Q3	18 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15	–	42.5	–	> 50	28	50	NI-200
T2G6003028-FL	30 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	14	–	45	–	50	28	200	NI-200
T2G6003028-FS	30 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	14	–	45	–	50	28	200	NI-200

Discrete Transistors (Cont.)

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
TGF2021-01	X-Band Discrete Power pHEMT	DC to 12	11	–	> 30	–	59	8 to 12	75 to 125	Die
TGF2021-02	X-Band Discrete Power pHEMT	DC to 12	11	–	> 33	–	59	8 to 12	150 to 250	Die
TGF2021-04	X-Band Discrete Power pHEMT	DC to 12	11	–	> 36	–	59	8 to 12	300 to 500	Die
TGF2021-08	X-Band Discrete Power pHEMT	DC to 12	11	–	> 39	–	59	8 to 12	600 to 1,000	Die
TGF2021-12	X-Band Discrete Power pHEMT	DC to 12	11	–	> 42	–	58	8 to 12	900 to 1,500	Die
TGF2023-2-01	6 W Discrete Power GaN on SiC HEMT	DC to 18	18	–	38	–	71.6	12 to 32	25 to 125	Die
TGF2023-2-02	12 W Discrete Power GaN on SiC HEMT	DC to 18	21	–	40.1	–	73.3	12 to 32	50 to 250	Die
TGF2023-2-05	25 W Discrete Power GaN on SiC HEMT	DC to 18	18	–	43	–	78.3	12 to 32	100 to 500	Die
TGF2023-2-10	50 W Discrete Power GaN on SiC HEMT	DC to 18	19.8	–	47.3	–	69.5	12 to 32	200 to 1,000	Die
TGF2023-2-20	90 W Discrete Power GaN on SiC HEMT	DC to 18	19.2	–	50.5	–	70.5	12 to 32	400 to 2,000	Die
TGF2022-06	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 28	–	58	8 to 12	45 to 75	Die
TGF2022-12	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 31	–	58	8 to 12	90 to 150	Die
TGF2022-24	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 34	–	58	8 to 12	180 to 300	Die
TGF2022-48	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 37	–	58	8 to 12	360 to 600	Die
TGF2022-60	Ku-Band Discrete Power pHEMT	DC to 20	12	–	> 38	–	57	8 to 12	448 to 752	Die
TGF2040	400 um Discrete GaAs pHEMT	DC to 20	13	–	26	1.1	55	8	65	Die
TGF2060	600 um Discrete GaAs pHEMT	DC to 20	12	–	28	1.4	55	8	97	Die
TGF2080	800 um Discrete GaAs pHEMT	DC to 20	11.5	–	29.5	–	56	8	129	Die
TGF2120	1200 um Discrete GaAs pHEMT	DC to 20	11	31	–	–	57	8	194	Die
TGF2160	1600 um Discrete GaAs pHEMT	DC to 20	10.4	32.5	–	–	63	8	258	Die
TGF4350	0.3 mm, 0.25-µm mmW pHEMT 2MI	DC to 22	13 @ 10 GHz	–	16	0.8 @ 10 GHz	–	3	15	Die

NOTES: *** = Preview***

Limiters

Part	Description	Frequency (GHz)	Insertion Loss (dB)	Flat Leakage (dBm)	Package Style
*TGL2208-SM**	2-20 GHz Dual-Stage VPIN Limiter	2 to 20	< 1.0	< 18	QFN 3x3 mm 14L

NOTES: *** = New***

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
*TGA2567-SM**	2 - 20 GHz LNA Amplifier	2 to 20	2	17	29	19	5	100	QFN 4 x 4 mm 24L
TGA4508	Ka-Band Low Noise Amplifier	30 to 42	2.8	21	–	14	3	40	Die

NOTES: *** = New***

Modulator Drivers

Part	Description	Frequency (GHz)	Vpp (V)	Gain (dB)	3 dB Bandwidth (GHz)	Voltage (V)	Current (mA)	Package Style
TGA4832	DC - 35 GHz Wideband Amplifier	DC to 35	4	12	35	5	135	Die
TGA4830	CFP Low Power Driver	DC to 40	2.5	13	40	5	50	Die
TGA4803	DC to > 50 GHz Medium Power Amplifier with AGC	DC to 50+	3.5	8	> 50	6.5	100	Die

Oscillators

Part	Description	Frequency (GHz)	Power (dBm)	Phase Noise (dBc/Hz)	Voltage (V)	Current (mA)	Package (mm)
TGV2561-SM	8.9 - 9.8 GHz VCO with Divide by 2	8.9 to 9.8	16	-114 @ 100 kHz	5	195	5 x 5
TGV2562-SM	9.5 - 10.3 GHz VCO with Divide by 2	9.5 to 10.3	15	-113 @ 100 kHz	5	195	5 x 5
TGV2563-SM	9.7 - 10.8 GHz VCO with Divide by 2	9.7 to 10.8	11	-111 @ 100 kHz	5	175	5 x 5
TGV2564-SM	10.3 - 11.1 GHz VCO with Divide by 2	10.3 to 11.1	10	-111 @ 100 kHz	5	175	5 x 5
TGV2539-SM	10.7 - 11.5 GHz VCO with Divide by 2	10.7 to 11.5	10	-111 @ 100 kHz	5	185	5 x 5
TGV2565-SM	11.3 - 12.3 GHz VCO with Divide by 2	11.3 to 12.3	11	-111 @ 100 kHz	5	180	5 x 5
TGV2584-SM	12.6 - 13.8 GHz VCO with Divide by 2	12.6 to 13.8	10	-110 @ 100 kHz	5	180	5 x 5
TGV2566-SM	13.4 - 14.4 GHz VCO with Divide by 2	13.4 to 14.4	9	-110 @ 100 kHz	5	175	5 x 5

Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA2237	0.03 - 2.5 GHz 10 W GaN Power Amplifier	0.03 to 2.5	40	19	–	> 52	30	360
TGA2237-SM	0.03 - 2.5 GHz 10W GaN Power Amplifier	0.03 to 2.5	40	19	–	> 50	30	360
TGA2216	0.1 - 3 GHz 12 W GaN Power Amplifier	0.1 to 3	41	22	–	> 40	48	360
TGA2216-SM	0.1 - 3 GHz 12W GaN Power Amplifier	0.1 to 3	40.5	21	–	> 40	40	360
TGA2578	2 - 6 GHz 30 W Power Amplifier	2 to 6	45	27	–	40	28	400
TGA2573-2	2 - 18 GHz, 10 W GaN Amplifier	2 to 18	40	10	–	20	30	500
TGA2573-2-TS	2 - 18 GHz, 10 W GaN Amplifier on Carrier	2 to 18	40	10	–	20	30	500
TGA2509-FL	Wideband Packaged High Power Amplifier with AGC	2 to 20	29	15	–	–	12	1,100
TGA2509	Wideband 1 W High Power Amplifier with AGC	2 to 22	30	17	–	–	12	1,100
TGA2576-2-FL	2.5 - 6 GHz 40 W GaN Power Amplifier	2.5 to 6	46.5	29	–	36	30	1,550
TGA2590	6 - 12 GHz 30 W GaN Power Amplifier	6 to 12	45	29	–	28	25	1100
TGA2501	High Power Amplifier	6 to 18	34.5	24	–	20	8	1,200
TGA2501-GSG	2.8 W 6 - 18 GHz Power Amplifier	6 to 18	34.5	26	–	20	8	1,200
TGA2501-TS	6 - 18 GHz, 2.8 W Power Amplifier	6 to 18	34.5	24	–	25	8	1,200
TGA9092-SCC	Power Amplifier (Per Channel)	6 to 18	34.5	24	–	20	8	1,200
TGA2586-FL	7.9 - 8.4 GHz 50 W GaN Power Amplifier	7.9 to 8.4	47	14	–	36	24	2,240
TGA2312-FL*	X-Band 60 W GaN Power Amplifier	9 to 10	48	13	–	38	24	2,400
TGA2579-2-FL	20 W Ku-Band GaN Power Amplifier	14 to 15.35	43	35	–	27	25	1,000
TGA4030-SM	17 - 37 GHz Medium Power Amplifier/Multiplier	17 to 37	19	20	–	–	5	140
TGA4031-SM	17 - 40 GHz Medium Power Amplifier/Multiplier	17 to 40	19	22	–	–	5	140
TGA4040	17 - 43 GHz Medium Power Amplifier/Multiplier	17 to 43	22	25	–	–	5	140
TGA4036	19 - 38 GHz Medium Power Amplifier	19 to 38	22	20	–	–	5	160
TGA4536-SM*	K-Band Power Amplifier	24.2 to 26.5	34	18	7	20	6	1,430
TGA2594	27 - 31 GHz 5 W GaN Power Amplifier	27 to 31	37	23	–	28	20	140
TGA2595	27.5 - 31 GHz 9 W Power Amplifier	27.5 to 31	39.5	23	–	24	20	280
TGA4537-SM	K-Band Power Amplifier	29 to 35	32	18	6	15	6	1,100
TGA4516	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050
TGA4516-TS	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050

NOTES: ** = New, ** = Preview*

Spatium™ Amplifiers

Part	Description	Frequency (GHz)	Psat (W)	Power Gain (dB)	Small Signal Gain (dB)	Power (dBm)	PAE (%)	Voltage (V)	ECCN	Package (mm)
KA130W-2730*	27 - 30 GHz 130 W Ka-Band GaN SSPA	27 to 30	130	14	> 20	51.14	> 15	20	3A001b.4.b	104 x 74 x 61
KA150W-2730*	27 - 30 GHz 150 W Spatium™ Solid-State Power Amplifier	27 to 30	150	15	22	52	28	20	3A001.b.4.b	104 x 74 x 61
KA130W-3031*	30 - 31 GHz 130 W Ka-Band GaN SSPA	30 to 31	130	14	> 20	51.14	> 15	20	3A001b.4.b	104 x 74 x 61

NOTES: ** = New*

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGS2303	SP3T VPIN	0.2 to 20	0.5	35	–	–	10	Die
TGS2304-SCC	SP4T VPIN	0.2 to 20	0.6	38	23	–	10	Die
TGS2354**	0.5 - 6 GHz 40 W GaN SPDT Switch	0.5 to 6	< 1	40	> 25	0, -40	< 1	Die
TGS2354-SM**	0.5 - 6 GHz 40 W GaN SPDT Switch	0.5 to 6	< 1	40	> 25	0, -40	< 1	4 x 4 mm QFN
TGS2355**	0.5 - 6 GHz 80 W GaN SPDT Switch	0.5 to 6	< 1.25	> 80	> 40	0, -40	< 1	Die
TGS2352-2-SM**	0.5 to 12 GHz High Power SPDT Reflective Switch	0.5 to 12	< 1	-35	20	0 to -40	–	QFN
TGS2353-2-SM**	0.5 to 18 GHz High Power SPDT Reflective Switch	0.5 to 18	< 1.5	-30	10	0 to -40	–	QFN
TGS2313	4 - 18 GHz VPIN SP3T Switch	4 to 18	1.0	35	20	2.7, -2.7	20	Die
TGS2302	4 - 20 GHz VPIN SPDT Switch	4 to 20	0.9	35	20	2.7, -2.7	20	Die
TGS4302	High Power Ka-Band SPDT Switch	27 to 46	0.9	27	> 33	5, -5	20	Die
TGS4304	High Power Ka-Band Absorptive SPDT Switch	32 to 40	0.9	35	> 33	5, -5	30	Die

NOTES: *** = Preview*

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	Psat (dBm)	PAE (%)	Voltage (V)	Current (mA)	Package Style
T1G2028536-FL**	285 W, 36 V DC - 2 GHz, GaN RF Power Transistor	DC to 2	19	54.2	54	36	576	NI-780
T1G2028536-FS**	285 W, 36 V DC - 2 GHz, GaN RF Power Transistor	DC to 2	19	54.2	54	36	576	NI-780
T1G3000532-SM**	5 W, 32 V, DC - 3 GHz GaN RF Power Transistor	DC to 3	16	37	50	32	25	5 x 5 mm
T1G4012036-FL**	120 W Peak, 24 W Average Power, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	50.8	52	36	360	NI-360
T1G4020036-FL**	2 x 120 W, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	54	52	36	520	NI-650
T1G4020036-FS**	2 x 120 W, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	54	52	36	520	NI-650
T1G4004532-FL**	45 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	19	46.4	52	32	220	NI-360
T1G4004532-FS**	45 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	19	46.4	52	32	220	NI-360
T2G4003532-FL	30 W, 32 V, DC-3.5 GHz GaN RF Power Transistor	DC to 3.5	16.5	44.5	49	32	150	NI-360
T2G4003532-FS	30 W, 32 V, DC-3.5 GHz GaN RF Power Transistor	DC to 3.5	16.5	44.5	49	32	150	NI-360

Discrete Transistors (Cont.)

Part	Description	Frequency (GHz)	Linear Gain (dB)	Psat (dBm)	PAE (%)	Voltage (V)	Current (mA)	Package Style
T2G4005528-FS	55 W, 28 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	15	47.2	> 50	28	200	NI-360
*T1G6001032-SM***	10 W, 32 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	19	40	54	32	50	5 x 5 mm
*T2G6001528-SG***	15 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15.5	42.3	70	28	100	NI-200
T2G6000528-Q3	7 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15.5	39.5	50	28	50	NI-200
T2G6001528-Q3	18 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15	42.5	> 50	28	50	NI-200
T2G6003028-FL	30 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	14	45	50	28	200	NI-200
T2G6003028-FS	30 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	14	45	50	28	200	NI-200
TGF2023-2-01	6 W Discrete Power GaN on SiC HEMT	DC to 18	18	38	71.6	12 to 32	25 to 125	Die
TGF2023-2-02	12 W Discrete Power GaN on SiC HEMT	DC to 18	21	40.1	73.3	12 to 32	50 to 250	Die
TGF2023-2-05	25 W Discrete Power GaN on SiC HEMT	DC to 18	18	43	78.3	12 to 32	100 to 500	Die
TGF2023-2-10	50 W Discrete Power GaN on SiC HEMT	DC to 18	19.8	47.3	69.5	12 to 32	200 to 1,000	Die
TGF2023-2-20	90 W Discrete Power GaN on SiC HEMT	DC to 18	19.2	50.5	70.5	12 to 32	400 to 2,000	Die

NOTES: *** = Preview***

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
*TGA2611***	2 - 6 GHz GaN LNA	2 to 6	1.5	25	32	22	10	110	Die
*TGA2611-SM***	2 - 6 GHz GaN LNA	2 to 6	1.2	25	32	22	10	100	4 x 4 mm Overmold QFN
*TGA2612***	6 - 12 GHz GaN LNA	6 to 12	1.8	22	29	20	10	100	Die

NOTES: *** = Preview***

Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	PAE (%)	Voltage (V)	IQ (mA)
*TGA2237***	0.03 - 2.5 GHz 10 W GaN Power Amplifier	0.03 to 2.5	40	19	> 52	30	360
*TGA2237-SM***	0.03 - 2.5 GHz 10 W GaN Power Amplifier	0.03 to 2.5	40	19	> 50	30	360
*TGA2216***	0.1 - 3 GHz 12 W GaN Power Amplifier	0.1 to 3	41	22	> 40	48	360
*TGA2216-SM***	0.1 - 3 GHz 12 W GaN Power Amplifier	0.1 to 3	40.5	21	> 40	40	360
*TGA2578***	2 - 6 GHz 30 W Power Amplifier	2 to 6	45	27	40	28	400
*TGA2573-2-TS***	2 - 18 GHz, 10 W GaN Amplifier on Carrier	2 to 18	40	10	20	30	500
*TGA2576-2-FL***	2.5 - 6 GHz 40 W GaN Power Amplifier	2.5 to 6	46.5	29	36	30	1,550
*TGA2576-FS***	2.5 - 6 GHz 40 W GaN Power Amplifier	2.5 to 6	46.5	29	35	30	1550
*TGA2583***	2.7 - 3.7 GHz 10 W GaN Power Amplifier	2.7 to 3.7	40	33	54	25	175
*TGA2585***	2.7 - 3.7 GHz 18 W GaN Power Amplifier	2.7 to 3.7	42.8	33	54	28	225
*TGA2583-SM***	2.7 - 3.7 GHz 10 W GaN Power Amplifier	2.7 to 3.7	41	33	>50	25	175
*TGA2585-SM***	2.7 - 3.7 GHz 18 W GaN Power Amplifier	2.7 to 3.7	42.8	32	>50	28	225
*TGA2813***	3.1 - 3.6 GHz 100 W GaN Power Amplifier	3.1 to 3.6	50.7	22	55	30	150
*TGA2814***	3.1 - 3.6 GHz 80 W GaN Power Amplifier	3.1 to 3.6	49.5	22	56	30	125
*TGA2590***	6 - 12 GHz 30 W GaN Power Amplifier	6 to 12	45	29	28	25	1100
*TGA2586-FL***	7.9 - 8.4 GHz 50 W GaN Power Amplifier	7.9 to 8.4	47	14	36	24	2,240
*TGA2312-FL**	X-Band 60 W GaN Power Amplifier	9 to 10	48	13	38	24	2,400
*TGA2622***	9 - 10 GHz 40 W GaN Power Amplifier	9 to 10	46	32	> 46	28	290
*TGA2624***	9 - 10 GHz 18 W GaN Power Amplifier	9 to 10	42.5	35	40	28	365

Power Amplifiers (Cont.)

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA2623**	10 -11 GHz 35 W GaN Power Amplifier	10 to 11	45.5	35	> 47	28	290
TGA2625**	10 - 11 GHz 18 W GaN Power Amplifier	10 to 11	42.5	34	40	28	365
TGA2579-2-FL	20 W Ku-Band GaN Power Amplifier	14 to 15.35	43	35	27	25	1,000
TGA2572-2-FL**	16 W Ku-Band GaN Power Amplifier	14 to 16	42	25	20	30	2,000
TGA2594**	27 - 31 GHz 5 W GaN Power Amplifier	27 to 31	37	23	28	20	140
TGA2595**	27.5 - 31 GHz 9 W Power Amplifier	27.5 to 31	39.5	23	24	20	280

NOTES: * = New, ** = Preview

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGS2354**	0.5 - 6 GHz 40 W GaN SPDT Switch	0.5 to 6	< 1	40	> 25	0, -40	< 1	Die
TGS2354-SM**	0.5 - 6 GHz 40 W GaN SPDT Switch	0.5 to 6	< 1	40	> 25	0, -40	< 1	4 x 4 mm QFN
TGS2355**	0.5 - 6 GHz 80 W GaN SPDT Switch	0.5 to 6	< 1.25	> 80	> 40	0, -40	< 1	Die
TGS2352-2-SM**	0.5 - 12 GHz High Power SPDT Reflective Switch	0.5 to 12	< 1	-35	20	0 to -40	–	QFN
TGS2353-2-SM**	0.5 - 18 GHz High Power SPDT Reflective Switch	0.5 to 18	< 1.5	-30	10	0 to -40	–	QFN

NOTES: ** = Preview

Attenuators

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Control Voltage (V)	Package Style
TGL4203-SM	DC - 30 GHz Wideband Analog Attenuator	Analog	DC to 30	1.5	16	20	-1 to 0	Die
TGL4201-00	Wideband Fixed 0 dB Attenuator	Analog	DC to 50	0	–	20	Passive	Die
TGL4201-02	Wideband Fixed 2 dB Attenuator	Analog	DC to 50	2	–	20	Passive	Die
TGL4201-03	Wideband Fixed 3 dB Attenuator	Analog	DC to 50	3	–	20	Passive	Die
TGL4201-06	Wideband Fixed 6 dB Attenuator	Analog	DC to 50	6	–	20	Passive	Die
TGL4201-10	Wideband Fixed 10 dB Attenuator	Analog	DC to 50	10	–	20	Passive	Die
TGL4203	50 GHz Wideband Analog Attenuator	Analog	DC to 50	2	17	15	-1 to 0	Die

CATV Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package (mm)	Applications
TGA2803-SM	CATV TIA / Gain Block	40 to 1,000	20	28	45	1.5	8	350	4 x 4	Receiver
TGA2806-SM	CATV Linear Amplifier	40 to 1,000	20	28	45	1.7	8	380	5 x 5	General Purpose Dual

Diplexers

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
890086**	1176.45/1575.42 MHz High Attenuation SAW Diplexer	SAW	1,176.45, 1,575.42	20.46	3.5	SE/SE	5 x 5
890087**	1176.45/1575.42 MHz Low Loss SAW Diplexer	SAW	1,176.45, 1,575.42	20.46	0.9	SE/SE	5 x 5

Diplexers (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
890084**	1227.6/1575.42 MHz High Attenuation SAW Diplexer	SAW	1,227.6, 1,575.42	20.46	3.5	SE/SE	5 x 5
890085**	1227.6/1575.42 MHz Low Loss SAW Diplexer	SAW	1,227.6, 1,575.42	20.46	0.9	SE/SE	5 x 5

NOTES: ** = Preview

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
TGF2021-04-SD	DC - 4 GHz Packaged Power pHEMT	DC to 4	16	26.5	–	0.6	–	5	150	SOT-89
TGF2021-01	X-Band Discrete Power pHEMT	DC to 12	11	–	> 30	–	59	8 to 12	75 to 125	Die
TGF2021-02	X-Band Discrete Power pHEMT	DC to 12	11	–	> 33	–	59	8 to 12	150 to 250	Die
TGF2021-04	X-Band Discrete Power pHEMT	DC to 12	11	–	> 36	–	59	8 to 12	300 to 500	Die
TGF2021-08	X-Band Discrete Power pHEMT	DC to 12	11	–	> 39	–	59	8 to 12	600 to 1,000	Die
TGF2021-12	X-Band Discrete Power pHEMT	DC to 12	11	–	> 42	–	58	8 to 12	900 to 1,500	Die
TGF2018	180 um Discrete GaAs pHEMT	DC to 20	14	–	22	1	55	8	29	Die
TGF2022-06	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 28	–	58	8 to 12	45 to 75	Die
TGF2022-12	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 31	–	58	8 to 12	90 to 150	Die
TGF2022-24	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 34	–	58	8 to 12	180 to 300	Die
TGF2022-48	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 37	–	58	8 to 12	360 to 600	Die
TGF2022-60	Ku-Band Discrete Power pHEMT	DC to 20	12	–	> 38	–	57	8 to 12	448 to 752	Die
TGF2025	250 um Discrete GaAs pHEMT	DC to 20	14	–	25	0.9	58	8	41	Die
TGF2040	400 um Discrete GaAs pHEMT	DC to 20	13	–	26	1.1	55	8	65	Die
TGF2060	600 um Discrete GaAs pHEMT	DC to 20	12	–	28	1.4	55	8	97	Die
TGF2080	800 um Discrete GaAs pHEMT	DC to 20	11.5	–	29.5	–	56	8	129	Die
TGF2120	1200 um Discrete GaAs pHEMT	DC to 20	11	31	–	–	57	8	194	Die
TGF2160	1600 um Discrete GaAs pHEMT	DC to 20	10.4	32.5	–	–	63	8	258	Die
TGF4350	0.3 mm, 0.25-µm mmW pHEMT 2MI	DC to 22	13 @ 10 GHz	–	16	0.8 @ 10 GHz	–	3	15	Die

Driver Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
TGA3500-SM**	Wide Band Driver Amplifier	2,000 to 12,000	34	21	29	3	5	200	QFN 8 x 8 mm

NOTES: ** = Preview

Frequency Converters / Mixers

Part	Description	RF (GHz)	IF (GHz)	LO (GHz)	Gain (dB)	Output IP3 (dBm)	NF (dB)	Output P1dB (dBm)	LO Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGC4403	8 - 15 GHz Doubler with Amplifier	16 to 30	8 to 15	–	20	–	–	20		5	150	Die
TGC4403-SM	8 - 15 GHz Packaged Doubler with Amplifier	16 to 30	8 to 15	–	18	–	–	20		5	150	4 x 4 mm
TGC4610-SM	K-Band Downconverter	17 to 27	DC to 4	6.5 to 15.5	15	18	2.5	–	5.5	3	228	5 x 5 mm
TGC4402	17 - 27 GHz Upconverting Mixer	17 to 27	0.5 to 3	14 to 28	-9	10	9	–	17	-0.9	–	Die
*TGC4405**	17 - 27 GHz Upconverter	17 to 27	0.5 to 3	8 to 13	13	–	–		2 to 5	5	425	Die
*TGC4405-SM**	17 - 27 GHz Packaged Upconverter	17 to 27	0.5 to 3	8 to 13	13	28	–	–	2	5	425	4 x 4 mm
TGC4402-SM	18 - 26 GHz Packaged Upconverting Mixer	18 to 26	0.5 to 3	16 to 26	-9	10	9	–	19	-0.9	–	4 x 4 mm
TGC1430F	Doubler	20 to 40	–	–	-12	–	–	–	–	–	–	Die
TGC4407-SM	Ka-Band Upconverter	21.5 to 32.5	DC to 7	11 to 16	-9	4	9	-5	0 to 7.5	5	65	3 x 3 mm
TGC4406-SM	28 - 34 GHz Packaged Doubler with Amplifier	28 to 34	14 to 17	–	15	–		20	–	5	150	4 x 4 mm
*TGC4546-SM**	37 - 46 GHz Upconverter	37 to 46	DC to 3.5	8.35 to 11.5	12	26	18.5	21	2 to 8	5	430	5 x 5 mm

NOTES: ** = New*

Gain Block Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
TQP369180	Cascadable Gain Block	DC to 6,000	15.7	15.2	29.8	3.6	5	45	SOT-89
TQP369181	Cascadable Gain Block	DC to 6,000	15.6	15.2	30	3.6	5	45	SOT-363
TQP369182	Cascadable Gain Block	DC to 6,000	22.3	16.1	29.6	3.8	5	45	SOT-89
TQP369184	Cascadable Gain Block	DC to 6,000	22	16.2	29.8	3.8	5	45	SOT-363
TQP369185	Cascadable Gain Block	DC to 6,000	19	19.6	31.7	4.7	5	75	SOT-89

Lange Couplers

Part	Description	Frequency (GHz)	Insertion Loss (dB)	Package Style
TGB2001	Lange Coupler	12 to 21	< 0.25	Die
TGB4001	Lange Coupler	18 to 32	< 0.25	Die
TGB4002	Lange Coupler	27 to 45	< 0.25	Die

Limiters

Part	Description	Frequency (GHz)	Insertion Loss (dB)	Flat Leakage (dBm)	Bias (V)	Package Style
*TGL2205***	S and C-Band 100 W VPIN Limiter	1 to 6	< 0.5	–	–	Die
*TGL2206***	S-Band 100 W VPIN Limiter	2 to 4.5	< 0.5	–	–	Die
*TGL2207***	S and C-Band 100 W VPIN Limiter	2 to 5	< 0.5	–	–	Die
TGL2201-SM	Wideband Dual-Stage VPIN Limiter	2 to 12	< 0.5	< 18	Passive	3 x 3 mm
*TGL2208-SM**	2 - 20 GHz Dual-Stage VPIN Limiter	2 to 20	< 1.0	< 18	–	QFN 3 x 3 mm 14L
TGL2201	Wideband VPIN Limiter	3 to 25	< 0.5	< 18	Passive	Die

NOTES: ** = New, ** = Preview*

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
*TGA2611***	2 - 6 GHz GaN LNA	2 to 6	1.5	25	32	22	10	110	Die
*TGA2611-SM***	2 - 6 GHz GaN LNA	2 to 6	1.2	25	32	22	10	100	4 x 4 mm Overmold QFN
TGA2525	2 - 18 GHz Low Noise Amplifier with AGC	2 to 18	2	17	29	22	5	75	Die
TGA2513-SM	Wideband Low Noise Amplifier	2 to 20	2.5	17	–	16	5	75	4 x 4 mm
TGA2526	2 - 20 GHz Low Noise Amplifier with AGC	2 to 20	2.5	17.5	29	22	5	100	Die
*TGA2567-SM**	2 - 20 GHz LNA Amplifier	2 to 20	2	17	29	19	5	100	QFN 4 x 4 mm 24L
TGA2513	Wideband Low Noise Amplifier	2 to 23	2	17	–	16	5	75	Die
*TGA2613***	S-Band High-Linearity LNA	2.5 to 4	2.5	12.5	29	29	6	320	Die
*TGA2614***	S-Band High Gain LNA	2.7 to 3.8	0.9	18	33	20	6	110	Die
*TGA2614-SM***	S-Band High Gain LNA	2.7 to 3.8	1.2	17	33	19	6	120	QFN 5 x 5 mm 32L
TGA2512-1-SM	4 - 14 GHz Balanced Low Noise Amplifier	4 to 14	2.3	25	16	12	5	160	4 x 4 mm
TGA2512-2-SM	4 - 14 GHz Balanced Low Noise Amplifier	4 to 14	2.3	25	24	12	5	160	4 x 4 mm
*TGM2543-SM***	4 - 20 GHz Limiter/Low Noise Amplifier	4 to 20	2	17	28	21	5	100	7 x 7 mm
TGA2512	X-Band Low Noise Amplifier	5 to 15	1.4	27	24	13	5	160	Die
*TGA2612***	6 - 12 GHz GaN LNA	6 to 12	1.8	22	29	20	10	100	Die
TGA2511	X-Band Low Noise Amplifier	6 to 14	1.3	20	24	12	5	160	Die
TGA4506	K-Band Low Noise Amplifier	20 to 27	2.2	21	–	12	3.5	60	Die
TGA4507	Ka-Band Low Noise Amplifier	28 to 36	2.3	22	–	12	3	60	Die
TGA4508	Ka-Band Low Noise Amplifier	30 to 42	2.8	21	–	14	3	40	Die

NOTES: *** = Preview***

Modulator Drivers

Part	Description	Frequency (GHz)	Vpp (V)	Gain (dB)	3 dB Bandwidth (GHz)	Voltage (V)	Current (mA)	Package Style
TGA4832	DC - 35 GHz Wideband Amplifier	DC to 35	4	12	35	5	135	Die
TGA4830	CFP Low Power Driver	DC to 40	2.5	13	40	5	50	Die

Phase Shifters

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	RMS Amplitude Error (dB)	RMS Phase Error (Degrees)	Bits	Control Voltage (V)	Package Style
*TGP2105***	6 - 18 GHz 6-Bit Digital Phase Shifter (+Vc)	Digital	6 to 18	< 10	0.45	4	6	0, 5	Die
*TGP2105-SM***	6 - 18 GHz 6-Bit Digital Phase Shifter (+Vc)	Digital	6 to 18	< 10	0.45	4	6	0, 5	QFN 5 x 5 mm 32L
*TGP2107***	6 - 18 GHz 6-Bit Digital Phase Shifter (-Vc)	Digital	6 to 18	< 10	0.55	5	6	-5, 0	Die
*TGP2107-SM***	6 - 18 GHz 6-Bit Digital Phase Shifter (-Vc)	Digital	6 to 18	< 10	0.55	5	6	-5, 0	QFN 5 x 5 mm 32L
TGP2100	30 GHz 5 Bit Phase Shifter	Digital	28 to 32	6	0.5	5	5	0, 5	Die
TGP2104	30 - 40 GHz 180 Degree Phase Shifter	Digital	30 to 40	3.5	0.3	10	1	0, 5	Die
TGP2102	35 GHz 5 Bit Phase Shifter	Digital	32 to 37	7	0.4	3.5	5	-5, 0	Die

NOTES: *** = Preview***

Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
*TGA2237-SM***	0.03 - 2.5 GHz 10 W GaN Power Amplifier	0.03 to 2.5	40	19	–	> 50	30	360
*TGA2216-SM***	0.1 - 3 GHz 12 W GaN Power Amplifier	0.1 to 3	40.5	21	–	> 40	40	360

Power Amplifiers (Cont.)

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA2573-2	2 - 18 GHz, 10 W GaN Amplifier	2 to 18	40	10	–	20	30	500
TGA2573-2-TS	2 - 18 GHz, 10 W GaN Amplifier on Carrier	2 to 18	40	10	–	20	30	500
TGA2509-FL	Wideband Packaged High Power Amplifier with AGC	2 to 20	29	15	–	–	12	1,100
TGA2509	Wideband 1 W High Power Amplifier with AGC	2 to 22	30	17	–	–	12	1,100
TGA2576-FS	2.5 - 6 GHz 40 W GaN Power Amplifier	2.5 to 6	46.5	29	–	35	30	1550
TGA2583-SM	2.7 - 3.7 GHz 10 W GaN Power Amplifier	2.7 to 3.7	41	33	–	> 50	25	175
TGA2585-SM	2.7 - 3.7 GHz 18 W GaN Power Amplifier	2.7 to 3.7	42.8	32	–	> 50	28	225
TGA2706-SM	2 W C-Band Packaged Power Amplifier	5.5 to 8.5	34	31	7	–	6	1,260
TGA2701-SM	3 W C-Band Packaged Power Amplifier	5.9 to 8.5	35	18	–	37	6	1,000
TGA2590	6 - 12 GHz 30 W GaN Power Amplifier	6 to 12	45	29	–	28	25	1100
TGA2501	High Power Amplifier	6 to 18	34.5	24	–	20	8	1,200
TGA2501-GSG	2.8 W 6 - 18 GHz Power Amplifier	6 to 18	34.5	26	–	20	8	1,200
TGA2501-TS	6 - 18 GHz, 2.8 W Power Amplifier	6 to 18	34.5	24	–	25	8	1,200
TGA9092-SCC	Power Amplifier (per channel)	6 to 18	34.5	24	–	20	8	1,200
TGA9083-SCC	Power Amplifier - pHEMT	6.5 to 11.5	37, 39	19	–	40, 35	7 to 9	1,200
TGA2701	7 - 8.5 GHz High Power Amplifier	7 to 8.5	37	21	–	> 40	5 to 7	1,050
TGA2517	16 W X-Band Power Amplifier	7.5 to 11.5	42	28	–	35	9 to 12	2,000
TGA2517-GSG	14 W X-Band Power Amplifier	7.5 to 11.5	41.6	30	–	28	12	3,000
TGA2700	X-Band Driver Amplifier	8 to 13	30	25	–	–	9	300
TGA2622	9 - 10 GHz 40 W GaN Power Amplifier	9 to 10	46	32	–	> 46	28	290
TGA2624	9 - 10 GHz 18 W GaN Power Amplifier	9 to 10	42.5	35	–	40	28	365
TGA2704	9 - 10.5 GHz High Power Amplifier	9 to 10.5	38	20	–	> 40	7 to 9	1,050
TGA2704-SM	8 W, 9 - 11 GHz Power Amplifier	9 to 11	39	21	–	–	9	1,050
TGA2710-SM	8 W, 9.5 - 11.5 GHz Power Amplifier	9.5 to 11.5	39	22	–	–	9	1,050
TGA2535-SM	X-Band Power Amplifier	10 to 12	34.5	25	–	30	6	1,300
TGA2710	10.5 - 12 GHz High Power Amplifier	10.5 to 12	38	19	–	> 40	7 to 9	1,050
TGA2565-SM*	11-17 GHz Medium Power Amplifier	11 to 17	27	27	–	–	6	210
TGA2524-SM	Ku-Band Power Amplifier	12 to 16	26.5	23	7	–	5	320
TGA2527-SM	Ku-Band Power Amplifier	12.5 to 15.5	31.5	25	7.5	–	6	650
TGA2533-SM	Ku-Band Power Amplifier	12.5 to 15.5	34.5	27	–	–	6	1,300
TGA2510	2 W Ku-Band Power Amplifier	12.5 to 17	34	26	–	–	7.5	650
TGA2510-TS	2 W Ku-Band Power Amplifier	12.5 to 17	34	26	–	–	7.5	650
TGA2533	Ku-Band Power Amplifier	12.7 to 15.4	35	28	6	–	6	1,300
TGA2514-FL	6.5 W Ku-Band Power Amplifier	13 to 16	38	24	–	–	8	2,600
TGA2505	Ku-Band High Power Amplifier	13 to 17	34	25	–	–	7	640
TGA2902-1-SCC-SG	2 W Packaged Amplifier	13 to 17	34	26	–	–	7.5	650
TGA2514	6.5 W Ku-Band Power Amplifier	13 to 18	38	24	–	–	8	2,600
TGA2559-FL	4 W Ku-Band Power Amplifier	14 to 16	36	24	–	30	6	1,000
TGA2521-SM	17 - 24 GHz Linear Driver Amplifier	17 to 24	25	20	5	–	5	320
TGA2522-SM	17 - 24 GHz Power Amplifier	17 to 24	28	17	–	–	5	712
TGA4531	K-Band High Linearity Power Amplifier	17 to 24	32	23	6	–	7	720
TGA4502-SCC	Ka-Band High Power Amplifier	17 to 27	29	22	–	–	7	760
TGA4030-SM	17 - 37 GHz Medium Power Amplifier / Multiplier	17 to 37	19	20	–	–	5	140
TGA4031-SM	17 - 40 GHz Medium Power Amplifier / Multiplier	17 to 40	19	22	–	–	5	140
TGA4040	17 - 43 GHz Medium Power Amplifier / Multiplier	17 to 43	22	25	–	–	5	140
TGA4532	K-Band Power Amplifier	17.5 to 20	32.5	23	6	–	6	900
TGA4532-SM	K-Band Power Amplifier	17.7 to 19.7	32.5	23	7	–	6	900
TGA4022	K-Band High Power Amplifier	18 to 23	32.5	26	–	–	7	840
TGA1135B-SCC	K-Band High Power Amplifier	18 to 27	30	14	–	–	5 to 7	540
TGA1073G-SCC	K-Band Medium Power Amplifier	19 to 27	25	22	–	–	5 to 7	220
TGA4036	19 - 38 GHz Medium Power Amplifier	19 to 38	22	20	–	–	5	160
TGA4533-SM	K-Band Power Amplifier	21.2 to 23.6	32	22	6	–	6	880
TGA4902-SM	Ka-Band Packaged Medium Power Amplifier	25 to 35	25	18	–	–	6	220
TGA1073A-SCC	Ka-Band Medium Power Amplifier	26 to 35	25	19	–	–	5 to 7	220
TGA1073B-SCC	Ka-Band High Power Amplifier	27 to 32	28.5	25	–	–	6 to 8	420
TGA4903-SM	Ka-Band Medium Power Amplifier	27 to 32	24	15	–	–	5	170
TGA4539-SM	1 W Ka-Band Power Amplifier	28 to 30	30.5	20	–	–	6	420

Power Amplifiers (Cont.)

