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May 2007

Microwave Journal

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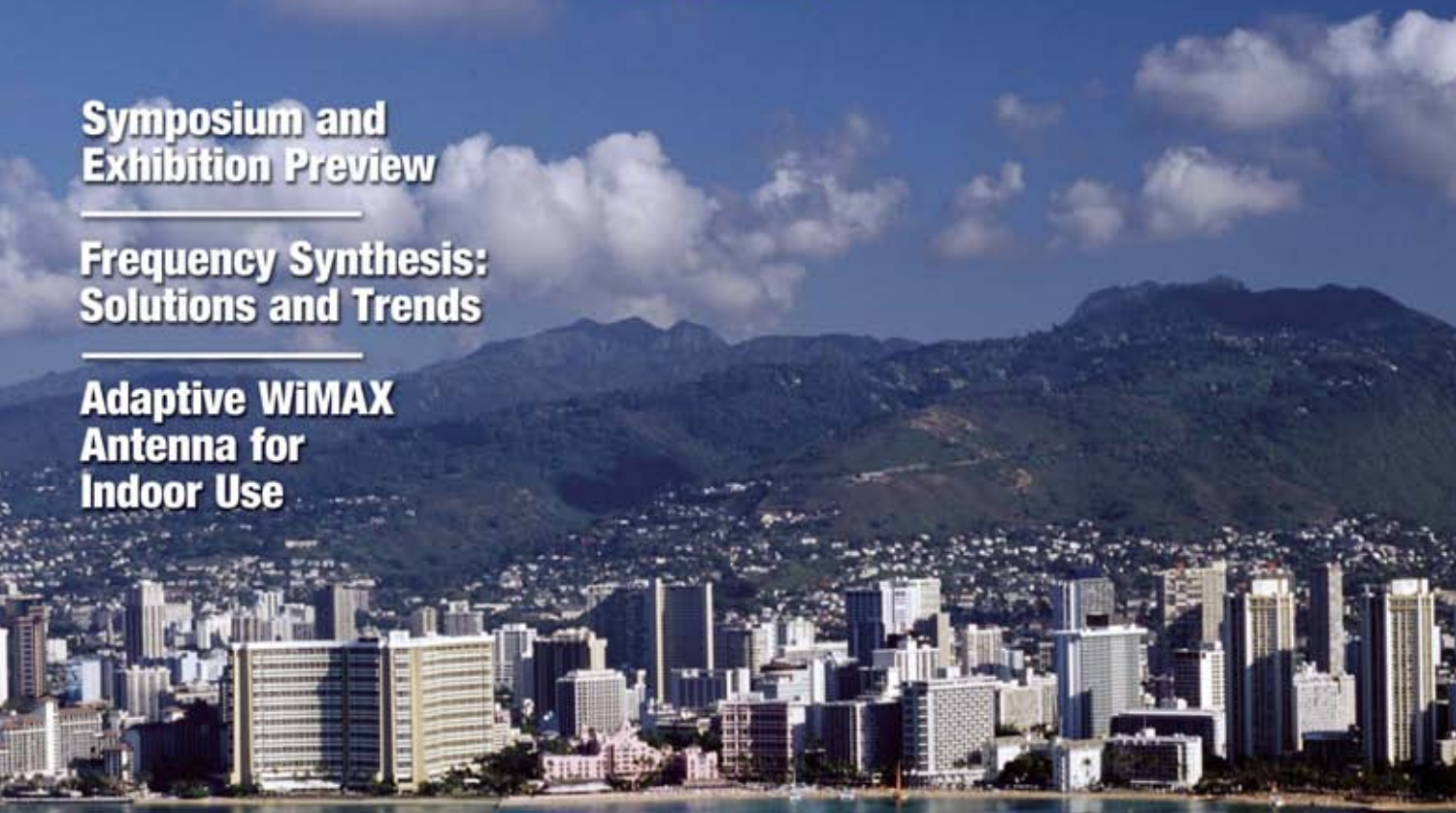
MTT-S IMS Show Issue

Honolulu, HI

Symposium and Exhibition Preview

Frequency Synthesis: Solutions and Trends

Adaptive WiMAX Antenna for Indoor Use



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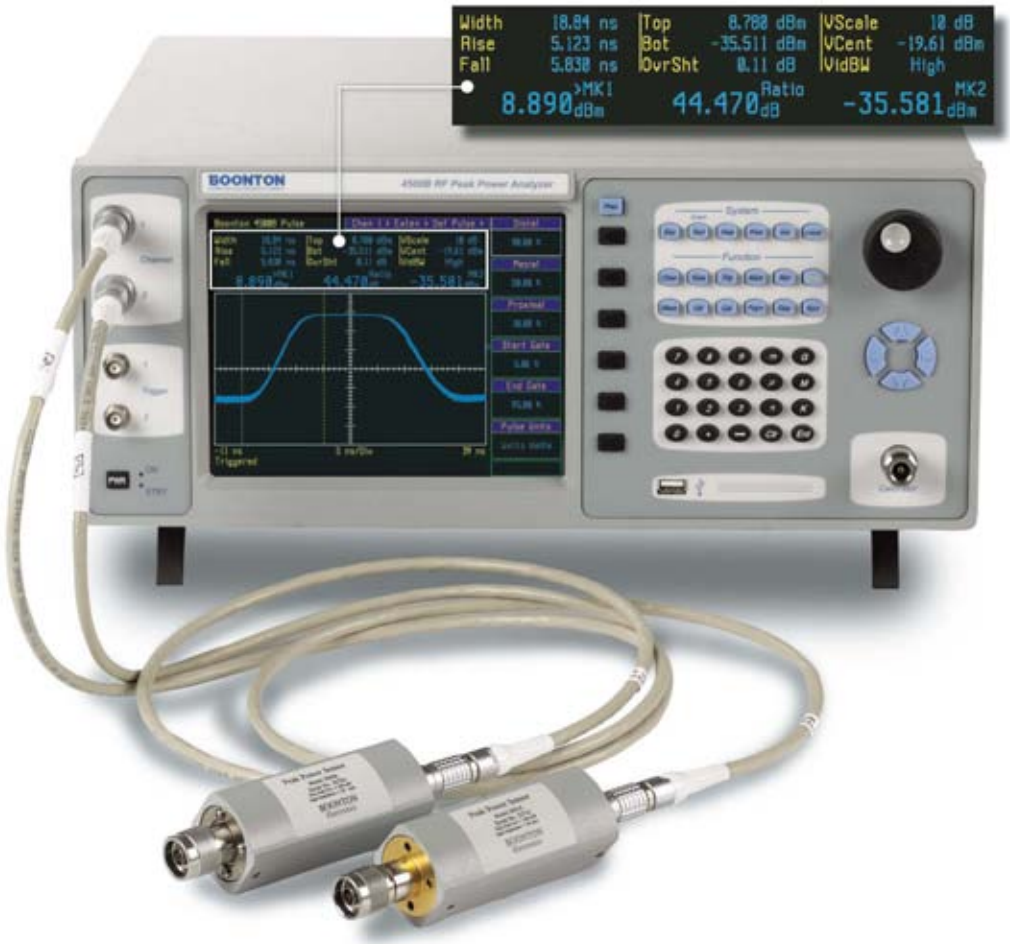

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IMAGE REJECTION MIXERS

Model Number	RF/LO Frequency (GHz)	Conversion Loss (dB) Max.	Image Rejection (dB) Min.	LO-to-RF Isolation (dB) Min.
IMAGE REJECTION MIXERS				
IRM0204(*)C2(**)	2 – 4	7.5	18	20
IRM0408(*)C2(**)	4 – 8	8	18	20
IRM0812(*)C2(**)	8 – 12	8	18	20
IRM1218(*)C2(**)	12 – 18	10	18	20
IRM0208(*)C2(**)	2 – 8	9	18	18
IRM0618(*)C2(**)	6 – 18	10	18	18
IR1826NI7(**)	18 – 26	10.5	18	20
IR2640NI7(**)	26 – 40	12	18	20

Model Number	RF/LO Frequency (GHz)	Conversion Loss (dB) Max.	Balance Phase (±Deg.) Typ./Max.	Balance Amplitude (±dB) Typ./Max.	LO-to-RF Isolation (dB) Min.
I/Q DEMODULATORS					
IRM0204(*)C2Q	2 – 4	10.5	7.5/10	1.0/1.5	20
IRM0408(*)C2Q	4 – 8	11	7.5/10	1.0/1.5	20
IRM0812(*)C2Q	8 – 12	11	5/7.5	.75/1.0	20
IRM1218(*)C2Q	12 – 18	13	10/15	1.0/1.5	20
IRM0208(*)C2Q	2 – 8	12	7.5/10	1.0/1.5	18
IRM0618(*)C2Q	6 – 18	13	10/15	1.0/1.5	18
IR1826NI7Q	18 – 26	13.5	10/15	1.0/1.5	20
IR2640NI7Q	26 – 40	15	10/15	1.0/1.5	20

SSB UPCONVERTERS OR I/Q MODULATORS

Model Number	RF Frequency (GHz)	Conversion Loss (dB) Max.	Carrier Suppression (dBc) Min.	Carrier Suppression Carrier - Fundamental IF (dBc) Min.
IF DRIVEN MODULATORS				
SSM0204(*)C2MD(**)	2 – 4	9	20	20
SSM0408(*)C2MD(**)	4 – 8	9	20	18
SSM0812(*)C2MD(**)	8 – 12	9	20	20
SSM1218(*)C2MD(**)	12 – 18	10	20	18
SSM0208(*)C2MD(**)	2 – 8	9	20	18
SSM0618(*)C2MD(**)	6 – 18	12	20	18

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For Carrier Driven Modulators, please contact MITEQ.