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA4512-SM	Ka-Band Driver Amplifier	28 to 32	17	14.5	7.5	–	6	80
TGA4516	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050
TGA4516-TS	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050
TGA4514	2 W Ka-Band Power Amplifier	31 to 35	33.5	19	–	–	6 to 7	1,150
TGA4517	Ka-Band Power Amplifier	31 to 37	35	15	–	–	6	2,000
TGA4521	32 - 45 GHz Wideband Driver Amplifier	32 to 45	24	15	–	–	6	200
TGA1141	Ka-Band High Power Amplifier	33 to 36	31	17	–	–	6 to 7	880
TGA4522	33 - 47 GHz Wideband Driver Amplifier	33 to 47	27	14	–	–	6	400
TGA1073C-SCC	Ka-Band High Power Amplifier	36 to 40	26	15	–	–	5 to 7	240
TGA1171-SCC	Ka-Band High Power Amplifier	36 to 40	30	14	–	–	6 to 7	500
TGA4538	37 - 40 GHz Power Amplifier	37 to 40	29.5	24	–	–	5	600
TGA4043	Q-Band Power Amplifier	40 to 45	29	10	–	–	7	500
TGA4042	Q-Band Driver Amplifier	41 to 45	18	14	–	–	6	168
TGA4046	2 W Q-Band High Power Amplifier	41 to 46	33	16	–	–	6	2,000

NOTES: ** = New, ** = Preview*

SAW/BAW Filters

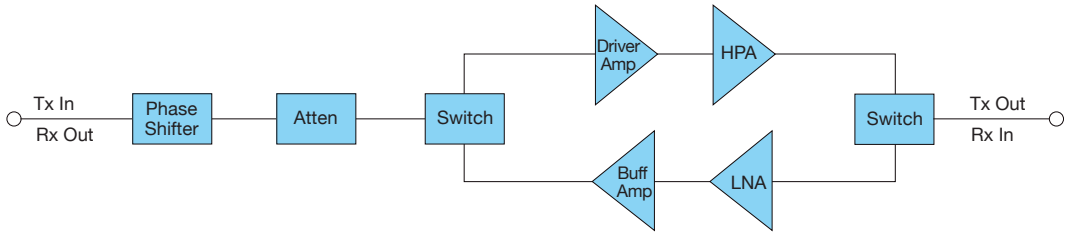
Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856980	70 MHz IF SAW Filter	SAW	70	2.5	9	SE/SE	13.3 x 6.5
857174	70 MHz SAW Filter	SAW	70	4.9	25.5 Max	SE/SE	19 x 6.5
857175	70 MHz SAW Filter	SAW	70	5.7	21	SE/SE	19 x 6.5
857176	140 MHz SAW Filter	SAW	140	28.5	19.75	SE/SE	9 x 7.01
857177	140 MHz SAW Filter	SAW	140	1.5	23.5	SE/SE	19 x 6.5
856288	Filter - GPS IF	SAW	465	6	1.43	SE/SE	3 x 3
857191	810 MHz SAW Filter	SAW	810	5	4.6	SE/SE	3 x 3
857162	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	700	30	SE/SE	25.4 x 12.7
857163	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	430	23.3	SE/SE	25.4 x 12.7
857164	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	353.5	21.25	SE/SE	25.4 x 12.7
857165	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	703	31	SE/SE	25.4 x 12.7
857166	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	700	31.75	SE/SE	25.4 x 12.7
857167	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	705	33.7	SE/SE	25.4 x 12.7
857168	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	707	34.6	SE/SE	25.4 x 12.7
857169	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	705	35.3	SE/SE	25.4 x 12.7
880367	1,030 MHz SSR/IFF BAW Filter	BAW	1,030	14	3	SE/SE	3.71 x 2.57
880374	1,090 MHz SSR/IFF BAW Filter	BAW	1,090	16	3	SE/SE	3.71 x 2.57
856440	Filter - GPS L5 RF	SAW	1,176	35	2.4	SE/SE	2 x 1.5
880364	1,176 MHz GPS L5 BAW Filter	BAW	1,176	30	2.5	SE/SE	3.26 x 1.6
857143	1176.45 MHz SAW Filter	SAW	1,176.45	20.46	0.5	SE/SE	1.4 x 1.2
857144	1176.45 MHz SAW Filter	SAW	1,176.45	20.46	2	SE/SE	1.4 x 1.2
857141	1227.6 MHz SAW Filter	SAW	1,227.60	20.46	0.5	SE/SE	1.4 x 1.2
857142	1227.6 MHz SAW Filter	SAW	1,227.60	20.46	2.1	SE/SE	1.4 x 1.2
880060	1,227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	25	1.8	SE/SE	3.26 x 1.6
*880272**	1,227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	30	2.25	SE/SE	3.26 x 1.6
880368	1,280 MHz L-Band BAW Filter	BAW	1,280	19	4	SE/SE	3.71 x 2.57
856561	GPS SAW Filter, SE/SE	SAW	1,575.42	2	0.75	SE/SE	1.4 x 1.2 x 0.46
856576	GPS SAW Filter, SE/BAL	SAW	1,575.42	2	1.1	SE/BAL	1.4 x 1.2
857139	1575.42 MHz SAW Filter	SAW	1,575.42	20.46	0.6	SE/SE	1.4 x 1.2
857140	1575.42 MHz SAW Filter	SAW	1,575.42	20.46	2.6	SE/SE	1.4 x 1.2
880094	1,575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	30	1.8	SE/SE	3.26 x 1.6
880273	1,575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	40	2.35	SE/SE	3.26 x 1.6
*857207**	1,585.66 MHz SAW Filter	SAW	1,585.66	41	1.45	SE/BAL	1.4 x 1.2
880157	2,560 MHz S-Band BAW Filter	BAW	2,560	30	3.8	SE/SE	3.71 x 2.57

NOTES: ** = New*

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGS2303	SP3T VPIN	0.2 to 20	0.5	35	–	–	10	Die
TGS2304-SCC	SP4T VPIN	0.2 to 20	0.6	38	23	–	10	Die
*TGS2354***	0.5 - 6 GHz 40 W GaN SPDT Switch	0.5 to 6	< 1	40	> 25	0, -40	< 1	Die
*TGS2354-SM***	0.5 - 6 GHz 40 W GaN SPDT Switch	0.5 to 6	< 1	40	> 25	0, -40	< 1	4 x 4 mm QFN
*TGS2355***	0.5 - 6 GHz 80 W GaN SPDT Switch	0.5 to 6	< 1.25	> 80	> 40	0, -40	< 1	Die
*TGS2352-2-SM***	0.5 - 12 GHz High Power SPDT Reflective Switch	0.5 to 12	< 1	-35	20	0 to -40	–	QFN
*TGS2353-2-SM***	0.5 - 18 GHz High Power SPDT Reflective Switch	0.5 to 18	< 1.5	-30	10	0 to -40	–	QFN
TGS2302	4 - 20 GHz VPIN SPDT Switch	4 to 20	0.9	35	20	2.7, -2.7	20	Die
TGS2313	4 - 18 GHz VPIN SP3T Switch	4 to 18	1	35	20	2.7, -2.7	20	Die
TGS4302	High Power Ka-Band SPDT Switch	27 to 46	0.9	27	> 33	5, -5	20	Die
TGS4304	High Power Ka-Band Absorptive SPDT Switch	32 to 40	0.9	35	> 33	5, -5	30	Die

NOTES: *** = Preview*



Radar Block Diagram

Attenuators

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Control Voltage (V)	Package Style
TGL4203-SM	DC - 30 GHz Wideband Analog Attenuator	Analog	DC to 30	1.5	16	20	-1 to 0	Die
TGL4201-00	Wideband Fixed 0 dB Attenuator	Analog	DC to 50	0	–	20	Passive	Die
TGL4201-02	Wideband Fixed 2 dB Attenuator	Analog	DC to 50	2	–	20	Passive	Die
TGL4201-03	Wideband Fixed 3 dB Attenuator	Analog	DC to 50	3	–	20	Passive	Die
TGL4201-06	Wideband Fixed 6 dB Attenuator	Analog	DC to 50	6	–	20	Passive	Die
TGL4201-10	Wideband Fixed 10 dB Attenuator	Analog	DC to 50	10	–	20	Passive	Die
TGL4203	50 GHz Wideband Analog Attenuator	Analog	DC to 50	2	17	15	-1 to 0	Die

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
*T1G2028536-FL***	285 W, 36 V DC - 2 GHz, GaN RF Power Transistor	DC to 2	19	–	54.2	–	54	36	576	NI-780
*T1G2028536-FS***	285 W, 36 V DC - 2 GHz, GaN RF Power Transistor	DC to 2	19	–	54.2	–	54	36	576	NI-780
*T1G3000532-SM***	5 W, 32 V, DC - 3 GHz GaN RF Power Transistor	DC to 3	16	–	37	–	50	32	25	5 x 5 mm
*T1G4012036-FS***	120 W Peak, 24 W Average Power, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	50.8	–	52	36	360	NI-360
*T1G4012036-FL***	120 W Peak, 24 W Average Power, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	50.8	–	52	36	360	NI-360

Discrete Transistors (Cont.)

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
*T1G4020036-FL***	2 x 120 W, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	54	–	52	36	520	NI-650
*T1G4020036-FS***	2 x 120 W, 36 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16	–	54	–	52	36	520	NI-650
*T1G4004532-FL***	45 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	19	–	46.4	–	52	32	220	NI-360
*T1G4004532-FS***	45 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	19	–	46.4	–	52	32	220	NI-360
T2G4003532-FL	30 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16.5	–	44.5	–	49	32	150	NI-360
T2G4003532-FS	30 W, 32 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	16.5	–	44.5	–	49	32	150	NI-360
T2G4005528-FS	55 W, 28 V, DC - 3.5 GHz GaN RF Power Transistor	DC to 3.5	15	–	47.2	–	> 50	28	200	NI-360
TGF2021-04-SD	DC - 4 GHz Packaged Power pHEMT	DC to 4	16	26.5	–	0.6	–	5	150	SOT-89
*T1G6001032-SM***	10 W, 32 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	19	–	40	–	54	32	50	5 x 5 mm
*T2G6001528-SG***	15 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15.5	–	42.3	–	70	28	100	NI-200
T2G6000528-Q3	7 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15.5	–	39.5	–	50	28	50	NI-200
T2G6001528-Q3	18 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	15	–	42.5	–	> 50	28	50	NI-200
T2G6003028-FL	30 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	14	–	45	–	50	28	200	NI-200
T2G6003028-FS	30 W, 28 V, DC - 6 GHz GaN RF Power Transistor	DC to 6	14	–	45	–	50	28	200	NI-200
TGF2021-01	X-Band Discrete Power pHEMT	DC to 12	11	–	> 30	–	59	8 to 12	75 to 125	Die
TGF2021-02	X-Band Discrete Power pHEMT	DC to 12	11	–	> 33	–	59	8 to 12	150 to 250	Die
TGF2021-04	X-Band Discrete Power pHEMT	DC to 12	11	–	> 36	–	59	8 to 12	300 to 500	Die
TGF2021-08	X-Band Discrete Power pHEMT	DC to 12	11	–	> 39	–	59	8 to 12	600 to 1,000	Die
TGF2021-12	X-Band Discrete Power pHEMT	DC to 12	11	–	> 42	–	58	8 to 12	900 to 1,500	Die
TGF2023-2-01	6 W Discrete Power GaN on SiC HEMT	DC to 18	18	–	38	–	71.6	12 to 32	25 to 125	Die
TGF2023-2-02	12 W Discrete Power GaN on SiC HEMT	DC to 18	21	–	40.1	–	73.3	12 to 32	50 to 250	Die
TGF2023-2-05	25 W Discrete Power GaN on SiC HEMT	DC to 18	18	–	43	–	78.3	12 to 32	100 to 500	Die
TGF2023-2-10	50 W Discrete Power GaN on SiC HEMT	DC to 18	19.8	–	47.3	–	69.5	12 to 32	200 to 1,000	Die
TGF2023-2-20	90 W Discrete Power GaN on SiC HEMT	DC to 18	19.2	–	50.5	–	70.5	12 to 32	400 to 2,000	Die
TGF2018	180 um Discrete GaAs pHEMT	DC to 20	14	–	22	1	55	8	29	Die
TGF2022-06	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 28	–	58	8 to 12	45 to 75	Die
TGF2022-12	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 31	–	58	8 to 12	90 to 150	Die
TGF2022-24	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 34	–	58	8 to 12	180 to 300	Die
TGF2022-48	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 37	–	58	8 to 12	360 to 600	Die
TGF2022-60	Ku-Band Discrete Power pHEMT	DC to 20	12	–	> 38	–	57	8 to 12	448 to 752	Die
TGF2025	250 um Discrete GaAs pHEMT	DC to 20	14	–	25	0.9	58	8	41	Die
TGF2040	400 um Discrete GaAs pHEMT	DC to 20	13	–	26	1.1	55	8	65	Die
TGF2060	600 um Discrete GaAs pHEMT	DC to 20	12	–	28	1.4	55	8	97	Die
TGF2080	800 um Discrete GaAs pHEMT	DC to 20	11.5	–	29.5	–	56	8	129	Die
TGF2120	1200 um Discrete GaAs pHEMT	DC to 20	11	31	–	–	57	8	194	Die
TGF2160	1600 um Discrete GaAs pHEMT	DC to 20	10.4	32.5	–	–	63	8	258	Die
TGF4350	0.3 mm, 0.25-µm mmW pHEMT 2MI	DC to 22	13 @ 10 GHz	–	16	0.8 @ 10 GHz	–	3	15	Die

NOTES: *** = Preview*

Driver Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
*TGA3500-SM***	Wide Band Driver Amplifier	2,000 to 12,000	34	21	29	3	5	200	QFN 8 x 8 mm

NOTES: *** = Preview*

Frequency Converters / Mixers

Part	Description	RF (GHz)	Gain (dB)	Package Style
TGC1430F	Doubler	20 to 40	-12	Die

Lange Couplers

Part	Description	Frequency (GHz)	Insertion Loss (dB)	Package Style
TGB2001	Lange Coupler	12 to 21	< 0.25	Die
TGB4001	Lange Coupler	18 to 32	< 0.25	Die
TGB4002	Lange Coupler	27 to 45	< 0.25	Die

Limiters

Part	Description	Frequency (GHz)	Insertion Loss (dB)	Flat Leakage (dBm)	Bias (V)	Package Style
*TGL2205***	S and C-Band 100 W VPIN Limiter	1 to 6	< 0.5	–	–	Die
*TGL2206***	S-Band 100 W VPIN Limiter	2 to 4.5	< 0.5	–	–	Die
*TGL2207***	S and C-Band 100 W VPIN Limiter	2 to 5	< 0.5	–	–	Die
TGL2201-SM	Wideband Dual-Stage VPIN Limiter	2 to 12	< 0.5	< 18	Passive	3 x 3 mm
*TGL2208-SM**	2 - 20 GHz Dual-Stage VPIN Limiter	2 to 20	< 1.0	< 18	–	QFN 3 x 3 mm 14L
TGL2201	Wideband VPIN Limiter	3 to 25	< 0.5	< 18	Passive	Die

NOTES: ** = New, ** = Preview*

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
*TGA2611***	2 - 6 GHz GaN LNA	2 to 6	1.5	25	32	22	10	110	Die
*TGA2611-SM***	2 - 6 GHz GaN LNA	2 to 6	1.2	25	32	22	10	100	4 x 4 mm Overmold QFN
TGA2525	2 - 18 GHz Low Noise Amplifier with AGC	2 to 18	2	17	29	22	5	75	Die
TGA2513-SM	Wideband Low Noise Amplifier	2 to 20	2.5	17	–	16	5	75	4 x 4 mm
TGA2526	2 - 20 GHz Low Noise Amplifier with AGC	2 to 20	2.5	17.5	29	22	5	100	Die
*TGA2567-SM**	2 - 20 GHz LNA Amplifier	2 to 20	2	17	29	19	5	100	QFN 4 x 4 mm 24L
TGA2513	Wideband Low Noise Amplifier	2 to 23	2	17	–	16	5	75	Die
*TGA2613***	S-Band High-Linearity LNA	2.5 to 4	2.5	12.5	29	29	6	320	Die
*TGA2614***	S-Band High Gain LNA	2.7 to 3.8	0.9	18	33	20	6	110	Die
*TGA2614-SM***	S-Band High Gain LNA	2.7 to 3.8	1.2	17	33	19	6	120	QFN 5 x 5 mm 32L
TGA2512-1-SM	4 - 14 GHz Balanced Low Noise Amplifier	4 to 14	2.3	25	16	12	5	160	4 x 4 mm
TGA2512-2-SM	4 - 14 GHz Balanced Low Noise Amplifier	4 to 14	2.3	25	24	12	5	160	4 x 4 mm
*TGM2543-SM***	4 - 20 GHz Limiter/Low Noise Amplifier	4 to 20	2	17	28	21	5	100	7 x 7 mm
TGA2512	X-Band Low Noise Amplifier	5 to 15	1.4	27	24	13	5	160	Die
*TGA2612***	6 - 12 GHz GaN LNA	6 to 12	1.8	22	29	20	10	100	Die
TGA2511	X-Band Low Noise Amplifier	6 to 14	1.3	20	24	12	5	160	Die
TGA4507	Ka-Band Low Noise Amplifier	28 to 36	2.3	22	–	12	3	60	Die
TGA4508	Ka-Band Low Noise Amplifier	30 to 42	2.8	21	–	14	3	40	Die
TGA4600	60 GHz Low Noise Amplifier	57 to 65	4	13	–	–	3	41	Die

NOTES: ** = New, ** = Preview*

Modulator Drivers

Part	Description	Frequency (GHz)	Vpp (V)	Gain (dB)	3 dB Bandwidth (GHz)	Voltage (V)	Current (mA)	Package Style
TGA4832	DC - 35 GHz Wideband Amplifier	DC to 35	4	12	35	5	135	Die
TGA4830	CFP Low Power Driver	DC to 40	2.5	13	40	5	50	Die

Phase Shifters

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	RMS Amplitude Error (dB)	RMS Phase Error (Degrees)	Bits	Control Voltage (V)	Package Style
*TGP2105***	6 - 18 GHz 6-Bit Digital Phase Shifter (+Vc)	Digital	6 to 18	< 10	0.45	4	6	0, 5	Die
*TGP2105-SM***	6 - 18 GHz 6-Bit Digital Phase Shifter (+Vc)	Digital	6 to 18	< 10	0.45	4	6	0, 5	QFN 5 x 5 mm 32L
*TGP2107***	6 - 18 GHz 6-Bit Digital Phase Shifter (-Vc)	Digital	6 to 18	< 10	0.55	5	6	-5, 0	Die
*TGP2107-SM***	6 - 18 GHz 6-Bit Digital Phase Shifter (-Vc)	Digital	6 to 18	< 10	0.55	5	6	-5, 0	QFN 5 x 5 mm 32L
TGP2100	30 GHz 5 Bit Phase Shifter	Digital	28 to 32	6	0.5	5	5	0, 5	Die
TGP2104	30 - 40 GHz 180 Degree Phase Shifter	Digital	30 to 40	3.5	0.3	10	1	0, 5	Die
TGP2102	35 GHz 5 Bit Phase Shifter	Digital	32 to 37	7	0.4	3.5	5	-5, 0	Die

NOTES: *** = Preview*

Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
*TGA2237***	0.03 - 2.5 GHz 10 W GaN Power Amplifier	0.03 to 2.5	40	19	–	> 52	30	360
*TGA2237-SM***	0.03 - 2.5 GHz 10 W GaN Power Amplifier	0.03 to 2.5	40	19	–	> 50	30	360
*TGA2216***	0.1 - 3 GHz 12 W GaN Power Amplifier	0.1 to 3	41	22	–	> 40	48	360
*TGA2216-SM***	0.1 - 3 GHz 12 W GaN Power Amplifier	0.1 to 3	40.5	21	–	> 40	40	360
*TGA2578***	2 - 6 GHz 30 W Power Amplifier	2 to 6	45	27	–	40	28	400
TGA2509-FL	Wideband Packaged High Power Amplifier with AGC	2 to 20	29	15	–	–	12	1,100
TGA2509	Wideband 1 W High Power Amplifier with AGC	2 to 22	30	17	–	–	12	1,100
*TGA2576-2-FL***	2.5 - 6 GHz 40 W GaN Power Amplifier	2.5 to 6	46.5	29	–	36	30	1,550
*TGA2576-FS***	2.5 - 6 GHz 40 W GaN Power Amplifier	2.5 to 6	46.5	29	–	35	30	1,550
*TGA2583***	2.7 - 3.7 GHz 10 W GaN Power Amplifier	2.7 to 3.7	40	33	–	54	25	175
*TGA2585***	2.7 - 3.7 GHz 18 W GaN Power Amplifier	2.7 to 3.7	42.8	33	–	54	28	225
*TGA2583-SM***	2.7 - 3.7 GHz 10 W GaN Power Amplifier	2.7 to 3.7	41	33	–	> 50	25	175
*TGA2585-SM***	2.7 - 3.7 GHz 18 W GaN Power Amplifier	2.7 to 3.7	42.8	32	–	> 50	28	225
*TGA2813***	3.1 - 3.6 GHz 100 W GaN Power Amplifier	3.1 to 3.6	50.7	22	–	55	30	150
*TGA2814***	3.1 - 3.6 GHz 80 W GaN Power Amplifier	3.1 to 3.6	49.5	22	–	56	30	125
TGA2706-SM	2 W C-Band Packaged Power Amplifier	5.5 to 8.5	34	31	7	–	6	1,260
TGA2701-SM	3 W C-Band Packaged Power Amplifier	5.9 to 8.5	35	18	–	37	6	1,000
*TGA2590***	6 - 12 GHz 30 W GaN Power Amplifier	6 to 12	45	29	–	28	25	1,100
TGA2501	High Power Amplifier	6 to 18	34.5	24	–	20	8	1,200
*TGA2501-GSG***	2.8 W 6 - 18 GHz Power Amplifier	6 to 18	34.5	26	–	20	8	1,200
TGA9092-SCC	Power Amplifier (Per hannel)	6 to 18	34.5	24	–	20	8	1,200
TGA9083-SCC	Power Amplifier - pHEMT	6.5 to 11.5	37, 39	19	–	40, 35	7 to 9	1,200
TGA2701	7 - 8.5 GHz High Power Amplifier	7 to 8.5	37	21	–	> 40	5 to 7	1,050
TGA2517	16 W X-Band Power Amplifier	7.5 to 11.5	42	28	–	35	9 to 12	2,000
*TGA2517-GSG***	14 W X-Band Power Amplifier	7.5 to 11.5	41.6	30	–	28	12	3,000
TGA2517-TS	16 W X-Band Power Amplifier on Thermal Spreader	7.5 to 11.5	42	28	–	35	9 to 12	2,000
*TGA2586-FL***	7.9 - 8.4 GHz 50 W GaN Power Amplifier	7.9 to 8.4	47	14	–	36	24	2,240
TGA2700	X-Band Driver Amplifier	8 to 13	30	25	–	–	9	300
*TGA2622***	9 - 10 GHz 40 W GaN Power Amplifier	9 to 10	46	32	–	> 46	28	290
*TGA2624***	9 - 10 GHz 18 W GaN Power Amplifier	9 to 10	42.5	35	–	40	28	365
*TGA2312-FL**	X-Band 60 W GaN Power Amplifier	9 to 10	48	13	–	38	24	2,400
TGA2704	9 - 10.5 GHz High Power Amplifier	9 to 10.5	38	20	–	> 40	7 to 9	1,050
*TGA2704-SM***	8 W, 9 - 11 GHz Power Amplifier	9 to 11	39	21	–	–	9	1,050
*TGA2710-SM***	8 W, 9.5 - 11.5 GHz Power Amplifier	9.5 to 11.5	39	22	–	–	9	1,050
*TGA2623***	10 - 11 GHz 35 W GaN Power Amplifier	10 to 11	45.5	35	–	> 47	28	290
*TGA2625***	10 - 11 GHz 18 W GaN Power Amplifier	10 to 11	42.5	34	–	40	28	365
TGA2535-SM	X-Band Power Amplifier	10 to 12	34.5	25	–	30	6	1,300
TGA2710	10.5 - 12 GHz High Power Amplifier	10.5 to 12	38	19	–	> 40	7 to 9	1,050

Power Amplifiers (Cont.)

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA2533	Ku-Band Power Amplifier	12.7 to 15.4	35	28	6	–	6	1,300
TGA2514-FL	6.5 W Ku-Band Power Amplifier	13 to 16	38	24	–	–	8	2,600
TGA2902-1-SCC-SG	2 W Packaged Amplifier	13 to 17	34	26	–	–	7.5	650
TGA2514	6.5 W Ku-Band Power Amplifier	13 to 18	38	24	–	–	8	2,600
TGA2559-FL	4 W Ku-Band Power Amplifier	14 to 16	36	24	–	30	6	1,000
TGA2572-2-FL	16 W Ku-Band GaN Power Amplifier	14 to 16	42	25	–	20	30	2,000
TGA2521-SM	17 - 24 GHz Linear Driver Amplifier	17 to 24	25	20	5	–	5	320
TGA2522-SM	17 - 24 GHz Power Amplifier	17 to 24	28	17	–	–	5	712
TGA4531	K-Band High Linearity Power Amplifier	17 to 24	32	23	6	–	7	720
TGA4030-SM	17 - 37 GHz Medium Power Amplifier/Multiplier	17 to 37	19	20	–	–	5	140
TGA4031-SM	17 - 40 GHz Medium Power Amplifier/Multiplier	17 to 40	19	22	–	–	5	140
TGA4040	17 - 43 GHz Medium Power Amplifier/Multiplier	17 to 43	22	25	–	–	5	140
TGA4036	19 - 38 GHz Medium Power Amplifier	19 to 38	22	20	–	–	5	160
TGA4902-SM	Ka-Band Packaged Medium Power Amplifier	25 to 35	25	18	–	–	6	220
TGA2594	27 - 31 GHz 5 W GaN Power Amplifier	27 to 31	37	23	–	28	20	140
TGA2595	27.5 - 31 GHz 9 W Power Amplifier	27.5 to 31	39.5	23	–	24	20	280
TGA4539-SM	1 W Ka-Band Power Amplifier	28 to 30	30.5	20	–	–	6	420
TGA4516	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050
TGA4516-TS	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050
TGA4514	2 W Ka-Band Power Amplifier	31 to 35	33.5	19	–	–	6 to 7	1,150
TGA4517	Ka-Band Power Amplifier	31 to 37	35	15	–	–	6	2,000
TGA4521	32 - 45 GHz Wideband Driver Amplifier	32 to 45	24	15	–	–	6	200
TGA1141	Ka-Band High Power Amplifier	33 to 36	31	17	–	–	6 to 7	880
TGA4522	33 - 47 GHz Wideband Driver Amplifier	33 to 47	27	14	–	–	6	400
TGA4043	Q-Band Power Amplifier	40 to 45	29	10	–	–	7	500
TGA4042	Q-Band Driver Amplifier	41 to 45	18	14	–	–	6	168

NOTES: ** = New, ** = Preview*

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856980	70 MHz IF SAW Filter	SAW	70	2.5	9	SE/SE	13.3 x 6.5
857174	70 MHz SAW Filter	SAW	70	4.9	25.5 Max	SE/SE	19 x 6.5
857175	70 MHz SAW Filter	SAW	70	5.7	21	SE/SE	19 x 6.5
857176	140 MHz SAW Filter	SAW	140	28.5	19.75	SE/SE	9 x 7.01
857177	140 MHz SAW Filter	SAW	140	1.5	23.5	SE/SE	19 x 6.5
857162	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	700	30	SE/SE	25.4 x 12.7
857163	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	430	23.3	SE/SE	25.4 x 12.7
857164	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	353.5	21.25	SE/SE	25.4 x 12.7
857165	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	703	31	SE/SE	25.4 x 12.7
857166	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	700	31.75	SE/SE	25.4 x 12.7
857167	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	705	33.7	SE/SE	25.4 x 12.7
857168	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	707	34.6	SE/SE	25.4 x 12.7
857169	1,000 MHz Non Dispersive SAW Delay Line	SAW	1,000	705	35.3	SE/SE	25.4 x 12.7
880367	1,030 MHz SSR/IFF BAW Filter	BAW	1,030	14	3	SE/SE	3.71 x 2.57
880374	1,090 MHz SSR/IFF BAW Filter	BAW	1,090	16	3	SE/SE	3.71 x 2.57
880364	1,176 MHz GPS L5 BAW Filter	BAW	1,176	30	2.5	SE/SE	3.26 x 1.6
880060	1,227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	25	1.8	SE/SE	3.26 x 1.6
880368	1,280 MHz L-Band BAW Filter	BAW	1,280	19	4	SE/SE	3.71 x 2.57
880094	1,575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	30	1.8	SE/SE	3.26 x 1.6
880157	2,560 MHz S-Band BAW Filter	BAW	2,560	30	3.8	SE/SE	3.71 x 2.57

Spatium™ Amplifiers

Part	Description	Frequency (GHz)	Psat (W)	Power Gain (dB)	Small Signal Gain (dB)	Power (dBm)	PAE (%)	Voltage (V)	ECCN	Size (mm)
*KA130W-2730**	27 - 30 GHz 130 W Ka-Band GaN SSPA	27 to 30	130	14	> 20	51.14	> 15	20	3A001b.4.b	104 x 74 x 61
*KA150W-2730**	27 - 30 GHz 150 W Spatium™ Solid-State Power Amplifier	27 to 30	150	15	22	52	28	20	3A001.b.4.b	104 x 74 x 61
*KA130W-3031**	30 - 31 GHz 130 W Ka-Band GaN SSPA	30 to 31	130	14	> 20	51.14	> 15	20	3A001b.4.b	104 x 74 x 61

NOTES: ** = New*

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGS2303	SP3T VPIN	0.2 to 20	0.5	35	–	–	10	Die
TGS2304-SCC	SP4T VPIN	0.2 to 20	0.6	38	23	–	10	Die
*TGS2354***	0.5 - 6 GHz 40 W GaN SPDT Switch	0.5 to 6	< 1	40	> 25	0, -40	< 1	Die
*TGS2354-SM***	0.5 - 6 GHz 40 W GaN SPDT Switch	0.5 to 6	< 1	40	> 25	0, -40	< 1	4 x 4 mm QFN
*TGS2355***	0.5 - 6 GHz 80 W GaN SPDT Switch	0.5 to 6	< 1.25	> 80	> 40	0, -40	< 1	Die
*TGS2352-2-SM***	0.5 - 12 GHz High Power SPDT Reflective Switch	0.5 to 12	< 1	-35	20	0 to -40	–	QFN
*TGS2353-2-SM***	0.5 - 18 GHz High Power SPDT Reflective Switch	0.5 to 18	< 1.5	-30	10	0 to -40	–	QFN
TGS2313	4 - 18 GHz VPIN SP3T Switch	4 to 18	1.0	35	20	2.7, -2.7	20	Die
TGS2302	4 - 20 GHz VPIN SPDT Switch	4 to 20	0.9	35	20	2.7, -2.7	20	Die
TGS4302	High Power Ka-Band SPDT Switch	27 to 46	0.9	27	> 33	5, -5	20	Die
TGS4304	High Power Ka-Band Absorptive SPDT Switch	32 to 40	0.9	35	> 33	5, -5	30	Die

NOTES: *** = Preview*

TriQuint has a rich history and strong track record of supplying highly reliable active and passive devices for space and aerospace programs including satellite and planetary missions. TriQuint supports MIL-STD-883 and performs 100% element electrical results, burn-in, 1000 hour life test and wafer-level lot acceptance testing for space qualification. Refer to our technical library on triquint.com to learn about our qualification processes. Most products throughout this Product Selection Guide may be considered for qualification. The tables below contain a sub-set of our products, fabricated with various production processes, that have been space qualified. Contact TriQuint prior to designing any of these parts into your space application as certain conditions apply. Write to us at **info-defense@triquint.com** to request more information.

Space Qualified

Attenuators

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Control Voltage (V)	Package Style
TGL4203	50 GHz Wideband Analog Attenuator	Analog	DC to 50	2	17	15	-1 to 0	Die

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
TGA4506	K-Band Low Noise Amplifier	20 to 27	2.2	21	12	3.5	60	Die
TGA4508	Ka-Band Low Noise Amplifier	30 to 42	2.8	21	14	3	40	Die

Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA9083-SCC	Power Amplifier - pHEMT	6.5 to 11.5	37, 39	19	40, 35	7 to 9	1,200
TGA2704	9 - 10.5 GHz High Power Amplifier	9 to 10.5	38	20	> 40	7 to 9	1,050
TGA4036	19 - 38 GHz Medium Power Amplifier	19 to 38	22	20	–	5	160
TGA4517	Ka-Band Power Amplifier	31 to 37	35	15	–	6	2,000
TGA4521	32 - 45 GHz Wideband Driver Amplifier	32 to 45	24	15	–	6	200
TGA1171-SCC	Ka-Band High Power Amplifier	36 to 40	30	14	–	6 to 7	500

Space Recommended

Bessel Filters & Through Lines

Part	Description	3 dB Frequency Cut-Off (GHz)	Group Delay (psec)	Return Loss (dB)	Package Style
TGB2010-00	Bessel Filter (Thru)	Thru	< ±1.25	> 15	Die
TGB2010-06	6 GHz Bessel Filter	6	< ±1.25	> 15	Die
TGB2010-07	7 GHz Bessel Filter	7	< ±1.25	> 15	Die
TGB2010-08	8 GHz Bessel Filter	8	< ±1.25	> 15	Die
TGB2010-09	9 GHz Bessel Filter	9	< ±1.25	> 15	Die
TGB2010-10	10 GHz Bessel Filter	10	< ±1.25	> 15	Die
TGB2010-11	11 GHz Bessel Filter	11	< ±1.25	> 15	Die

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
TGF2021-01	X-Band Discrete Power pHEMT	DC to 12	11	> 30	–	59	8 to 12	75 to 125	Die
TGF2021-02	X-Band Discrete Power pHEMT	DC to 12	11	> 33	–	59	8 to 12	150 to 250	Die
TGF2021-04	X-Band Discrete Power pHEMT	DC to 12	11	> 36	–	59	8 to 12	300 to 500	Die
TGF2021-08	X-Band Discrete Power pHEMT	DC to 12	11	> 39	–	59	8 to 12	600 to 1,000	Die
TGF2021-12	X-Band Discrete Power pHEMT	DC to 12	11	> 42	–	58	8 to 12	900 to 1,500	Die
TGF2022-06	Ku-Band Discrete Power pHEMT	DC to 20	13	> 28	–	58	8 to 12	45 to 75	Die
TGF2022-12	Ku-Band Discrete Power pHEMT	DC to 20	13	> 31	–	58	8 to 12	90 to 150	Die
TGF2022-24	Ku-Band Discrete Power pHEMT	DC to 20	13	> 34	–	58	8 to 12	180 to 300	Die
TGF2022-48	Ku-Band Discrete Power pHEMT	DC to 20	13	> 37	–	58	8 to 12	360 to 600	Die
TGF2022-60	Ku-Band Discrete Power pHEMT	DC to 20	12	> 38	–	57	8 to 12	448 to 752	Die
TGF4350	0.3 mm, 0.25-µm mmW pHEMT 2MI	DC to 22	13 @ 10 GHz	16	0.8 @ 10 GHz	–	3	15	Die

Frequency Converters/Mixers

Part	Description	RF (GHz)	IF (GHz)	LO (GHz)	Gain (dB)	Output IP3 (dBm)	NF (dB)	Output P1dB (dBm)	LO Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGC4403	8 - 15 GHz Doubler with Amplifier	16 to 30	8 to 15	–	20	–	–	20	–	5	150	Die
TGC4402	17 - 27 GHz Upconverting Mixer	17 to 27	0.5 to 3	14 to 28	-9	10	9	–	17	-0.9	–	Die
*TGC4405**	17 - 27 GHz Upconverter	17 to 27	0.5 to 3	8 to 13	13	–	–	–	2 to 5	5	425	Die
TGC1430F	Doubler	20 to 40	–	–	-12	–	–	–	–	–	–	Die
TGC4703-FC	19 - 38 GHz Doubler	38 to 38.5	19 to 19.25	–	8	–	–	14	–	3.5	65	Die
TGC4702-FC	77 GHz Downconverting IQ Mixer	75 to 82	DC to 0.1	75 to 82	-12	–	–	–	11	1.1	1	Die
TGC4704-FC	38 - 77 GHz Doubler and Medium Power Amplifier	76 to 77	38 to 38.5	–	5	–	–	14	–	3.75	180	Die

NOTES: ** = New*

Lange Couplers

Part	Description	Frequency (GHz)	Insertion Loss (dB)	Package Style
TGB2001	Lange Coupler	12 to 21	< 0.25	Die
TGB4001	Lange Coupler	18 to 32	< 0.25	Die
TGB4002	Lange Coupler	27 to 45	< 0.25	Die

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
*TGA2611***	2 - 6 GHz GaN LNA	2 to 6	1.5	25	32	22	10	110	Die
*TGA2611-SM***	2 - 6 GHz GaN LNA	2 to 6	1.2	25	32	22	10	100	4x4mm Overmold QFN
TGA2525	2 - 18 GHz Low Noise Amplifier with AGC	2 to 18	2	17	29	22	5	75	Die
TGA2513-SM	Wideband Low Noise Amplifier	2 to 20	2.5	17	–	16	5	75	4 x 4 mm
TGA2526	2 - 20 GHz Low Noise Amplifier with AGC	2 to 20	2.5	17.5	29	22	5	100	Die
*TGA2567-SM**	2 - 20 GHz LNA Amplifier	2 to 20	2	17	29	19	5	100	QFN 4 x 4 mm 24L
TGA2513	Wideband Low Noise Amplifier	2 to 23	2	17	–	16	5	75	Die
*TGA2613***	S-Band High-Linearity LNA	2.5 to 4	2.5	12.5	29	29	6	320	Die
*TGA2614***	S-Band High Gain LNA	2.7 to 3.8	0.9	18	33	20	6	110	Die
*TGA2614-SM***	S-Band High Gain LNA	2.7 to 3.8	1.2	17	33	19	6	120	QFN 5x5 mm 32L
TGA2512-1-SM	4 - 14 GHz Balanced Low Noise Amplifier	4 to 14	2.3	25	16	12	5	160	4 x 4 mm
TGA2512-2-SM	4 - 14 GHz Balanced Low Noise Amplifier	4 to 14	2.3	25	24	12	5	160	4 x 4 mm
*TGM2543-SM***	4 - 20 GHz Limiter/Low Noise Amplifier	4 to 20	2	17	28	21	5	100	7 x 7 mm
TGA2512	X-Band Low Noise Amplifier	5 to 15	1.4	27	24	13	5	160	Die
*TGA2612***	6 - 12 GHz GaN LNA	6 to 12	1.8	22	29	20	10	100	Die
TGA2511	X-Band Low Noise Amplifier	6 to 14	1.3	20	24	12	5	160	Die

NOTES: ** = New, ** = Preview*

Modulator Drivers

Part	Description	Frequency (GHz)	Vpp (V)	Gain (dB)	3 dB Bandwidth (GHz)	Voltage (V)	Current (mA)	Package Style
TGA4830	CFP Low Power Driver	DC to 40	2.5	13	40	5	50	Die
TGA4803	DC to >50 GHz Medium Power Amplifier with AGC	DC to 50+	3.5	8	> 50	6.5	100	Die

Phase Shifters

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	RMS Amplitude Error (dB)	RMS Phase Error (Degrees)	Bits	Control Voltage (V)	Package Style
TGP2100	30 GHz 5 Bit Phase Shifter	Digital	28 to 32	6	0.5	5	5	0, 5	Die
TGP2104	30 - 40 GHz 180 Degree Phase Shifter	Digital	30 to 40	3.5	0.3	10	1	0, 5	Die
TGP2102	35 GHz 5 Bit Phase Shifter	Digital	32 to 37	7	0.4	3.5	5	-5, 0	Die

Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA2573-2	2 - 18 GHz, 10 W GaN Amplifier	2 to 18	40	10	–	20	30	500
TGA2509	Wideband 1 W High Power Amplifier with AGC	2 to 22	30	17	–	–	12	1,100
TGA2501	High Power Amplifier	6 to 18	34.5	24	–	20	8	1,200
TGA2701	7 - 8.5 GHz High Power Amplifier	7 to 8.5	37	21	–	> 40	5 to 7	1,050
TGA2517	16 W X-Band Power Amplifier	7.5 to 11.5	42	28	–	35	9 to 12	2,000
*TGA2586-FL***	7.9 - 8.4 GHz 50 W GaN Power Amplifier	7.9 to 8.4	47	14	–	36	24	2,240
TGA2700	X-Band Driver Amplifier	8 to 13	30	25	–	–	9	300

Power Amplifiers (Cont.)

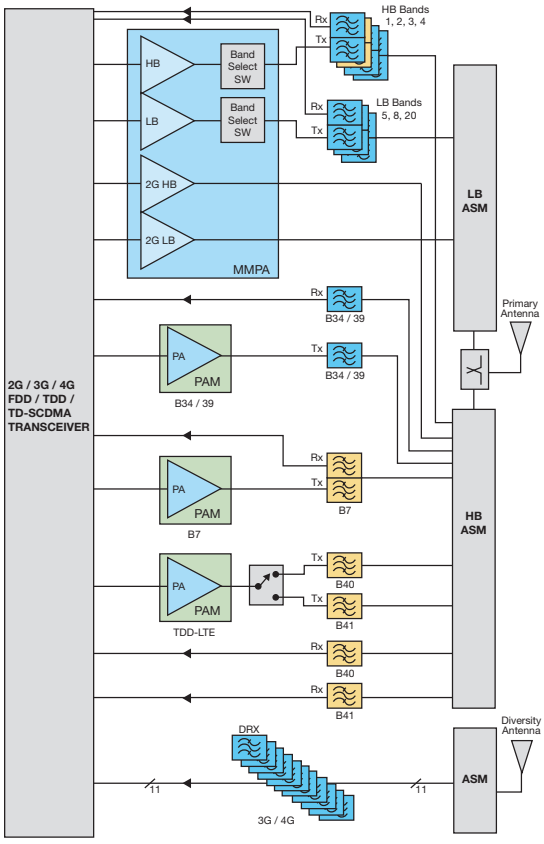
Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA2710	10.5 - 12 GHz High Power Amplifier	10.5 to 12	38	19	–	> 40	7 to 9	1,050
TGA2510	2 W Ku-Band Power Amplifier	12.5 to 17	34	26	–	–	7.5	650
TGA2533	Ku-Band Power Amplifier	12.7 to 15.4	35	28	6	–	6	1,300
TGA2505	Ku-Band High Power Amplifier	13 to 17	34	25	–	–	7	640
TGA2514	6.5 W Ku-Band Power Amplifier	13 to 18	38	24	–	–	8	2,600
TGA4530	K-Band High Linearity Power Amplifier	17 to 21	30	20	–	–	5 to 7	825
TGA4531	K-Band High Linearity Power Amplifier	17 to 24	32	23	6	–	7	720
TGA4532	K-Band Power Amplifier	17.5 to 20	32.5	23	6	–	6	900
TGA4022	K-Band High Power Amplifier	18 to 23	32.5	26	–	–	7	840
TGA4509	30 GHz High Power Amplifier	27 to 31	30	22	–	–	6	420
TGA4513	27 - 31 GHz, 2 W Balanced Power Amplifier	27 to 31	33	20	–	–	6	840
TGA4906	4 W Ka-Band High Power Amplifier	28 to 31	36	24	–	–	6	1,600
TGA4916	7 W Ka-Band High Power Amplifier	29 to 31	38.5	21	–	–	6	3,200
TGA4510	29 - 37 GHz Driver Amplifier	29 to 37	16	16	–	–	6	60
TGA4516	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050
TGA4514	2 W Ka-Band Power Amplifier	31 to 35	33.5	19	–	–	6 to 7	1,150
TGA2575	3 W Ka-Band Power Amplifier	32 to 38	35.5	19	–	22	6	2,100
TGA2575-TS	Ka-Band 3 W Power Amplifier On Carrier	32 to 38	35.5	19	–	22	6	2,100
TGA1141	Ka-Band High Power Amplifier	33 to 36	31	17	–	–	6 to 7	880
TGA4522	33 - 47 GHz Wideband Driver Amplifier	33 to 47	27	14	–	–	6	400
TGA4043	Q-Band Power Amplifier	40 to 45	29	10	–	–	7	500
TGA4042	Q-Band Driver Amplifier	41 to 45	18	14	–	–	6	168
TGA4046	2 W Q-Band High Power Amplifier	41 to 46	33	16	–	–	6	2,000

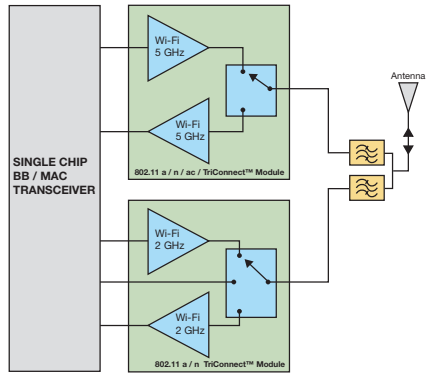
NOTES: ***** = Preview***

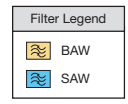
SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856980	70 MHz IF SAW Filter	SAW	70	2.5	9	SE/SE	13.3 x 6.5
857174	70 MHz SAW Filter	SAW	70	4.9	25.5 max	SE/SE	19 x 6.5
857175	70 MHz SAW Filter	SAW	70	5.7	21	SE/SE	19 x 6.5
857176	140 MHz SAW Filter	SAW	140	28.5	19.75	SE/SE	9 x 7.01
857177	140 MHz SAW Filter	SAW	140	1.5	23.5	SE/SE	19 x 6.5
880272*	1227.6 MHz GPS L2 BAW Filter	BAW	1,227.6	30	2.25	SE/SE	3.26 x 1.6
880273	1575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	40	2.35	SE/SE	3.26 x 1.6

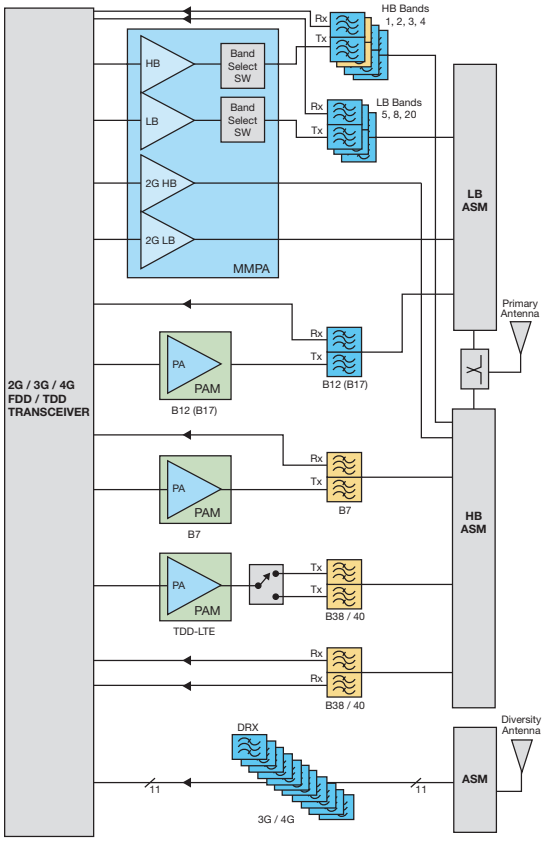
NOTES: ***** = New***

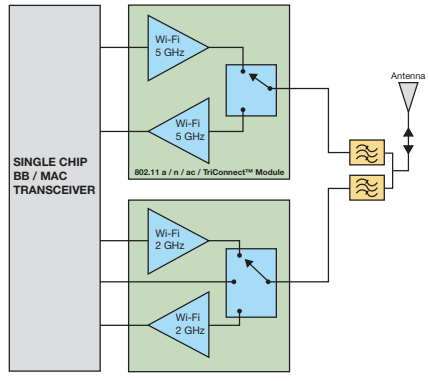


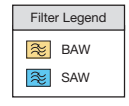




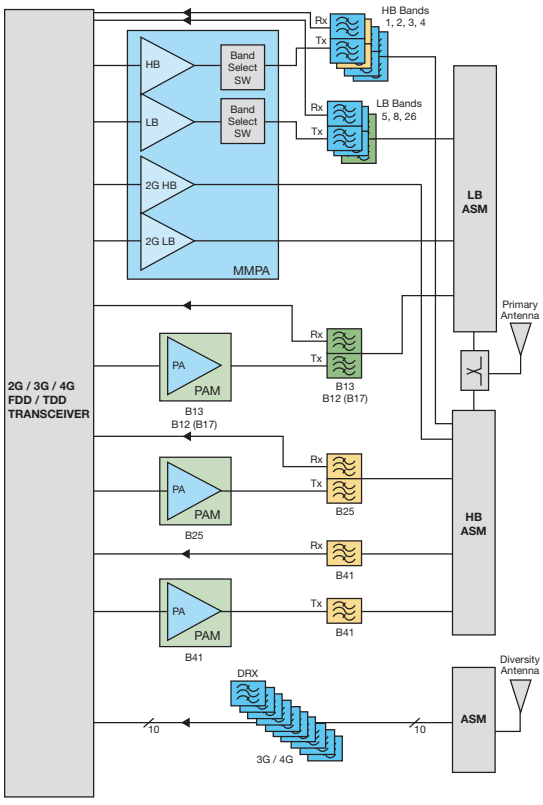
Regional Phone Asia

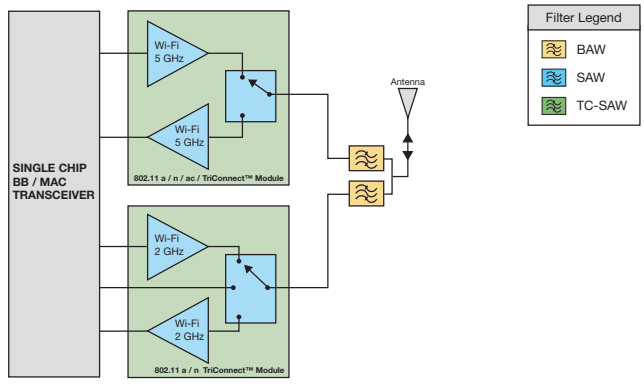






Regional Phone Europe / EMEA





Regional Phone North America

Power Amplifiers

Part	Description	Standards	Bands	Pout (dBm)	Gain (dB)	PAE (%)	Package (mm)
TQM7M5005H	Quad-Band GSM/GPRS/EDGE-Linear Power Amplifier Module	GSM, GPRS, EDGE	GSM850/900, DCS/PCS	35	32	55	5 x 5
TQM7M5013	Quad-Band GSM/GPRS/EDGE-Linear Power Amplifier Module	GSM, GPRS, EDGE	GSM850/900, DCS/PCS	35	–	55	5 x 5
TQM7M5022	Quad-Band GSM/GPRS/EDGE-Polar Power Amplifier Module	GSM, GPRS, EDGE	GSM850/900, DCS/PCS	35	–	55	5 x 5
TQM7M5050	Quad-Band GSM/GPRS/EDGE-Linear Power Amplifier Module	GSM, GPRS, EDGE	GSM850/900, DCS/PCS	35	28	55	5 x 3.5

Transmit Modules

Part	Description	Bands	Features	Package (mm)
TQF9088	QUANTUM Tx™ Dual-Band WCDMA/LTE/GPRS SP6T Transmit Module	QDE + DB	Integrated QB GSM/GPRS & 2 WCDMA Antenna Switch Ports, Low Rx Insertion Loss	6 x 5 x 1
*TQF9089***	QUANTUM Tx™ Quad-Band WCDMA/LTE/GPRS SP8T Transmit Module	QDE + QB	Integrated QB GSM/GPRS & 4 WCDMA Antenna Switch Ports, Low Rx Insertion Loss	6 x 5 x 1

NOTES: *** = Preview*

Duplexers

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856999	CDMA BC10 SAW Duplexer	SAW	833, 878	32	2.5, 2.5	SE/BAL	2.5 x 2
TQM966002	PCS BAW Duplexer	BAW	1,880, 1,960	60	1.8, 1.9	SE/SE	2.5 x 2
TQM963014	LTE BC14/Band 25 BAW Duplexer	BAW	1,882.5, 1,962.5	65	1.8, 2.2	SE/SE	2.5 x 2

Filter / Duplexer Modules

Part	Description	Bands	Features	Package (mm)
*TQQ2526***	B25 PCS/B26 Cellular Bands Duplexer Bank Module	B25, B26	Duplexer Bank for B25/B26 Applications	2.8 x 4.7 x 1

NOTES: *** = Preview*

Power Amplifier Modules

Part	Description	Standards	Bands	Band Classes	Pout (dBm)	Gain (dB)	PAE (%)	Package (mm)
TQM716015	CDMA & WCDMA/HSUPA Power Amplifier Module with Coupler	CDMA, WCDMA, LTE	5	0	28.3	27	40	3 x 3
TQM756014	CDMA & WCDMA/HSUPA Power Amplifier Module with Coupler	CDMA, WCDMA, LTE	4	15	28.3	27	41	3 x 3
TQM766012	CDMA & WCDMA/HSUPA Power Amplifier Module with Coupler	CDMA, WCDMA, LTE	2	1	28.6	27	41	3 x 3
TQM7M6025	Dual-Band WCDMA Power Amplifier Module with Coupler	CDMA, WCDMA	2, 5	0, 1	28.6	27	45	4 x 3
TQM7M6125	Dual-Broadband WCDMA Power Amplifier Module with Coupler	CDMA, WCDMA, LTE	1, 2, 5, 8	0, 1	28.5	27	45	4 x 3

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
TQM966025	1,962.5 MHz RF BAW Filter - Band 25 Diversity Rx	BAW	1,962.5	65	2.6	SE/SE	2.5 x 2

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package (mm)
TQP4M3019	CDMA SP3T Switch	0.824 to 1.990	0.5 to 0.6	22 to 27	38	2.6	0.01	2.5 x 2

Duplexers

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
TQM966002	PCS BAW Duplexer	BAW	1,880, 1,960	60	1.8, 1.9	SE/SE	2.5 x 2

Multi-Mode, Multi-Band Power Amplifier (MMPA) Modules

Part	Description	Bands	Features	Package (mm)
TQM7M9023	TRIUMF™ MMPA Module with Quad-Band GMSK/EDGE and Dual-Band WCDMA	GSM850/900, DCS/PCS, WCDMA B1 & B5/8	2-Bit (Hi/Med/Lo Power Modes)	7.5 x 5 x 1
TQM7M9053	TRIUMF™ MMPA Module with Quad-Band GMSK/EDGE and Dual-Band WCDMA	GSM850/900, DCS/PCS, WCDMA B1 & B5/8	1-Bit (Hi/Med Power Modes)	7.5 x 5 x 1

Power Amplifier Duplexer Modules

Part	Description	Bands	Features	Package (mm)
TQM616025	TRITIUM™ WCDMA/HSUPA PA-Duplexer Module; SE Input with Coupler, Detector	Bands 5 & 6	1-Bit (Hi/Lo Power Modes)	7 x 4 x 1.1
TQM626028L	TRITIUM™ WCDMA/HSUPA PA-Duplexer Module; SE Input with Coupler, Detector	Band 8	1-Bit (Hi/Lo Power Modes)	7 x 4 x 1.1
TQM666022	TRITIUM™ WCDMA/HSUPA PA-Duplexer Module; SE Input with Coupler, Detector	Band 2	1-Bit (Hi/Lo Power Modes)	7 x 4 x 1.1
TQM666052	TRITIUM™ WCDMA/HSUPA PA-Duplexer Module; BAL Input with Coupler	Band 2	1-Bit (Hi/Lo Power Modes)	4.5 x 3.5 x 1
TQM676021	TRITIUM™ WCDMA/HSUPA PA-Duplexer Module; SE Input with Coupler, Detector	Band 1	1-Bit (Hi/Lo Power Modes)	7 x 4 x 1.1

Power Amplifier Modules

Part	Description	Standards	Bands	Band Classes	Pout (dBm)	Gain (dB)	PAE (%)	Package (mm)
TQM716015	CDMA & WCDMA/HSUPA Power Amplifier Module with Coupler	CDMA, WCDMA, LTE	5	0	28.3	27	40	3 x 3
TQM726018	WCDMA/HSUPA Power Amplifier Module with Coupler	CDMA, WCDMA, LTE	8	3	28.5	27	39	3 x 3
TQM756014	CDMA & WCDMA/HSUPA Power Amplifier Module with Coupler	CDMA, WCDMA, LTE	4	15	28.3	27	41	3 x 3
TQM766012	CDMA & WCDMA/HSUPA Power Amplifier Module with Coupler	CDMA, WCDMA, LTE	2	1	28.6	27	41	3 x 3
TQM776011	WCDMA/HSUPA Power Amplifier Module with Coupler	CDMA, WCDMA, LTE	1	6	28.3	27.5	41	3 x 3
TQM7M5013	Quad-Band GSM/GPRS/EDGE-Linear Power Amplifier Module	GSM, GPRS, EDGE	GSM850/900, DCS/PCS	–	35	–	55	5 x 5
TQM7M5022	Quad-Band GSM/GPRS/EDGE-Polar Power Amplifier Module	GSM, GPRS, EDGE	GSM850/900, DCS/PCS	–	35	–	55	5 x 5
TQM7M6018	Dual-Broadband WCDMA Power Amplifier Module with Coupler	CDMA, WCDMA	1, 2, 5, 8	0, 1	28.3	27	45	4 x 3
TQM7M6025	Dual-Band WCDMA Power Amplifier Module with Coupler	CDMA, WCDMA	2, 5	0, 1	28.6	27	45	4 x 3
TQM7M6125	Dual-Broadband WCDMA Power Amplifier Module with Coupler	CDMA, WCDMA, LTE	1, 2, 5, 8	0, 1	28.5	27	45	4 x 3
TQM7M6158	Dual-Band WCDMA Power Amplifier Module with Coupler	WCDMA, LTE	1, 8	–	27.5	27	45	4 x 3

Transmit Modules

Part	Description	Bands	Features	Package (mm)
TQF9088	QUANTUM Tx™ Dual-Band WCDMA/LTE/GPRS SP6T Transmit Module	QDE + DB	Integrated QB GSM/GPRS & 2 WCDMA Antenna Switch Ports, Low Rx Insertion Loss	6 x 5 x 1
*TQF9089***	QUANTUM Tx™ Quad-Band WCDMA/LTE/GPRS SP8T Transmit Module	QDE + QB	Integrated QB GSM/GPRS & 4 WCDMA Antenna Switch Ports, Low Rx Insertion Loss	6 x 5 x 1
TQM6M9098	QUANTUM Tx™ GSM/GPRS/EDGE/TD-SCDMA/TDD-LTE Transmit Module; PA/LPF/SP8T Switch with Up to 4 WCDMA Antenna Switch Ports	GSM850, GSM900, DCS, PCS, TD-SCDMA (Bands 34 & 39) + 4 WCDMA/LTE/TD-SCDMA/TDD-LTE Bands	Integrated QB GSM/GPRS/EDGE/TD-SCDMA & 8 Antenna Switch Ports, Low Rx Insertion Loss	6 x 5 x 0.8

NOTES: *** = Preview*

Duplexers

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856931	LTE Band 17 SAW Duplexer	SAW	710, 740	12	1.8, 1.9	SE/SE, SE/BAL	2.5 x 2
856879	LTE Band 13 SAW Duplexer	SAW	751, 782	10	1.85, 2.2	SE/SE, SE/BAL	2.5 x 2
856979	LTE Band 20 TC SAW Duplexer	TC SAW	806, 847	30	2.5, 3.0	SE/SE, SE/BAL	2.5 x 2
*TQQ2504***	B4, B25 LTE SE/SE Duplexer	SAW/BAW	1,850 to 1,915	65	2	SE/SE	3.6 x 2 x 0.9
TQM963014	LTE BC14/Band 25 BAW Duplexer	BAW	1,882.5, 1,962.5	65	1.8, 2.2	SE/SE	2.5 x 2
*TQM976027**	B7 BAW Duplexer	BAW	2,500 to 2,570, 2,620 to 2,690	70	3	SE/SE	2 x 1.6

NOTES: ** = New, ** = Preview*

Filter/Duplexer Modules

Part	Description	Bands	Features	Package (mm)
*TQM9M9030**	Dual-Band Duplexer Bank	Band 1 Duplexer, Band 8 Duplexer, DCS Filter	Low Insertion Loss with Excellent Attenuation	3.6 x 5 x 1
*TQQ2526***	B25 PCS/B26 Cellular Bands Duplexer Bank Module	B25, B26	Duplexer Bank for B25/B26 Applications	2.8 x 4.7 x 1

NOTES: ** = New, ** = Preview*

Multi-Mode, Multi-Band Power Amplifier (MMPA) Modules

Part	Description	Bands	Features	Package (mm)
TQM7M9050	TRIUMF™ MMPA Module with Quad-Band GSM/EDGE and Penta-Band W/CDMA/HSPA+/LTE	GSM850/900, DCS/PCS & WCDMA & LTE B1, B2, B3/4, 5 and 8	High/Low Power Modes	7 x 5 x 1
*TQP9051**	TRIUMF™ ET/APT-MIPI MMPA	GSM850/900, DCS/PCS & WCDMA & LTE B1, B2, B3, B4, B5, B8, B26	High/Low Power Modes	5 x 7 x 1
*TQP9058H**	TRIUMF™ Quad Band GSM-EDGE and Penta Band W/CDMA/HSPA+/LTE	GSM 850/900, DCS/PCS, & WCDMA & LTE B1, B2, B3/4, B5, B8	High/Low Power Modes	7 x 5 x 1
*TQP9059**	TRIUMF™ Advanced ET/ APT-MIPI MMPA	GSM850/900, DCS/PCS & WCDMA & LTE B1, B2, B3, B4, B5, B8, B17, B20, B26	High/Low Power Modes	5 x 7 x 1
*TQP9059S**	TRIUMF™ Advanced ET/ APT-MIPI MMPA	GSM850/900, DCS/PCS & WCDMA & LTE B1, B2, B3, B4, B5, B8, B20, B26	High/Low Power Modes	5 x 7 x 1

NOTES: ** = New, ** = Preview*

Power Amplifier Modules

Part	Description	Standards	Bands	Pout (dBm)	Gain (dB)	PAE (%)	Package (mm)
TQM700013	LTE Power Amplifier Module with Coupler	LTE	13	27.5	31	40	3 x 3
TQM700017	LTE Power Amplifier Module with Coupler	LTE	17	27.5	31	40	3 x 3

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
857031	SVLTE Notch SAW Filter	TC SAW	751, 782	10	0.65	SE/SE	2.5 x 2
857061	SVLTE Notch SAW Filter	TC SAW	751, 836.5, 881.5	10, 25	1	SE/SE	2.5 x 2
TQM966025	1,962.5 MHz RF BAW Filter - Band 25 Diversity Rx	BAW	1,962.5	65	2.6	SE/SE	2.5 x 2
885049	2,350 MHz RF BAW Filter - Band 40	BAW	2,350	100	1.3	SE/SE	1.4 x 1.2
885032	2.4 GHz RF BAW Filter - WLAN/ BT LTE Coexistence	BAW	2,442	79	1.7	SE/SE	1.4 x 1.2
*TQQ0041**	B41 Rx BAW Filter	BAW	2,580	196	3.5	SE/SE	2 x 2
*885043**	B38/B40 Tx Diplexed BAW Filter	BAW	2,595, 2,350	100	3.5	SE/SE	1.7 x 1.3

NOTES: ** = New*

Duplexers

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
*TQQ1013***	Band 13 LTE SE/SE Duplexer	SAW	777 to 787, 746 to 756	–	2.4	SE/SE	2.5 x 2
856979	LTE Band 13 SAW Duplexer	SAW	751, 782	10	1.85, 2.2	SE/SE, SE/BAL	2.5 x 2
*TQQ2504***	B4, B25 LTE SE/SE Duplexer	SAW/BAW	1,850 to 1,915	65	2	SE/SE	3.6 x 2 x 0.9
TQM966002	PCS BAW Duplexer	BAW	1,880, 1,960	60	1.8, 1.9	SE/SE	2.5 x 2.0
TQM963014	LTE BC14/Band 25 BAW Duplexer	BAW	1,882.5, 1,962.5	65	1.8, 2.2	SE/SE	2.5 x 2
*TQM976027**	B7 BAW Duplexer	BAW	2,500 to 2,570, 2,620 to 2,690	70	3	SE/SE	2.0 x 1.6

NOTES: ** = New, ** = Preview*

Filter/Duplexer Modules

Part	Description	Bands	Features	Package (mm)
*TQQ2526***	B25 PCS/B26 Cellular Bands Duplexer Bank Module	B25, B26	Duplexer Bank for B25/B26 Applications	2.8 x 4.7 x 1

NOTES: *** = Preview*

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
857031	SVLTE Notch SAW Filter	TC SAW	751, 782	10	0.65	SE/SE	2.5 x 2
857061	SVLTE Notch SAW Filter	TC SAW	751, 836.5, 881.5	10, 25	1	SE/SE	2.5 x 2
TQM966025	1,962.5 MHz RF BAW Filter - Band 25 Diversity Rx	BAW	1,962.5	65	2.6	SE/SE	2.5 x 2
885049	2,350 MHz RF BAW Filter - Band 40	BAW	2,350	100	1.3	SE/SE	1.4 x 1.2
885032	2.4 GHz RF BAW Filter - WLAN/ BT LTE Coexistence	BAW	2,442	79	1.7	SE/SE	1.4 x 1.2
885033	2.4 GHz RF BAW Filter - WLAN/ BT LTE Coexistence	BAW	2,442	79	1.7	SE/SE	1.4 x 1.2
*TQQ0041**	B41 Rx BAW Filter	BAW	2,580	196	3.5	SE/SE	2 x 2
*885043**	B38/B40 Tx Diplexed BAW Filter	BAW	2,595, 2,350	100	3.5	SE/SE	1.7 x 1.3

NOTES: ** = New*

GPS Front End Modules

Part	Description	NF (dB)	Gain (dB)	Output IP3 (dBm)
TQM640002	GPS Low Noise Amplifier/Filter Module	1.56	16	> 9

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856039	GPS SAW Filter	SAW	1,575.42	2	1.8	SE/SE	3 x 3
856139	GPS SAW Filter	SAW	1,575.42	2.4	1.3	SE/SE	3 x 3
856561	GPS SAW Filter, SE/SE	SAW	1,575.42	2	0.75	SE/SE	1.4 x 1.2 x 0.46
856576	GPS SAW Filter, SE/BAL	SAW	1,575.42	2	1.1	SE/BAL	1.4 x 1.2

Bluetooth Power Amplifiers

Part	Description	Bands	Features	Package (mm)
TQP770001	Bluetooth® EDR v2.0 Class 1 Power Amplifier MMIC	2.4 to 2.5 GHz ISM Band	STSLP-12 Package	2 x 2 x 0.57

Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	Voltage (V)	IQ (mA)
TQP787011	5 GHz WLAN Power Amplifier MMIC	5.15 to 5.875	16	32	3.3	125

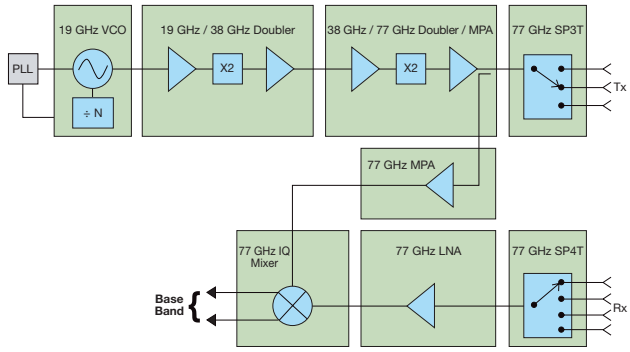
SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
885032	2.4 GHz RF BAW Filter - WLAN/ BT LTE Coexistence	BAW	2,442	79	1.7	SE/SE	1.4 x 1.2
885033	2.4 GHz RF BAW Filter - WLAN/ BT LTE Coexistence	BAW	2,442	79	1.7	SE/SE	1.4 x 1.2

WLAN Front End Modules

Part	Description	Frequency (GHz)	802.11 Standards	Typ Pout 1.78% EVM (dBm)	Typ Pout 3.0% EVM (dBm)	Tx Gain (dB)	Rx Gain (dB)	Rx NF (dB)	Nom Bias Voltage (V)	Current (mA)	Package (mm)
TQF9046	802.11b/g/n Bluetooth® Power Amplifier + Pdet, LNA with Bypass, SP3T Switch	2.4 to 2.5	b/g/n	16	19.3	25	13.5	2.2	3.8	152	2.5 x 2.5 x 0.4
TQM679002A	802.11b/g/n Bluetooth® Po wer Amplifier + Pdet, SP3T Switch with WLAN Rx Balun	2.4 to 2.5	b/g/n	–	16	33.5	–	–	3.6	114	3 x 3 x 0.45
TQP879001A	WLAN Low Noise Amplifier & SP3T Switch with WLAN TX and Bluetooth® Path	2.4 to 2.5	b/g/n	–	–	–	13.5	1.9	3.3	–	1.5 x 1.5 x 0.55
TQP6M9002	802.11a/b/g/n Bluetooth® Power Amplifier + Pdet, SP3T, SP2T Switch with WLAN RX Balun	2.4 to 2.5, 4.9 to 5.85	a/b/g/n	–	16, 16	34, 32	–	–	3.6	110, 150	4 x 4 x 0.55
TQP6M9017	High Performance 802.11a/b/ g/n/ac Bluetooth® Power Amplifier + Pdet, SP3T, SP2T Switch, with LNA + RX Balun	2.4 to 2.5, 4.9 to 5.85	a/b/g/n/ac	17, 16.5	18, 18	36, 37	4, 12	3, 3	3	165, 250	4 x 4 x 0.55
TQP887052	802.11a/n/ac Power Amplifier, SP2T Switch	4.5 to 5.925	a/n/ac	18.5	20.5	37	–	–	3.6	250	2.5 x 2.5 x 0.4
*TQF7062***	802.11a/n/ac Power Amplifier, LNA with Bypass, SP2T Switch	4.9 to 5.925	a/n/ac	19	20.5	36	13	2.5	3.6	290	2.5 x 2.5 x 0.4
TQP887051	802.11a/n/ac Power Amplifier + Pdet, LNA with Bypass, SP2T Switch	5.15 to 5.85	a/n/ac	16	19	31	13.5	2.6	3.6	230	2.5 x 2.5 x 0.4
*TQL1600**	5 GHz WLAN Switch / LNA Front End Module	5.15 to 5.875	a/n/ac	–	–	–	13	2.5	3.3, 5	8	2.5 x 2.5 x 0.45
TQP8080	5 GHz WLAN 802.11a/n/ac Front End Module with PA + Pdet, SP2T and LNA	5.15 to 5.875	a/n/ac	18	20	29.5	13	2.5	5	240	2.5 x 2.5 x 0.4

NOTES: ** = New, ** = Preview*



Example of a 77 GHz Radar Front-End

Frequency Converters/Mixers

Part	Description	RF (GHz)	IF (GHz)	LO (GHz)	Gain (dB)	Output P1dB (dBm)	LO Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGC4703-FC	19 - 38 GHz Doubler	38 to 38.5	19 to 19.25	–	8	14	–	3.5	65	Die
TGC4702-FC	77 GHz Downconverting IQ Mixer	75 to 82	DC to 0.1	75 to 82	-12	–	11	1.1	1	Die
TGC4704-FC	38 - 77 GHz Doubler and Medium Power Amplifier	76 to 77	38 to 38.5	–	5	14	–	3.75	180	Die