MODEL NUMBER OPTION TABLE

(*) Add Letter	LO/IF Power Range	P1 dB C.P. (dBm) (Typ.)
L	10 – 13 dBm	+6
M	13 – 16 dBm	+10
H	17 – 20 dBm	+15

(**) Add Letter	IF FREQUENCY OPTION (MHz)
A	20 – 40
B	40 – 80
C	100 – 200
Q	DC – 500 (I/Q)

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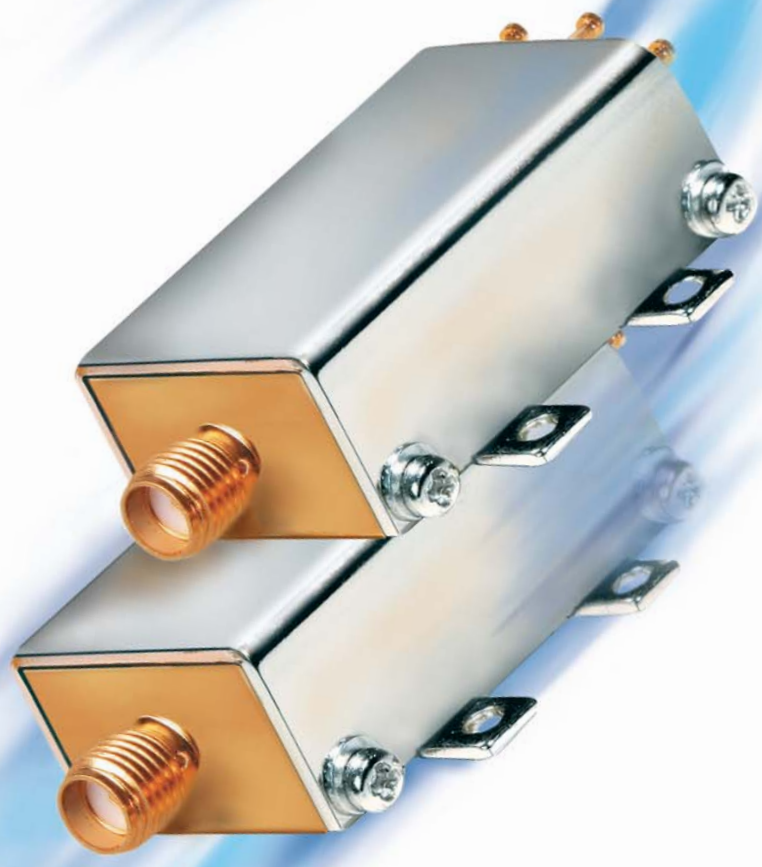

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SERIES Model No.	Freq. (MHz) Min. Max.	POUT (dBm) Typ.	Phase Noise* Typ.	VTUNE (V) Max.	Harmonics (dB) Typ.	Current (mA) Max.	Price $ea. (1-9)
ZX95-100	50-100	10.0	-110	17	-33	20	37.95
ZX95-200	100-200	10.0	-106	17	-30	20	37.95
ZX95-400	200-380	10.0	-104	17	-25	21	39.95
ZX95-535	300-520	6.0	-101	17	-25	21	39.95
ZX95-765	485-765	8.0	-98	16	-35	22	40.95
ZX95-1200W	612-1200	10.0	-96	18	-16	30	49.95
ZX95-1410	850-1410	8.0	-101	11	-17	30	44.95
ZX95-1600W	800-1600	9.0	-99	24	-22	35	44.95
ZX95-1700W	770-1700	9.0	-100	24	-25	35	49.95
ZX95-1900V	1450-1900	8.0	-104	20	-20	25	42.95
ZX95-2150VW	970-2150	4.0	-99	25	-22	26	54.95
ZX95-2500	1600-2500	7.5	-91	14	-17	28	46.95
ZX95-2650	2165-2650	5.0	-101	19	-12	25	43.95

*Phase Noise: SSB at 10 kHz offset, dBc/Hz.

U.S. Patent Number 6,790,049

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Low Pass *VLF Models $21.95 ea. (1-9)*

Model	Passband (MHz)	fco, Nom. Loss 3 dB (MHz) Typ.	Stopband Loss >20 dB (MHz) Min.
VLF-80	DC-80	145	200
VLF-95	DC-95	165	220
VLF-105	DC-105	180	250
VLF-120	DC-120	195	280
VLF-160+	DC-160	230	330
VLF-180+	DC-180	270	370
VLF-190+	DC-190	280	400
VLF-225	DC-225	350	460
VLF-320	DC-320	460	560
VLF-400	DC-400	560	660
VLF-490	DC-490	650	800
VLF-530	DC-530	700	820
VLF-575	DC-575	770	900
VLF-630	DC-630	830	1000
VLF-800	DC-800	1075	1275
VLF-1000	DC-1000	1300	1550
VLF-1200	DC-1200	1530	1865
VLF-1400	DC-1400	1700	2015
VLF-1450	DC-1450	1825	2025
VLF-1500	DC-1500	1825	2100
VLF-1525	DC-1525	1750	2040
VLF-1575	DC-1575	1875	2175
VLF-1700	DC-1700	2050	2375
VLF-1800	DC-1800	2125	2425
VLF-2250	DC-2250	2575	2900
VLF-2500	DC-2500	3075	3675
VLF-2600	DC-2600	3125	3750
VLF-2750	DC-2750	3150	4000
VLF-2850	DC-2800	3300	4000
VLF-3000	DC-3000	3600	4550
VLF-3800+	DC-3900	4850	6000
VLF-4400+	DC-4400	5290	6700
VLF-5000	DC-5000	5580	6850
VLF-5500+	DC-5500	6200	7200
VLF-5850+	DC-5850	6540	7600
VLF-6000	DC-6000	6800	8500
VLF-6400+	DC-6400	7200	8300
VLF-6700	DC-6700	7600	9300
VLF-7200+	DC-7200	8150	9500

U.S. Patent Numbers 6,790,049 & 6,943,646

High Pass *VHF Models $24.95 ea. (1-9)*

Model	Passband (MHz)	fco, Nom. Loss 3 dB (MHz) Typ.	Stopband Loss >20 dB (MHz) Min.
VHF-650	710-2490	650	480
VHF-740	780-2800	740	550
VHF-880	950-3200	880	640
VHF-1200	1220-4600	1180	940
VHF-1300	1400-5000	1300	930
VHF-1320	1400-5000	1320	1060
VHF-1500	1600-5500	1550	1250
VHF-1600	1650-5000	1600	1290
VHF-1760	1900-5500	1760	1230
VHF-1810	1900-4750	1810	1480
VHF-1910	2000-5200	1910	1400
VHF-2000	2260-6250	2000	1530
VHF-2100	2200-6000	2100	1530
VHF-2275	2450-7000	2275	1770
VHF-2700	2650-6500	2500	1800
VHF-2700A+	2900-8700	2700	2150
VHF-3100+	3400-9900	3100	2450
VHF-3500+	3900-9800	3500	2800
VHF-3800	4250-10000	3800	3200
VHF-4400+	5000-10100	4400	3500
VHF-4600+	5000-11000	4600	3800
VHF-5050+	5500-10000	5050	4200
VHF-5500	6000-11500	5500	4500
VHF-7150+	7900-11000	7150	6150
VHF-8400	9000-13000	8400	6000

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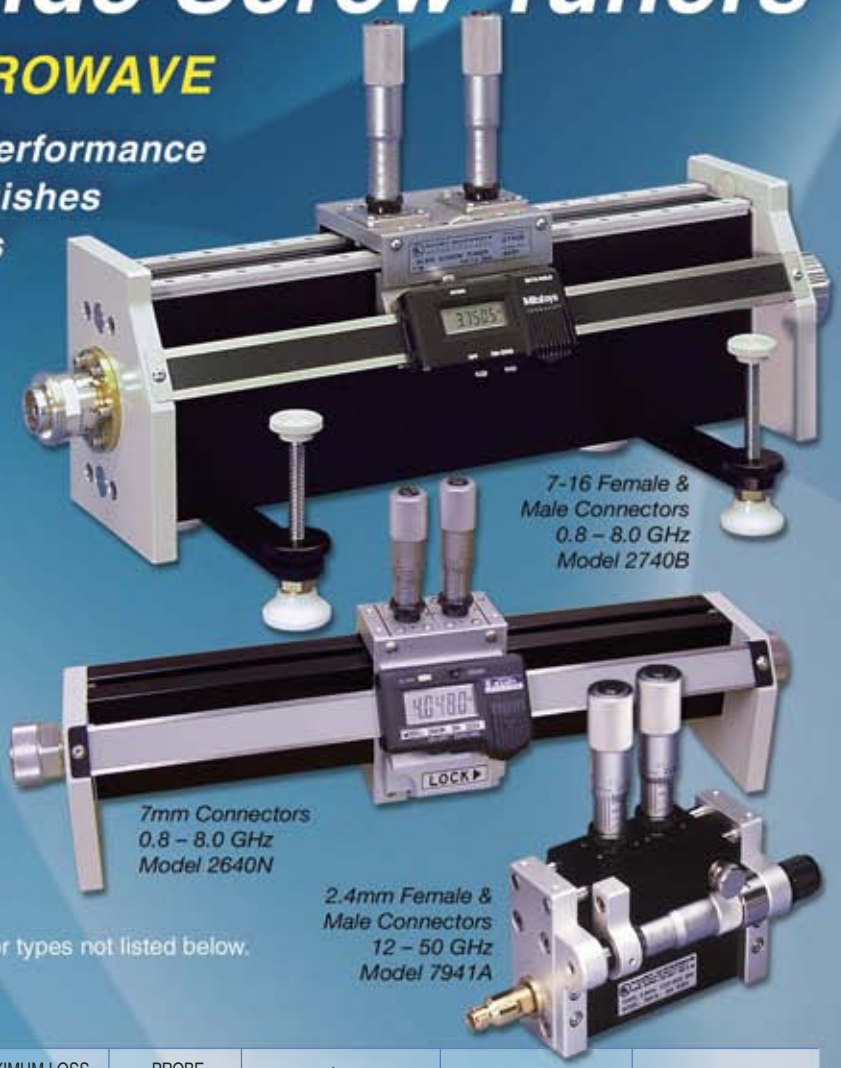

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Available Models

MODEL	FREQUENCY RANGE (GHz)	CONNECTOR TYPE	VSWR MATCHING RANGE	MAXIMUM LOSS (PROBES RETRACTED)	PROBE CROSSOVER FREQUENCY	POWER [1] HANDLING (AVE./PK. WATTS)	CARRIAGE TRAVEL INCHES	(CM)	OVERALL LENGTH INCHES	(CM)
7941A	12.0 — 50.0	2.4mm	10:1	1.0 dB	21.5 GHz	15/150	0.417	(1.059)	4.62	(11.735)
8041C	12.0 — 34.0	3.5mm	10:1	0.7 dB	16.0 GHz	15/150	0.417	(1.059)	4.95	(12.573)
8045D1	1.8 — 18.0	3.5mm	12:1	0.4 dB	5.5 GHz	25/250	3.4	(8.636)	8.94	(22.708)
2640D1		7mm				50/500	3.4	(8.636)	8.88	(22.555)
1643D1		Type N				50/500	3.4	(8.636)	8.92	(22.657)
8045P	0.8 — 18.0	3.5mm	10:1	0.6 dB	4.6 GHz	25/250	7.8	(19.812)	13.34	(33.884)
2640P		7mm				50/500	7.8	(19.812)	13.28	(33.731)
1643P		Type N				50/500	7.8	(19.812)	13.32	(33.833)
1643N	0.8 — 2.5	Type N	25:1	0.5 dB	2.8 GHz	50/500	7.8	(19.812)	13.32	(33.833)
	2.5 — 8.0		18:1							
2640N	0.8 — 2.5	7mm	25:1	0.5 dB	2.8 GHz	50/500	7.8	(19.812)	13.28	(33.731)
	2.5 — 8.0		18:1							
8045N	0.8 — 2.5	3.5mm	25:1	0.5 dB	2.8 GHz	25/250	7.8	(19.812)	13.34	(33.884)
	2.5 — 8.0		18:1							
2740B	0.8 — 8.0	7-16	35:1	0.1 dB	2.8 GHz	100/1000	7.88	(20.015)	14.48	(36.779)
2440B		14mm					7.88	(20.015)	13.07	(33.198)
2740C	0.4 — 4.0	7-16	25:1	0.1 dB	1.4 GHz	100/1000	14.95	(37.973)	22.76	(57.810)
2440C		14mm					14.95	(37.973)	21.35	(54.229)

[1] Within rated matching range.

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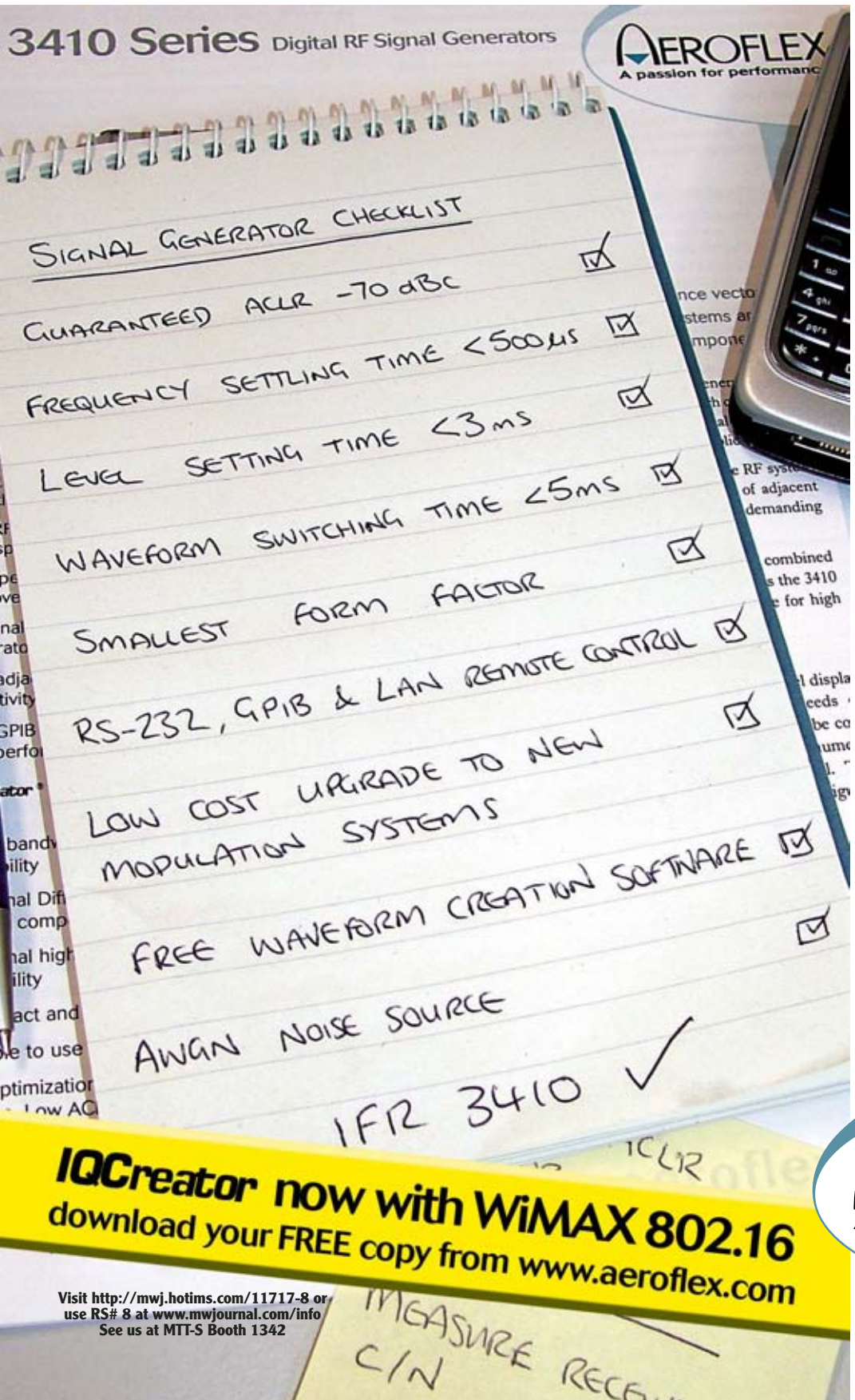