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Voltage (V)	Current (mA)	Package Style
TGA4705-FC	77 GHz Flip-Chip Low Noise Amplifier	72 to 80	5	23	2	60	Die

Oscillators

Part	Description	Frequency (GHz)	Power (dBm)	Phase Noise (dBc/Hz)	Voltage (V)	Current (mA)	Package Style
*TGV2204-FC**	19 GHz VCO with Prescaler	18.5 to 19.5	7	-105 @ 1 MHz	5	158	Die

NOTES: ** = New*

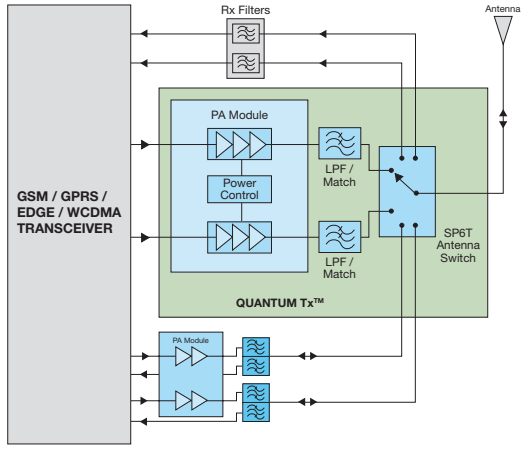
Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	Voltage (V)	IQ (mA)
TGA4706-FC	77 GHz Medium Power Amplifier	76 to 83	14	12	3.5	75

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Voltage (V)	Current (mA)	Package Style
TGS4305-FC	60 - 90 GHz SP3T Switch Flip Chip	60 to 90	2.3	20	1.35, -5	10, 0	Die
*TGS4307**	77 GHz Transceiver Switch	70 to 85	2.5	40	1.3	40	Die
TGS4306-FC	70 - 90 GHz SP4T Switch Flip Chip	70 to 90	3	20	1.35, -5	10, 0	Die

NOTES: ** = New*



Cellular & GPS Transceiver for Auto Telematics

Diplexers

Part	Description	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
TQM2M9016	GPS-SDARS Antenna Diplexer	1,575.42, 2,332.5	3, 25	0.6, 0.8	SE/SE	3 x 3

Duplexers

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856908	Cell Band SAW Duplexer	SAW	836.5, 881.5	25	2, 2.5	SE/SE	3.8 x 3.8
856565	CDMA 2-in-1 Rx Filter	SAW	881.5, 1,960	25, 60	1.6, 2.2	SE/BAL	2 x 1.5

GPS Front End Modules

Part	Description	NF (dB)	Gain (dB)	Output IP3 (dBm)
TQM640002	GPS Low Noise Amplifier/Filter Module	1.56	16	> 9

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
857038	836.5 MHz SAW Filter	SAW	836.5	25	2.3	SE/SE	1.4 x 1.2
856039	GPS SAW Filter	SAW	1,575.42	2	1.8	SE/SE	3 x 3
856139	GPS SAW Filter	SAW	1,575.42	2.4	1.3	SE/SE	3 x 3
856561	GPS SAW Filter, SE/SE	SAW	1,575.42	2	0.75	SE/SE	1.4 x 1.2 x 0.46
856576	GPS SAW Filter, SE/BAL	SAW	1,575.42	2	1.1	SE/BAL	1.4 x 1.2

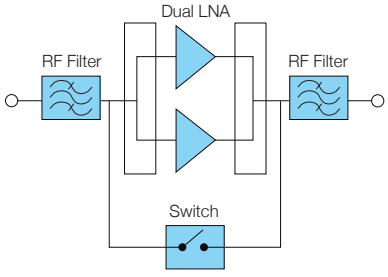
Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
TQP4M0009	High Isolation Reflective SPDT Switch	0.1 to 5	0.6	54	33	3.3	0.015	8-pin MSOP
TQP4M0008	Low Loss Reflective SPDT Switch	0.1 to 6	0.4	26	37	3.3	0.015	2 x 2 mm
TQP4M0011	Low Loss Reflective SP3T Switch	0.1 to 6	0.6	34	34	3.3	0.015	12-pin 3 x 3 mm QFN Package

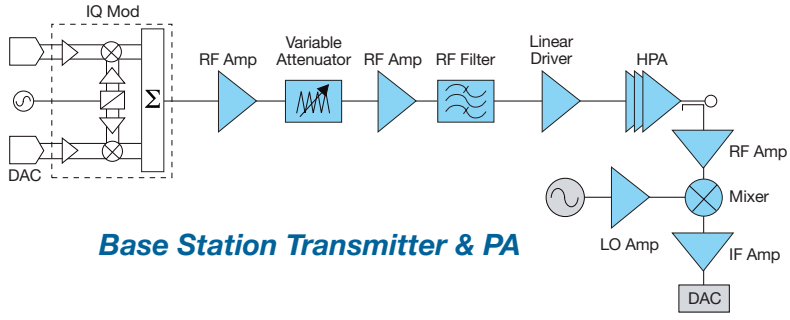
WLAN Front End Modules

Part	Description	Frequency (GHz)	802.11 Standards	Rx Gain (dB)	Rx NF (dB)	Nom Bias Voltage (V)	Current (mA)	Package (mm)
TQL1600*	5 GHz WLAN Switch / LNA Front End Module	5.15 to 5.875	a/n/ac	13	2.5	3.3, 5	8	2.5 x 2.5 x 0.45

NOTES: * = New



Tower Mounted LNA



Base Station Transmitter & PA

Duplexers

Part	Description	Type	Frequency (MHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Package (mm)
856908	Cell Band SAW Duplexer	SAW	836.5, 881.5	25	2, 2.5	SE/SE	3.8 x 3.8
856565	CDMA 2-in-1 Rx Filter	SAW	881.5, 1,960	25, 60	1.6, 2.2	SE/BAL	2 x 1.5

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
855107	IF SAW Filter - CDMA	SAW	70	1.228	19	SE/SE	74.7 x 18.9
856929	IF SAW Filter - Multi-Standard	SAW	140	18.4	9.1	SE/SE	7 x 5.5
855395	IF SAW Filter - CDMA	SAW	141	1.18	11.7	SE/SE	19 x 6.5
854833-1	Filter - CDMA BTS	SAW	150	1.18	19.5	SE/SE	19 x 6.5
856582	Filter - 3G BTS	SAW	172.8	18	8.7	SE/SE	7 x 5.5
856802	IF SAW Filter - Multi-Standard	SAW	172.8	20	8	SE/SE, SE/BAL	5 x 5
856893	IF SAW Filter - Multi-Standard	SAW	172.8	21	8.2	BAL/BAL	7 x 5.5
855992	Filter - CDMA BTS	SAW	240	3.6	14.3	SE/SE	13.3 x 6.5
855914	Filter - 3G BTS	SAW	326.4	17.4	12.61	SE/SE	7.01 x 5.51
856771	IF SAW Filter - Multi-Standard	SAW	358.4	19.2	10.1	BAL/BAL	7 x 5.5
856884	RF SAW Filter - Band 12 Uplink	SAW	707	18	1.5	SE/SE	3 x 3
856883	RF SAW Filter - Band 12 Downlink	SAW	737	18	1.8	SE/SE	3 x 3

SAW/BAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856844	RF SAW Filter	SAW	782	10	1.52	SE/SE	3 x 3
856932	RF SAW Filter - Band 20 Uplink	SAW	847	30	1.3	SE/SE	3 x 3
855728	Filter - CDMA/Amps (Rx) High Rejection	SAW	881.5	25	2.7	SE/SE	3 x 3
856824	RF SAW Filter	SAW	897.5	35	1.4	SE/SE	3 x 3
856928	RF SAW Filter - Band 11 Uplink	SAW	1,445.40	35	1.25	SE/SE	3 x 3
856654	RF SAW Filter - Band 3 Uplink	SAW	1,747.50	75	2.2	SE/SE	3 x 3
855849	RF SAW Filter - Band 2 Uplink	SAW	1,880	60	2.4	SE/SE	3 x 3
856530	Filter - U.S. PCS (Tx) Full-Band	SAW	1,880	60	2.8	SE/SE	3 x 3
856880	RF SAW Filter - Band 2 Uplink	SAW	1,880	60	2.3	SE/SE	3 x 3
885025	1880 MHz RF BAW Filter - Band 2 Uplink	BAW	1,880	60	3.5	SE/SE	3 x 3
856992	RF SAW Filter - Band 25 Uplink	SAW	1,882.50	65	1.9	SE/SE	3 x 3
855817	RF Filter, PCS	SAW	1,960	60	2.1	SE/SE	3 x 3
856531	RF Filter, PCS	SAW	1,960	60	2.25	SE/SE	3 x 3
856717	Delay Filter 450 ns	SAW	1,960	60	22	SE/SE	9.1 x 4.8
885024	1960 MHz RF BAW Filter - Band 2 Downlink	BAW	1,960	60	3.7	SE/SE	3 x 3
856649	SAW Delay Line	SAW	2,140	100	25	SE/SE, BAL/SE	7 x 5.5

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package (mm)
TQP4M3019	CDMA SP3T Switch	0.824 to 1.99	0.5 to 0.6	22 to 27	38	2.6	0.01	2.5 x 2

Duplexers

Part	Description	Type	Frequency (MHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Package (mm)
856908	Cell Band SAW Duplexer	SAW	836.5, 881.5	25	2.0, 2.5	SE/SE	3.8 x 3.8

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
854651	Filter - Standard Low Loss	SAW	70	0.55	7.6	SE/SE	19 x 6.5
854823	Filter - GSM BTS	SAW	86.6	0.40 min	5.5	SE/SE	19 x 6.5
855884	IF SAW Filter - GSM	SAW	125	0.4	5.7	SE/SE	13.3 x 6.5
856444	IF SAW Filter - GSM	SAW	125	0.4	5.9	SE/SE	9.1 x 4.8
856447	IF SAW Filter - GSM	SAW	170.6	0.18	5.59	SE/SE	13.3 x 6.5
855625	IF SAW Filter - GSM	SAW	190	0.2	4.2	SE/SE	7 x 5.5
856541	IF SAW Filter - GSM	SAW	201	0.22	6.1	BAL/BAL	13.3 x 6.5
855885	IF SAW Filter - GSM	SAW	208	0.4	5	SE/SE	13.3 x 6.5
856445	IF SAW Filter - GSM	SAW	208	0.4	5.88	SE/SE	9.1 x 4.8
856378	IF Filter, GSM	SAW	211	0.2	5.2	SE/SE	13.3 x 6.5
856884	RF SAW Filter - Band 12 Uplink	SAW	707	18	1.5	SE/SE	3 x 3
856883	RF SAW Filter - Band 12 Downlink	SAW	737	18	1.8	SE/SE	3 x 3
855728	Filter - CDMA/Amps (Rx) High Rejection	SAW	881.5	25	2.7	SE/SE	3 x 3
855782	RF Filter, Cell Band	SAW	881.5	25	1.8	SE/SE	3 x 3

SAW/BAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856671	RF Filter, EGSM	SAW	897.5	35	1.8	SE/SE	3 x 3
855810	RF SAW Filter - Band 8 Downlink	SAW	942.5	35	3.2	SE/SE	3 x 3
855820	RF SAW Filter - Band 8 Downlink	SAW	942.5	35	2	SE/SE	3 x 3
856528	RF Filter, EGSM	SAW	942.5	35	2.5	SE/SE	3 x 3
855860	RF SAW Filter - Band 3 Downlink	SAW	1,842.50	75	1.9	SE/SE	3 x 3
856530	Filter - U.S. PCS (Tx) Full-Band	SAW	1,880	60	2.8	SE/SE	3 x 3
855817	RF Filter, PCS	SAW	1,960	60	2.1	SE/SE	3 x 3
856531	RF Filter, PCS	SAW	1,960	60	2.25	SE/SE	3 x 3
856717	Delay Filter 450 ns	SAW	1,960	60	22	SE/SE	9.1 x 4.8
856649	SAW Delay Line	SAW	2,140	100	25	SE/SE, BAL/SE	7 x 5.5

Attenuators

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Bits	Control Voltage (V)	Package (mm)
TQP4M9071	Parallel Controlled 6 Bit, 31.5 dB Digital Step Attenuator	Digital	0 to 4	1.6	31.5	30	6	5	4 x 4
TQP4M9072	Serial Controlled 6 Bit, 31.5 dB Digital Step Attenuator	Digital	0 to 4	1.6	31.5	30	6	5	4 x 4
TQP4M9083	High Linearity Serial Controlled 7 Bit, 31.75 dB Digital Step Attenuator	Digital	0.4 to 3.5	1.5	31.75	30	7	5	4 x 4

Through Lines

Part	Description	3 dB Frequency Cut-Off (GHz)	Return Loss (dB)	Package (mm)
TQM4M9073	Through Line	> 6	25	3 x 3

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
CLY2	GaAs FET	DC to 3	14.5	23.5	–	0.79	–	3	180	MW6
TGF2021-04-SD	DC - 4 GHz Packaged Power pHEMT	DC to 4	16	26.5	–	0.6	–	5	150	SOT-89
CLY5	GaAs FET	0.4 to 2.5	11	27	–	1.7	–	3	350	MW6
TQP3M6004	700 - 915 MHz High IP3 Dual pHEMT Low Noise Amplifier	0.7 to 0.915	20.5	20.7	–	0.32	–	4	70	4 x 4 mm
*TGA2601-SM**	800 - 3000 MHz High IP3 Dual pHEMT	0.8 to 3	19 to 24	23	–	0.7	–	4	100	4 x 4 mm
TGA2602-SM	Dual GaAs pHEMT	0.8 to 3	20.5	20	–	0.55	–	4	100	2 x 2 mm
TQP3M6005	1700 - 2000 MHz High IP3 Dual pHEMT Low Noise Amplifier	1.7 to 2	17.9	21.6	–	0.36	–	4.5	50	4 x 4 mm

NOTES: ** = New*

Driver Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
TQP3301	8 W Linear Amplifier	400 to 2,700	17.4	40	52	4.7	5	500	4 x 5

Driver Amplifiers (Cont.)

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
TQP7M9105	1 W 5 V High Linearity Amplifier	50 to 1,500	19.4	30	49	6.3	5	220	SOT-89
TQP7M9106	2 W 5 V High Linearity Amplifier	50 to 1,500	20.8	33	50	4.8	5	455	4 x 4 mm
AH118-89G	0.25 W Linear Amplifier	60 to 3,500	20.5	24	40	4	5	160	SOT-89
AH225-S8G	1 W Linear Amplifier	400 to 2,700	15.2	31	47	6.3	5	300	SOIC-8
AH420-EG	4 W Linear Amplifier	400 to 2,700	16	35.7	50	5.3	5	800	4 x 5 mm
AH128-89G	0.25 W Linear Amplifier	400 to 3,500	16.9	25	40	4.6	5	115	SOT-89
AH125-89G	0.5 W Linear Amplifier	400 to 3,600	16.2	28	45	4.4	5	150	SOT-89
TQP7M9101	0.25 W Linear Amplifier	400 to 4,000	17.5	24.8	40	4	5	88	SOT-89
TQP7M9102	0.5 W Linear Amplifier	400 to 4,000	17.8	27.5	44	3.9	5	137	SOT-89
TQP7M9103	1 W Linear Amplifier	400 to 4,000	16.6	29.1	45	4.4	5	235	SOT-89
AH323-G	2 W 2-Stage Linear Amplifier	700 to 2,700	27	33	50	4.2	5	680	5 x 5 mm
TQP7M9104	2 W Linear Amplifier	700 to 2,700	15.8	32.8	49.5	4.4	5	435	4 x 4 mm
AP561-F	8 W Linear Amplifier	700 to 2,900	15.8	39	50	5.3	12	300	5 x 6 mm
AH212-S8G	1 W 2-Stage Linear Amplifier	1,800 to 2,700	27	30.5	46.5	5.5	5	400	SOIC-8
AH314-G	2 W Linear Amplifier	2,300 to 2,900	23	33	42	6.4	5	600	5 x 5 mm
AP562-F	8 W Linear Amplifier	3,300 to 3,800	11.5	39.4	50	6	12	400	5 x 6 mm

Duplexers

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856908	Cell Band SAW Duplexer	SAW	836.5, 881.5	25	2.0, 2.5	SE/SE	3.8 x 3.8
TQM969001	PCS BAW Duplexer	BAW	1,880, 1,960	60	1.32, 1.52	SE/SE	3.8 x 3.8

Frequency Converters/Mixers

Part	Description	RF (GHz)	IF (GHz)	LO (GHz)	Gain (dB)	Output IP3 (dBm)	NF (dB)	Output P1dB (dBm)	LO Power (dBm)	Voltage (V)	Current (mA)	Package Style
CMY210	Mixer with LO Amplifier	0.5 to 2.5	0.05 to 0.25	0.5 to 2.5	-5.7	18.3	6	8	0	3	6	MW-6
CMY212	Downconverter with LO, IF Amplifiers	0.5 to 2.5	0.05 to 0.25	0.5 to 2.5	10	20	8	8	-4	3	11	SCT598
CMY213	Downconverter with LO, IF Amplifiers	0.5 to 2.5	0.05 to 0.25	0.5 to 2.5	9.5	19.5	8	8	-5	3	8	SCT598
TQP519021	High IP3 Dual Channel Downconverter	0.68 to 0.92	0.07 to 0.28	0.6 to 1.1	9	34.5	10.8	20.8	0	5	295	6 x 6 mm
ML483-G	Mixer with LO Amplifier	0.7 to 1	0.07 to 0.3	0.7 to 1.3	-8.6	27.4	9.1	14.9	0	5	50	MSOP-8
ML485-G	Mixer with LO Amplifier	1.6 to 3.2	0.05 to 0.3	1.4 to 3.5	-8.5	26.3	9.1	11.3	0	5	40	MSOP-8
TQP569022	High IP3 Dual Channel Downconverter	1.7 to 2.2	0.07 to 0.28	1.4 to 2.5	9	34.5	9.7	21	0	5	295	6 x 6 mm

Gain Block Amplifiers

Part	Description	Frequency (GHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
AG603-89G	Cascadable Gain Block	DC to 3,000	18.5	19.5	33	3.8	6	75	SOT-89
AG602-89G	Cascadable Gain Block	DC to 3,500	14	18.5	33	4.4	6	75	SOT-89
ECG008B-G	Cascadable Gain Block	DC to 4,000	15	24	40	4.6	9	120	SOT-89
ECG006C-G	Cascadable Gain Block	DC to 5,500	15	15.5	32	3.7	5	45	SOT-86
AG201-63G	Cascadable Gain Block	DC to 6,000	11	6.5	19.5	4.4	5	20	SOT-363
AG201-86G	Cascadable Gain Block	DC to 6,000	11	6.5	19.5	4.4	5	20	SOT-86
AG203-63G	Cascadable Gain Block	DC to 6,000	20	8	21	3.1	5	20	SOT-363
AG203-86G	Cascadable Gain Block	DC to 6,000	20	8	21	3.1	5	20	SOT-86
AG302-63G	Cascadable Gain Block	DC to 6,000	15.5	13.5	26	3.2	5	35	SOT-363
AG302-86G	Cascadable Gain Block	DC to 6,000	15.5	13.5	26	3.2	5	35	SOT-86

Gain Block Amplifiers (Cont.)

Part	Description	Frequency (GHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
AG303-63G	Cascadable Gain Block	DC to 6,000	20.5	14	26	3	5	35	SOT-363
AG303-86G	Cascadable Gain Block	DC to 6,000	20.5	14	26	3	5	35	SOT-86
AG402-86G	Cascadable Gain Block	DC to 6,000	15	17	32.5	3.7	6	60	SOT-86
AG402-89G	Cascadable Gain Block	DC to 6,000	15	17	32.5	3.7	6	60	SOT-89
AG403-86G	Cascadable Gain Block	DC to 6,000	21	18	31.5	3	6	60	SOT-86
AG403-89G	Cascadable Gain Block	DC to 6,000	21	18	31.5	3	6	60	SOT-89
AG503-86G	Cascadable Gain Block	DC to 6,000	21	16	29	2.9	6	45	SOT-86
AG503-89G	Cascadable Gain Block	DC to 6,000	21	16	29	2.9	6	45	SOT-89
AG604-86G	Cascadable Gain Block	DC to 6,000	21.5	19.5	33.5	3.5	6	75	SOT-86
AG604-89G	Cascadable Gain Block	DC to 6,000	21.5	19.5	33.5	3.5	6	75	SOT-89
ECG003B-G	Cascadable Gain Block	DC to 6,000	20	24	39	3.5	9	110	SOT-89
TQP369180	Cascadable Gain Block	DC to 6,000	15.7	15.2	29.8	3.6	5	45	SOT-89
TQP369181	Cascadable Gain Block	DC to 6,000	15.6	15.2	30	3.6	5	45	SOT-363
TQP369182	Cascadable Gain Block	DC to 6,000	22.3	16.1	29.6	3.8	5	45	SOT-89
TQP369184	Cascadable Gain Block	DC to 6,000	22	16.2	29.8	3.8	5	45	SOT-363
TQP369185	Cascadable Gain Block	DC to 6,000	19	19.6	31.7	4.7	5	75	SOT-89
WJA1500	Cascadable Gain Block	50 to 1,000	19.2	20.5	44	5	5	95	SOT-89
WJA1510	Cascadable Gain Block	50 to 1,000	14.2	20	47	5.4	5	95	SOT-89
TQL9047*	High Linearity Gain Block with Shutdown Function	50 to 4,000	14.5	21.2	35.5	1.6	5	70	2 x 2 mm
TQL9048*	High Linearity Gain Block with Shutdown Function	50 to 4,000	14.5	22	40.5	1.7	5	130	2 x 2 mm
TQP3M9028	High Linearity Low Noise Gain Block	50 to 4,000	14.7	20.7	40	2	5	85	SOT-89
TQP3M9038	High Linearity LNA Gain Block	50 to 4,000	14.9	21.6	39.5	2	5	85	3 x 3 mm

NOTES: *** = New**

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
TQP3M9039	High IP3 Dual E-PHEMT Low Noise Amplifier	0.05 to 1.5	0.6	18	38.8	21.5	4.35	57	4 x 4 mm
TQP3M9018	High Linearity Low Noise Gain Block	0.05 to 4	1.3	20.5	36	20	5	85	3 x 3 mm
TQP3M9008	High Linearity Low Noise Gain Block	0.05 to 4	1.3	20.6	35.5	20	5	85	SOT-89
TQP3M9009	High Linearity Low Noise Gain Block	0.05 to 4	1.3	21.8	39.5	22	5	125	SOT-89
TQP3M9019	High Linearity Low Noise Gain Block	0.05 to 4	1.3	22	39.5	22	5	125	3 x 3 mm
TQP3M9035	High Linearity LNA Gain Block	0.05 to 4	0.66	16.5	37	22.5	5	110	2 x 2 mm
TQP3M9005	Low Noise Amplifier Gain Block	0.1 to 4	0.8	15.3	34	22.3	5	50	3 x 3 mm
TQP3M9007	High Linearity Low Noise Gain Block	0.1 to 4	1.3	13	41	23.6	5	125	SOT-89
TQP3M9036	Ultra Low Noise, High Linearity LNA	0.4 to 2	0.45	19	35	20	5	65	2 x 2 mm
TQL9042	Ultra Low Noise, High Linearity LNA with Bypass Function	0.5 to 2	0.42	19	36	23	5	70	3 x 3 mm
TQP3M9006	High Linearity Low Noise Gain Block	0.5 to 4	1	13.5	38.5	22.4	5	90	3 x 3 mm
TQP3M9040	High IP3 Dual E-PHEMT Low Noise Amplifier	1.5 to 2.3	0.67	18	40	21.8	4.35	57	4 x 4 mm
TQL9043	Ultra Low Noise, High Linearity LNA with Bypass Function	1.5 to 4	0.6	17.5	33	19.4	5	80	3 x 3 mm
TQL9044*	Ultra Low Noise, High Linearity LNA with Bypass Function	1.5 to 4	0.6	19.4	34.5	20.4	5	70	3 x 3 mm
TQP3M9037	Ultra Low Noise, High Linearity LNA	1.5 to 4	0.4	20	35	20	5	65	2 x 2 mm
TQP3M9041	High IP3 Dual E-PHEMT Low Noise Amplifier	2.3 to 6	0.8	18	38	22.5	4.35	57	4 x 4 mm
TQP3M9041	High IP3 Dual E-PHEMT Low Noise Amplifier	2.3 to 6	0.80	18	38	22.5	4.35	57	4 x 4 mm

NOTES: *** = New**

Power Amplifier Modules

Part	Description	Standards	Bands	Pout (dBm)	Gain (dB)	PAE (%)	Package (mm)
TGP2453-SM**	1800 MHz 2.5 W Small Cell PA Module	W-CDMA, LTE	3,9	43.0	34	35	20 x 20
TGP2451-SM**	1900 MHz 2.5 W Small Cell PA Module	W-CDMA, LTE	2, 25, 36	43.0	35	38	20 x 20
TGA2450-SM*	2100 MHz 2.5 W Small Cell PA Module	W-CDMA, LTE	1, 4, 10	42.5	35	35	20 x 20

NOTES: ** = New, ** = Preview*

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
855035	140 MHz SAW Filter	SAW	140	0.47	18.5	SE/SE	19 x 6.5
856656	Low Loss IF Filter	SAW	140	10	9.2	SE/SE	13.3 x 6.5
856684	Low Loss IF Filter	SAW	140	15	9.1	SE/SE	13.3 x 6.5
856774	Filter - Standard Low Loss	SAW	140	56	22.3	BAL/BAL	9.1 x 4.8
856929	IF SAW Filter - Multi-Standard	SAW	140	18.4	9.1	SE/SE	7 x 5.5
856727	IF Filter	SAW	144	75	21.2	SE/SE	9 x 7.01
856517	IF Filter	SAW	153.6	32	13	SE/SE	13.3 x 6.5
855886	161.5 MHz SAW Filter	SAW	161.5	25	22	SE/SE	9 x 7.01
856683	WCDMA IF Filter	SAW	167	5	8	SE/SE, BAL/BAL	9.1 x 4.8
856802	IF SAW Filter - Multi-Standard	SAW	172.8	20	8	SE/SE, SE/BAL	5 x 5
856893	IF SAW Filter - Multi-Standard	SAW	172.8	21	8.2	BAL/BAL	7 x 5.5
857124	184.32 MHz SAW Filter	SAW	184.32	25	7.8	BAL/BAL	7 x 5.5
857071	192.5 MHz SAW Filter	SAW	192.5	67.5	17	BAL/BAL	7 x 5.5
855816	205 MHz SAW Filter	SAW	205	1.3	22	SE/SE	13.3 x 6.5
857072	242.5 MHz SAW Filter	SAW	242.5	27.6	9	BAL/BAL	7 x 5.5
855549	242.625 MHz SAW Filter	SAW	242.625	1.3	18.7	SE/SE	19 x 6.5
856771	IF SAW Filter - Multi-Standard	SAW	358.4	19.2	10.1	BAL/BAL	7.0 x 5.5
857073	397.5 MHz SAW Filter	SAW	397.5	66.7	16.6	BAL/BAL	7 x 5.5
857074	447.5 MHz SAW Filter	SAW	447.5	28.16	14.1	BAL/BAL	7 x 5.5
855985	549.5 MHz SAW Filter	SAW	549.5	1	11.6	SE/SE	9 x 7.01
856884	RF SAW Filter - Band 12 Uplink	SAW	707	18	1.5	SE/SE	3 x 3
857193*	725.5 MHz SAW Band 28 Uplink Filter	SAW	725.5	45	4	SE/SE	3 x 3
856883	RF SAW Filter - Band 12 Downlink	SAW	737	18	1.8	SE/SE	3 x 3
856764	RF SAW Filter - Band 13 Uplink	SAW	781.5	11	1.46	SE/SE	3 x 3
856844	RF SAW Filter	SAW	782	10	1.52	SE/SE	3 x 3
856932	RF SAW Filter - Band 20 Uplink	SAW	847	30	1.3	SE/SE	3 x 3
856606	860.5 MHz SAW Filter	SAW	860.5	19	1.1	SE/SE	3 x 3
856824	RF SAW Filter	SAW	897.5	35	1.4	SE/SE	3 x 3
856928	RF SAW Filter - Band 11 Uplink	SAW	1,445.4	35	1.25	SE/SE	3 x 3
TQQ7303*	1747.5 MHz BAW Band 3 Uplink Filter	BAW	1,747.5	75	3.5	SE/SE	3 x 3
TQQ0302**	Band 3 Uplink RF Filter	BAW	1,747.5	75	3.5	SE/SE	3 x 3
TQQ0303**	Band 3 Downlink RF Filter	BAW	1,842.5	75	3.5	SE/SE	3 x 3
856705	RF SAW Filter - Band 2 Uplink	SAW	1,880	60	2.2	SE/SE	3 x 3
856880	RF SAW Filter - Band 2 Uplink	SAW	1,880	60	2.3	SE/SE	3 x 3
856678	RF Filter - 1950 MHz Band	SAW	1,950	60	1.8	SE/SE	3 x 3
857145	1960 MHz SAW Filter	SAW	1,960	160	3	SE/SE	3 x 3
856604	2332.5 MHz SAW Filter	SAW	2,332.5	45	1.7	SE/BAL	1.4 x 1.2
885069*	2350 MHz BAW Band 40 Filter	BAW	2,350	100	3	SE/SE	1.4 x 1.2
TQQ7307*	2535 MHz BAW Band 7 Uplink Filter	BAW	2,535	70	3.5	SE/SE	3 x 3
885026**	B38 Tx/Rx Filter	BAW	2,595	50	1.4	SE/SE	1.4 x 1.2

NOTES: ** = New, ** = Preview*

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
*TQP4M0013**	High Isolation Absorptive SPST Switch	0.1 to 4	0.55	50	35	3.3	0.08	2 x 2 mm
TQP4M0009	High Isolation Reflective SPDT Switch	0.1 to 5	0.6	54	33	3.3	0.015	8-pin MSOP
TQP4M0008	Low Loss Reflective SPDT Switch	0.1 to 6	0.4	26	37	3.3	0.015	2 x 2 mm
TQP4M0010	High Isolation Absorptive SPDT Switch	0.1 to 6	0.5	55	33	3.3	0.07	4 x 4 mm
*TQC0015**	High Isolation Absorptive SPDT Switch	0.1 to 6	0.5	55	33	3.3	0.1	4 x 4 mm
TQP4M0011	Low Loss Reflective SP3T Switch	0.1 to 6	0.6	34	34	3.3	0.015	12-pin 3 x 3 mm QFN Package

NOTES: ** = New*

Variable Gain Amplifiers

Part	Description	Frequency (MHz)	Attenuation Range (dB)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package (mm)
TQM8M9075	Digital Variable Gain Amplifier	50 to 4,000	31.5	18	20.5	36.5	2.9	5	88	5 x 5
TQM8M9076	Digital Variable Gain Amplifier	50 to 4,000	31.5	19.5	22	38.5	2.9	5	125	5 x 5
TQM8M9077	Digital Variable Gain Amplifier	50 to 4,000	31.5	13	21.5	38.5	3.7	5	88	5 x 5
TQM8M9079	Variable Gain Amplifier	500 to 2,700	30	38	16	29	4	5	95	5 x 5
TQM829007	Digital Variable Gain Amplifier	600 to 1,000	31.5	31.7	24.3	40	2.1	5	174	6 x 6
*TQC9305**	Digital Variable Gain Amplifier with Shutdown Mode	700 to 3,600	31.5	13	23	39.7	3.1	5	130	5 x 5
TQM879026	Digital Variable Gain Amplifier	700 to 4,000	31.5	32.5	24	42.5	1.5	5	176	4 x 4
TQM879028	Digital Variable Gain Amplifier	700 to 4,000	31.5	33	27.3	45	1.5	5	230	4 x 4
TQM879006A	Digital Variable Gain Amplifier Module	1,400 to 2,700	31.5	31.7	24.5	43	1.5	5	174	6 x 6
TQM879008	Digital Variable Gain Amplifier	1,500 to 2,700	31.5	41.5	27.3	48.5	3.9	5	285	6 x 6

NOTES: ** = New*

Duplexers

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856908	Cell Band SAW Duplexer	SAW	836.5, 881.5	25	2.0, 2.5	SE/SE	3.8 x 3.8

Power Amplifier Modules

Part	Description	Standards	Bands	Pout (dBm)	Gain (dB)	PAE (%)	Package (mm)
*TGP2453-SM***	1800 MHz 2.5 W Small Cell PA Module	W-CDMA, LTE	3,9	43	34	35	20 x 20
*TGP2451-SM***	1900 MHz 2.5 W Small Cell PA Module	W-CDMA, LTE	2, 25, 36	43	35	38	20 x 20
*TGA2450-SM**	2100 MHz 2.5 W Small Cell PA Module	W-CDMA, LTE	1, 4, 10	42.5	35	35	20 x 20

NOTES: ** = New, ** = Preview*

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856656	Low Loss IF Filter	SAW	140	10	9.2	SE/SE	13.3 x 6.5
856684	Low Loss IF Filter	SAW	140	15	9.1	SE/SE	13.3 x 6.5
856774	Filter - Standard Low Loss	SAW	140	56	22.3	BAL/BAL	9.1 x 4.8
856929	IF SAW Filter - Multi-Standard	SAW	140	18.4	9.1	SE/SE	7 x 5.5

SAW/BAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856517	IF Filter	SAW	153.6	32	13	SE/SE	13.3 x 6.5
856748	IF SAW Filter - Multi-Standard	SAW	153.6	18.3	10	SE/SE	13.3 x 6.5
856683	WCDMA IF Filter	SAW	167	5	8	SE/SE, BAL/BAL	9.1 x 4.8
856512	IF SAW Filter - Multi-Standard	SAW	168.5	26.4	8	SE/SE, SE/BAL	5 x 5
856582	Filter - 3G BTS	SAW	172.8	18	8.7	SE/SE	7 x 5.5
856620	IF SAW Filter - WCDMA	SAW	172.8	8.84	9	SE/SE, SE/BAL	7 x 5.5
856802	IF SAW Filter - Multi-Standard	SAW	172.8	20	8	SE/SE, SE/BAL	5 x 5
856893	IF SAW Filter - Multi-Standard	SAW	172.8	21	8.2	BAL/BAL	7 x 5.5
856234	Filter - CDMA IF	SAW	183.6	1.26	7.4	SE/BAL, BAL/BAL	7 x 5.5
857124	184.32 MHz SAW Filter	SAW	184.32	25	7.8	BAL/BAL	7 x 5.5
855529	IF SAW Filter - WCDMA	SAW	190	4	9.8	SE/SE	13.3 x 6.5
855770	Filter - 3G BTS	SAW	190	5	8	SE/SE	5 x 5
856731	IF SAW Filter - Multi-Standard	SAW	192	60	13.5	SE/BAL, SE/SE	7 x 5.5
856496	IF SAW Filter - WCDMA	SAW	208	3.84	11.5	BAL/BAL	9.1 x 4.8
855914	Filter - 3G BTS	SAW	326.4	17.4	12.61	SE/SE	7.01 x 5.51
856771	IF SAW Filter - Multi-Standard	SAW	358.4	19.2	10.1	BAL/BAL	7 x 5.5
856882	IF SAW Filter	SAW	358.4	39.6	9.5	BAL/BAL	7 x 5.5
856966	IF SAW Filter - Multi-Standard	SAW	358.4	24.8	9	BAL/BAL	7 x 5.5
855954	Filter - Wireless Data	SAW	380	7.3	9.5	SE/SE	3.8 x 3.8
855559	IF SAW Filter - WCDMA	SAW	398	22	7.5	SE/SE	7 x 5.5
855561	IF SAW Filter - WCDMA	SAW	398	4.3	9.9	SE/SE	7 x 5.5
856687	IF SAW Filter - Multi-Standard	SAW	456	19	10	BAL/BAL	7 x 5.5
856884	RF SAW Filter - Band 12 Uplink	SAW	707	18	1.5	SE/SE	3 x 3
*857193**	725.5 MHz SAW Band 28 Uplink Filter	SAW	725.5	45	4	SE/SE	3 x 3
856883	RF SAW Filter - Band 12 Downlink	SAW	737	18	1.8	SE/SE	3 x 3
*857217**	742.5 MHz SAW Filter	SAW	742.5	27	2.5	SE/SE	3 x 3
856764	RF SAW Filter - Band 13 Uplink	SAW	781.5	11	1.46	SE/SE	3 x 3
856844	RF SAW Filter	SAW	782	10	1.52	SE/SE	3 x 3
856977	RF SAW Filter - Band 13/14 Uplink	SAW	787.5	21	2.05	SE/SE	3 x 3
857019	Band 5e Uplink RF Filter	SAW	835	30	2.1	SE/SE	3 x 3
856503	RF SAW Filter - Band 5 Uplink	SAW	836.5	25	2.7	SE/SE	3 x 3
856704	RF SAW Filter - Band 5 Uplink	SAW	836.5	25	1.2	SE/SE	3 x 3
856932	RF SAW Filter - Band 20 Uplink	SAW	847	30	1.3	SE/SE	3 x 3
855728	Filter - CDMA/Amps (Rx) High Rejection	SAW	881.5	25	2.7	SE/SE	3 x 3
855782	RF Filter, Cell Band	SAW	881.5	25	1.8	SE/SE	3 x 3
856504	RF SAW Filter - Band 5 Downlink	SAW	881.5	25	2.7	SE/SE	3 x 3
856824	RF SAW Filter	SAW	897.5	35	1.4	SE/SE	3 x 3
856928	RF SAW Filter - Band 11 Uplink	SAW	1,445.4	35	1.25	SE/SE	3 x 3
*TQQ7303***	1,747.5 MHz BAW Band 3 Uplink Filter	BAW	1,747.5	75	3.5	SE/SE	3 x 3
*TQQ0302***	Band 3 Uplink RF Filter	BAW	1,747.5	75	3.5	SE/SE	3 x 3
856934	Band 3 Downlink RF Filter	SAW	1,842.5	75	2.9	SE/SE	3 x 3
856530	Filter - U.S. PCS (Tx) Full-Band	SAW	1,880	60	2.8	SE/SE	3 x 3
856705	RF SAW Filter - Band 2 Uplink	SAW	1,880	60	2.2	SE/SE	3 x 3
856934	Band 3 Downlink RF Filter	SAW	1,842.5	75	2.9	SE/SE	3 x 3
856880	RF SAW Filter - Band 2 Uplink	SAW	1,880	60	2.3	SE/SE	3 x 3
885025	1,880 MHz RF BAW Filter - Band 2 Uplink	BAW	1,880	60	3.5	SE/SE	3 x 3
856532	RF Filter, UMTS	SAW	1,950	60	2.5	SE/SE	3 x 3
856678	RF Filter - 1950 MHz Band	SAW	1,950	60	1.8	SE/SE	3 x 3
855817	RF Filter, PCS	SAW	1,960	60	2.1	SE/SE	3 x 3
855859	RF SAW Filter - Band 2 Downlink	SAW	1,960	60	2.5	SE/SE	3 x 3
856531	RF Filter, PCS	SAW	1,960	60	2.25	SE/SE	3 x 3
856717	Delay Filter 450 ns	SAW	1,960	60	22	SE/SE	9.1 x 4.8
885024	1,960 MHz RF BAW Filter - Band 2 Downlink	BAW	1,960	60	3.7	SE/SE	3 x 3