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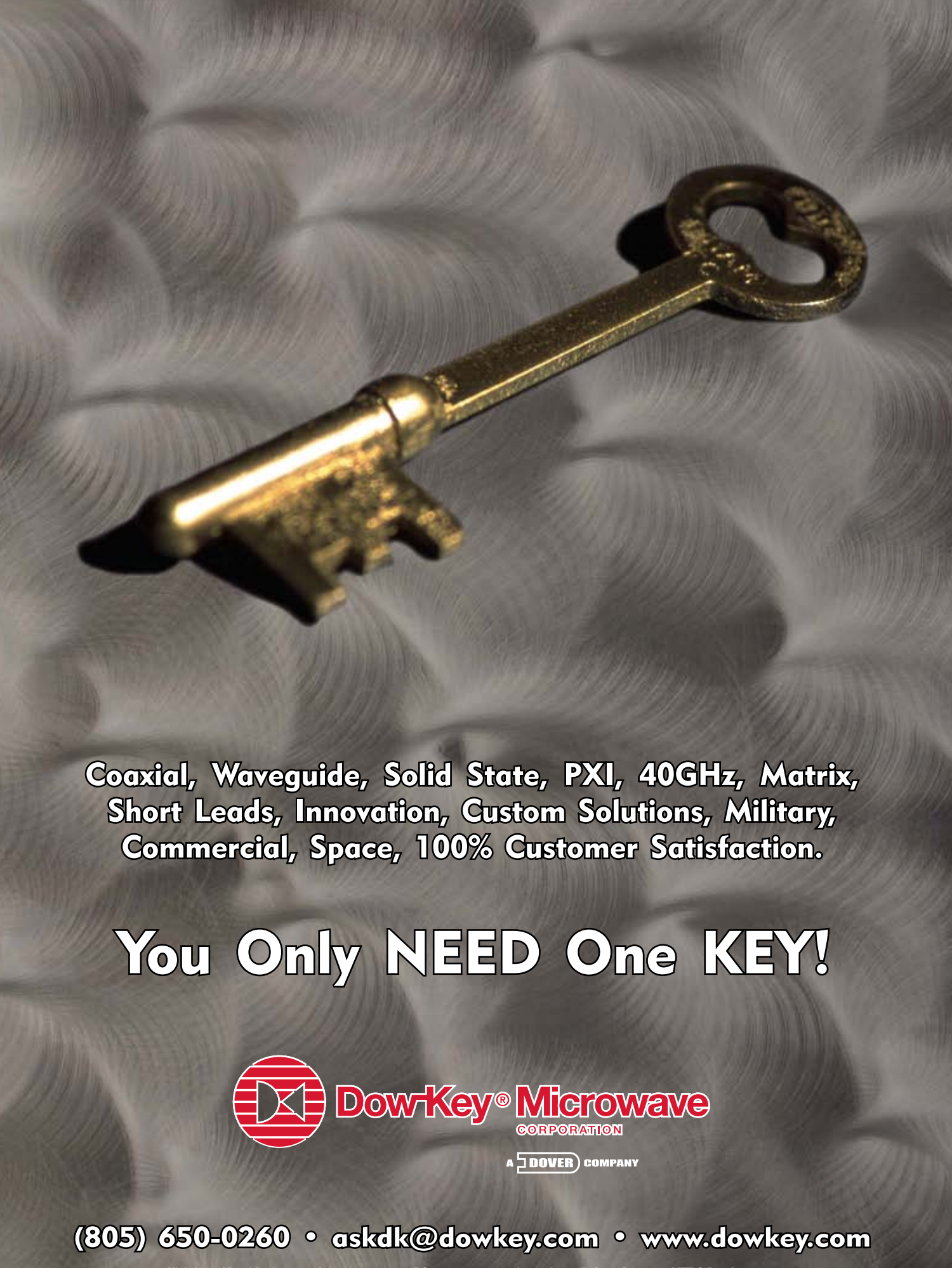
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2007 IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM & EXHIBITION

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Microwave Journal

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164 A Printed Heart Monopole Antenna with Band-rejected Characteristics for IEEE 802.16a and UWB Applications

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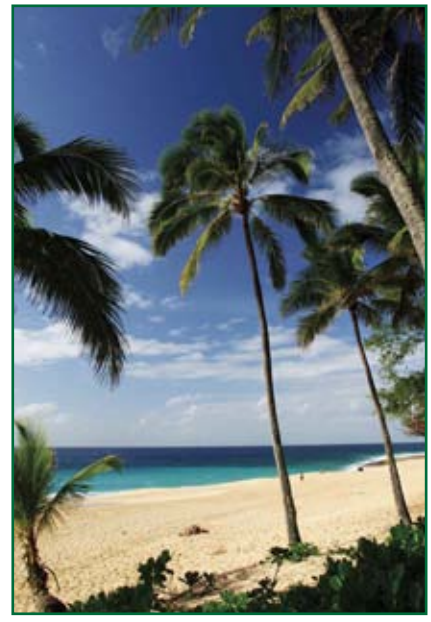

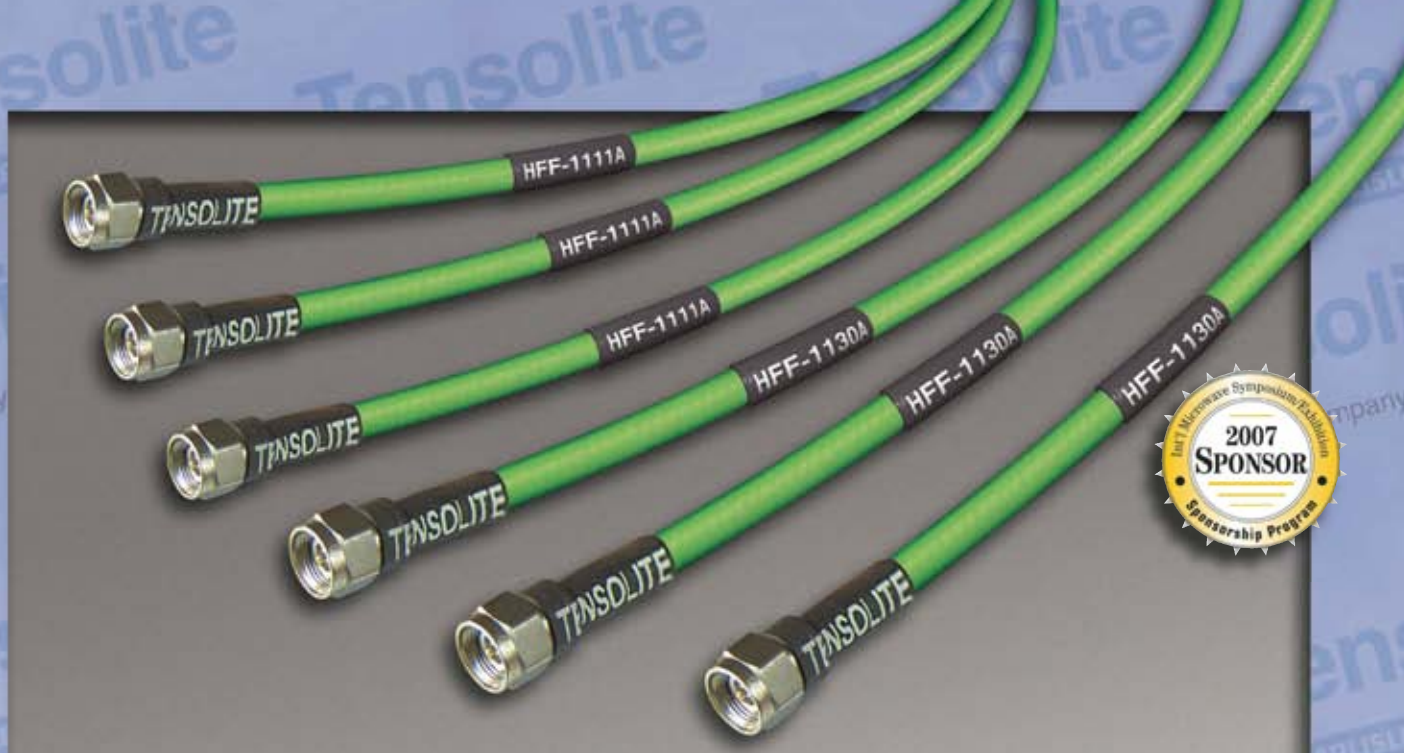

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THIS MONTH ON THE WEB

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IEEE 2007 Radar Conference
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Waltham, MA

Microwave Journal's David Vye provides a wrap-up of select news, information and product announcements at this year's IEEE Radar Conference, including a detailed look at the new products on display.

802.16e Mobile WiMAX Key RF Receiver Requirements

By Jun Lee
Skyworks Solutions Inc.

Description of key mobile WiMAX IEEE 802.16e radio frequency receiver requirements including NF, P1dB, IP2, IP3 and DC settling time in order to identify radio frequency system requirements.

Silicon and MEMS Solution Vendors Facing Challenges in a Monolithic Timing Device Industry

Vendors of solutions based on silicon and micro electro-mechanical systems (MEMS) face an uphill battle to make a dent in the huge market for timing devices. Most of the largest crystal oscillator vendors are Asia-Pacific based companies, and they rule the market, mass-producing low-cost crystal oscillators to feed the huge regional consumer electronics industry. That situation will continue beyond the end of the report's forecast period in 2011.

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How it works: Harlan has selected one question from his "Ask Harlan" column to be featured in the magazine. Please visit www.mwjournal.com/askharlan to provide an answer to this month's featured question (see below). Harlan will be monitoring the responses and will ultimately choose the best answer to the question. Although all of the responses to the featured question will be posted on our web site, we plan to publish the winning answer in the July issue. All responses must be submitted by **June 7, 2007**, to be eligible for the participation of the May question.

The winning response will win a free book from Artech House, along with an "I Asked Harlan!" t-shirt. In addition, everyone who submits a legitimate response will be sent an "I Asked Harlan!" t-shirt.

March Question and Winning Response

The March question was submitted by Madhusudhan from VT University, Belgaum, India:

Dear Harlan,

I would like to introduce myself as a PhD student in microwave and MEMS doing research in India. I have just started my research in modeling of MEMS devices and I have encountered a problem. I am very much confused by different things like field solvers and SPICE models. Could you provide any clarity between the two and also suggest field solvers or a low cost field solver that I can work with for my degree?