SAW/BAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856649	SAW Delay Line	SAW	2,140	100	25	SE/SE, BAL/SE	7 x 5.5
*885069**	2,350 MHz BAW Band 40 Filter	BAW	2,350	100	3	SE/SE	1.4 x 1.2
885009	2,535 MHz RF BAW Filter - Band 7 Uplink	BAW	2,535	70	1.3	SE/SE	3 x 3
*TQQ7307**	2,535 MHz BAW Band 7 Uplink Filter	BAW	2,535	70	3.5	SE/SE	3 x 3
*885026***	B38 Tx/Rx Filter	BAW	2,595	50	1.4	SE/SE	1.4 x 1.2

NOTES: ** = New, ** = Preview*

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package (mm)
*TQP4M0013**	High Isolation Absorptive SPST Switch	0.1 to 4	0.55	50	35	3.3	0.08	2 x 2
TQP4M0008	Low Loss Reflective SPDT Switch	0.1 to 6	0.4	26	37	3.3	0.015	2 x 2
TQP4M0010	High Isolation Absorptive SPDT Switch	0.1 to 6	0.5	55	33	3.3	0.07	4 x 4
*TQC0015**	High Isolation Absorptive SPDT Switch	0.1 to 6	0.5	60	33	3.3	0.1	4 x 4

NOTES: ** = New*

Attenuators

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Bits	Control Voltage (V)	Package (mm)
TQP4M9071	Parallel Controlled 6 Bit, 31.5 dB Digital Step Attenuator	Digital	0 to 4	1.6	31.5	30	6	5	4 x 4
TQP4M9072	Serial Controlled 6 Bit, 31.5 dB Digital Step Attenuator	Digital	0 to 4	1.6	31.5	30	6	5	4 x 4
TQP4M9083	High Linearity Serial Controlled 7 Bit, 31.75 dB Digital Step Attenuator	Digital	0.4 to 3.5	1.5	31.75	30	7	5	4 x 4

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
TGF2021-04-SD	DC - 4 GHz Packaged Power pHEMT	DC to 4	16	26.5	0.6	5	150	SOT-89
TGA2602-SM	Dual GaAs pHEMT	0.8 to 3	20.5	20	0.55	4	100	2 x 2 mm

Driver Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
TQP7M9105	1 W 5 V High Linearity Amplifier	50 to 1,500	19.4	30	49	6.3	5	220	SOT-89
TQP7M9106	2 W 5 V High Linearity Amplifier	50 to 1,500	20.8	33	50	4.8	5	455	4 x 4 mm
TQP3301	8 W Linear Amplifier	400 to 2,700	17.4	40	52	4.7	5	500	4 x 5
TQP7M9101	0.25 W Linear Amplifier	400 to 4,000	17.5	24.8	40	4	5	88	SOT-89
TQP7M9102	0.5 W Linear Amplifier	400 to 4,000	17.8	27.5	44	3.9	5	137	SOT-89
TQP7M9103	1 W Linear Amplifier	400 to 4,000	16.6	29.1	45	4.4	5	235	SOT-89
TQP7M9104	2 W Linear Amplifier	700 to 2,700	15.8	32.8	49.5	4.4	5	435	4 x 4 mm
AH323-G	2 W 2-Stage Linear Amplifier	700 to 2,700	27	33	50	4.2	5	680	5 x 5 mm
AP561-F	8 W Linear Amplifier	700 to 2,900	15.8	39	50	5.3	12	300	5 x 6 mm
AP562-F	8 W Linear Amplifier	3,300 to 3,800	11.5	39.4	50	6	12	400	5 x 6 mm

Gain Block Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
TQP3M9007	High Linearity Low Noise Gain Block	0.1 to 4	1.3	13	41	23.6	5	125	SOT-89
TQP3M9028	High Linearity Low Noise Gain Block	50 to 4,000	14.7	20.7	40	2	5	85	SOT-89
*TQL9047**	High Linearity Gain Block with Shutdown Function	50 to 4,000	14.5	21.2	35.5	1.6	5	70	2 x 2 mm
*TQL9048**	High Linearity Gain Block with Shutdown Function	50 to 4,000	14.5	22	40.5	1.7	5	130	2 x 2 mm
TQP3M9038	High Linearity LNA Gain Block	50 to 4,000	14.9	21.6	39.5	2	5	85	3 x 3 mm

NOTES: ** = New*

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
TQP3M9008	High Linearity Low Noise Gain Block	0.05 to 4	1.3	20.6	35.5	20	5	85	SOT-89
TQP3M9009	High Linearity Low Noise Gain Block	0.05 to 4	1.3	21.8	39.5	22	5	125	SOT-89
TQP3M9018	High Linearity Low Noise Gain Block	0.05 to 4	1.3	20.5	36	20	5	85	3 x 3 mm
TQP3M9019	High Linearity Low Noise Gain Block	0.05 to 4	1.3	22	39.5	22	5	125	3 x 3 mm
TQP3M9005	Low Noise Amplifier Gain Block	0.1 to 4	0.8	15.3	34	22.3	5	50	3 x 3 mm
TQP3M9006	High Linearity Low Noise Gain Block	0.5 to 4	1	13.5	38.5	22.4	5	90	3 x 3 mm

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
855679	Filter - Broadband Wireless Access	SAW	80	8	11.9	SE/SE	13.3 x 6.5
854920	Filter - Standard Low Loss	SAW	140	18	9.1	SE/SE	13.3 x 6.5
856140	310.7 MHz SAW Filter	SAW	310.7	3	3	SE/SE	5 x 5
855595	320 MHz SAW Filter	SAW	320	22	19.3	SE/SE	9 x 7.01
855596	320 MHz SAW Filter	SAW	320	22	19.4	SE/SE	9 x 7.01
854565	350 MHz SAW Filter	SAW	350	1.2	10.2	SE/SE	13.3 x 6.5
855399	Filter - Broadband Wireless Access	SAW	350	2.62	13.7	SE/SE, BAL/BAL	13.3 x 6.5
856466	IF Filter - WiMAX	SAW	374	18	9	BAL/BAL	3.8 x 3.8
856490	Filter - Standard IF 380 MHz SAW	SAW	380	9.2	10	BAL/BAL	7 x 5.5
856631	Filter - Standard IF 380 MHz SAW	SAW	380	10.5	8.7	BAL/BAL	7 x 5.5
856652	Filter - WiMAX IF SAW	SAW	398	10	8.7	BAL/BAL	5 x 5
856549	Filter - Standard IF 456 MHz SAW	SAW	456	7.8	7.9	BAL/BAL	5 x 5
856638	Filter - Standard IF 456 MHz SAW	SAW	456	10	8.3	BAL/BAL	5 x 5
856672	Filter - Standard IF 456 MHz SAW	SAW	456	10	8.3	BAL/BAL	7 x 5.5
856623	464 MHz SAW Filter	SAW	464	3.5	10.6	BAL/BAL	7 x 5.5
856586	467 MHz SAW Filter	SAW	467	10	3	SE/SE	3.8 x 3.8
855271	Filter - Standard IF 479.75 MHz SAW	SAW	479.75	11.7	19.5	SE/SE	7 x 5.5
855272	Filter - Test Equipment	SAW	479.75	25.5	9.8	SE/SE	7 x 5.5
856625	520 MHz SAW Filter	SAW	520	11	9.5	SE/SE	5 x 5
856680	520 MHz SAW Filter	SAW	520	7.09	10.8	SE/SE	5 x 5
856665	Filter - Standard IF 580 MHz SAW	SAW	580	10.5	10.7	BAL/BAL	7 x 5.5
856690	756 MHz SAW Filter	SAW	756	18.5	1.9	SE/SE	3.8 x 3.8
856866	756 MHz SAW Filter	SAW	756	29.15	0.9	SE/SE	3.8 x 3.8
856526	Filter - Standard IF 810 MHz SAW	SAW	810	10	3.5	SE/SE	3 x 3
856534	Filter - Standard IF 810 MHz SAW	SAW	810	5	4.6	SE/SE	3 x 3
856330	Broadband Access IF SAW Filter	SAW	1,086	10	4	BAL/BAL	3 x 3
856365	Broadband Access IF SAW Filter	SAW	1,216	8	3.75	BAL/BAL	3 x 3
856598	Broadband Access IF SAW Filter	SAW	1,220	50	3.9	BAL/BAL	3.8 x 3.8
885007	2,436 MHz BAW Filter - ISM Passband for Coexistence	BAW	2,436	72	2	SE/SE	1.7 x 1.3
885017	2,436 MHz BAW Filter - ISM Passband for Coexistence	BAW	2,436	72	1.8	SE/SE	1.4 x 1.2

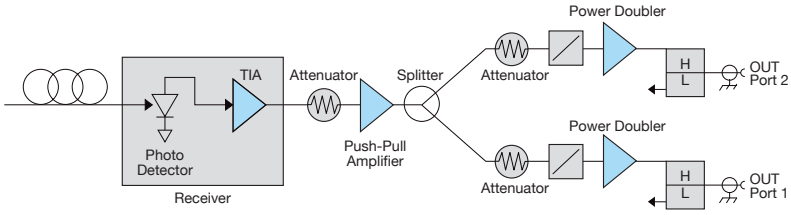
SAW/BAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
885008	2,440 MHz BAW Filter - ISM Notch for Coexistence	BAW	2,440	71	1.5 (Out of Band IL)	SE/SE	1.7 x 1.3
885010	2,440 MHz BAW Filter - ISM Notch for Coexistence	BAW	2,440	82	2 (Out of Band IL)	SE/SE	1.7 x 1.3

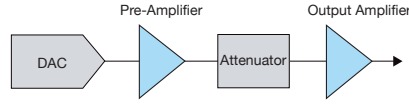
Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package (mm)
TQP4M0010	High Isolation Absorptive SPDT Switch	0.1 to 6	0.5	55	33	3.3	0.07	4 x 4
*TQC0015**	High Isolation Absorptive SPDT Switch	0.1 to 6	0.5	60	33	3.3	0.1	4 x 4

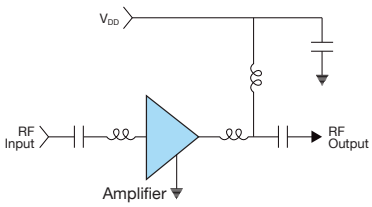
NOTES: *** = New**



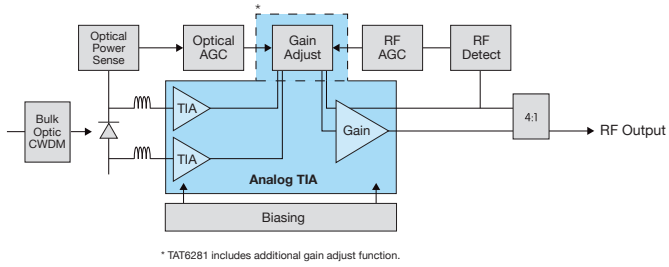
CATV Infrastructure



Edge QAM DOCSIS® 3.0



Subscriber Home Amplifiers



* TAT6281 includes additional gain adjust function.

FTTH/RFoG

CATV Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style	Applications
AG606-G	CATV Dual HBT Amplifier	DC to 1,000	13.5	20	37	4.5	> 7	165	SOIC-8	General Purpose Dual
TAT7457	CATV 75 Ohm pHEMT Adjustable Gain RF Amplifier	DC to 2,000	19	21	40	2	5 to 8	120	SOT-89	Single Ended Home Amplifier
TAT7467H	75 Ohm, 40 - 1,000 MHz RF Amplifier	40 to 1,000	17	24	43	4.7	5	380	SOIC-8	Headend DOCSIS
TAT8801A1H	75 Ohm, 40 - 1,000 MHz RF Amplifier Power Doubler	40 to 1,000	11	31	50	–	12	585	SOIC-16W	Infrastructure
*TAT8857A1H**	CATV Infrastructure Power Doubler	40 to 1,000	21 to 27	31	52	4	24	350	SOIC-16W	Infrastructure
TGA2803-SM	CATV TIA/Gain Block	40 to 1,000	20	28	45	1.5	8	350	4 x 4 mm	Receiver

CATV Amplifiers (Cont.)

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style	Applications
TGA2806-SM	CATV Linear Amplifier	40 to 1,000	20	28	45	1.7	8	380	5 x 5 mm	General Purpose Dual
TGA2807-SM	CATV Linear Amplifier	40 to 1,000	18.5	28	43	2.3	6	318	5 x 5 mm	Headend DOCSIS
TAT6254B	50 - 1,000 MHz FTTH/RFoG Amplifier	50 to 1,000	38	–	–	–	12 or 5	100 or 220	4 x 4 mm	Receiver
TAT6254C	50 - 1000 MHz FTTH RF Amplifier	50 to 1,000	33	–	–	–	12 or 5	100 or 220	4 x 4 mm	Receiver
*TAT6281***	50 - 1000 MHz FTTH Integrated Variable Gain Receiver	50 to 1,000	33	–	–	–	5	300	6 x 6 mm	Receiver
*TAT7427B-T1**	75 Ohm, 50 - 1000 MHz Single Ended RF Amplifier	50 to 1,000	18.5	–	39	2.5	8	145	SOT-89	Single Ended Home Amplifier
*TAT7430B-T1**	75 Ohm, 50 - 1000 MHz Single Ended RF Amplifier	50 to 1,000	22	22	41	2	5 to 8	190	SOT-89	Single Ended Home Amplifier
TAT7461	75 Ohm, 50 - 1,000 MHz Single Ended RF Amplifier	50 to 1,000	16	22	39	2.5	6	130	SOT-89	Single Ended Home Amplifier
*TAT7461-x**	75 Ohm, 50 - 1,000 MHz Single Ended RF Amplifier	50 to 1,000	16	24	39	2.5	5	115	SOT-89	Single Ended Home Amplifier
TAT7466	75 Ohm, 50 - 1,000 MHz RF Amplifier	50 to 1,000	14	–	41	4.5	6	190	SOIC-8	General Purpose Dual
*TAT8858A1H**	CATV Infrastructure Push Pull Amplifier	50 to 1,000	27 to 34	28	44	3	24	270	SOIC-16W	Infrastructure
TAT7469	75 Ohm, 50 - 1,200 MHz RF Amplifier	50 to 1,200	17.5	–	38	3.2	5	250	SOIC-8	General Purpose Dual
TAT8804D1H	21 dB CATV 12 V Power Doubler	50 to 1,200	21	35	49	4.5	12	650	5 x 7 mm	Infrastructure
*TAT9988**	GaN CATV MMIC Power Doubler	50 to 1,200	24	–	53	3.5	24	445	5 x 7 mm	Infrastructure
TAT7460	75 Ohm, 50 - 2600 MHz Single Ended RF Amplifier	50 to 2,600	16.5	20.5	36	2.5	5	100	SOT-89	Single Ended Home Amplifier
TAT7460B1A	CATV 50 - 2,600 MHz Amplifier	50 to 2,600	17	20	38	3	5	100	SOT-89	CATV + SAT Gain Block

NOTES: ** = New*

CATV Hybrid Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	RF Output / Tilt (dBmV / dB)	CSO (dBc)	CTB (dBc)	Voltage (V)	Current (mA)	Package Style	Applications
*TAT8884HO**	CATV High Output GaAs Power Doubler Hybrid	50 to 1,000	26	55 / 18	-75	-78	24	440	SOT115J	Power Doubler
*TAT8888**	CATV High Output GaN Power Doubler Hybrid	50 to 1,000	24	61 / 18	-65	-65	24	440	SOT115J	Power Doubler

NOTES: ** = New, ** = Preview*

Gain Block Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
TQP369180	Cascadable Gain Block	DC to 6,000	15.7	15.2	29.8	3.6	5	45	SOT-89
TQP369181	Cascadable Gain Block	DC to 6,000	15.6	15.2	30	3.6	5	45	SOT-363
TQP369182	Cascadable Gain Block	DC to 6,000	22.3	16.1	29.6	3.8	5	45	SOT-89
TQP369184	Cascadable Gain Block	DC to 6,000	22	16.2	29.8	3.8	5	45	SOT-363
TQP369185	Cascadable Gain Block	DC to 6,000	19	19.6	31.7	4.7	5	75	SOT-89
*TQL9047**	High Linearity Gain Block with Shutdown Function	50 to 4,000	14.5	21.2	35.5	1.6	5	70	2 x 2 mm
*TQL9048**	High Linearity Gain Block with Shutdown Function	50 to 4,000	14.5	22	40.5	1.7	5	130	2 x 2 mm
TQP3M9038	High Linearity LNA Gain Block	50 to 4,000	14.9	21.6	39.5	2	5	85	3 x 3 mm

NOTES: ** = New*

Protection Circuits

Part	Description	Trigger Voltage 1 (V)	Trigger Voltage 2 (V)	Trigger Voltage 3 (V)	Capacitance (fF)	Package (mm)
TQP200002	ESD Protection Circuit	19	27	46	50 to 65	1.5 x 1.2

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
855748	Filter - Broadband Access	SAW	36.15	8.14	20.59	SE/SE	27.2 x 12.6
855079	Filter - Broadband Access	SAW	44	6	20.3	SE/SE	27.2 x 12.6
856129	Filter - Broadband Access	SAW	44	6	20.8	SE/SE	24.6 x 9
855659	Filter - Broadband Access	SAW	110.59	0.79	6.52	SE/SE	13.3 x 6.5
855068	Filter - Broadband Access	SAW	202.75	1.1	6.6	SE/SE	13.3 x 6.5
855104	Filter - Broadband Access	SAW	499.25	1	7.08	SE/SE	9 x 7.01
855964	Filter - Broadband Access	SAW	1,086	10	4	BAL/BAL	3 x 3
856330	Broadband Access IF SAW Filter	SAW	1,086	10	4	BAL/BAL	3 x 3
856096	Filter - Broadband Access	SAW	1,090	10	5.6	BAL/BAL	3.8 x 3.8
857179	1090 MHz SAW Filter	SAW	1,090	10	5.6	BAL/BAL	3.8 x 3.8
856298	Filter - Broadband Access	SAW	1,220	10	4.5	BAL/BAL	3 x 3
856598	Broadband Access IF SAW Filter	SAW	1,220	50	3.9	BAL/BAL	3.8 x 3.8
856653	Filter - Broadband Access	SAW	1,250	100	6.8	BAL/BAL	3 x 3

Variable Gain Amplifiers

Part	Description	Frequency (MHz)	Attenuation Range (dB)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package (mm)
TAT3814	5 - 300 MHz Variable Gain Return Path Amplifier	5 to 300	20	36	26	40	IRL 15, ORL 20	8	320	6 x 6
TAT2814A	Variable Gain DOCSIS 3.0 Amplifier	45 to 1,003	18	30	28	49	2.7	5, 8	290, 415	7 x 7

GPS Front End Modules

Part	Description	NF (dB)	Gain (dB)	Output IP3 (dBm)
TQM640002	GPS Low Noise Amplifier/Filter Module	1.56	16	> 9

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856288	Filter - GPS IF	SAW	465	6	1.43	SE/SE	3 x 3
856440	Filter - GPS L5 RF	SAW	1,176	35	2.4	SE/SE	2 x 1.5
857143	1,176.45 MHz SAW Filter	SAW	1,176.45	20.46	0.5	SE/SE	1.4 x 1.2
857144	1,176.45 MHz SAW Filter	SAW	1,176.45	20.46	2	SE/SE	1.4 x 1.2
856700	GPS L2 SAW Filter	SAW	1,227.60	31	1.1	SE/SE	2 x 1.5
857141	1,227.6 MHz SAW Filter	SAW	1,227.60	20.46	0.5	SE/SE	1.4 x 1.2
857142	1,227.6 MHz SAW Filter	SAW	1,227.60	20.46	2.1	SE/SE	1.4 x 1.2
*880366**	1,227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	12	1.5	SE/SE	3.26 x 1.6
880372	1,227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	15	3	SE/SE	3.71 x 2.57
880365	1,380 MHz GPS L3/L4 BAW Filter	BAW	1,380	38	2.75	SE/SE	3.26 x 1.6

SAW/BAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856039	GPS SAW Filter	SAW	1,575.42	2	1.8	SE/SE	3 x 3
856139	GPS SAW Filter	SAW	1,575.42	2.4	1.3	SE/SE	3 x 3
856561	GPS SAW Filter, SE/SE	SAW	1,575.42	2	0.75	SE/SE	1.4 x 1.2 x 0.46
856576	GPS SAW Filter, SE/BAL	SAW	1,575.42	2	1.1	SE/BAL	1.4 x 1.2
856793	GPS SAW Filter, SE/SE	SAW	1,575.42	2.4	0.6	SE/SE	1.4 x 1.2
857139	1,575.42 MHz SAW Filter	SAW	1,575.42	20.46	0.6	SE/SE	1.4 x 1.2
857140	1,575.42 MHz SAW Filter	SAW	1,575.42	20.46	2.6	SE/SE	1.4 x 1.2
880085	1,575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	15	1.5	SE/SE	3.26 x 1.6
*880098**	1,575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	20	4 Max	SE/SE	3.71 x 2.57
880373	1,575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	23	3	SE/SE	3.71 x 2.57
*857207**	1,585.66 MHz SAW Filter	SAW	1,585.66	41	1.45	SE/BAL	1.4 x 1.2
856909	1,601.5 MHz SAW Filter	SAW	1,601.50	17	2.2	SE/SE	3 x 3

NOTES: ** = New*

Attenuators

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Bits	Control Voltage (V)	Package Style
TGL4203	50 GHz Wideband Analog Attenuator	Analog	DC to 50	2	17	15	N/A	-1 to 0	Die
TGL4203-SM	DC - 30 GHz Wideband Analog Attenuator	Analog	DC to 30	1.5	16	20	N/A	-1 to 0	Die
TQP4M9071	Parallel Controlled 6 Bit, 31.5 dB Digital Step Attenuator	Digital	0 to 4	1.6	31.5	30	6	5	4 x 4 mm
TQP4M9072	Serial Controlled 6 Bit, 31.5 dB Digital Step Attenuator	Digital	0 to 4	1.6	31.5	30	6	5	4 x 4 mm
TQP4M9083	High Linearity Serial Controlled 7 Bit, 31.75 dB Digital Step Attenuator	Digital	0.4 to 3.5	1.5	31.75	30	7	5	4 x 4 mm

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
TGF2021-04-SD	DC - 4 GHz Packaged Power pHEMT	DC to 4	16	26.5	–	0.6	–	5	150	SOT-89
TGF2018	180 um Discrete GaAs pHEMT	DC to 20	14	–	22	1	55	8	29	Die
TGF2025	250 um Discrete GaAs pHEMT	DC to 20	14	–	25	0.9	58	8	41	Die
TGF2040	400 um Discrete GaAs pHEMT	DC to 20	13	–	26	1.1	55	8	65	Die
TGF2060	600 um Discrete GaAs pHEMT	DC to 20	12	–	28	1.4	55	8	97	Die
TGF2080	800 um Discrete GaAs pHEMT	DC to 20	11.5	–	29.5	–	56	8	129	Die
TGF2120	1,200 um Discrete GaAs pHEMT	DC to 20	11	31	–	–	57	8	194	Die
TGF2160	1,600 um Discrete GaAs pHEMT	DC to 20	10.4	32.5	–	–	63	8	258	Die
TGA2602-SM	Dual GaAs pHEMT	0.8 to 3	20.5	20	–	0.55	–	4	100	2 x 2 mm

Driver Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
TQP7M9105	1 W 5V High Linearity Amplifier	50 to 1,500	19.4	30	49	6.3	5	220	SOT-89
TQP7M9106	2 W 5V High Linearity Amplifier	50 to 1,500	20.8	33	50	4.8	5	455	4 x 4 mm

Driver Amplifiers (Cont.)

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
AH225-S8G	1 W Linear Amplifier	400 to 2,700	15.2	31	47	6.3	5	300	SOIC-8
AH420-EG	4 W Linear Amplifier	400 to 2,700	16	35.7	50	5.3	5	800	4 x 5 mm
AH128-89G	0.25 W Linear Amplifier	400 to 3,500	16.9	25	40	4.6	5	115	SOT-89
AH125-89G	0.5 W Linear Amplifier	400 to 3,600	16.2	28	45	4.4	5	150	SOT-89
TQP7M9101	0.25 W Linear Amplifier	400 to 4,000	17.5	24.8	40	4	5	88	SOT-89
TQP7M9102	0.5 W Linear Amplifier	400 to 4,000	17.8	27.5	44	3.9	5	137	SOT-89
TQP7M9103	1 W Linear Amplifier	400 to 4,000	16.6	29.1	45	4.4	5	235	SOT-89
AH323-G	2 W 2-Stage Linear Amplifier	700 to 2,700	27	33	50	4.2	5	680	5 x 5 mm
TQP7M9104	2 W Linear Amplifier	700 to 2,700	15.8	32.8	49.5	4.4	5	435	4 x 4 mm

Frequency Converters / Mixers

Part	Description	RF (GHz)	IF (GHz)	LO (GHz)	Gain (dB)	Output IP3 (dBm)	NF (dB)	Output P1dB (dBm)	LO Power (dBm)	Voltage (V)	Current (mA)	Package (mm)
CMY212	Downconverter with LO, IF Amplifiers	0.5 to 2.5	0.05 to 0.25	0.5 to 2.5	10	20	8	8	-4	3	11	SCT598

Gain Block Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
AG603-89G	Cascadable Gain Block	DC to 3,000	18.5	19.5	33	3.8	6	75	SOT-89
AG602-89G	Cascadable Gain Block	DC to 3,500	14	18.5	33	4.4	6	75	SOT-89
ECG008B-G	Cascadable Gain Block	DC to 4,000	15	24	40	4.6	9	120	SOT-89
ECG006C-G	Cascadable Gain Block	DC to 5,500	15	15.5	32	3.7	5	45	SOT-86
AG604-86G	Cascadable Gain Block	DC to 6,000	21.5	19.5	33.5	3.5	6	75	SOT-86
AG604-89G	Cascadable Gain Block	DC to 6,000	21.5	19.5	33.5	3.5	6	75	SOT-89
ECG003B-G	Cascadable Gain Block	DC to 6,000	20	24	39	3.5	9	110	SOT-89
TQP369180	Cascadable Gain Block	DC to 6,000	15.7	15.2	29.8	3.6	5	45	SOT-89
TQP369181	Cascadable Gain Block	DC to 6,000	15.6	15.2	30	3.6	5	45	SOT-363
AG201-63G	Cascadable Gain Block	DC to 6,000	11	6.5	19.5	4.4	5	20	SOT-363
AG201-86G	Cascadable Gain Block	DC to 6,000	11	6.5	19.5	4.4	5	20	SOT-86
AG203-63G	Cascadable Gain Block	DC to 6,000	20	8	21	3.1	5	20	SOT-363
AG203-86G	Cascadable Gain Block	DC to 6,000	20	8	21	3.1	5	20	SOT-86
AG302-63G	Cascadable Gain Block	DC to 6,000	15.5	13.5	26	3.2	5	35	SOT-363
AG302-86G	Cascadable Gain Block	DC to 6,000	15.5	13.5	26	3.2	5	35	SOT-86
AG303-63G	Cascadable Gain Block	DC to 6,000	20.5	14	26	3	5	35	SOT-363
AG303-86G	Cascadable Gain Block	DC to 6,000	20.5	14	26	3	5	35	SOT-86
AG402-86G	Cascadable Gain Block	DC to 6,000	15	17	32.5	3.7	6	60	SOT-86
AG402-89G	Cascadable Gain Block	DC to 6,000	15	17	32.5	3.7	6	60	SOT-89
AG403-86G	Cascadable Gain Block	DC to 6,000	21	18	31.5	3	6	60	SOT-86
AG403-89G	Cascadable Gain Block	DC to 6,000	21	18	31.5	3	6	60	SOT-89
TQP369182	Cascadable Gain Block	DC to 6,000	22.3	16.1	29.6	3.8	5	45	SOT-89
TQP369184	Cascadable Gain Block	DC to 6,000	22	16.2	29.8	3.8	5	45	SOT-363
TQP369185	Cascadable Gain Block	DC to 6,000	19	19.6	31.7	4.7	5	75	SOT-89
WJA1500	Cascadable Gain Block	50 to 1,000	19.2	20.5	44	5	5	95	SOT-89
WJA1510	Cascadable Gain Block	50 to 1,000	14.2	20	47	5.4	5	95	SOT-89
TQP3M9028	High Linearity Low Noise Gain Block	50 to 4,000	14.7	20.7	40	2	5	85	SOT-89
*TQL9047**	High Linearity Gain Block with Shutdown Function	50 to 4,000	14.5	21.2	35.5	1.6	5	70	2 x 2 mm
*TQL9048**	High Linearity Gain Block with Shutdown Function	50 to 4,000	14.5	22	40.5	1.7	5	130	2 x 2 mm
TQP3M9038	High Linearity LNA Gain Block	50 to 4,000	14.9	21.6	39.5	2	5	85	3 x 3 mm

NOTES: ** = New*

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
TQP3M9008	High Linearity Low Noise Gain Block	0.05 to 4	1.3	20.6	35.5	20	5	85	SOT-89
TQP3M9009	High Linearity Low Noise Gain Block	0.05 to 4	1.3	21.8	39.5	22	5	125	SOT-89
TQP3M9018	High Linearity Low Noise Gain Block	0.05 to 4	1.3	20.5	36	20	5	85	3 x 3 mm
TQP3M9019	High Linearity Low Noise Gain Block	0.05 to 4	1.3	22	39.5	22	5	125	3 x 3 mm
TQP3M9005	Low Noise Amplifier Gain Block	0.1 to 4	0.8	15.3	34	22.3	5	50	3 x 3 mm
TQP3M9007	High Linearity Low Noise Gain Block	0.1 to 4	1.3	13	41	23.6	5	125	SOT-89
TQL9042	Ultra Low Noise, High Linearity LNA with Bypass Function	0.5 to 2	0.42	19	36	23	5	70	3 x 3 mm
TQP3M9006	High Linearity Low Noise Gain Block	0.5 to 4	1	13.5	38.5	22.4	5	90	3 x 3 mm
TQL9043	Ultra Low Noise, High Linearity LNA with Bypass Function	1.5 to 4	0.6	17.5	33	19.4	5	80	3 x 3 mm
TQL9044*	Ultra Low Noise, High Linearity LNA with Bypass Function	1.5 to 4	0.6	19.4	34.5	20.4	5	70	3 x 3 mm

NOTES: **** = New***

Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA4534-SM	K-Band Power Amplifier	17.7 to 19.7	34	21	9	–	6	1,430
TGA4535-SM	K-Band Power Amplifier	21.2 to 23.6	34	22	8	–	6	1,430
TGA4536-SM*	K-Band Power Amplifier	24.2 to 26.5	34	18	7	20	6	1,430
TGA4542	37 - 40 GHz Power Amplifier	37 to 40	32.4	26	–	18	6	900
TGA4543	40.5 - 43.5 GHz Power Amplifier	40.5 to 43.5	30	23	–	–	6	900

NOTES: **** = New***

SAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
854652	Filter - Standard Low Loss	SAW	70	1.1	7.3	SE/SE	19 x 6.5
854653	Filter - Standard Low Loss	SAW	70	1.52	7.5	SE/SE	19 x 6.5
854654	Filter - Standard Low Loss	SAW	70	2.1	7.85	SE/SE	19 x 6.5
854655	Filter - Standard Low Loss	SAW	70	2.59	8.75	SE/SE	19 x 6.5
854656	Filter - Standard Low Loss	SAW	70	3.5	6.95	SE/SE	13.3 x 6.5
854657	Filter - Standard Low Loss	SAW	70	3.8	7.25	SE/SE	13.3 x 6.5
854658	Filter - Standard Low Loss	SAW	70	4.45	6.8	SE/SE	13.3 x 6.5
854659	Filter - Standard Low Loss	SAW	70	4.9	6.8	SE/SE	13.3 x 6.5
854660	Filter - Standard Low Loss	SAW	70	5.35	7.25	SE/SE	13.3 x 6.5
854661	Filter - Standard Low Loss	SAW	70	6.35	7.5	SE/SE	13.3 x 6.5
854662	Filter - Standard Low Loss	SAW	70	7.4	8.5	SE/SE	13.3 x 6.5
854663	Filter - Standard Low Loss	SAW	70	8.4	9	SE/SE	13.3 x 6.5
854664	Filter - Standard Low Loss	SAW	70	9.4	9.75	SE/SE	13.3 x 6.5
854665	Filter - Standard Low Loss	SAW	70	10.45	10	SE/SE	13.3 x 6.5
854666	Filter - Standard Low Loss	SAW	70	12.5	11.5	SE/SE	13.3 x 6.5
854667	Filter - Standard Low Loss	SAW	70	14.45	12.5	SE/SE	13.3 x 6.5
854668	Filter - Standard Low Loss	SAW	70	16.5	12.5	SE/SE	13.3 x 6.5
854669	Filter - Standard Low Loss	SAW	70	18.5	13.5	SE/SE	13.3 x 6.5
854670	Filter - Standard Low Loss	SAW	70	20	14.5	SE/SE	13.3 x 6.5
854671	Filter - Standard Low Loss	SAW	70	22.3	15	SE/SE	13.3 x 6.5
854672	Filter - Standard Low Loss	SAW	70	24.45	16.25	SE/SE	13.3 x 6.5
854673	Filter - Standard Low Loss	SAW	70	26.4	17	SE/SE	13.3 x 6.5
854674	Filter - Standard Low Loss	SAW	70	28.5	17.6	SE/SE	13.3 x 6.5
854675	Filter - Standard Low Loss	SAW	70	30.3	17.5	SE/SE	13.3 x 6.5
854678	Filter - Standard Low Loss	SAW	70	36.2	20.2	SE/SE	13.3 x 6.5
854680	Filter - Standard Low Loss	SAW	70	40.35	21.5	SE/SE	13.3 x 6.5
855735	Filter - Standard 70 High Selectivity	SAW	70	0.31	16.36	SE/SE	24.6 x 9

SAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
855736	Filter - Standard 70 High Selectivity	SAW	70	0.7	21.3	SE/SE	24.6 x 9
855737	Filter - Standard 70 High Selectivity	SAW	70	1	22.2	SE/SE	24.6 x 9
855738	Filter - Standard 70 High Selectivity	SAW	70	1	21.6	SE/SE	24.6 x 9
855739	Filter - Standard 70 High Selectivity	SAW	70	2.2	23	SE/SE	19 x 6.5
855740	Filter - Standard 70 High Selectivity	SAW	70	2.7	20.25	SE/SE	19 x 6.5
855741	Filter - Standard 70 High Selectivity	SAW	70	3.1	23	SE/SE	19 x 6.5
855743	Filter - Standard 70 High Selectivity	SAW	70	4.4	23	SE/SE	19 x 6.5
855744	Filter - Standard 70 High Selectivity	SAW	70	4.9	23.7	SE/SE	19 x 6.5
855745	Filter - Standard 70 High Selectivity	SAW	70	5.7	22.2	SE/SE	19 x 6.5
856152	73 MHz SAW Filter	SAW	73	0.3	6	SE/SE	24.6 x 9
854909	Filter - Standard Low Loss	SAW	140	4.6	10.85	SE/SE	13.3 x 6.5
854913	Filter - Standard Low Loss	SAW	140	7.148	5.5	SE/SE	13.3 x 6.5
854916	Filter - Standard Low Loss	SAW	140	10.59	8.3	SE/SE	13.3 x 6.5
854917	Filter - Standard Low Loss	SAW	140	12.4	8.87	SE/SE	13.3 x 6.5
854919	Filter - Standard Low Loss	SAW	140	16.9	8.4	SE/SE	13.3 x 6.5
854923	Filter - Standard Low Loss	SAW	140	24.26	11.33	SE/SE	13.3 x 6.5
854927	Filter - Standard Low Loss	SAW	140	33.4	11.5	SE/SE	13.3 x 6.5
855035	140 MHz SAW Filter	SAW	140	0.47	18.5	SE/SE	19 x 6.5
855579	140 MHz SAW Filter	SAW	140	1.7	11	SE/SE	19 x 6.5
856062	Filter - Standard 140 High Selectivity	SAW	140	0.75	20.8	SE/SE	19 x 6.5
856063	Filter - Standard 140 High Selectivity	SAW	140	1.5	21.9	SE/SE	19 x 6.5
856064	Filter - Standard 140 High Selectivity	SAW	140	2	21.5	SE/SE	19 x 6.5
856065	Filter - Standard 140 High Selectivity	SAW	140	3	22.4	SE/SE	19 x 6.5
856066	Filter - Standard 140 High Selectivity	SAW	140	6.2	23	SE/SE	13.3 x 6.5
856067	Filter - Standard 140 High Selectivity	SAW	140	7.1	24.5	SE/SE	13.3 x 6.5
856068	Filter - Standard 140 High Selectivity	SAW	140	8.2	23.4	SE/SE	13.3 x 6.5
856069	Filter - Standard 140 High Selectivity	SAW	140	10	20.87	SE/SE	13.3 x 6.5
856070	Filter - Standard 140 High Selectivity	SAW	140	14.1	23.3	SE/SE	13.3 x 6.5
856071	Filter - Standard 140 High Selectivity	SAW	140	16.2	21.7	SE/SE	13.3 x 6.5
856072	Filter - Standard 140 High Selectivity	SAW	140	33.2	21.7	SE/SE	9.0 x 7.01
856074	Filter - Standard 140 High Selectivity	SAW	140	57	18.65	SE/SE	9.0 x 7.01
856314	Filter - Standard 140 High Selectivity	SAW	140	72	21	SE/SE	9 x 7.01
856592	Low Loss IF Filter	SAW	140	21.6	9.3	SE/SE	13.3 x 6.5
856774	Filter - Standard Low Loss	SAW	140	56	22.3	BAL/BAL	9.1 x 4.8
855678	Filter - Other BTS	SAW	150	8	12.1	SE/SE	13.3 x 6.5
856990	Filter - MICS Band SAW	SAW	403.5	3	2.1	BAL/SE	3 x 3
856930	Filter - ISM Band SAW	SAW	457.5	15	2.2	SE/SE	3.8 x 3.8
856963	Filter - ISM Band SAW	SAW	875	10	1.8	SE/SE	2 x 1.5
856327	Filter - ISM Band SAW	SAW	915	26	2.3	SE/SE	2 x 1.5
856905	Filter - ISM Band SAW	SAW	921.5	13	1.9	SE/SE	2 x 1.5
857216*	1030 MHz SAW Filter	SAW	1,030	10	2.3	SE/SE	3 x 3
857215*	1090 MHz SAW Filter	SAW	1,090	10	2.6	SE/SE	3 x 3

NOTES: *** = New***

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
TQP4M0013*	High Isolation Absorptive SPST Switch	0.1 to 4	0.55	50	35	3.3	0.08	2 x 2 mm
TQP4M0009	High Isolation Reflective SPDT Switch	0.1 to 5	0.6	54	33	3.3	0.015	8-pin MSOP
TQP4M0008	Low Loss Reflective SPDT Switch	0.1 to 6	0.4	26	37	3.3	0.015	2 x 2 mm
TQP4M0010	High Isolation Absorptive SPDT Switch	0.1 to 6	0.5	55	33	3.3	0.07	4 x 4 mm
TQC0015*	High Isolation Absorptive SPDT Switch	0.1 to 6	0.5	60	33	3.3	0.1	4 x 4 mm
TQP4M0011	Low Loss Reflective SP3T Switch	0.1 to 6	0.6	34	34	3.3	0.015	12-pin 3 x 3 mm QFN Package

NOTES: *** = New***

Variable Gain Amplifiers

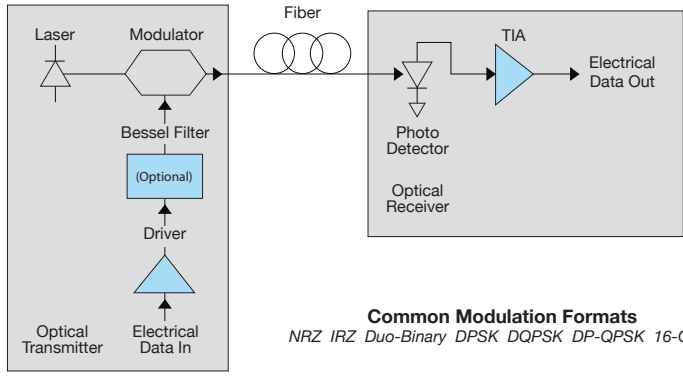
Part	Description	Frequency (MHz)	Attenuation Range (dB)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package (mm)
TQM8M9075	Digital Variable Gain Amplifier	50 to 4,000	31.5	18	20.5	36.5	2.9	5	88	5 x 5
TQM8M9076	Digital Variable Gain Amplifier	50 to 4,000	31.5	19.5	22	38.5	2.9	5	125	5 x 5
TQM8M9077	Digital Variable Gain Amplifier	50 to 4,000	31.5	13	21.5	38.5	3.7	5	88	5 x 5
TQM8M9079	Variable Gain Amplifier	500 to 2,700	30	38	16	29	4	5	95	5 x 5
*TQC9305**	Digital Variable Gain Amplifier with Shutdown Mode	700 to 3,600	31.5	13	23	39.7	3.1	5	130	5 x 5

NOTES: ** = New*

WLAN Front End Modules

Part	Description	Frequency (GHz)	802.11 Standards	Typ Pout 1.78% EVM (dBm)	Typ Pout 3.0% EVM (dBm)	Tx Gain (dB)	Rx Gain (dB)	Rx NF (dB)	Nom Bias Voltage (V)	Current (mA)	Package (mm)
*TQL1600**	5 GHz WLAN Switch/LNA Front End Module	5.15 to 5.875	a/n/ac	–	–	–	13	2.5	3.3, 5	8	2.5 x 2.5 x 0.45
TQP8080	5 GHz WLAN 802.11a/n/ac Front End Module with PA + Pdet, SP2T and LNA	5.15 to 5.875	a/n/ac	18	20	29.5	13	2.5	5	240	2.5 x 2.5 x 0.4

NOTES: ** = New*



Common Modulation Formats
NRZ IRZ Duo-Binary DPSK DQPSK DP-QPSK 16-QAM

Optical Systems (10, 40 & 100 Gb/s)

Attenuators

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Control Voltage (V)	Package Style
TGL4203-SM	DC - 30 GHz Wideband Analog Attenuator	Analog	DC to 30	1.5	16	20	-1 to 0	Die
TGL4203	50 GHz Wideband Analog Attenuator	Analog	DC to 50	2	17	15	-1 to 0	Die

Bessel Filters & Through Lines

Part	Description	3 dB Frequency Cut-Off (GHz)	Group Delay (psec)	Return Loss (dB)	Package Style
TGB2010-00	Bessel Filter (Thru)	Thru	< ±1.25	> 15	Die
TGB2010-06	6 GHz Bessel Filter	6	< ±1.25	> 15	Die
TGB2010-07	7 GHz Bessel Filter	7	< ±1.25	> 15	Die
TGB2010-08	8 GHz Bessel Filter	8	< ±1.25	> 15	Die
TGB2010-09	9 GHz Bessel Filter	9	< ±1.25	> 15	Die
TGB2010-10	10 GHz Bessel Filter	10	< ±1.25	> 15	Die
TGB2010-11	11 GHz Bessel Filter	11	< ±1.25	> 15	Die

CATV Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package (mm)	Applications
TGA2803-SM	CATV TIA/Gain Block	40 to 1,000	20	28	45	1.5	8	350	4 x 4	Receiver

Modulator Drivers

Part	Description	Frequency (GHz)	Vpp (V)	Gain (dB)	3 dB Bandwidth (GHz)	Voltage (V)	Current (mA)	Package Style
*TGA4195-SM**	11.3 Gb/s EML Driver, Diff In/Diff Out	DC to 10	6	26	8	3.3	0.65	4 x 4 mm
TGA4953-SL	9.9 - 12.5 Gb/s Optical Modulator Driver	DC to 12	10	35	10	5	210	11.4 x 8.9 mm
TGA4954-SL	9.9 - 12.5 Gb/s Optical Modulator Driver	DC to 12	9	35	10	5	180	11.4 x 8.9 mm
TGA4826-SM	9 - 18 Gb/s, 3 - 10 Vpp Linear Modulator Driver	DC to 18	3 to 10	24	15	7	280	6 x 6 mm
*TGA4892-SL**	200Gb/s 16 QAM Linear Dual Driver, SE In/SE Out	DC to 27	3 to 5	24	25	5 - 7	500	13 x 10.6 mm
TGA4957-SM	28 Gb/s Differential Modulator Driver Amplifier	DC to 28	4 to 8	20	22	5	470	6 x 6 mm
TGA4943-SL	40 & 100 Gb/s, 8 Vpp Optical Modulator Driver	DC to 30	4 to 9	32	30	6	280	14.4 x 7 mm
*TGA4893-SL***	200Gb/s 16 QAM Linear Dual Driver, Diff In/SE Out	DC to 30	4 to 5	24	25	5	500	16.1 x 10.6 mm
TGA4959-SL	32 Gb/s Differential SMT Modulator Driver	DC to 30	6 to 9	24	27	5	428	10 x 7 mm
*TGA4894-SL**	100Gb/s Linear Dual Driver, SE In/SE Out	DC to 30	5 to 8	33	25	5 - 7	650	16.1 x 10.6 mm
*TGA4840-SM**	28Gb/s CFP2/CFP4 Modulator Driver	DC to 32	1 to 3	10	25	3.3	50	4 x 3 mm
TGA4832	DC - 35 GHz Wideband Amplifier	DC to 35	4	12	35	5	135	Die
*TGA4947-MOD**	Quad Channel 100Gb/s Modulator Driver	DC to 35	3 to 9	27	32	5 to 6	1,100	45 x 33.4 mm
TGA4947-SL	100 Gb/s, 8 Vpp Dual Channel SMT Driver with 2 Internal Bias-T's	DC to 35	3 to 9	32	32	5 to 6	468	16 x 10.5 mm
TGA4830	CFP Low Power Driver	DC to 40	2.5	13	40	5	50	Die
TGA4942-SL	22 - 43 Gb/s, 8 Vpp DPSK SMT Driver, Internal Bias-T	DC to 40	5 to 9	30	35	5 to 7	250	16 x 8 mm
TGA4803	DC to >50 GHz Medium Power Amplifier with AGC	DC to 50+	3.5	8	> 50	6.5	100	Die

NOTES: ** = New, **= Preview*

Power Amplifiers

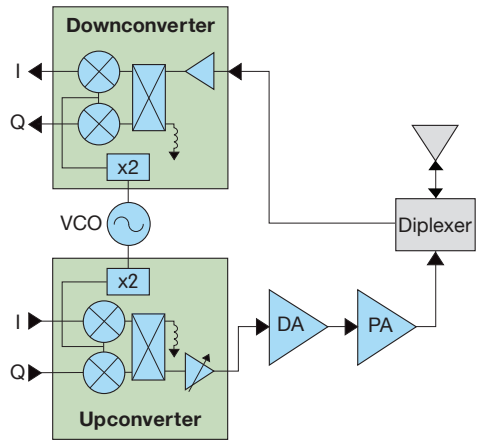
Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	Voltage (V)	IQ (mA)
*TGA2565-SM**	11-17 GHz Medium Power Amplifier	11 to 17	27	27	6	210

NOTES: ** = New*

Transimpedance Amplifiers

Part	Description	Bandwidth (GHz)	Differential Transimpedance Gain (ohm)	Differential Output Vpp (mV)	Equivalent Input Noise (pA/rtHz)	Voltage (V)	Current (mA)
TGA4861	Dual 13 Gb/s Linear Transimpedance Amplifier with AGC	11	250 to 4,800	200 to 900	24	3.3	175
TIA56A	43 Gb/s Limiting Transimpedance Amplifier with PLD	27	3,200	600	30	-5.2	85
TGA4864	Dual 32 Gb/s Linear Transimpedance Amplifier with AGC	28	250 to 4,800	200 to 900	24	3.3	175
TIA56	43 Gb/s Limiting Transimpedance Amplifier	30	4,500	600	30	-5.2	85
*TGA4872***	Dual 32 Gb/s Linear Transimpedance Amplifier with AGC	30	7000	200 to 900	20	3.3	175
*TGA4874***	Quad 32 Gb/s Linear Transimpedance Amplifier with AGC + Optional SPI Control	30	7000	200 to 900	20	3.3	350
*TGA4871***	4-Channel 28 Gb/s Limiting TIA	30	6000	600	15	3.3	300
*TGA4866***	44.6 Gb/s Limiting Transimpedance Amplifier	40	2,800	600	15	3.3	75

NOTES: *** = Preview*



Attenuators

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Control Voltage (V)	Package Style
TGL4203-SM	DC - 30 GHz Wideband Analog Attenuator	Analog	DC to 30	1.5	16	20	-1 to 0	Die
TGL4203	50 GHz Wideband Analog Attenuator	Analog	DC to 50	2	17	15	-1 to 0	Die

Through Lines

Part	Description	3 dB Frequency Cut-Off (GHz)	Return Loss (dB)	Package (mm)
TQM4M9073	Through Line	> 6	25	3 x 3

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
TGF2021-04-SD	DC - 4 GHz Packaged Power pHEMT	DC to 4	16	26.5	–	0.6	–	5	150	SOT-89
TGF2021-01	X-Band Discrete Power pHEMT	DC to 12	11	–	> 30	–	59	8 to 12	75 to 125	Die
TGF2021-02	X-Band Discrete Power pHEMT	DC to 12	11	–	> 33	–	59	8 to 12	150 to 250	Die
TGF2021-04	X-Band Discrete Power pHEMT	DC to 12	11	–	> 36		59	8 to 12	300 to 500	Die
TGF2021-08	X-Band Discrete Power pHEMT	DC to 12	11	–	> 39	–	59	8 to 12	600 to 1,000	Die
TGF2021-12	X-Band Discrete Power pHEMT	DC to 12	11	–	> 42	–	58	8 to 12	900 to 1,500	Die
TGF2023-2-01	6 W Discrete Power GaN on SiC HEMT	DC to 18	18	–	38	–	71.6	12 to 32	25 to 125	Die
TGF2023-2-10	50 W Discrete Power GaN on SiC HEMT	DC to 18	19.8	–	47.3	–	69.5	12 to 32	200 to 1,000	Die
TGF2023-2-20	90 W Discrete Power GaN on SiC HEMT	DC to 18	19.2	–	50.5	–	70.5	12 to 32	400 to 2,000	Die
TGF2018	180 um Discrete GaAs pHEMT	DC to 20	14	–	22	1	55	8	29	Die
TGF2022-06	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 28	–	58	8 to 12	45 to 75	Die
TGF2022-12	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 31	–	58	8 to 12	90 to 150	Die
TGF2022-24	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 34	–	58	8 to 12	180 to 300	Die
TGF2022-48	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 37	–	58	8 to 12	360 to 600	Die
TGF2022-60	Ku-Band Discrete Power pHEMT	DC to 20	12	–	> 38	–	57	8 to 12	448 to 752	Die
TGF2025	250 um Discrete GaAs pHEMT	DC to 20	14	–	25	0.9	58	8	41	Die
TGF2040	400 um Discrete GaAs pHEMT	DC to 20	13	–	26	1.1	55	8	65	Die
TGF2060	600 um Discrete GaAs pHEMT	DC to 20	12	–	28	1.4	55	8	97	Die
TGF2080	800 um Discrete GaAs pHEMT	DC to 20	11.5	–	29.5	–	56	8	129	Die
TGF2120	1200 um Discrete GaAs pHEMT	DC to 20	11	31	–	–	57	8	194	Die
TGF2160	1600 um Discrete GaAs pHEMT	DC to 20	10.4	32.5	–	–	63	8	258	Die
TGF4350	0.3 mm, 0.25-µm mmW pHEMT 2MI	DC to 22	13 @ 10 GHz	–	16	0.8 @ 10 GHz	–	3	15	Die

Frequency Converters/Mixers

Part	Description	RF (GHz)	IF (GHz)	LO (GHz)	Gain (dB)	Output IP3 (dBm)	NF (dB)	Output P1dB (dBm)	LO Power (dBm)	Voltage (V)	Current (mA)	Package Style
*TGC2610-SM**	Ku-Band Downconverter	10 to 15.4	DC to 4	6 to 19	14	16	1.5	7	0 to 8	4	160	5 x 5 mm
TGC2510-SM	Ku-Band Upconverter	10 to 16	DC to 3.5	6.5 to 19	17	33		10	0 to 6	5	300	5 x 5 mm
TGC4403	8 - 15 GHz Doubler with Amplifier	16 to 30	8 to 15	–	20	–	–	20	–	5	150	Die
TGC4403-SM	8 - 15 GHz Packaged Doubler with Amplifier	16 to 30	8 to 15	–	18	–	–	20	–	5	150	4 x 4 mm
TGC4402	17 - 27 GHz Upconverting Mixer	17 to 27	0.5 to 3	14 to 28	-9	10	9	–	17	-0.9	–	Die
*TGC4405**	17 - 27 GHz Upconverter	17 to 27	0.5 to 3	8 to 13	13	–	–	–	2 to 5	5	425	Die
*TGC4405-SM**	17 - 27 GHz Packaged Upconverter	17 to 27	0.5 to 3	8 to 13	13	28	–	–	2	5	425	4 x 4 mm
TGC4610-SM	K-Band Downconverter	17 to 27	DC to 4	6.5 to 15.5	15	18	2.5		5.5	3	228	5 x 5 mm
TGC4510-SM	K-Band Upconverter	17.7 to 26.5	DC to 4	6.85 to 15.25	13	32	15	23	6	5, 3.3	360, 170	5 x 5 mm
TGC4402-SM	18 - 26 GHz Packaged Upconverting Mixer	18 to 26	0.5 to 3	16 to 26	-9	10	9	–	19	-0.9	–	4 x 4 mm
TGC1430F	Doubler	20 to 40	–	–	-12	–	–	–	–	–	–	Die
TGC4407-SM	Ka-Band Upconverter	21.5 to 32.5	DC to 7	11 to 16	-9	4	9	-5	0 to 7.5	5	65	3 x 3 mm
TGC4406-SM	28 - 34 GHz Packaged Doubler with Amplifier	28 to 34	14 to 17	–	15	–	–	20	–	5	150	4 x 4 mm
*TGC4546-SM**	37-46 GHz Upconverter	37 to 46	DC to 3.5	8.35 to 11.5	12	26	18.5	21	2 to 8	5	430	5 x 5 mm
*TGC4671***	71 - 86 GHz Sub-Harmonic Image Reject Mixer	71 to 86	DC to 7	31 to 42	-12	–	–	–	15	–	–	Die

NOTES: ** = New, ** = Preview*

Gain Block Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
TQP369180	Cascadable Gain Block	DC to 6,000	15.7	15.2	29.8	3.6	5	45	SOT-89
TQP369181	Cascadable Gain Block	DC to 6,000	15.6	15.2	30	3.6	5	45	SOT-363
TQP369182	Cascadable Gain Block	DC to 6,000	22.3	16.1	29.6	3.8	5	45	SOT-89
TQP369184	Cascadable Gain Block	DC to 6,000	22	16.2	29.8	3.8	5	45	SOT-363
TQP369185	Cascadable Gain Block	DC to 6,000	19	19.6	31.7	4.7	5	75	SOT-89

Lange Couplers

Part	Description	Frequency (GHz)	Insertion Loss (dB)	Package Style
TGB2001	Lange Coupler	12 to 21	< 0.25	Die
TGB4001	Lange Coupler	18 to 32	< 0.25	Die
TGB4002	Lange Coupler	27 to 45	< 0.25	Die

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
*TGA2611***	2 - 6 GHz GaN LNA	2 to 6	1.5	25	32	22	10	110	Die
*TGA2611-SM***	2 - 6 GHz GaN LNA	2 to 6	1.2	25	32	22	10	100	4 x 4 mm Overmold QFN
TGA2525	2 - 18 GHz Low Noise Amplifier with AGC	2 to 18	2	17	29	22	5	75	Die
TGA2513-SM	Wideband Low Noise Amplifier	2 to 20	2.5	17	–	16	5	75	4 x 4 mm
TGA2526	2 - 20 GHz Low Noise Amplifier with AGC	2 to 20	2.5	17.5	29	22	5	100	Die

Low Noise Amplifiers (Cont.)

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
*TGA2567-SM**	2-20 GHz LNA Amplifier	2 to 20	2	17	29	19	5	100	QFN 4 x 4 mm 24L
TGA2513	Wideband Low Noise Amplifier	2 to 23	2	17	–	16	5	75	Die
*TGA2613***	S-Band High-Linearity LNA	2.5 to 4	2.5	12.5	29	29	6	320	Die
*TGA2614***	S-Band High Gain LNA	2.7 to 3.8	0.9	18	33	20	6	110	Die
*TGA2614-SM***	S-Band High Gain LNA	2.7 to 3.8	1.2	17	33	19	6	120	QFN 5 x 5 mm 32L
TGA2512-1-SM	4 - 14 GHz Balanced Low Noise Amplifier	4 to 14	2.3	25	16	12	5	160	4 x 4 mm
TGA2512-2-SM	4 - 14 GHz Balanced Low Noise Amplifier	4 to 14	2.3	25	24	12	5	160	4 x 4 mm
*TGM2543-SM***	4 - 20 GHz Limiter/Low Noise Amplifier	4 to 20	2	17	28	21	5	100	7 x 7 mm
TGA2512	X-Band Low Noise Amplifier	5 to 15	1.4	27	24	13	5	160	Die
*TGA2612***	6 - 12 GHz GaN LNA	6 to 12	1.8	22	29	20	10	100	Die
TGA2511	X-Band Low Noise Amplifier	6 to 14	1.3	20	24	12	5	160	Die
TGA4506	K-Band Low Noise Amplifier	20 to 27	2.2	21	–	12	3.5	60	Die
TGA4507	Ka-Band Low Noise Amplifier	28 to 36	2.3	22	–	12	3	60	Die
TGA4508	Ka-Band Low Noise Amplifier	30 to 42	2.8	21	–	14	3	40	Die

NOTES: ** = New, ** = Preview*

Modulator Drivers

Part	Description	Frequency (GHz)	Vpp (V)	Gain (dB)	3 dB Bandwidth (GHz)	Voltage (V)	Current (mA)	Package Style
TGA4832	DC - 35 GHz Wideband Amplifier	DC to 35	4	12	35	5	135	Die
TGA4830	CFP Low Power Driver	DC to 40	2.5	13	40	5	50	Die
TGA4803	DC to >50 GHz Medium Power Amplifier with AGC	DC to 50+	3.5	8	> 50	6.5	100	Die

Oscillators

Part	Description	Frequency (GHz)	Power (dBm)	Phase Noise (dBc/Hz)	Voltage (V)	Current (mA)	Package (mm)
TGV2561-SM	8.9 - 9.8 GHz VCO with Divide by 2	8.9 to 9.8	16	-114 @ 100 kHz	5	195	5 x 5
TGV2562-SM	9.5 - 10.3 GHz VCO with Divide by 2	9.5 to 10.3	15	-113 @ 100 kHz	5	195	5 x 5
TGV2563-SM	9.7 - 10.8 GHz VCO with Divide by 2	9.7 to 10.8	11	-111 @ 100 kHz	5	175	5 x 5
TGV2564-SM	10.3 - 11.1 GHz VCO with Divide by 2	10.3 to 11.1	10	-111 @ 100 kHz	5	175	5 x 5
TGV2539-SM	10.7 - 11.5 GHz VCO with Divide by 2	10.7 to 11.5	10	-111 @ 100 kHz	5	185	5 x 5
TGV2565-SM	11.3 - 12.3 GHz VCO with Divide by 2	11.3 to 12.3	11	-111 @ 100 kHz	5	180	5 x 5
TGV2529-SM	12.5 - 13.5 GHz VCO with Divide by 2	12.5 to 13.5	7	-110 @ 100 kHz	5	165	5 x 5
TGV2584-SM	12.6 - 13.8 GHz VCO with Divide by 2	12.6 to 13.8	10	-110 @ 100 kHz	5	180	5 x 5
TGV2566-SM	13.4 - 14.4 GHz VCO with Divide by 2	13.4 to 14.4	9	-110 @ 100 kHz	5	175	5 x 5

Phase Shifters

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	RMS Amplitude Error (dB)	RMS Phase Error (Degrees)	Bits	Control Voltage (V)	Package Style
TGP2100	30 GHz 5 Bit Phase Shifter	Digital	28 to 32	6	0.5	5	5	0, 5	Die

Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA2509-FL	Wideband Packaged High Power Amplifier with AGC	2 to 20	29	15	–	–	12	1,100
TGA2509	Wideband 1 W High Power Amplifier with AGC	2 to 22	30	17	–	–	12	1,100
TGA2706-SM	2 W C-Band Packaged Power Amplifier	5.5 to 8.5	34	31	7	–	6	1,260
TGA2701-SM	3 W C-Band Packaged Power Amplifier	5.9 to 8.5	35	18	–	37	6	1,000
TGA2501	High Power Amplifier	6 to 18	34.5	24	–	20	8	1,200
TGA9092-SCC	Power Amplifier (per channel)	6 to 18	34.5	24	–	20	8	1,200
TGA9083-SCC	Power Amplifier - pHEMT	6.5 to 11.5	37, 39	19	–	40, 35	7 to 9	1,200
TGA2701	7 - 8.5 GHz High Power Amplifier	7 to 8.5	37	21	–	> 40	5 to 7	1,050
TGA2700	X-Band Driver Amplifier	8 to 13	30	25	–	–	9	300
TGA2704	9 - 10.5 GHz High Power Amplifier	9 to 10.5	38	20	–	> 40	7 to 9	1,050
TGA2704-SM*	8 W, 9 - 11 GHz Power Amplifier	9 to 11	39	21	–	–	9	1,050
TGA2710-SM*	8 W, 9.5 - 11.5 GHz Power Amplifier	9.5 to 11.5	39	22	–	–	9	1,050
TGA2535-SM	X-Band Power Amplifier	10 to 12	34.5	25	–	30	6	1,300
TGA2710	10.5 - 12 GHz High Power Amplifier	10.5 to 12	38	19	–	> 40	7 to 9	1,050
TGA2565-SM*	11 - 17 GHz Medium Power Amplifier	11 to 17	27	27	–	–	6	210
TGA2524-SM	Ku-Band Power Amplifier	12 to 16	26.5	23	7	–	5	320
TGA2527-SM	Ku-Band Power Amplifier	12.5 to 15.5	31.5	25	7.5	–	6	650
TGA2533-SM	Ku-Band Power Amplifier	12.5 to 15.5	34.5	27	–	–	6	1,300
TGA2510	2 W Ku-Band Power Amplifier	12.5 to 17	34	26	–	–	7.5	650
TGA2510-TS	2 W Ku-Band Power Amplifier	12.5 to 17	34	26	–	–	7.5	650
TGA2533	Ku-Band Power Amplifier	12.7 to 15.4	35	28	6	–	6	1,300
TGA2514-FL	6.5 W Ku-Band Power Amplifier	13 to 16	38	24	–	–	8	2,600
TGA2505	Ku-Band High Power Amplifier	13 to 17	34	25	–	–	7	640
TGA2902-1-SCC-SG	2 W Packaged Amplifier	13 to 17	34	26	–	–	7.5	650
TGA2514	6.5 W Ku-Band Power Amplifier	13 to 18	38	24	–	–	8	2,600
TGA4530	K-Band High Linearity Power Amplifier	17 to 21	30	20	–	–	5 to 7	825
TGA9088A-SCC	20 GHz Medium Power Amplifier	17 to 21	22	18.5	–	–	7	66
TGA2521-SM	17 - 24 GHz Linear Driver Amplifier	17 to 24	25	20	5	–	5	320
TGA2522-SM	17 - 24 GHz Power Amplifier	17 to 24	28	17	–	–	5	712
TGA4531	K-Band High Linearity Power Amplifier	17 to 24	32	23	6	–	7	720
TGA4502-SCC	Ka-Band High Power Amplifier	17 to 27	29	22	–	–	7	760
TGA4030-SM	17 - 37 GHz Medium Power Amplifier/Multiplier	17 to 37	19	20	–	–	5	140
TGA4031-SM	17 - 40 GHz Medium Power Amplifier/Multiplier	17 to 40	19	22	–	–	5	140
TGA4040	17 - 43 GHz Medium Power Amplifier/Multiplier	17 to 43	22	25	–	–	5	140
TGA4532	K-Band Power Amplifier	17.5 to 20	32.5	23	6	–	6	900
TGA4532-SM	K-Band Power Amplifier	17.7 to 19.7	32.5	23	7	–	6	900
TGA4534-SM	K-Band Power Amplifier	17.7 to 19.7	34	21	9	–	6	1,430
TGA4022	K-Band High Power Amplifier	18 to 23	32.5	26	–	–	7	840
TGA1135B-SCC	K-Band High Power Amplifier	18 to 27	30	14	–	–	5 to 7	540
TGA1073G-SCC	K-Band Medium Power Amplifier	19 to 27	25	22	–	–	5 to 7	220
TGA4036	19 - 38 GHz Medium Power Amplifier	19 to 38	22	20	–	–	5	160
TGA4533-SM	K-Band Power Amplifier	21.2 to 23.6	32	22	6	–	6	880
TGA4535-SM	K-Band Power Amplifier	21.2 to 23.6	34	22	8	–	6	1,430
TGA4536-SM*	K-Band Power Amplifier	24.2 to 26.5	34	18	7	20	6	1,430
TGA4902-SM	Ka-Band Packaged Medium Power Amplifier	25 to 35	25	18	–	–	6	220
TGA4544-SM	K-Band Power Amplifier	26 to 31	31.5	23	5	–	6	1100
TGA1073A-SCC	Ka-Band Medium Power Amplifier	26 to 35	25	19	–	–	5 to 7	220
TGA4509	30 GHz High Power Amplifier	27 to 31	30	22	–	–	6	420
TGA4513	27 - 31 GHz, 2 W Balanced Power Amplifier	27 to 31	33	20	–	–	6	840
TGA1073B-SCC	Ka-Band High Power Amplifier	27 to 32	28.5	25	–	–	6 to 8	420
TGA4903-SM	Ka-Band Medium Power Amplifier	27 to 32	24	15	–	–	5	170
TGA4539-SM	1 W Ka-Band Power Amplifier	28 to 30	30.5	20	–	–	6	420
TGA4509-SM	1 W Ka-Band Packaged Power Amplifier	28 to 31	30	22	–	–	6	420
TGA4906	4 W Ka-Band High Power Amplifier	28 to 31	36	24	–	–	6	1,600
TGA4906-SM	4 W Ka-Band Packaged High Power Amplifier	28 to 31	36	23	–	–	6	1,600
TGA4512-SM	Ka-Band Driver Amplifier	28 to 32	17	14.5	7.5	–	6	80

Power Amplifiers (Cont.)

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA4916	7 W Ka-Band High Power Amplifier	29 to 31	38.5	21	–	–	6	3,200
*TGA4537-SM***	K-Band Power Amplifier	29 to 35	32	18	6	15	6	1,100
TGA4510	29 - 37 GHz Driver Amplifier	29 to 37	16	16	–	–	6	60
TGA4516	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050
TGA4516-TS	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050
TGA4514	2 W Ka-Band Power Amplifier	31 to 35	33.5	19	–	–	6 to 7	1,150
TGA4517	Ka-Band Power Amplifier	31 to 37	35	15	–	–	6	2,000
TGA4521	32 - 45 GHz Wideband Driver Amplifier	32 to 45	24	15	–	–	6	200
TGA1141	Ka-Band High Power Amplifier	33 to 36	31	17	–	–	6 to 7	880
TGA4522	33 - 47 GHz Wideband Driver Amplifier	33 to 47	27	14	–	–	6	400
TGA1073C-SCC	Ka-Band High Power Amplifier	36 to 40	26	15	–	–	5 to 7	240
TGA1171-SCC	Ka-Band High Power Amplifier	36 to 40	30	14	–	–	6 to 7	500
TGA4538	37 - 40 GHz Power Amplifier	37 to 40	29.5	24	–	–	5	600
TGA4542	37 - 40 GHz Power Amplifier	37 to 40	32.4	26	–	18	6	900
TGA4043	Q-Band Power Amplifier	40 to 45	29	10	–	–	7	500
TGA4543	40.5 - 43.5 GHz Power Amplifier	40.5 to 43.5	30	23	–	–	6	900
TGA4042	Q-Band Driver Amplifier	41 to 45	18	14	–	–	6	168
TGA4046	2 W Q-Band High Power Amplifier	41 to 46	33	16	–	–	6	2,000

NOTES: ** = New, ** = Preview*

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856019	Filter - Standard 140 High Selectivity	SAW	140	28.5	20	SE/SE	9 x 7.01
856020	Filter - Standard 140 High Selectivity	SAW	140	65	17.8	SE/SE	9 x 7.01
856073	Filter - Standard 140 High Selectivity	SAW	140	44	21.75	SE/SE	9 x 7.01
856656	Low Loss IF Filter	SAW	140	10	9.2	SE/SE	13.3 x 6.5
856684	Low Loss IF Filter	SAW	140	15	9.1	SE/SE	13.3 x 6.5
856691	Filter - Standard Low Loss	SAW	140	1.5	12.1	SE/SE, BAL/SE	9.1 x 4.8
856692	Filter - Standard Low Loss	SAW	140	3	13.6	SE/SE, BAL/BAL	9.1 x 4.8
856693	Filter - Standard Low Loss	SAW	140	6	11	BAL/BAL	9.1 x 4.8
856694	Filter - Standard Low Loss	SAW	140	7	13.6	SE/SE, BAL/BAL	9.1 x 4.8
856695	Filter - Standard Low Loss	SAW	140	10	10	BAL/BAL	9.1 x 4.8
856696	Filter - Standard Low Loss	SAW	140	14	8.5	SE/SE, BAL/BAL	9.1 x 4.8
856697	Filter - Standard Low Loss	SAW	140	20	9.8	BAL/BAL	9.1 x 4.8
856698	Filter - Standard Low Loss	SAW	140	28	18	SE/SE, BAL/BAL	9.1 x 4.8
856774	Filter - Standard Low Loss	SAW	140	56	22.3	BAL/BAL	9.1 x 4.8
856817	IF Filter	SAW	140	28.56	30	SE/SE	13.3 x 6.5
856517	IF Filter	SAW	153.6	32	13	SE/SE	13.3 x 6.5
856466	IF Filter - WiMAX	SAW	374	18	9	BAL/BAL	3.8 x 3.8
856490	Filter - Standard IF 380 MHz SAW	SAW	380	9.2	10	BAL/BAL	7 x 5.5
856631	Filter - Standard IF 380 MHz SAW	SAW	380	10.5	8.7	BAL/BAL	7 x 5.5
856652	Filter - WiMAX IF SAW	SAW	398	10	8.7	BAL/BAL	5 x 5
855731	Filter - Broadband Access	SAW	426	5.16	18.02	SE/SE	13.3 x 6.5
856549	Filter - Standard IF 456 MHz SAW	SAW	456	7.8	7.9	BAL/BAL	5 x 5
856638	Filter - Standard IF 456 MHz SAW	SAW	456	10	8.3	BAL/BAL	5 x 5
856672	Filter - Standard IF 456 MHz SAW	SAW	456	10	8.3	BAL/BAL	7 x 5.5
856288	Filter - GPS IF	SAW	465	6	1.43	SE/SE	3 x 3
855271	Filter - Standard IF 479.75 MHz SAW	SAW	479.75	11.7	19.5	SE/SE	7 x 5.5
855272	Filter - Test Equipment	SAW	479.75	25.5	9.8	SE/SE	7 x 5.5
856665	Filter - Standard IF 580 MHz SAW	SAW	580	10.5	10.7	BAL/BAL	7 x 5.5
856526	Filter - Standard IF 810 MHz SAW	SAW	810	10	3.5	SE/SE	3 x 3
856534	Filter - Standard IF 810 MHz SAW	SAW	810	5	4.6	SE/SE	3 x 3
857191	810 MHz SAW Filter	SAW	810	5	4.6	SE/SE	3 x 3

Switches

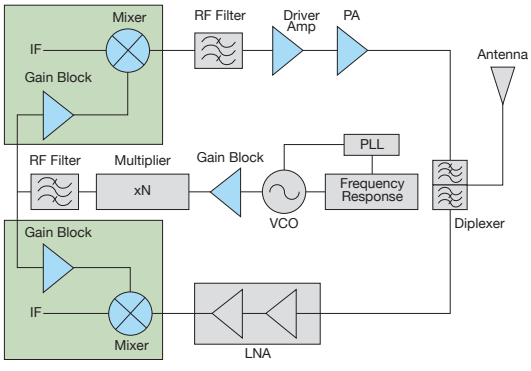
Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGS2303	SP3T VPIN	0.2 to 20	0.5	35	–	–	10	Die
TGS2304-SCC	SP4T VPIN	0.2 to 20	0.6	38	23	–	10	Die
*TGS2352-2-SM***	0.5 - 12 GHz High Power SPDT Reflective Switch	0.5 to 12	< 1	-35	20	0 to -40	–	QFN
*TGS2353-2-SM***	0.5 - 18 GHz High Power SPDT Reflective Switch	0.5 to 18	< 1.5	-30	10	0 to -40	–	QFN
TGS2313	4 - 18 GHz VPIN SP3T Switch	4 to 18	1.0	35	20	2.7, -2.7	20	Die
TGS2302	4 - 20 GHz VPIN SPDT Switch	4 to 20	0.9	35	20	2.7, -2.7	20	Die
TGS4302	High Power Ka-Band SPDT Switch	27 to 46	0.9	27	> 33	5, -5	20	Die
TGS4304	High Power Ka-Band Absorptive SPDT Switch	32 to 40	0.9	35	> 33	5, -5	30	Die

NOTES: *** = Preview*

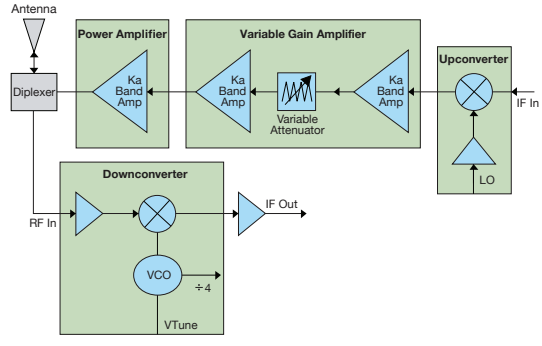
Variable Gain Amplifiers

Part	Description	Frequency (MHz)	Attenuation Range (dB)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
*TGA4541-SM**	Ka-Band Variable Gain Driver Amplifier	28,000 to 31,000	30	32	23	31	5	330	6 x 6

NOTES: ** = New*



Multi-Band VSAT



Ka-Band VSAT

Attenuators

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	Range (dB)	P1dB (dBm)	Control Voltage (V)	Package Style
TGL4203-SM	DC - 30 GHz Wideband Analog Attenuator	Analog	DC to 30	1.5	16	20	-1 to 0	Die
TGL4203	50 GHz Wideband Analog Attenuator	Analog	DC to 50	2	17	15	-1 to 0	Die

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
TGF2021-04-SD	DC - 4 GHz Packaged Power pHEMT	DC to 4	16	26.5	–	0.6	–	5	15	Die
TGF2021-01	X-Band Discrete Power pHEMT	DC to 12	11	–	> 30	–	59	8 to 12	29	Die
TGF2021-02	X-Band Discrete Power pHEMT	DC to 12	11	–	> 33	–	59	8 to 12	75 to 125	Die
TGF2021-04	X-Band Discrete Power pHEMT	DC to 12	11	–	> 36		59	8 to 12	150 to 250	Die
TGF2021-08	X-Band Discrete Power pHEMT	DC to 12	11	–	> 39	–	59	8 to 12	300 to 500	Die
TGF2021-12	X-Band Discrete Power pHEMT	DC to 12	11	–	> 42	–	58	8 to 12	150	SOT-89
TGF2018	180 um Discrete GaAs pHEMT	DC to 20	14	–	22	1	55	8	600 to 1,000	Die
TGF2022-06	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 28	–	58	8 to 12	900 to 1,500	Die
TGF2022-12	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 31	–	58	8 to 12	45 to 75	Die
TGF2022-24	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 34	–	58	8 to 12	90 to 150	Die
TGF2022-48	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 37	–	58	8 to 12	180 to 300	Die
TGF2022-60	Ku-Band Discrete Power pHEMT	DC to 20	12	–	> 38	–	57	8 to 12	360 to 600	Die
TGF2025	250 um Discrete GaAs pHEMT	DC to 20	14	–	25	0.9	58	8	448 to 752	Die
TGF2040	400 um Discrete GaAs pHEMT	DC to 20	13	–	26	1.1	55	8	41	Die
TGF2060	600 um Discrete GaAs pHEMT	DC to 20	12	–	28	1.4	55	8	65	Die
TGF2080	800 um Discrete GaAs pHEMT	DC to 20	11.5	–	29.5	–	56	8	97	Die
TGF2120	1200 um Discrete GaAs pHEMT	DC to 20	11	31	–	–	57	8	129	Die
TGF2160	1600 um Discrete GaAs pHEMT	DC to 20	10.4	32.5	–	–	63	8	194	Die
TGF2120	1200 um Discrete GaAs pHEMT	DC to 20	11	31	–	–	57	8	258	Die
TGF2160	1600 um Discrete GaAs pHEMT	DC to 20	10.4	32.5	–	–	63	8	15	Die
TGF4350	0.3 mm, 0.25-µm mmW pHEMT 2MI	DC to 22	13 @ 10 GHz	–	16	0.8 @ 10 GHz	–	3	194	Die

Frequency Converters/Mixers

Part	Description	RF (GHz)	IF (GHz)	LO (GHz)	Gain (dB)	Output IP3 (dBm)	NF (dB)	Output P1dB (dBm)	LO Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGC2510-SM	Ku-Band Upconverter	10 to 16	DC to 3.5	6.5 to 19	17	33	–	10	0 to 6	5	300	5 x 5 mm
*TGC2610-SM**	Ku-Band Downconverter	10 to 15.4	DC to 4	6 to 19	14	16	1.5	7	0 to 8	4	160	5 x 5 mm
TGC4403	8 - 15 GHz Doubler with Amplifier	16 to 30	8 to 15	–	20	–	–	20	–	5	150	Die
TGC4403-SM	8 - 15 GHz Packaged Doubler with Amplifier	16 to 30	8 to 15	–	18	–	–	20	–	5	150	4 x 4 mm
TGC4402	17 - 27 GHz Upconverting Mixer	17 to 27	0.5 to 3	14 to 28	-9	10	9	–	17	-0.9	–	Die
*TGC4405**	17 - 27 GHz Upconverter	17 to 27	0.5 to 3	8 to 13	13	–	–	–	2 to 5	5	425	Die
*TGC4405-SM**	17 - 27 GHz Packaged Upconverter	17 to 27	0.5 to 3	8 to 13	13	28	–	–	2	5	425	4 x 4
TGC4610-SM	K-Band Downconverter	17 to 27	DC to 4	6.5 to 15.5	15	18	2.5	–	5.5	3	228	5 x 5
TGC4510-SM	K-Band Upconverter	17.7 to 26.5	DC to 4	6.85 to 15.25	13	32	15	23	6	5, 3.3	360, 170	5 x 5
TGC4402-SM	18 - 26 GHz Packaged Upconverting Mixer	18 to 26	0.5 to 3	16 to 26	-9	10	9	–	19	-0.9	–	4 x 4 mm
TGC4408-SM	18 - 20 GHz Block Downconverter with Integrated VCO	18.3 to 20.2	0.95 to 1.95	–	8.5	1.5	6.5	-5.5	–	5	305	6 x 5
TGC1430F	Doubler	20 to 40	–	–	-12	–	–	–	–	–	–	Die
TGC4407-SM	Ka-Band Upconverter	21.5 to 32.5	DC to 7	11 to 16	-9	4	9	-5	0 to 7.5	5	65	3 x 3
TGC4406-SM	28 - 34 GHz Packaged Doubler with Amplifier	28 to 34	14 to 17	–	15	–	–	20	–	5	150	4 x 4

NOTES: ** = New*

Lange Couplers

Part	Description	Frequency (GHz)	Insertion Loss (dB)	Package Style
TGB2001	Lange Coupler	12 to 21	< 0.25	Die
TGB4001	Lange Coupler	18 to 32	< 0.25	Die
TGB4002	Lange Coupler	27 to 45	< 0.25	Die

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Output IP3 (dBm)	P1dB (dBm)	Voltage (V)	Current (mA)	Package Style
TGA2525	2 - 18 GHz Low Noise Amplifier with AGC	2 to 18	2	17	29	22	5	75	Die
TGA2513-SM	Wideband Low Noise Amplifier	2 to 20	2.5	17	–	16	5	75	Die
TGA2526	2 - 20 GHz Low Noise Amplifier with AGC	2 to 20	2.5	17.5	29	22	5	100	4 x 4 mm
TGA2513	Wideband Low Noise Amplifier	2 to 23	2	17	–	16	5	75	4 x 4 mm
TGA2512-1-SM	4 - 14 GHz Balanced Low Noise Amplifier	4 to 14	2.3	25	16	12	5	160	Die
TGA2512-2-SM	4 - 14 GHz Balanced Low Noise Amplifier	4 to 14	2.3	25	24	12	5	160	Die
TGA2512	X-Band Low Noise Amplifier	5 to 15	1.4	27	24	13	5	160	Die
TGA2511	X-Band Low Noise Amplifier	6 to 14	1.3	20	24	12	5	160	Die
TGA4506	K-Band Low Noise Amplifier	20 to 27	2.2	21	–	12	3.5	60	Die
TGA4507	Ka-Band Low Noise Amplifier	28 to 36	2.3	22	–	12	3	60	4 x 4 mm
TGA4508	Ka-Band Low Noise Amplifier	30 to 42	2.8	21	–	14	3	40	Die
TGA4600	60 GHz Low Noise Amplifier	57 to 65	4	13	–	–	3	41	Die

Oscillators

Part	Description	Frequency (GHz)	Power (dBm)	Phase Noise (dBc/Hz)	Voltage (V)	Current (mA)	Package (mm)
TGV2561-SM	8.9 - 9.8 GHz VCO with Divide by 2	8.9 to 9.8	16	-114 @ 100 kHz	5	195	5 x 5
TGV2562-SM	9.5 - 10.3 GHz VCO with Divide by 2	9.5 to 10.3	15	-113 @ 100 kHz	5	195	5 x 5
TGV2563-SM	9.7 - 10.8 GHz VCO with Divide by 2	9.7 to 10.8	11	-111 @ 100 kHz	5	175	5 x 5
TGV2564-SM	10.3 - 11.1 GHz VCO with Divide by 2	10.3 to 11.1	10	-111 @ 100 kHz	5	175	5 x 5
TGV2539-SM	10.7 - 11.5 GHz VCO with Divide by 2	10.7 to 11.5	10	-111 @ 100 kHz	5	185	5 x 5
TGV2565-SM	11.3 - 12.3 GHz VCO with Divide by 2	11.3 to 12.3	11	-111 @ 100 kHz	5	180	5 x 5
TGV2529-SM	12.5 - 13.5 GHz VCO with Divide by 2	12.5 to 13.5	7	-110 @ 100 kHz	5	165	5 x 5
TGV2584-SM	12.6 - 13.8 GHz VCO with Divide by 2	12.6 to 13.8	10	-110 @ 100 kHz	5	180	5 x 5
TGV2566-SM	13.4 - 14.4 GHz VCO with Divide by 2	13.4 to 14.4	9	-110 @ 100 kHz	5	175	5 x 5

Phase Shifters

Part	Description	Type	Frequency (GHz)	Insertion Loss (dB)	RMS Amplitude Error (dB)	RMS Phase Error (degrees)	Bits	Control Voltage (V)	Package Style
TGP2100	30 GHz 5 Bit Phase Shifter	Digital	28 to 32	6	0.5	5	5	0, 5	Die
TGP2102	35 GHz 5 Bit Phase Shifter	Digital	32 to 37	7	0.4	3.5	5	-5, 0	Die

Power Amplifiers

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA2509-FL	Wideband Packaged High Power Amplifier with AGC	2 to 20	29	15	–	–	12	–
TGA2509	Wideband 1 W High Power Amplifier with AGC	2 to 22	30	17	–	–	12	–
TGA2701-SM	3 W C-Band Packaged Power Amplifier	5.9 to 8.5	35	18	–	37	6	–
TGA2501	High Power Amplifier	6 to 18	34.5	24	–	20	8	–
TGA9092-SCC	Power Amplifier (per channel)	6 to 18	34.5	24	–	20	8	–
TGA9083-SCC	Power Amplifier - pHEMT	6.5 to 11.5	37, 39	19	–	40, 35	7 to 9	–
*TGA2565-SM**	11 - 17 GHz Medium Power Amplifier	11 to 17	27	27	–	–	6	–
TGA2524-SM	Ku-Band Power Amplifier	12 to 16	26.5	23	7	–	5	–

Power Amplifiers (Cont.)

Part	Description	Frequency (GHz)	Power (dBm)	Gain (dB)	NF (dB)	PAE (%)	Voltage (V)	IQ (mA)
TGA2527-SM	Ku-Band Power Amplifier	12.5 to 15.5	31.5	25	7.5	–	6	650
TGA2533-SM	Ku-Band Power Amplifier	12.5 to 15.5	34.5	27	–	–	6	1,300
TGA2510	2 W Ku-Band Power Amplifier	12.5 to 17	34	26	–	–	7.5	650
TGA2510-TS	2 W Ku-Band Power Amplifier	12.5 to 17	34	26	–	–	7.5	650
TGA2533	Ku-Band Power Amplifier	12.7 to 15.4	35	28	6	–	6	1,300
TGA2514-FL	6.5 W Ku-Band Power Amplifier	13 to 16	38	24	–	–	8	2,600
TGA2505	Ku-Band High Power Amplifier	13 to 17	34	25	–	–	7	640
TGA2902-1-SCC-SG	2 W Packaged Amplifier	13 to 17	34	26	–	–	7.5	650
TGA2514	6.5 W Ku-Band Power Amplifier	13 to 18	38	24	–	–	8	2,600
TGA4530	K-Band High Linearity Power Amplifier	17 to 21	30	20	–	–	5 to 7	825
TGA9088A-SCC	20 GHz Medium Power Amplifier	17 to 21	22	18.5	–	–	7	66
TGA2521-SM	17 - 24 GHz Linear Driver Amplifier	17 to 24	25	20	5	–	5	320
TGA2522-SM	17 - 24 GHz Power Amplifier	17 to 24	28	17	–	–	5	712
TGA4502-SCC	Ka-Band High Power Amplifier	17 to 27	29	22	–	–	7	760
TGA4030-SM	17 - 37 GHz Medium Power Amplifier/Multiplier	17 to 37	19	20	–	–	5	825
TGA4031-SM	17 - 40 GHz Medium Power Amplifier/Multiplier	17 to 40	19	22	–	–	5	140
TGA4040	17 - 43 GHz Medium Power Amplifier/Multiplier	17 to 43	22	25	–	–	5	140
TGA4532	K-Band Power Amplifier	17.5 to 20	32.5	23	6	–	6	900
TGA4532-SM	K-Band Power Amplifier	17.7 to 19.7	32.5	23	7	–	6	900
TGA4022	K-Band High Power Amplifier	18 to 23	32.5	26	–	–	7	840
TGA1135B-SCC	K-Band High Power Amplifier	18 to 27	30	14	–	–	5 to 7	540
TGA1073G-SCC	K-Band Medium Power Amplifier	19 to 27	25	22	–	–	5 to 7	220
TGA4036	19 - 38 GHz Medium Power Amplifier	19 to 38	22	20	–	–	5	160
TGA4536-SM*	K-Band Power Amplifier	24.2 to 26.5	34	18	7	20	6	1,430
TGA4902-SM	Ka-Band Packaged Medium Power Amplifier	25 to 35	25	18	–	–	6	220
TGA1073A-SCC	Ka-Band Medium Power Amplifier	26 to 35	25	19	–	–	5 to 7	220
TGA2594	27 - 31 GHz 5 W GaN Power Amplifier	27 to 31	37	23	–	28	20	140
TGA4509	30 GHz High Power Amplifier	27 to 31	30	22	–	–	6	420
TGA4513	27 - 31 GHz, 2 W Balanced Power Amplifier	27 to 31	33	20	–	–	6	840
TGA1073B-SCC	Ka-Band High Power Amplifier	27 to 32	28.5	25	–	–	6 to 8	420
TGA4903-SM	Ka-Band Medium Power Amplifier	27 to 32	24	15	–	–	5	170
TGA2595	27.5 - 31 GHz 9 W Power Amplifier	27.5 to 31	39.5	23	–	24	20	280
TGA4539-SM	1 W Ka-Band Power Amplifier	28 to 30	30.5	20	–	–	6	420
TGA4509-SM	1 W Ka-Band Packaged Power Amplifier	28 to 31	30	22	–	–	6	420
TGA4906	4 W Ka-Band High Power Amplifier	28 to 31	36	24	–	–	6	1,600
TGA4906-SM	4 W Ka-Band Packaged High Power Amplifier	28 to 31	36	23	–	–	6	1,600
TGA4512-SM	Ka-Band Driver Amplifier	28 to 32	17	14.5	7.5	–	6	80
TGA4916	7 W Ka-Band High Power Amplifier	29 to 31	38.5	21	–	–	6	3,200
TGA4537-SM*	K-Band Power Amplifier	29 to 35	32	18	6	15	6	1,100
TGA4510	29 - 37 GHz Driver Amplifier	29 to 37	16	16	–	–	6	60
TGA4516	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050
TGA4516-TS	2 W Ka-Band Power Amplifier	30 to 40	33	18	–	–	6	1,050
TGA4514	2 W Ka-Band Power Amplifier	31 to 35	33.5	19	–	–	6 to 7	1,150
TGA4517	Ka-Band Power Amplifier	31 to 37	35	15	–	–	6	2,000
TGA4521	32 - 45 GHz Wideband Driver Amplifier	32 to 45	24	15	–	–	6	200
TGA1141	Ka-Band High Power Amplifier	33 to 36	31	17	–	–	6 to 7	880
TGA4522	33 - 47 GHz Wideband Driver Amplifier	33 to 47	27	14	–	–	6	400
TGA1073C-SCC	Ka-Band High Power Amplifier	36 to 40	26	15	–	–	5 to 7	240
TGA1171-SCC	Ka-Band High Power Amplifier	36 to 40	30	14	–	–	6 to 7	500
TGA4538	37 - 40 GHz Power Amplifier	37 to 40	29.5	24	–	–	5	600
TGA4043	Q-Band Power Amplifier	40 to 45	29	10	–	–	7	500
TGA4042	Q-Band Driver Amplifier	41 to 45	18	14	–	–	6	168
TGA4046	2 W Q-Band High Power Amplifier	41 to 46	33	16	–	–	6	2,000

NOTES: **** = New, ** = Preview***

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
880126	2106 MHz RF BAW Filter	BAW	2,106	35	4 max	SE/SE	3.26 x 1.6

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
TGS2303	SP3T VPIN	0.2 to 20	0.5	35	–	–	10	Die
TGS2304-SCC	SP4T VPIN	0.2 to 20	0.6	38	23	–	10	Die
TGS2313	4 - 18 GHz VPIN SP3T Switch	4 to 18	1.0	35	20	2.7, -2.7	20	Die
TGS2302	4 - 20 GHz VPIN SPDT Switch	4 to 20	0.9	35	20	2.7, -2.7	20	Die
TGS4302	High Power Ka-Band SPDT Switch	27 to 46	0.9	27	> 33	5, -5	20	Die
TGS4304	High Power Ka-Band Absorptive SPDT Switch	32 to 40	0.9	35	> 33	5, -5	30	Die

Variable Gain Amplifiers

Part	Description	Frequency (MHz)	Attenuation Range (dB)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
*TGA4541-SM**	Ka-Band Variable Gain Driver Amplifier	28,000 to 31,000	30	32	23	31	5	330	6 x 6

NOTES: *** = New**

Bluetooth Power Amplifiers

Part	Description	Bands	Features	Package (mm)
TQP770001	Bluetooth® EDR v2.0 Class 1 Power Amplifier MMIC	2.4 to 2.5 GHz ISM Band	STSLP-12 Package	2 x 2 x 0.57

Discrete Transistors

Part	Description	Frequency (GHz)	Linear Gain (dB)	P1dB (dBm)	Psat (dBm)	NF (dB)	PAE (%)	Voltage (V)	Current (mA)	Package Style
CLY2	GaAs FET	DC to 3	14.5	23.5	–	0.79	–	3	180	MW6
TGF2021-01	X-Band Discrete Power pHEMT	DC to 12	11	–	> 30	–	59	8 to 12	75 to 125	Die
TGF2021-02	X-Band Discrete Power pHEMT	DC to 12	11	–	> 33	–	59	8 to 12	150 to 250	Die
TGF2021-04	X-Band Discrete Power pHEMT	DC to 12	11	–	> 36	–	59	8 to 12	300 to 500	Die
TGF2021-08	X-Band Discrete Power pHEMT	DC to 12	11	–	> 39	–	59	8 to 12	600 to 1,000	Die
TGF2021-12	X-Band Discrete Power pHEMT	DC to 12	11	–	> 42	–	58	8 to 12	900 to 1,500	Die
TGF2022-06	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 28	–	58	8 to 12	45 to 75	Die
TGF2022-12	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 31	–	58	8 to 12	90 to 150	Die
TGF2022-24	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 34	–	58	8 to 12	180 to 300	Die
TGF2022-48	Ku-Band Discrete Power pHEMT	DC to 20	13	–	> 37	–	58	8 to 12	360 to 600	Die
TGF2022-60	Ku-Band Discrete Power pHEMT	DC to 20	12	–	> 38	–	57	8 to 12	448 to 752	Die
TGF4350	0.3 mm, 0.25-µm mmW pHEMT 2MI	DC to 22	13 @ 10 GHz	–	16	0.8 @ 10 GHz	–	3	15	Die
CLY5	GaAs FET	0.4 to 2.5	11	27	–	1.7	–	3	350	MW6
TGA2602-SM	Dual GaAs pHEMT	0.8 to 3	20.5	20	–	0.55	–	4	100	2 x 2 mm

Frequency Converters/Mixers

Part	Description	RF (GHz)	IF (GHz)	LO (GHz)	Gain (dB)	Output IP3 (dBm)	NF (dB)	Output P1dB (dBm)	LO Power (dBm)	Voltage (V)	Current (mA)	Package (mm)
CMY210	Mixer with LO Amplifier	0.5 to 2.5	0.05 to 0.25	0.5 to 2.5	-5.7	18.3	6	8	0	3	6	MW-6
CMY212	Downconverter with LO, IF Amplifiers	0.5 to 2.5	0.05 to 0.25	0.5 to 2.5	10	20	8	8	-4	3	11	SCT598
CMY213	Downconverter with LO, IF Amplifiers	0.5 to 2.5	0.05 to 0.25	0.5 to 2.5	9.5	19.5	8	8	-5	3	8	SCT598

Gain Block Amplifiers

Part	Description	Frequency (MHz)	Gain (dB)	P1dB (dBm)	Output IP3 (dBm)	NF (dB)	Voltage (V)	Current (mA)	Package Style
TQP369180	Cascadable Gain Block	DC to 6,000	15.7	15.2	29.8	3.6	5	45	SOT-89
TQP369181	Cascadable Gain Block	DC to 6,000	15.6	15.2	30	3.6	5	45	SOT-363
TQP369182	Cascadable Gain Block	DC to 6,000	22.3	16.1	29.6	3.8	5	45	SOT-89
TQP369184	Cascadable Gain Block	DC to 6,000	22	16.2	29.8	3.8	5	45	SOT-363
TQP369185	Cascadable Gain Block	DC to 6,000	19	19.6	31.7	4.7	5	75	SOT-89

Low Noise Amplifiers

Part	Description	Frequency (GHz)	NF (dB)	Gain (dB)	Voltage (V)	Current (mA)	Package Style
TGA4600	60 GHz Low Noise Amplifier	57 to 65	4	13	3	41	Die

Modulator Drivers

Part	Description	Frequency (GHz)	Vpp (V)	Gain (dB)	3 dB Bandwidth (GHz)	Voltage (V)	Current (mA)	Package Style
TGA4832	DC - 35 GHz Wideband Amplifier	DC to 35	4	12	35	5	135	Die
TGA4830	CFP Low Power Driver	DC to 40	2.5	13	40	5	50	Die

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
855377	Filter - Wireless Data	SAW	350	2.4	8.2	SE/SE	7 x 5.5
855653	Filter - Wireless Data	SAW	374	17	8.5	SE/SE, BAL/BAL	7 x 5.5
855898	Filter - Wireless Data	SAW	374	17	8.5	SE/SE, BAL/BAL	5 x 5
855954	Filter - Wireless Data	SAW	380	7.3	9.5	SE/SE	3.8 x 3.8
855959	549.5 MHz SAW Filter	SAW	549.5	10	11.8	SE/SE	7.01 x 5.51
855942-1	Filter - Wireless Data	SAW	770	17	4.74	BAL/BAL	5 x 5
857191	810 MHz SAW Filter	SAW	810	5	4.6	SE/SE	3 x 3
880371	915 MHz ISM BAW Filter	BAW	915	13	3	SE/SE	6.39 x 4.61
856338	970 MHz SAW Filter	SAW	970	9	24	SE/SE	9.1 x 4.8
856339	970 MHz SAW Filter	SAW	970	18	24.7	SE/SE	7 x 5.5
856256	Filter - Wireless Data	SAW	1,150	16	4.4	BAL/BAL	3 x 3
*880404**	1575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	35	1.5	SE/SE	3.71 x 2.57
*885070**	2436 MHz BAW Filter - ISM Passband for WiFi Bandedge and LTE Coexistence	BAW	2,436	72	0.7	SE/SE	1.7x1.3
885017	2436 MHz BAW Filter - ISM Passband for Coexistence	BAW	2,436	72	1.8	SE/SE	1.4 x 1.2
857005	2437 MHz SAW Filter	SAW	2,437	66	2.1	SE/SE	1.4 x 1.2
*885062**	2440 MHz BAW Filter - ISM Passband for WLAN/LTE Coexistence	BAW	2,440	82	1.6	SE/SE	1.4 x 1.2
*885071**	2440 MHz BAW Filter - ISM Passband for WLAN/LTE Coexistence	BAW	2,440	82	1.6	SE/SE	1.4 x 1.2

SAW/BAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
885008	2440 MHz BAW Filter - ISM Notch for Coexistence	BAW	2,440	71	1.5 (Out of Band IL)	SE/SE	1.7 x 1.3
885010	2440 MHz BAW Filter - ISM Notch for Coexistence	BAW	2,440	82	2 (Out of Band IL)	SE/SE	1.7 x 1.3
856539	Bluetooth SAW Filter	SAW	2,441	83.5	2	SE/SE	1.4 x 1.2
855916	Filter - ISM Band RF Bluetooth/WLAN	SAW	2,441.80	83.5	2.76	SE/SE	3 x 3
885009	2535 MHz RF BAW Filter - Band 7 Uplink	BAW	2,535	70	1.3	SE/SE	3 x 3
880369	5775 MHz WLAN 802.11a BAW Filter	BAW	5,775	100	3	SE/SE	3.26 x 1.6

NOTES: ** = New*

Switches

Part	Description	Frequency (GHz)	Insertion Loss (dB)	ISO (dB)	Input Power (dBm)	Voltage (V)	Current (mA)	Package Style
TQP4M0008	Low Loss Reflective SPDT Switch	0.1 to 6	0.4	26	37	3.3	0.015	2 x 2 mm
TQP4M0009	High Isolation Reflective SPDT Switch	0.1 to 5	0.6	54	33	3.3	0.015	8-pin MSOP
TQP4M0011	Low Loss Reflective SP3T Switch	0.1 to 6	0.6	34	34	3.3	0.015	12-pin 3 x 3 mm QFN Package
TQS5200	SPDT 802.11a/b/g	1 to 6	0.6	28	31.5	3, 0	< 0.05	2 x 1.3 mm
TQS5202	Diversity Switch 802.11a/b/g	1 to 6	0.8	33	33	3, 0	< 0.05	3 x 3 mm

WLAN Front End Modules

Part	Description	Frequency (GHz)	802.11 Standards	Typ Pout 1.78% EVM (dBm)	Typ Pout 3.0% EVM (dBm)	Tx Gain (dB)	Rx Gain (dB)	Rx NF (dB)	Nom Bias Voltage (V)	Current (mA)	Package (mm)
*TQP5523**	5 GHz WLAN 802.11a/n/ac Power Amplifier (+22dBm)	4.9 to 5.925	a/n/ac	22	24	32	–	–	3.3, 5	315	4 x 4 x 0.85
*TQP5525**	5 GHz WLAN 802.11a/n/ac Power Amplifier (+24dBm)	4.9 to 5.925	a/n/ac	24	26	32	–	–	3.3, 5	550	4 x 4 x 0.85
*TQL1600**	5 GHz WLAN Switch / LNA Front End Module	5.15 to 5.875	a/n/ac	–	–	–	13	2.5	3.3, 5	8	2.5 x 2.5 x 0.45
TQP8080	5 GHz WLAN 802.11a/n/ac Front End Module with PA + Pdet, SP2T and LNA	5.15 to 5.875	a/n/ac	18	20	29.5	13	2.5	5	240	2.5 x 2.5 x 0.4

NOTES: ** = New*

Duplexers

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856931	LTE Band 17 SAW Duplexer	SAW	710, 740	12	1.8, 1.9	SE/SE, SE/BAL	2.5 x 2
856879	LTE Band 13 SAW Duplexer	SAW	751, 782	10	1.85, 2.2	SE/SE, SE/BAL	2.5 x 2
*TQQ1013***	Band 13 LTE SE/SE Duplexer	SAW	777 to 787, 746 to 756	10	2.4	SE/SE	2.5 x 2.5
856979	LTE Band 20 TC SAW Duplexer	TC SAW	806, 847	30	2.5, 3	SE/SE, SE/BAL	2.5 x 2
856999	CDMA BC10 SAW Duplexer	SAW	833, 878	32	2.5, 2.5	SE/BAL	2.5 x 2
856908	Cell Band SAW Duplexer	SAW	836.5, 881.5	25	2, 2.5	SE/SE	3.8 x 3.8
*856565**	CDMA 2-in-1 Rx Filter	SAW	881.5, 1,960	25, 60	1.6, 2.2	SE/BAL	2 x 1.5
TQM2M9016	GPS-SDARS Antenna Diplexer	–	1,575.42, 2,332.5	3, 25	0.6, 0.8	SE/SE	3 x 3
*TQQ2504***	B4, B25 LTE SE/SE Duplexer	SAW / BAW	1,850 to 1,915	65	2	SE/SE	3.6 x 2 x 0.9
TQM966002	PCS BAW Duplexer	BAW	1,880, 1,960	60	1.8, 1.9	SE/SE	2.5 x 2
TQM969001	PCS BAW Duplexer	BAW	1,880, 1,960	60	1.32, 1.52	SE/SE	3.8 x 3.8
TQM963014	LTE BC14/Band 25 BAW Duplexer	BAW	1,882.5, 1,962.5	65	1.8, 2.2	SE/SE	2.5 x 2
*TQM976027**	B7 BAW Duplexer	BAW	2,500 to 2,570, 2,620 to 2,690	60	1.32, 1.52	SE/SE	3.8 x 3.8

NOTES: ** = New, ** = Preview*

Filter/Duplexer Modules

Part	Description	Bands	Features	Package (mm)
*TQM9M9030**	Dual-Band Duplexer Bank	Band 1 Duplexer, Band 8 Duplexer, DCS Filter	Low Insertion Loss with Excellent Attenuation	3.6 x 5 x 1
*TQQ2526***	B25 PCS/B26 Cellular Bands Duplexer Bank Module	B25, B26	Duplexer Bank for B25/B26 Applications	2.8 x 4.7 x 1

NOTES: ** = New, ** = Preview*

Diplexers

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
*890086***	1176.45/1575.42 MHz High Attenuation SAW Diplexer	SAW	1,176.45, 1,575.42	20.46	3.5	SE/SE	5 x 5
*890087***	1176.45/1575.42 MHz Low Loss SAW Diplexer	SAW	1,176.45, 1,575.42	20.46	0.9	SE/SE	5 x 5
*890084***	1227.6/1575.42 MHz High Attenuation SAW Diplexer	SAW	1,227.6, 1,575.42	20.46	3.5	SE/SE	5 x 5
*890085***	1227.6/ 575.42 MHz Low Loss SAW Diplexer	SAW	1,227.6, 1,575.42	20.46	0.9	SE/SE	5 x 5
TQM2M9016	GPS-SDARS Antenna Diplexer	–	1,575.42, 2,332.5	3, 25	0.6, 0.8	SE/SE	3 x 3

NOTES: *** = Preview*

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
855748	Filter - Broadband Access	SAW	36.15	8.14	20.59	SE/SE	27.2 x 12.6
855079	Filter - Broadband Access	SAW	44	6	20.3	SE/SE	27.2 x 12.6
856129	Filter - Broadband Access	SAW	44	6	20.8	SE/SE	24.6 x 9
854651	Filter - Standard Low Loss	SAW	70	0.55	7.6	SE/SE	19 x 6.5
854652	Filter - Standard Low Loss	SAW	70	1.1	7.3	SE/SE	19 x 6.5
854653	Filter - Standard Low Loss	SAW	70	1.52	7.5	SE/SE	19 x 6.5
854654	Filter - Standard Low Loss	SAW	70	2.1	7.85	SE/SE	19 x 6.5
854655	Filter - Standard Low Loss	SAW	70	2.59	8.75	SE/SE	19 x 6.5
854656	Filter - Standard Low Loss	SAW	70	3.5	6.95	SE/SE	13.3 x 6.5
854657	Filter - Standard Low Loss	SAW	70	3.8	7.25	SE/SE	13.3 x 6.5
854658	Filter - Standard Low Loss	SAW	70	4.45	6.8	SE/SE	13.3 x 6.5
854659	Filter - Standard Low Loss	SAW	70	4.9	6.8	SE/SE	13.3 x 6.5
854660	Filter - Standard Low Loss	SAW	70	5.35	7.25	SE/SE	13.3 x 6.5
854661	Filter - Standard Low Loss	SAW	70	6.35	7.5	SE/SE	13.3 x 6.5
854662	Filter - Standard Low Loss	SAW	70	7.4	8.5	SE/SE	13.3 x 6.5
854663	Filter - Standard Low Loss	SAW	70	8.4	9	SE/SE	13.3 x 6.5
854664	Filter - Standard Low Loss	SAW	70	9.4	9.75	SE/SE	13.3 x 6.5
854665	Filter - Standard Low Loss	SAW	70	10.45	10	SE/SE	13.3 x 6.5
854666	Filter - Standard Low Loss	SAW	70	12.5	11.5	SE/SE	13.3 x 6.5
854667	Filter - Standard Low Loss	SAW	70	14.45	12.5	SE/SE	13.3 x 6.5
854668	Filter - Standard Low Loss	SAW	70	16.5	12.5	SE/SE	13.3 x 6.5
854669	Filter - Standard Low Loss	SAW	70	18.5	13.5	SE/SE	13.3 x 6.5
854670	Filter - Standard Low Loss	SAW	70	20	14.5	SE/SE	13.3 x 6.5
854671	Filter - Standard Low Loss	SAW	70	22.3	15	SE/SE	13.3 x 6.5
854672	Filter - Standard Low Loss	SAW	70	24.45	16.25	SE/SE	13.3 x 6.5
854673	Filter - Standard Low Loss	SAW	70	26.4	17	SE/SE	13.3 x 6.5
854674	Filter - Standard Low Loss	SAW	70	28.5	17.6	SE/SE	13.3 x 6.5
854675	Filter - Standard Low Loss	SAW	70	30.3	17.5	SE/SE	13.3 x 6.5
854678	Filter - Standard Low Loss	SAW	70	36.2	20.2	SE/SE	13.3 x 6.5
854680	Filter - Standard Low Loss	SAW	70	40.35	21.5	SE/SE	13.3 x 6.5
855107	IF SAW Filter - CDMA	SAW	70	1.228	19	SE/SE	74.7 x 18.9
855735	Filter - Standard 70 High Selectivity	SAW	70	0.31	16.36	SE/SE	24.6 x 9
855736	Filter - Standard 70 High Selectivity	SAW	70	0.7	21.3	SE/SE	24.6 x 9
855737	Filter - Standard 70 High Selectivity	SAW	70	1	22.2	SE/SE	24.6 x 9
855738	Filter - Standard 70 High Selectivity	SAW	70	1	21.6	SE/SE	24.6 x 9
855739	Filter - Standard 70 High Selectivity	SAW	70	2.2	23	SE/SE	19 x 6.5
855740	Filter - Standard 70 High Selectivity	SAW	70	2.7	20.25	SE/SE	19 x 6.5
855741	Filter - Standard 70 High Selectivity	SAW	70	3.1	23	SE/SE	19 x 6.5
855743	Filter - Standard 70 High Selectivity	SAW	70	4.4	23	SE/SE	19 x 6.5
855744	Filter - Standard 70 High Selectivity	SAW	70	4.9	23.7	SE/SE	19 x 6.5
855745	Filter - Standard 70 High Selectivity	SAW	70	5.7	22.2	SE/SE	19 x 6.5
856980	70 MHz IF SAW Filter	SAW	70	2.5	9	SE/SE	13.3 x 6.5
857174	70 MHz SAW Filter	SAW	70	4.9	25.5 max	SE/SE	19 x 6.5
857175	70 MHz SAW Filter	SAW	70	5.7	21	SE/SE	19 x 6.5
856152	73 MHz SAW Filter	SAW	73	0.3	6	SE/SE	24.6 x 9
855679	Filter - Broadband Wireless Access	SAW	80	8	11.9	SE/SE	13.3 x 6.5