The winning response to the March question is from Alberto Armoni of Selex Communications SpA:

Field solvers are tools that simulate the behavior of the electromagnetic field inside a structure. They use a mathematical model to find a solution very similar to the solution of the physical differential equations (deriving from Maxwell's equations) that describe the electromagnetic field in every point of the domain you consider. A field solver uses mathematical methods such as FEM (Finite Element Method) or MoM (Method of Moments). Field solvers work at a physical layer. SPICE models (Simulation Program with Integrated Circuit Emphasis) are general-purpose analog circuit simulators that use nodal analysis to construct the circuit equations; SPICE models take a text netlist describing the circuit elements (transistors, resistors, capacitors, etc.) and their connections, and translate this description into equations to be solved. It links together the various component equations and the Kirchhoff's circuit laws at an electrical level. One of the most popular field solvers is Ansoft HFSS, but I do not think it can be described as "low cost."

Harlan's response:
SPICE programs are designed to solve problems in one dimension only, while most field solvers work in two or three dimensions. Most field solving software is quite expensive; however, Sonnet Software does offer some free software at www.sonnetsoftware.com/lite.

This Month's Question of the Month
(answer on-line at www.mwjournal.com/askharlan)

Majeed Ahamad from Urjita Electronics Pvt. Ltd. has submitted this month's question:

Dear Harlan,

In the case of passive filters (LPF, HPF and BPF), would it be possible that voltage across any component (inductors and capacitors) is more than the input voltage fed to that filter? If yes, then why and how?

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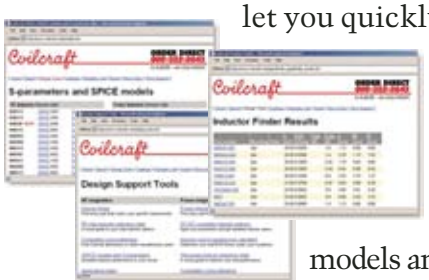

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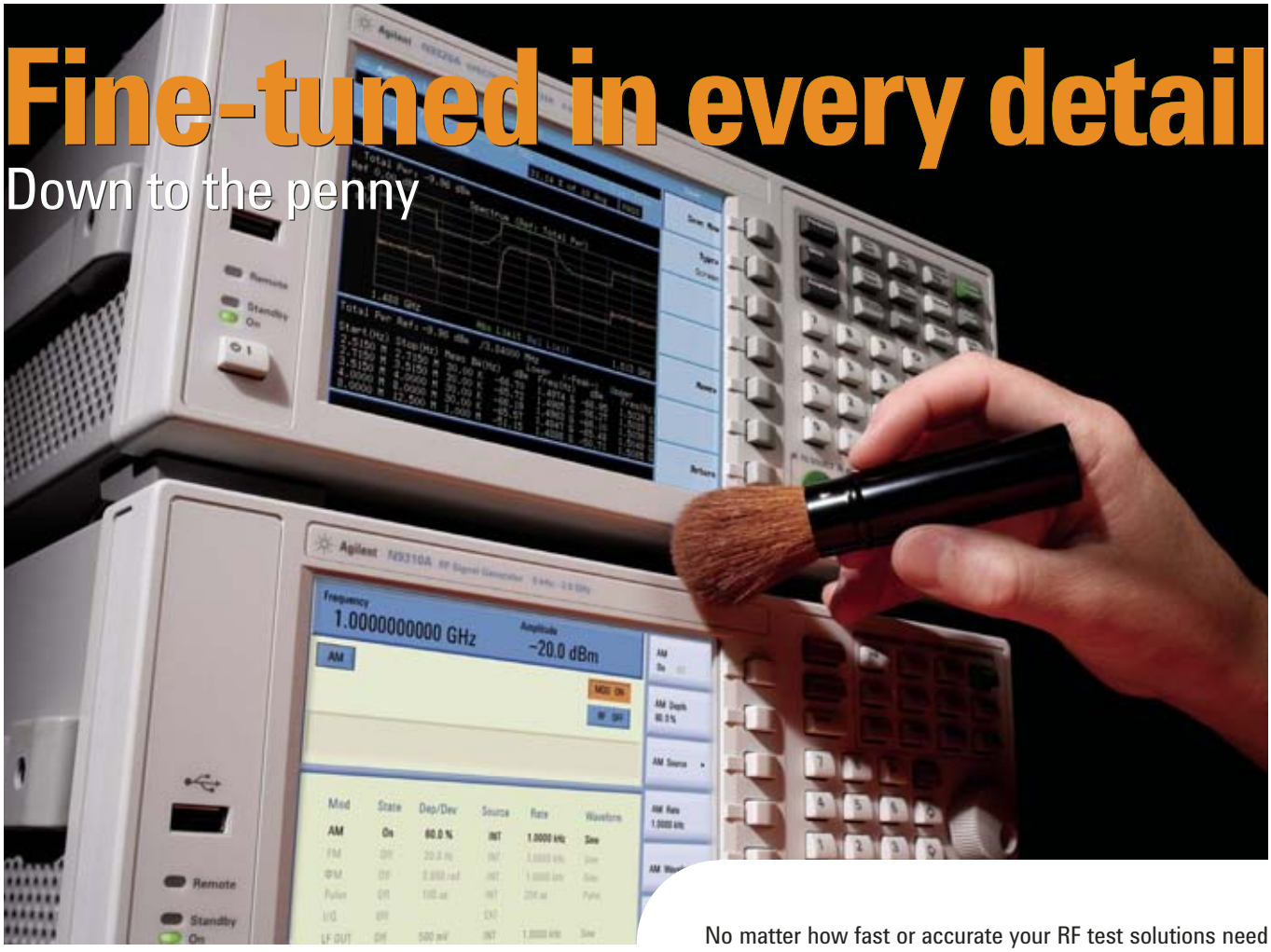

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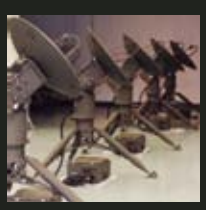

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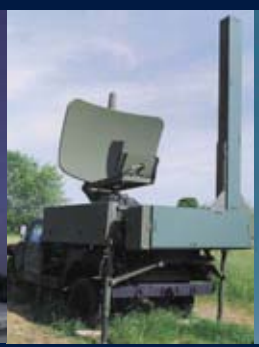

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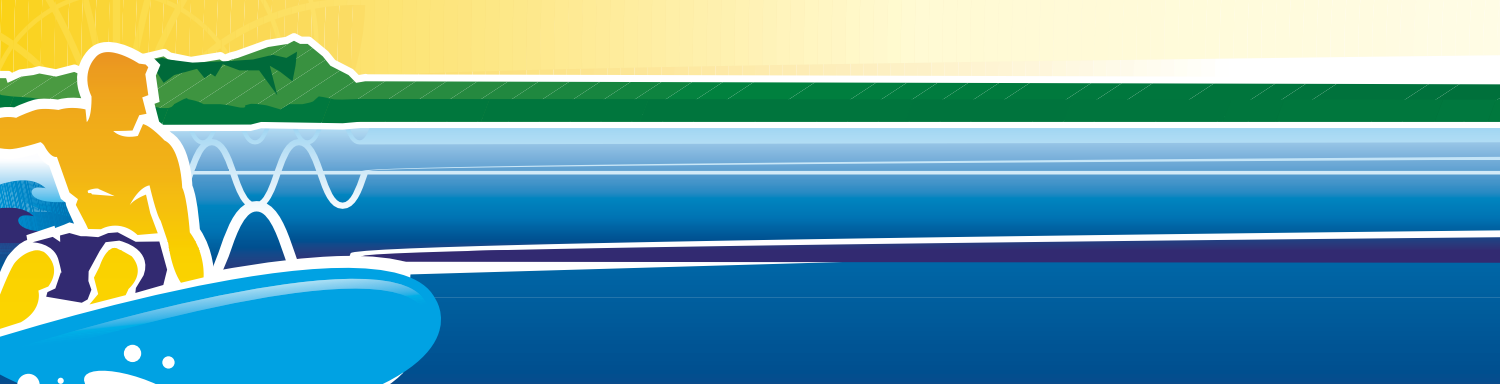

Welcome to the 2007 International Microwave Symposium

Wayne A. Shiroma *received his BS degree from the University of Hawaii at Manoa, his MEng degree from Cornell University and his PhD degree from the University of Colorado at Boulder, all in electrical engineering. In 1996, he joined the University of Hawaii (UH) at Manoa, where he is now an associate professor of electrical engineering and co-director of the Hawaii Space Flight Laboratory. Through the UH Small-satellite Program that he established in 2001, he advised over 100 engineering students in the design and construction of nanosatellites for launch into low earth orbit. Prior to joining UH, he was with Hughes Space and Communications (El Segundo, CA), developing solid-state power amplifiers for commercial and military satellites. He has over 50 publications, with approximately half related to retrodirective antennas and nanosatellites, and has one patent and one patent pending in these areas. He is one of the founders of Pipeline Communications and Technology (Honolulu, HI), which is commercializing aspects of this technology. His research team consists of students ranging from PhD to undergraduate level. In the past six years, three of his students won the Alton B. Zerby and Carl T. Koerner Outstanding Electrical and Computer Engineering Student Award (presented by the electrical engineering honor society Eta Kappa Nu), identifying them as the top electrical engineering students in the nation. He is the recipient of the 2003 UH Regents Medal for Excellence in Teaching, UH's highest teaching award. He served as IEEE MTT-S AdCom Secretary in 2001 and has been an Elected Member since 2002.*