SAW/BAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
854823	Filter - GSM BTS	SAW	86.6	0.40 min	5.5	SE/SE	19 x 6.5
855659	Filter - Broadband Access	SAW	110.59	0.79	6.52	SE/SE	13.3 x 6.5
855884	IF SAW Filter - GSM	SAW	125	0.4	5.7	SE/SE	13.3 x 6.5
856444	IF SAW Filter - GSM	SAW	125	0.4	5.9	SE/SE	9.1 x 4.8
854909	Filter - Standard Low Loss	SAW	140	4.6	10.85	SE/SE	13.3 x 6.5
854913	Filter - Standard Low Loss	SAW	140	7.148	5.5	SE/SE	13.3 x 6.5
854916	Filter - Standard Low Loss	SAW	140	10.59	8.3	SE/SE	13.3 x 6.5
854917	Filter - Standard Low Loss	SAW	140	12.4	8.87	SE/SE	13.3 x 6.5
854919	Filter - Standard Low Loss	SAW	140	16.9	8.4	SE/SE	13.3 x 6.5
854920	Filter - Standard Low Loss	SAW	140	18	9.1	SE/SE	13.3 x 6.5
854923	Filter - Standard Low Loss	SAW	140	24.26	11.33	SE/SE	13.3 x 6.5
854927	Filter - Standard Low Loss	SAW	140	33.4	11.5	SE/SE	13.3 x 6.5
855579	140 MHz SAW Filter	SAW	140	1.7	11	SE/SE	19 x 6.5
856019	Filter - Standard 140 High Selectivity	SAW	140	28.5	20	SE/SE	9 x 7.01
856020	Filter - Standard 140 High Selectivity	SAW	140	65	17.8	SE/SE	9 x 7.01
856062	Filter - Standard 140 High Selectivity	SAW	140	0.75	20.8	SE/SE	19 x 6.5
856063	Filter - Standard 140 High Selectivity	SAW	140	1.5	21.9	SE/SE	19 x 6.5
856064	Filter - Standard 140 High Selectivity	SAW	140	2	21.5	SE/SE	19 x 6.5
856065	Filter - Standard 140 High Selectivity	SAW	140	3	22.4	SE/SE	19 x 6.5
856066	Filter - Standard 140 High Selectivity	SAW	140	6.2	23	SE/SE	13.3 x 6.5
856067	Filter - Standard 140 High Selectivity	SAW	140	7.1	24.5	SE/SE	13.3 x 6.5
856068	Filter - Standard 140 High Selectivity	SAW	140	8.2	23.4	SE/SE	13.3 x 6.5
856069	Filter - Standard 140 High Selectivity	SAW	140	10	20.87	SE/SE	13.3 x 6.5
856070	Filter - Standard 140 High Selectivity	SAW	140	14.1	23.3	SE/SE	13.3 x 6.5
856071	Filter - Standard 140 High Selectivity	SAW	140	16.2	21.7	SE/SE	13.3 x 6.5
856072	Filter - Standard 140 High Selectivity	SAW	140	33.2	21.7	SE/SE	9 x 7.01
856073	Filter - Standard 140 High Selectivity	SAW	140	44	21.75	SE/SE	9 x 7.01
856074	Filter - Standard 140 High Selectivity	SAW	140	57	18.65	SE/SE	9 x 7.01
856314	Filter - Standard 140 High Selectivity	SAW	140	72	21	SE/SE	9 x 7.01
856592	Low Loss IF Filter	SAW	140	21.6	9.3	SE/SE	13.3 x 6.5
856656	Low Loss IF Filter	SAW	140	10	9.2	SE/SE	13.3 x 6.5
856684	Low Loss IF Filter	SAW	140	15	9.1	SE/SE	13.3 x 6.5
856691	Filter - Standard Low Loss	SAW	140	1.5	12.1	SE/SE, BAL/SE	9.1 x 4.8
856692	Filter - Standard Low Loss	SAW	140	3	13.6	SE/SE, BAL/BAL	9.1 x 4.8
856693	Filter - Standard Low Loss	SAW	140	6	11	BAL/BAL	9.1 x 4.8
856694	Filter - Standard Low Loss	SAW	140	7	13.6	SE/SE, BAL/BAL	9.1 x 4.8
856695	Filter - Standard Low Loss	SAW	140	10	10	BAL/BAL	9.1 x 4.8
856696	Filter - Standard Low Loss	SAW	140	14	8.5	SE/SE, BAL/BAL	9.1 x 4.8
856697	Filter - Standard Low Loss	SAW	140	20	9.8	BAL/BAL	9.1 x 4.8
856698	Filter - Standard Low Loss	SAW	140	28	18	SE/SE, BAL/BAL	9.1 x 4.8
856774	Filter - Standard Low Loss	SAW	140	56	22.3	BAL/BAL	9.1 x 4.8
856817	IF Filter	SAW	140	28.56	30	SE/SE	13.3 x 6.5
856929	IF SAW Filter - Multi-Standard	SAW	140	18.4	9.1	SE/SE	7 x 5.5

SAW/BAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
857176	140 MHz SAW Filter	SAW	140	28.5	19.75	SE/SE	9 x 7.01
857177	140 MHz SAW Filter	SAW	140	1.5	23.5	SE/SE	19 x 6.5
855395	IF SAW Filter - CDMA	SAW	141	1.18	11.7	SE/SE	19 x 6.5
856727	IF Filter	SAW	144	75	21.2	SE/SE	9 x 7.01
854833-1	Filter - CDMA BTS	SAW	150	1.18	19.5	SE/SE	19 x 6.5
855678	Filter - Other BTS	SAW	150	8	12.1	SE/SE	13.3 x 6.5
856517	IF Filter	SAW	153.6	32	13	SE/SE	13.3 x 6.5
856748	IF SAW Filter - Multi-Standard	SAW	153.6	18.3	10	SE/SE	13.3 x 6.5
855886	161.5 MHz SAW Filter	SAW	161.5	25	22	SE/SE	9 x 7.01
856683	WCDMA IF Filter	SAW	167	5	8	SE/SE, BAL/BAL	9.1 x 4.8
856512	IF SAW Filter - Multi-Standard	SAW	168.5	26.4	8	SE/SE, SE/BAL	5 x 5
856447	IF SAW Filter - GSM	SAW	170.6	0.18	5.59	SE/SE	13.3 x 6.5
856582	Filter - 3G BTS	SAW	172.8	18	8.7	SE/SE	7 x 5.5
856620	IF SAW Filter - WCDMA	SAW	172.8	8.84	9	SE/SE, SE/BAL	7 x 5.5
856802	IF SAW Filter - Multi-Standard	SAW	172.8	20	8	SE/SE, SE/BAL	5 x 5
856893	IF SAW Filter - Multi-Standard	SAW	172.8	21	8.2	BAL/BAL	7 x 5.5
856234	Filter - CDMA IF	SAW	183.6	1.26	7.4	SE/BAL, BAL/BAL	7 x 5.5
857124	184.32 MHz SAW Filter	SAW	184.32	25	7.8	BAL/BAL	7 x 5.5
855529	IF SAW Filter - WCDMA	SAW	190	4	9.8	SE/SE	13.3 x 6.5
855625	IF SAW Filter - GSM	SAW	190	0.2	4.2	SE/SE	7 x 5.5
855770	Filter - 3G BTS	SAW	190	5	8	SE/SE	5 x 5
856731	IF SAW Filter - Multi-Standard	SAW	192	60	13.5	SE/BAL, SE/SE	7 x 5.5
857071	192.5 MHz SAW Filter	SAW	192.5	67.5	17	BAL/BAL	7 x 5.5
856541	IF SAW Filter - GSM	SAW	201	0.22	6.1	BAL/BAL	13.3 x 6.5
855068	Filter - Broadband Access	SAW	202.75	1.1	6.6	SE/SE	13.3 x 6.5
855816	205 MHz SAW Filter	SAW	205	1.3	22	SE/SE	13.3 x 6.5
855885	IF SAW Filter - GSM	SAW	208	0.4	5	SE/SE	13.3 x 6.5
856445	IF SAW Filter - GSM	SAW	208	0.4	5.88	SE/SE	9.1 x 4.8
856496	IF SAW Filter - WCDMA	SAW	208	3.84	11.5	BAL/BAL	9.1 x 4.8
856378	IF Filter, GSM	SAW	211	0.2	5.2	SE/SE	13.3 x 6.5
855992	Filter - CDMA BTS	SAW	240	3.6	14.3	SE/SE	13.3 x 6.5
857072	242.5 MHz SAW Filter	SAW	242.5	27.6	9	BAL/BAL	7 x 5.5
855549	242.625 MHz SAW Filter	SAW	242.625	1.3	18.7	SE/SE	19 x 6.5
856140	310.7 MHz SAW Filter	SAW	310.7	3	3	SE/SE	5 x 5
855595	320 MHz SAW Filter	SAW	320	22	19.3	SE/SE	9 x 7.01
855596	320 MHz SAW Filter	SAW	320	22	19.4	SE/SE	9 x 7.01
855914	Filter - 3G BTS	SAW	326.4	17.4	12.61	SE/SE	7.01 x 5.51
854565	350 MHz SAW Filter	SAW	350	1.2	10.2	SE/SE	13.3 x 6.5
855377	Filter - Wireless Data	SAW	350	2.4	8.2	SE/SE	7 x 5.5
855399	Filter - Broadband Wireless Access	SAW	350	2.62	13.7	SE/SE, BAL/BAL	13.3 x 6.5
856771	IF SAW Filter - Multi-Standard	SAW	358.4	19.2	10.1	BAL/BAL	7 x 5.5
856882	IF SAW Filter	SAW	358.4	39.6	9.5	BAL/BAL	7 x 5.5
856966	IF SAW Filter - Multi-Standard	SAW	358.4	24.8	9	BAL/BAL	7 x 5.5
855653	Filter - Wireless Data	SAW	374	17	8.5	SE/SE, BAL/BAL	7 x 5.5
855898	Filter - Wireless Data	SAW	374	17	8.5	SE/SE, BAL/BAL	5 x 5
856466	IF Filter - WiMAX	SAW	374	18	9	BAL/BAL	3.8 x 3.8
855954	Filter - Wireless Data	SAW	380	7.3	9.5	SE/SE	3.8 x 3.8
856490	Filter - Standard IF 380 MHz SAW	SAW	380	9.2	10	BAL/BAL	7 x 5.5
856631	Filter - Standard IF 380 MHz SAW	SAW	380	10.5	8.7	BAL/BAL	7 x 5.5

SAW/BAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
857073	397.5 MHz SAW Filter	SAW	397.5	66.7	16.6	BAL/BAL	7 x 5.5
855559	IF SAW Filter - WCDMA	SAW	398	22	7.5	SE/SE	7 x 5.5
855561	IF SAW Filter - WCDMA	SAW	398	4.3	9.9	SE/SE	7 x 5.5
856652	Filter - WiMAX IF SAW	SAW	398	10	8.7	BAL/BAL	5 x 5
855731	Filter - Broadband Access	SAW	426	5.16	18.02	SE/SE	13.3 x 6.5
857074	447.5 MHz SAW Filter	SAW	447.5	28.16	14.1	BAL/BAL	7 x 5.5
856549	Filter - Standard IF 456 MHz SAW	SAW	456	7.8	7.9	BAL/BAL	5 x 5
856638	Filter - Standard IF 456 MHz SAW	SAW	456	10	8.3	BAL/BAL	5 x 5
856672	Filter - Standard IF 456 MHz SAW	SAW	456	10	8.3	BAL/BAL	7 x 5.5
856687	IF SAW Filter - Multi-Standard	SAW	456	19	10	BAL/BAL	7 x 5.5
856623	464 MHz SAW Filter	SAW	464	3.5	10.6	BAL/BAL	7 x 5.5
856288	Filter - GPS IF	SAW	465	6	1.43	SE/SE	3 x 3
856586	467 MHz SAW Filter	SAW	467	10	3	SE/SE	3.8 x 3.8
855271	Filter - Standard IF 4 79.75 MHz SAW	SAW	479.75	11.7	19.5	SE/SE	7 x 5.5
855272	Filter - Test Equipment	SAW	479.75	25.5	9.8	SE/SE	7 x 5.5
855104	Filter - Broadband Access	SAW	499.25	1	7.08	SE/SE	9 x 7.01
856625	520 MHz SAW Filter	SAW	520	11	9.5	SE/SE	5 x 5
856680	520 MHz SAW Filter	SAW	520	7.09	10.8	SE/SE	5 x 5
855959	549.5 MHz SAW Filter	SAW	549.5	10	11.8	SE/SE	7.01 x 5.51
855985	549.5 MHz SAW Filter	SAW	549.5	1	11.6	SE/SE	9 x 7.01
856665	Filter - Standard IF 580 MHz SAW	SAW	580	10.5	10.7	BAL/BAL	7 x 5.5
857031	SVLTE Notch SAW Filter	TC SAW	751, 782	10	0.65	SE/SE	2.5 x 2
857061	SVLTE Notch SAW Filter	TC SAW	751, 836.5, 881.5	10, 25	1	SE/SE	2.5 x 2
856690	756 MHz SAW Filter	SAW	756	18.5	1.9	SE/SE	3.8 x 3.8
856866	756 MHz SAW Filter	SAW	756	29.15	0.9	SE/SE	3.8 x 3.8
855942-1	Filter - Wireless Data	SAW	770	17	4.74	BAL/BAL	5 x 5
856526	Filter - Standard IF 810 MHz SAW	SAW	810	10	3.5	SE/SE	3 x 3
856534	Filter - Standard IF 810 MHz SAW	SAW	810	5	4.6	SE/SE	3 x 3
856338	970 MHz SAW Filter	SAW	970	9	24	SE/SE	9.1 x 4.8
856339	970 MHz SAW Filter	SAW	970	18	24.7	SE/SE	7 x 5.5
857162	1000 MHz Non Dispersive SAW Delay Line	SAW	1,000	700	30	SE/SE	25.4 x 12.7
857163	1000 MHz Non Dispersive SAW Delay Line	SAW	1,000	430	23.3	SE/SE	25.4 x 12.7
857164	1000 MHz Non Dispersive SAW Delay Line	SAW	1,000	353.5	21.25	SE/SE	25.4 x 12.7
857165	1000 MHz Non Dispersive SAW Delay Line	SAW	1,000	703	31	SE/SE	25.4 x 12.7
857166	1000 MHz Non Dispersive SAW Delay Line	SAW	1,000	700	31.75	SE/SE	25.4 x 12.7
857167	1000 MHz Non Dispersive SAW Delay Line	SAW	1,000	705	33.7	SE/SE	25.4 x 12.7
857168	1000 MHz Non Dispersive SAW Delay Line	SAW	1,000	707	34.6	SE/SE	25.4 x 12.7
857169	1000 MHz Non Dispersive SAW Delay Line	SAW	1,000	705	35.3	SE/SE	25.4 x 12.7
855964	Filter - Broadband Access	SAW	1,086	10	4	BAL/BAL	3 x 3
856330	Broadband Access IF SAW Filter	SAW	1,086	10	4	BAL/BAL	3 x 3
856096	Filter - Broadband Access	SAW	1,090	10	5.6	BAL/BAL	3.8 x 3.8
856256	Filter - Wireless Data	SAW	1,150	16	4.4	BAL/BAL	3 x 3

SAW/BAW Filters

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856365	Broadband Access IF SAW Filter	SAW	1,216	8	3.75	BAL/BAL	3 x 3
856298	Filter - Broadband Access	SAW	1,220	10	4.5	BAL/BAL	3 x 3
856598	Broadband Access IF SAW Filter	SAW	1,220	50	3.9	BAL/BAL	3.8 x 3.8
856793	GPS SAW Filter, SE/SE	SAW	1,575.42	2.4	0.6	SE/SE	1.4 x 1.2
856531	RF Filter, PCS	SAW	1,960	60	2.25	SE/SE	3 x 3
856717	Delay Filter 450 ns	SAW	1,960	60	22	SE/SE	9.1 x 4.8
TQM966025	1962.5 MHz RF BAW Filter - Band 25 Diversity Rx	BAW	1,962.50	65	2.6	SE/SE	2.5 x 2
856649	SAW Delay Line	SAW	2,140	100	25	SE/SE, BAL/SE	7 x 5.5
856990	Filter - MICS Band SAW	SAW	403.5	3	2.1	BAL/SE	3 x 3
856930	Filter - ISM Band SAW	SAW	457.5	15	2.2	SE/SE	3.8 x 3.8
856884	RF SAW Filter - Band 12 Uplink	SAW	707	18	1.5	SE/SE	3 x 3
857193	725.5 MHz SAW Band 28 Uplink Filter	SAW	725.5	45	4	SE/SE	3 x 3
856883	RF SAW Filter - Band 12 Downlink	SAW	737	18	1.8	SE/SE	3 x 3
857217	742.5 MHz SAW Filter	SAW	742.5	27	2.5	SE/SE	3 x 3
857031	SVLTE Notch SAW Filter	TC SAW	751, 782	10	0.65	SE/SE	2.5 x 2
857061	SVLTE Notch SAW Filter	TC SAW	751, 836.5, 881.5	10, 25	1	SE/SE	2.5 x 2
856764	RF SAW Filter - Band 13 Uplink	SAW	781.5	11	1.46	SE/SE	3 x 3
856844	RF SAW Filter	SAW	782	10	1.52	SE/SE	3 x 3
856977	RF SAW Filter - Band 13 / 14 Uplink	SAW	787.5	21	2.05	SE/SE	3 x 3
857191	810 MHz SAW Filter	SAW	810	5	4.6	SE/SE	3 x 3
857019	Band 5e Uplink RF Filter	SAW	835	30	2.1	SE/SE	3 x 3
856503	RF SAW Filter - Band 5 Uplink	SAW	836.5	25	2.7	SE/SE	3 x 3
856704	RF SAW Filter - Band 5 Uplink	SAW	836.5	25	1.2	SE/SE	3 x 3
857038	836.5 MHz SAW Filter	SAW	836.5	25	2.3	SE/SE	1.4 x 1.2
856932	RF SAW Filter - Band 20 Uplink	SAW	847	30	1.3	SE/SE	3 x 3
856606	860.5 MHz SAW Filter	SAW	860.5	19	1.1	SE/SE	3 x 3
856963	Filter - ISM Band SAW	SAW	875	10	1.8	SE/SE	2 x 1.5
855728	Filter - CDMA/Amps (Rx) High Rejection	SAW	881.5	25	2.7	SE/SE	3 x 3
855782	RF Filter, Cell Band	SAW	881.5	25	1.8	SE/SE	3 x 3
856504	RF SAW Filter - Band 5 Downlink	SAW	881.5	25	2.7	SE/SE	3 x 3
856671	RF Filter, EGSM	SAW	897.5	35	1.8	SE/SE	3 x 3
856824	RF SAW Filter	SAW	897.5	35	1.4	SE/SE	3 x 3
856327	Filter - ISM Band SAW	SAW	915	26	2.3	SE/SE	2 x 1.5
880371	915 MHz ISM BAW Filter	BAW	915	13	3	SE/SE	6.39 x 4.61
856905	Filter - ISM Band SAW	SAW	921.5	13	1.9	SE/SE	2.x 1.5
855810	RF SAW Filter - Band 8 Downlink	SAW	942.5	35	3.2	SE/SE	3 x 3
855820	RF SAW Filter - Band 8 Downlink	SAW	942.5	35	2	SE/SE	3 x 3
856528	RF Filter, EGSM	SAW	942.5	35	2.5	SE/SE	3 x 3
857216	1030 MHz SAW Filter	SAW	1,030	10	2.3	SE/SE	3 x 3
880367	1030 MHz SSR/IFF BAW Filter	BAW	1,030	14	3	SE/SE	3.71 x 2.57

SAW/BAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
857179	1090 MHz SAW Filter	SAW	1,090	10	5.6	BAL/BAL	3.8 x 3.8
857215	1090 MHz SAW Filter	SAW	1,090	10	2.6	SE/SE	3 x 3
880374	1090 MHz SSR/IFF BAW Filter	BAW	1,090	16	3	SE/SE	3.71 x 2.57
856440	Filter - GPS L5 RF	SAW	1,176	35	2.4	SE/SE	2 x 1.5
880364	1176 MHz GPS L5 BAW Filter	BAW	1,176	30	2.5	SE/SE	3.26 x 1.6
857143	1176.45 MHz SAW Filter	SAW	1,176.45	20.46	0.5	SE/SE	1.4 x 1.2
857144	1176.45 MHz SAW Filter	SAW	1,176.45	20.46	2	SE/SE	1.4 x 1.2
856700	GPS L2 SAW Filter	SAW	1,227.60	31	1.1	SE/SE	2 x 1.5
857141	1227.6 MHz SAW Filter	SAW	1,227.60	20.46	0.5	SE/SE	1.4 x 1.2
880060	1227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	25	1.8	SE/SE	3.26 x 1.6
880272	1227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	30	2.25	SE/SE	3.26 x 1.6
880366	1227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	12	1.5	SE/SE	3.26 x 1.6
880372	1227.6 MHz GPS L2 BAW Filter	BAW	1,227.60	15	3	SE/SE	3.71 x 2.57
856653	Filter - Broadband Access	SAW	1,250	100	6.8	BAL/BAL	3 x 3
880368	1280 MHz L-Band BAW Filter	BAW	1,280	19	4	SE/SE	3.71 x 2.57
880365	1380 MHz GPS L3/L4 BAW Filter	BAW	1,380	38	2.75	SE/SE	3.26 x 1.6
856928	RF SAW Filter - Band 11 Uplink	SAW	1,445.40	35	1.25	SE/SE	3 x 3
856039	GPS SAW Filter	SAW	1,575.42	2	1.8	SE/SE	3 x 3
856139	GPS SAW Filter	SAW	1,575.42	2.4	1.3	SE/SE	3 x 3
856561	GPS SAW Filter, SE/SE	SAW	1,575.42	2	0.75	SE/SE	1.4 x 1.2 x 0.46
856576	GPS SAW Filter, SE/BAL	SAW	1,575.42	2	1.1	SE/BAL	1.4 x 1.2
857139	1575.42 MHz SAW Filter	SAW	1,575.42	20.46	0.6	SE/SE	1.4 x 1.2
857140	1575.42 MHz SAW Filter	SAW	1,575.42	20.46	2.6	SE/SE	1.4 x 1.2
880085	1575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	15	1.5	SE/SE	3.26 x 1.6
880094	1575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	30	1.8	SE/SE	3.26 x 1.6
880098	1575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	20	4 max	SE/SE	3.71 x 2.57
880273	1575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	40	2.35	SE/SE	3.26 x 1.6
880373	1575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	23	3	SE/SE	3.71 x 2.57
880404	1575.42 MHz GPS L1 BAW Filter	BAW	1,575.42	35	1.5	SE/SE	3.71 x 2.57
857207	1585.66 MHz SAW Filter	SAW	1,585.66	41	1.45	SE/BAL	1.4 x 1.2
856909	1601.5 MHz SAW Filter	SAW	1,601.50	17	2.2	SE/SE	3 x 3
TQQ0302	Band 3 Uplink RF Filter	BAW	1,747.5	75	3.5	SE/SE	3 x 3
TQQ0303	Band 3 Downlink RF Filter	BAW	1,842.5	75	5	SE/SE	3 x 3
856654	RF SAW Filter - Band 3 Uplink	SAW	1,747.50	75	2.2	SE/SE	3 x 3
TQQ7303	1747.5 MHz BAW Band 3 Uplink Filter	BAW	1,747.50	75	3.5	SE / SE	3 x 3
855860	RF SAW Filter - Band 3 Downlink	SAW	1,842.50	75	1.9	SE/SE	3 x 3
856934	Band 3 Downlink RF Filter	SAW	1,842.50	75	2.9	SE/SE	3 x 3
855849	RF SAW Filter - Band 2 Uplink	SAW	1,880	60	2.4	SE/SE	3 x 3
856530	Filter - U.S. PCS (Tx) Full-Band	SAW	1,880	60	2.8	SE/SE	3 x 3

SAW/BAW Filters (Cont.)

Part	Description	Technology	Frequency (MHz)	Bandwidth (MHz)	Insertion Loss (dB)	I/O Configuration	Package (mm)
856705	RF SAW Filter - Band 2 Uplink	SAW	1,880	60	2.2	SE/SE	3 x 3
856880	RF SAW Filter - Band 2 Uplink	SAW	1,880	60	2.3	SE/SE	3 x 3
885025	1880 MHz RF BAW Filter - Band 2 Uplink	BAW	1,880	60	3.5	SE/SE	3 x 3
856992	RF SAW Filter - Band 25 Uplink	SAW	1,882.50	65	1.9	SE/SE	3 x 3
856532	RF Filter, UMTS	SAW	1,950	60	2.5	SE/SE	3 x 3
856678	RF Filter - 1950 MHz Band	SAW	1,950	60	1.8	SE/SE	3 x 3
855859	RF SAW Filter - Band 2 Downlink	SAW	1,960	60	2.5	SE/SE	3 x 3
855817	RF Filter, PCS	SAW	1,960	60	2.1	SE/SE	3 x 3
857145	1960 MHz SAW Filter	SAW	1,960	160	3	SE/SE	3 x 3
885024	1960 MHz RF BAW Filter - Band 2 Downlink	BAW	1,960	60	3.7	SE/SE	3 x 3
TQM966025	1962.5 MHz RF BAW Filter - Band 25 Diversity Rx	BAW	1,962.50	65	2.6	SE/SE	2.5 x 2
880126	2106 MHz RF BAW Filter	BAW	2,106	35	4 max	SE/SE	3.26 x 1.6
880148	2324 MHz RF BAW Filter	BAW	2,324	38	3	SE/SE	3.71 x 2.57
856604	2332.5 MHz SAW Filter	SAW	2,332.50	45	1.7	SE/BAL	1.4 x 1.2
885049	2350 MHz RF BAW Filter - Band 40	BAW	2,350	100	1.3	SE/SE	1.4 x 1.2
885069	2350 MHz BAW Band 40 Filter	BAW	2,350	100	3	SE/SE	1.4 x 1.2
885007	2436 MHz BAW Filter - ISM Passband for Coexistence	BAW	2,436	72	2	SE/SE	1.7 x 1.3
885017	2436 MHz BAW Filter - ISM Passband for Coexistence	BAW	2,436	72	1.8	SE/SE	1.4 x 1.2
857005	2437 MHz SAW Filter	SAW	2,437	66	2.1	SE/SE	1.4 x 1.2
885008	2440 MHz BAW Filter - ISM Notch for Coexistence	BAW	2,440	71	1.5 (Out of Band IL)	SE/SE	1.7 x 1.3
885010	2440 MHz BAW Filter - ISM Notch for Coexistence	BAW	2,440	82	2 (Out of Band IL)	SE/SE	1.7 x 1.3
856539	Bluetooth SAW Filter	SAW	2,441	83.5	2	SE/SE	1.4 x 1.2
855916	Filter - ISM Band RF Bluetooth/WLAN	SAW	2,441.80	83.5	2.76	SE/SE	3 x 3
885032	2.4 GHz RF BAW Filter - WLAN/BT LTE Coexistence	BAW	2,442	79	1.7	SE/SE	1.4 x 1.2
885033	2.4 GHz RF BAW Filter - WLAN/BT LTE Coexistence	BAW	2,442	79	1.7	SE/SE	1.4 x 1.2
885009	2535 MHz RF BAW Filter - Band 7 Uplink	BAW	2,535	70	1.3	SE/SE	3 x 3
885009	2535 MHz RF BAW Filter - Band 7 Uplink	BAW	2,535	70	1.3	SE/SE	3 x 3
TQQ7307	2535 MHz BAW Band 7 Uplink Filter	BAW	2,535	70	3.5	SE / SE	3 x 3
880157	2560 MHz S-Band BAW Filter	BAW	2,560	30	3.8	SE/SE	3.71 x 2.57
TQQ0041	B41 Rx BAW Filter	BAW	2,580	196	3.5	SE/SE	2 x 2
885026	B38 Tx/Rx Filter	BAW	2,595	50	1.4	SE/SE	1.4 x 1.2
885043	B38/B40 Tx Diplexed BAW Filter	BAW	2,595, 2,350	100	3.5	SE/SE	1.7 x 1.3
880369	5775 MHz WLAN 802.11a BAW Filter	BAW	5,775	100	3	SE/SE	3.26 x 1.6

Ordering

TriQuint products can be purchased through:

- ***TriQuint Online Store:***
  Select TriQuint products are now available for purchase online at **http://store.triquint.com.**
- ***TriQuint Field Sales Offices:***
  We have regional sales offices across the globe to work closely with you on your next TriQuint product purchase. To identify the closest regional sales office, please go to our website at **www.triquint.com/sales.**
- ***Local Sales Representatives:***
  Local sales representatives are skilled at examining application needs from a variety of angles to aid the design process. Their insight and specialized experience, paired with your goals, can find the combination of products that best meet overall objectives. Since these representatives work with a variety of customers in many different design environments, their experience can be valuable in determining the right 'fit' for your particular application. To locate a sales representative, please visit our website at **www.triquint.com/sales.**
- ***Distributors - Buy / Resale Reps:***
  TriQuint products can be purchased from any one of the distributors or buy / resale reps listed on our website at **www.triquint.com/sales.**

Terms & Conditions

For a complete listing of TriQuint terms and conditions of sale, please visit our website at **www.triquint.com/sales.**

Export Compliance

Almost all products TriQuint offers for sale as detailed in this Product Selection Guide are available for export subject to US government regulations. Please contact your TriQuint salesperson for details.

Product Support

- ***Product Data Sheets:***
  Detailed information on our products including datasheets can be found on the TriQuint website at **www.triquint.com.**
- ***Applications Support:***
  Detailed product support information can be found on the TriQuint website at **www.triquint.com/sales.**

Reliability Programs

Our programs are in line with JEDEC and other industry standards.

Environmental, Health & Safety Policy

TriQuint is committed to driving continuous improvement; providing employees with a safe and healthy working environment; and being a role model for sound environmental stewardship and pollution prevention, while meeting or exceeding all applicable federal, state and local requirements.

Environmental Systems

- ISO-14001:2004 (Select Sites)

Quality Policy

Each of us at TriQuint is committed to zero defects, continuous improvement, quality and reliability to meet or exceed customer requirements.

Quality Systems

- ISO-9001:2008 Certified (Select Sites)
- ISO / TS 16949:2009 Certified (Select Sites)
- ISO / AS9100B Certified (Select Sites)

Quality Tools Utilized

- Design Failure Mode & Effects Analysis (DFMEA)
- Process Failure Mode & Effects Analysis (PFMEA)
- Process Control Plan (PCP)
- Production Part Approval Process (PPAP)
- Eight Discipline Problem Solving (8-D)
- Real Time Statistical Process Control (SPC)
- Measurement System Analysis (MSA)
- Advanced Product Quality Planning (APQP)

For further details on TriQuint quality and reliability information, please visit our website at **www.triquint.com/about-us/quality.**

Product Compliance Policies

TriQuint is committed to meeting all global product environmental regulations that affect its products. These regulations include:

- Directive 2002 / 95 / EC (RoHS Directive) and its recast Directive 2011 / 65 / EU
- Management Methods for Control of Pollution Caused by Electronic Information Products (China RoHS)
- Directive 94 / 62 / EC (Packaging Directive)
- Directive 2006 / 122 / EC (PFOS Directive)
- Regulation (EC) No 1907 / 2006 (REACH Regulation)
- Commission Decision 2009 / 251 / EC (Dimethylfumarate Ban)

All active TriQuint commercial standard products are compliant with these directives. Contact TriQuint for the RoHS compliance status of custom products, military products and products manufactured prior to June 2006. All new product designs are halogen-free since late 2008. TriQuint does not use any REACH Substances of Very High Concern (SVHCs) in its products or packaging materials above a concentration of 0.1% (at the product level). Also, TriQuint is committed to complying with Section 1502 (Conflict Minerals) of the Dodd-Frank Wall Street Regulation and Consumer Protection Act. We are actively surveying our supply chain to determine the source of the conflict mineral derivatives in our products. At this time, we have determined that gold, tin, and tantalum are being sourced from the Conflict Region, but all smelters identified as sourcing from this are are certified as Conflict-Free Smelter Program Compliant. At this time, we do not have enough information about the sourcing of the tungsten smelters in our supply chain to be able to determine if they are sourcing from the Conflict Region. Please contact TriQuint at rohs_info@triquint.com for more information on the use of conflict mineral derivatives in TriQuint products.

In addition to being compliant with the above product compliance laws and regulations, TriQuint participates in the following customer programs:

- Sony Green Partner
- Samsung Eco-Partner

Please contact TriQuint at **rohs_info@triquint.com** for any product compliance information requests.
For further details on TriQuint environmental, health & safety information, please visit our website at **www.triquint.com/about-us.**

Notice

The data provided in this selection guide is subject to change without notice. TriQuint reserves the right to make changes to specifications and other information at any time.

Authorized Channel Partners:

Global

Global

Americas & EMEA

Asia

Taiwan

India

China

China

Japan

China

For more information, visit **www.triquint.com/sales.**

OREGON, UNITED STATES
Phone: +1.503.615.9000
Facsimile: +1.503.615.8900
E-mail: infoamericas@triquint.com

TEXAS, UNITED STATES
Phone: +1.972.994.8200
Facsimile: +1.972.994.8504
E-mail: infoamericas@triquint.com

FLORIDA, UNITED STATES
Phone: +1.407.886.8860
Facsimile: +1.407.886.7061
E-mail: infoamericas@triquint.com

EUROPE / MID EAST / AFRICA
Phone: +49.89.99628.2600
Facsimile: +49.89.99628.2699
E-mail: infoemea@triquint.com

CHINA
Phone: +86.21.5011.7290
Facsimile: +86.21.5011.7295
E-mail: infoasia@triquint.com

TAIWAN
Phone: +886.2.2758.3066
Facsimile: +886.2.2758.3185
E-mail: infoasia@triquint.com

KOREA
Phone: +82.31.788.7231
Facsimile: +82.31.788.7245
E-mail: infoasia@triquint.com

JAPAN
Phone: +81.3.5719.5210
Facsimile: +81.3.3779.5182
E-mail: infoasia@triquint.com

Visit www.triquint.com/subscribe and register for TriQuint product and process updates.

TriQuint
Reach Further • Reach Faster™