EKomo Mai (Welcome) to Honolulu, HI, this year's host city of what is widely regarded as the most prestigious microwave industry gathering in the world: the 2007 International Microwave Symposium (IMS 2007). IMS 2007 is the largest international conference devoted to the research, development, and application of RF and microwave theory and techniques, with approximately 10,000 participants and 400 exhibiting companies from around the world. This conference is sponsored by the Microwave Theory and Techniques Society (MTT-S) of the Institute of Electrical and Electronics Engineers (IEEE). IMS 2007 (www.ims2007.org) is the centerpiece of Microwave Week 2007, which also includes the Radio Frequency Integrated Circuit (RFIC) Symposium (www.rfic2007.org) and the Automatic Radio Frequency Techniques Group (ARFTG) Conference (www.arftg.org).

Sun... Surf... and Microwaves?

Although one typically associates Hawaii with sun and surf, our state's historical role in radio waves is also recognized by the IEEE. The Opana Radar Site, located on the north shore of Oahu, is designated as an IEEE Milestone in Electrical Engineering and Computing with the following citation: "On December 7, 1941, an SCR-270B radar located at this site tracked incoming Japanese aircraft for over 30 minutes until they were obscured by the island ground clutter. This was the first wartime use of radar by the United States Military, and led to the successful application throughout the theater."

Hawaii's strategic location at the Crossroads of the Pacific is no less important today than it was half a century ago. But instead of dividing east and west, today Hawaii is the perfect venue for bridging it, especially considering that the biggest microwave market growth is currently in Asia.

Wayne A. Shiroma
General Chair, 2007 International Microwave Symposium

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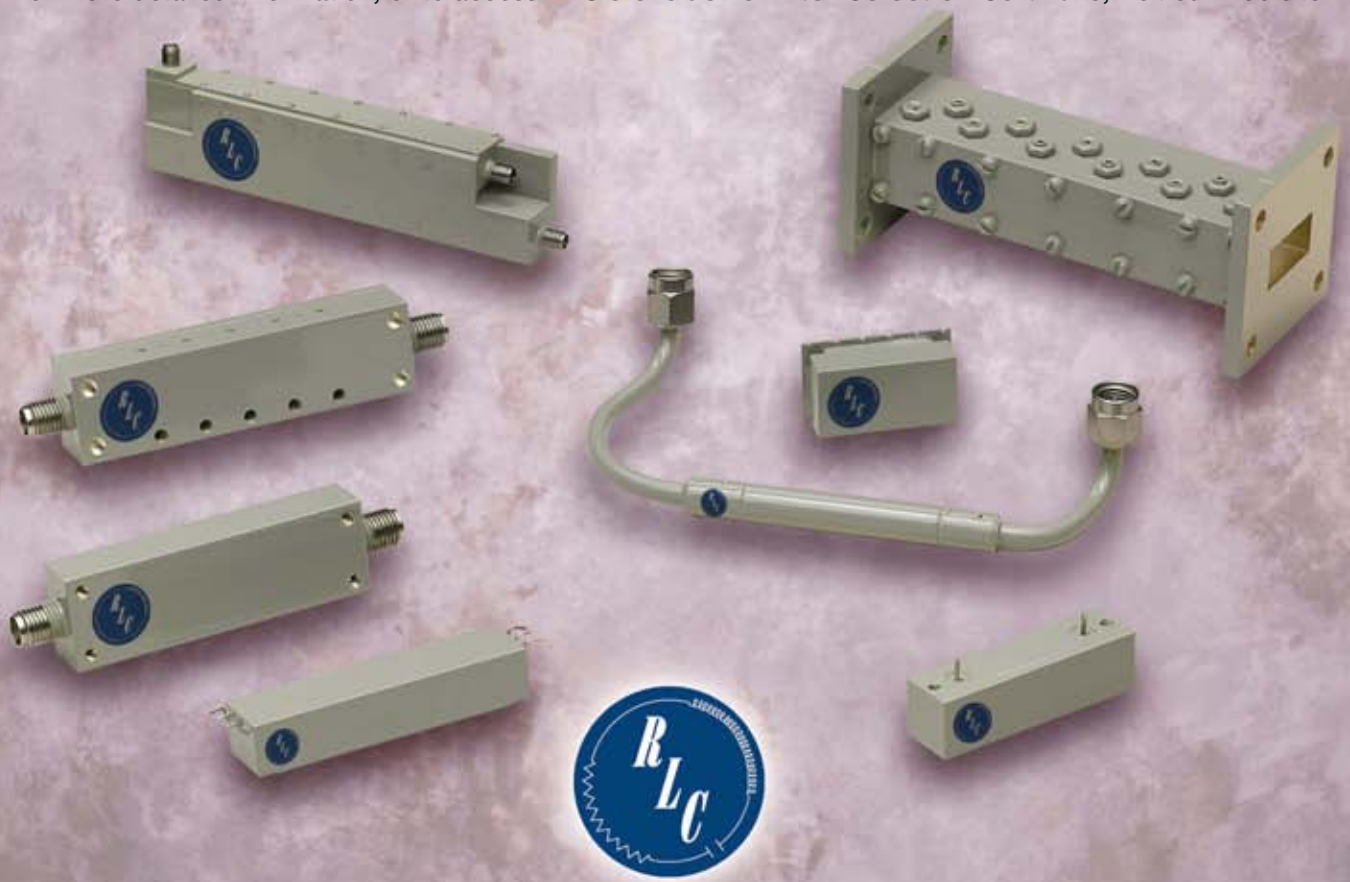

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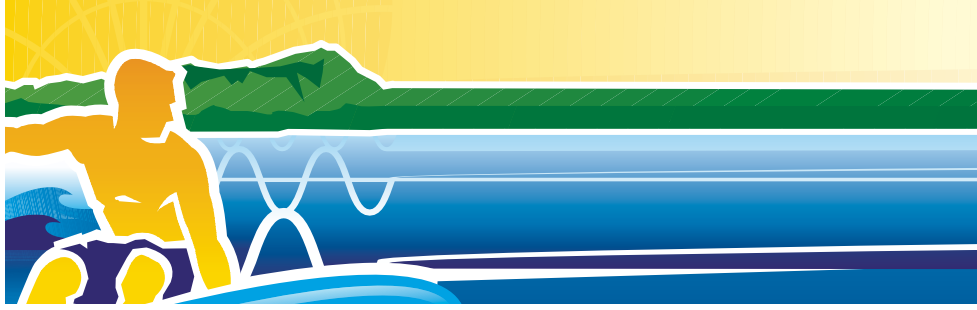

Fifty Years of the IMS

While it's pure coincidence that the 50th state of the US is hosting the 50th occurrence of the International Microwave Symposium, there's no denying that this is the first time that this symposium is being held off of the North American continent. Perhaps this is why IMS 2007 received 1069 manuscripts, the second-highest number of submissions in IMS history. RFIC 2007 received an all-time record of 350 manuscripts, a 30 percent increase over last year. Under the leadership of Tatsuo Itoh, the IMS 2007 Technical Program Committee has assembled a top-notch technical program that includes workshops, panel sessions, oral sessions and student competitions. For the first time in recent IMS history, we are offering eight short courses from world-class experts that allow participants to earn IEEE continuing education units. Also new this year is an expanded interactive forum during the morning and afternoon of Wednesday and Thursday.

Go for the GOLD

The MTT-S is going the extra mile in assimilating Graduates of the Last Decade (GOLD), that is, IEEE members who graduated with their first professional electrical engineering degree within the past 10 years. The MTT-S GOLD Committee is sponsoring a Thursday panel session on "Career Development: Giving Your Career a Never-ending Boost." A reception and luau will be held on Thursday evening for all GOLD members who fill out a short survey at the MTT-S Membership Booth or GOLD panel session.

Go Holoholo (Excursions)

Hawaii's reputation as a visitor destination allows us to offer an exciting array of tours that appeals to all ages: Polynesian Cultural Center, Sea Life Park Luau, Doris Duke Estate (Shangri-La), Star Sunset Cruise, Tropical Ocean Fun Cruise, A Day on the Bay, Cirque Hawaii, Dolphin Adventures Program, Grand Circle Island Tour, Hole in the Wall Lunch Tour, Kualoa Ranch, and the Arizona Memorial, USS Missouri and City Tour. In addition to these exciting Oahu-based tours are one-day neighbor-island getaways and three-day pre- and post-conference vacation packages to Maui, Kauai and the Big Island.

To round out the week, sign up for the IMS 2007 Golf Tournament on Saturday, June 9. Once recognized as one of *Golf Digest*'s "Top 75 Golf Resorts in the US," the Ko Olina Golf Resort is the perfect venue to entertain your client or relax with friends after the symposium. Co-sponsored by Anritsu, Ansoft, AWR and the IMS 2007 Steering Committee, this shotgun tournament promises to be a fun event for all.

Go Kama'aina (Native)

Hawaii's tropical climate lends itself to a more relaxed lifestyle, so we encourage attendees and exhibitors alike to leave their coats and ties at home. Conservative and tasteful aloha wear is accepted business attire in Hawaii, and is perfectly suitable for presenting a paper, attending a workshop, or visiting the exhibition hall. Beachwear, of course, is not considered acceptable. IMS 2007 has partnered with Hilo Hattie, the largest retailer of aloha wear in Hawaii, to have a Hawaiian Hut in the Hawaii Convention Center lobby. Conference attendees and exhibitors can purchase aloha wear at a 20 percent discount valid only at the IMS 2007 Hawaiian Hut.

Aloha

All in all, Microwave Week is sure to be the blockbuster microwave event of the year, and possibly a family vacation you will long remember. All of us on the IMS 2007 Steering Committee extend to you a warm aloha! ■

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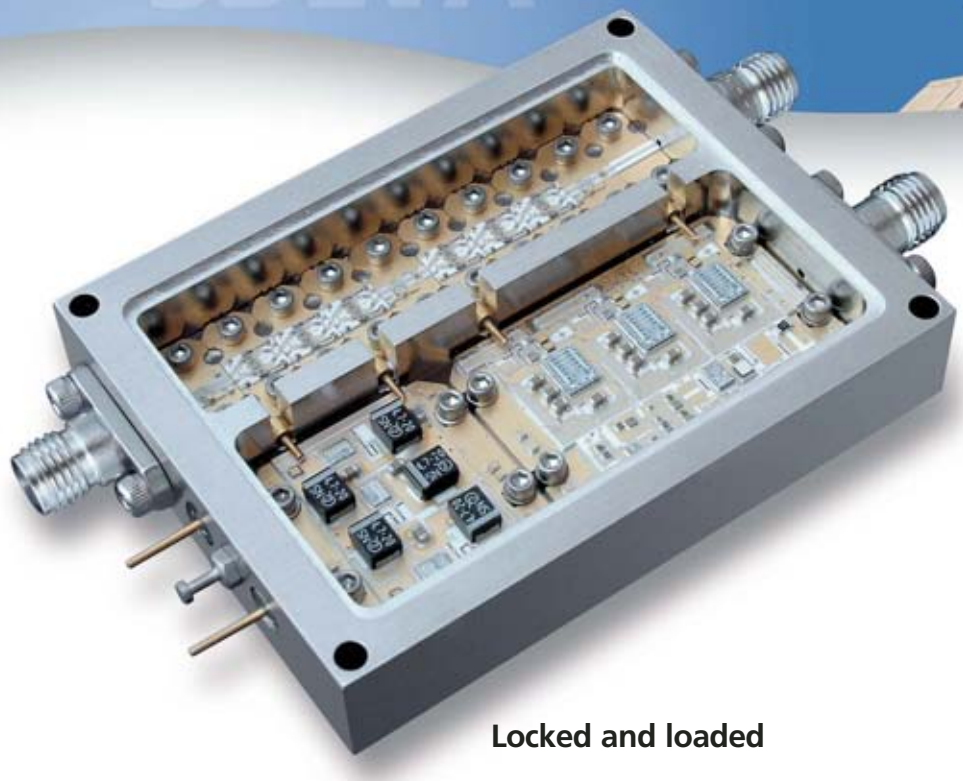

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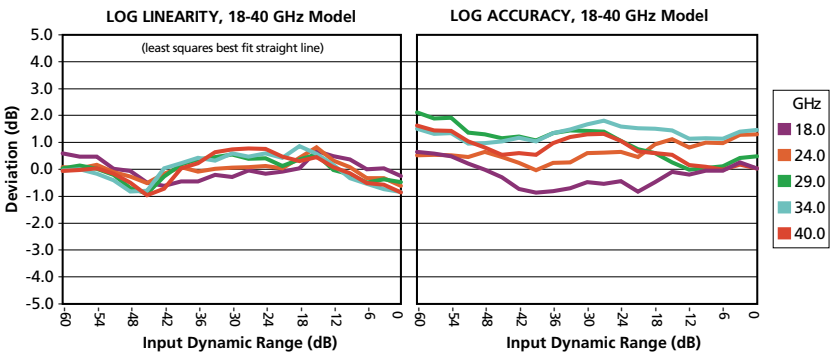

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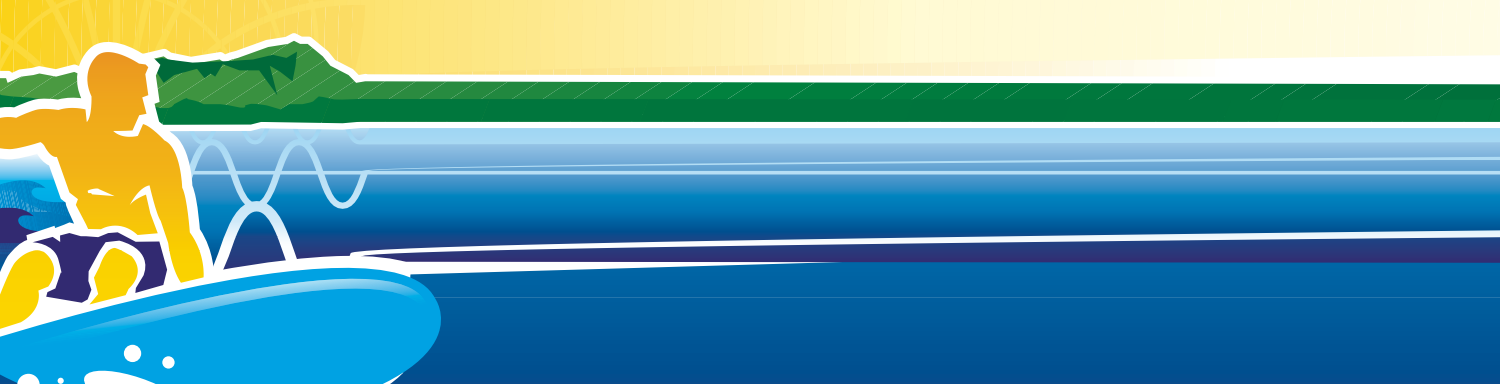

Attending the Conference

This year there will be an exchange of cultures as East meets West when the IEEE MTT-S International Microwave Symposium (IMS) and Exhibition is held in Honolulu, HI. The technical program continues to be the largest microwave meeting in the world with seven parallel sessions plus the usual panel sessions, interactive forum and workshops. The RFIC symposium and ARFTG meeting will also be held as part of the week's activities. On-site registration opens at 2:00 PM on Saturday, June 2, with the first workshops starting on Sunday, June 3. Workshops continue on Monday, June 4. The last workshops and the ARFTG meeting are on Friday, June 8. The IMS sessions, RFIC sessions, panel sessions, workshops and exhibition will all be held in the Hawaii Convention Center (HCC). The ARFTG meeting will be held in the Hilton Mid-Pacific Conference Center. A detailed program of events is available at www.ims2007.org.

Travel to Honolulu

There are three official airlines with reduced fares: American Airlines (800-433-1790 Code A575AB), Continental Airlines (800-468-7022 Code ZUHX, BYM1CS) and United Airlines (800-521-4041 Code 565PW). The Honolulu International Airport (HNL) is located about eight miles from the Hawaii Convention Center. Transfers from the airport to the city are available by taxi, bus, shuttle service and rental car. The taxi fare outside of rush hour is $25–$35. There is 24-hour bus service departing every 20 minutes. Fares are $9 one way or $15 round trip. For further information, visit www.robertshawaii.com/hat.htm. There are numerous shuttle companies available on a pre-arranged basis. For further information, visit www.hawaii.gov/dot/airports/hnl/hnl_ground_trans.htm. Major rental car companies all have counters at HNL. Traffic in downtown Honolulu is very heavy. Rental cars are not recommended unless you plan to tour the island on your own.

Hotels

There are 10 hotels with convention rates. All of these are downtown. The Ala Moana hotel is within two blocks walking distance of the convention center. The other hotels are further away. The headquarters hotel is the Hilton Hawaiian Village. Transportation will be provided to and from all the hotels to the HCC except from Ala Moana.

Guest Program

The guest program this year is perhaps the most extensive ever with city and island trips, visits to other islands, an ocean cruise and a sunset dinner cruise. There will also be a golf tournament at the Ko Olina Golf Club on Saturday, June 9. Guest program information and registration can be found at www.mcahawaii.com/grps07/ims2007hi or by phone at 1-808-589-5583. Advance registration for all events is strongly recommended. There will also be two hospitality suites, one at the Hilton Hawaiian Village and one at the Sheraton Waikiki. Guest badges are required for entry.

Harlan Howe, Jr.
Editor, Microwave Journal

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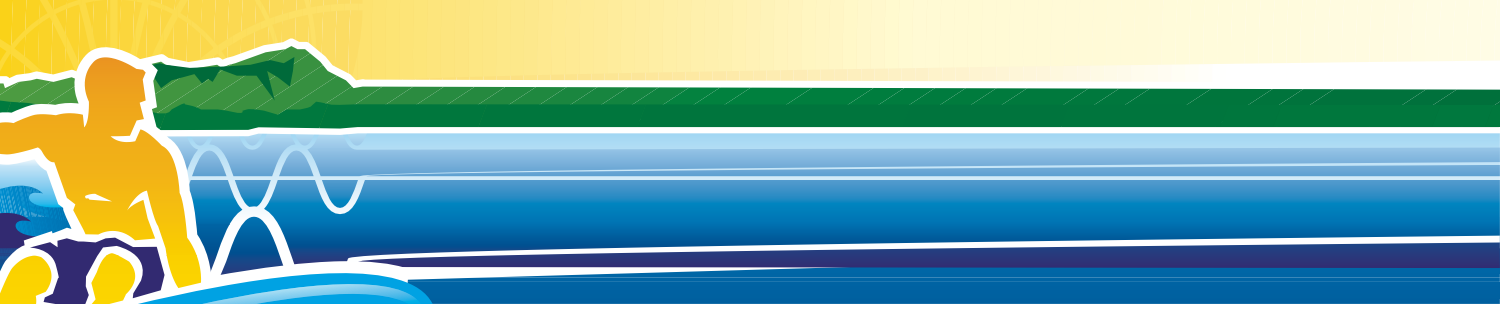


Social Highlights

The RFIC Reception will be held Sunday evening from 7:00 PM to 9:00 PM at the Hawaii Convention Center Rooftop Garden. On Monday evening the *Microwave Journal*/MTT-S Reception will be held from 6:00 PM to 8:00 PM at the HCC Rooftop Garden. There are several events on Tuesday. The Women in Microwaves Reception will be held on the Hilton Village Green from 6:00 PM to 8:00 PM. The Student Reception will be held at the Hilton Kalia Tower Pool from 7:00 PM to 9:00 PM and the MTT-17 Anniversary Reception will be held at the same time in the Hilton Mid-Pacific Conference Center (MPCC) in Coral 2, followed by the Ham Radio Social in the same location from 8:00 PM to 10:00 PM. Wednesday evening the Industry Hosted Cocktail Reception will be held from 5:45 PM to 7:15 PM at MPCC Coral 3 followed by the MTT-S Awards Banquet from 7:30 PM to 10:00 PM at MPCC Coral 4. The MTT-S Student Awards Luncheon will be held on Thursday from noon to 2:00 PM in Ballroom C of the HCC. That evening the MTT-S GOLD Reception and Luau will be held on the Sheraton Diamond Head Lawn and the adjacent Royal Hawaiian Hotel starting at 5:30 PM until 9:00 PM.

MTT-S IMS Technical Program

This year there will be 381 papers presented in seven parallel regular IMS sessions plus nine focused and special sessions with an additional 142 papers presented in four open forum sessions. There will be 30 oral papers presented in the RFIC sessions, plus two open forum sessions and two panel sessions. Twenty-four student papers have been nominated for special judging with awards for the best papers given at the Student Paper Luncheon. There will be seven panel sessions held at noon on Monday through Thursday. The sessions are open to everyone at no charge. Box lunches, if desired, may be purchased for these sessions. There will be 47 workshops and tutorial sessions on Sunday, Monday and Friday, all of which include meals and refreshments as part of the registration fee. The complete technical program is available at www.ims2007.org and on pages 72–134.

Plenary Session

Everyone is invited to attend the plenary session at 10:10 AM on Tuesday. After welcoming remarks by Wayne Shiroma, IMS chairman, Steve Kenney, MTT-S president, and Tatsuo Itoh, chairman of the technical program committee, there will be the presentation of IEEE Fellow awards followed by two keynote addresses. Anil Kripalani, senior vice president for global technology affairs at QUALCOMM, will speak on "The Future of Mobile Broadband." Following his talk, Ryuji Kohno, professor and director, Center of Medical Information and Communications Technology at Yokohama National University, Japan, will present "The Next Direction of Advanced Wireless Communication Technology—Medical ICT."

Exhibition

The IMS exhibition continues to be the largest and most influential show in our industry. Over 450 companies will exhibit their new products and services in Halls I, II and III on the street level of the convention center. The exhibits will be open from 9:00 AM to 5:00 PM on Tuesday and Wednesday and from 9:00 AM to 3:00 PM on Thursday. The Micro-Apps program has been reinstated this year and will be held on the right-hand side of the show floor on Tuesday, Wednesday and Thursday. A free CD-ROM of the program details will be given to all Micro-Apps attendees. For a list of exhibitors, see pages 60–66. The floor plan of the convention center is on pages 68–69. Exhibition catalogs will be available on-site. Please note that children under the age of 14 will not be admitted to the exhibition halls at any time.

Historical Exhibit

The historical exhibit is a collection of significant hardware developments, books, papers and video presentations encompassing the history of the microwave industry. Included this year are parts and photographs of the SCR 270 radar that detected Japanese warplanes approaching Pearl Harbor on December 7, 1941. The exhibit is on the right-hand side of the exhibition hall and is open to all attendees during exhibition hours.

Cyber Cafe

There will be a hard-wired cyber café on the ballroom level of the convention center. The convention center is not fully covered for 802.11. No coverage is available in the exhibition halls; however, there will be hot spots in the hallway areas. Tables, chairs and power will be provided. There is no charge for the service.

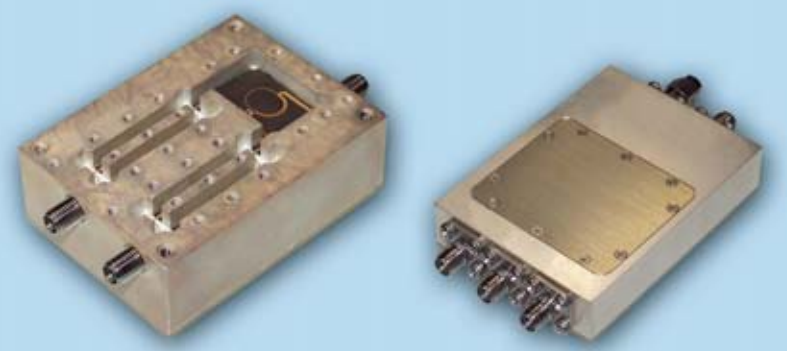
Awards

Recognition of the new IEEE Fellows will take place at the plenary session. All the other awards will be presented at the Awards Banquet on Wednesday evening. The Microwave Career Award is given in recognition of a career of meritorious achievement and outstanding technical contribution in the field of microwave theory and techniques. This year's award will be presented to Robert J. Wenzel.

The Distinguished Service Award recognizes outstanding service to the MTT-S over a sustained period of time. The award this year will be given to Lawrence R. Whicker.

The Distinguished Educator Award was inspired by the death of professor Fred Rosenbaum. It honors an educator in the field of microwave engineering and science who best exemplifies the special human qualities of Fred Rosenbaum. This year's recipients are Les Besser and Kai Chang.

CONTROL COMPONENTS



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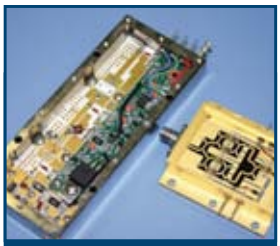
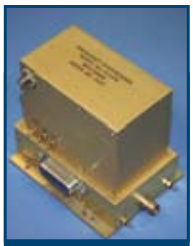
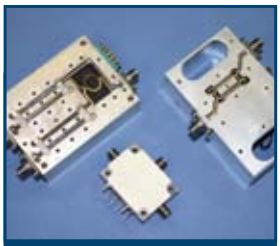

Amplifiers

Converters/Receivers

Integrated Microwave Assemblies


Synthesizers


Attenuators/Switches

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The Microwave Pioneer Award recognizes an individual or team for pioneering efforts as evidenced by an archival paper published at least 20 years prior to the year of the award. This year's recipients are Alan Sokal and Nathan Sokal for their work on Class E power amplifiers.

The Application Award recognizes an individual or team for outstanding application of microwave theory and techniques. The year's recipient is Robert Weigel for his work on ultra high frequency acoustic devices.

The Microwave Prize is given annually for the best paper published during the previous year. The recipients are Thomas Luthi and Christian Matzler for their paper "Stereoscopic Passive Millimeter-wave Imaging and Ranging."

The N. Walter Cox award has been established in recognition of the qualities of N. Walter Cox and his service to the MTT-S prior to his death in 1988. It is given to a society volunteer whose efforts on behalf of MTT-S best exemplify Walter's spirit and dedication. This year's winner is Jenshan Lin.

The Outstanding Young Engineer Award is given to a young engineer who has made an outstanding contribution in the areas of theory, application or education. There are two winners this year: Christophe Caloz for his work in applications of electromagnetic metamaterials and Vesna Radisic for his leadership in the field of microwave applications of defected ground structures, active antenna and millimeter-wave electronics.

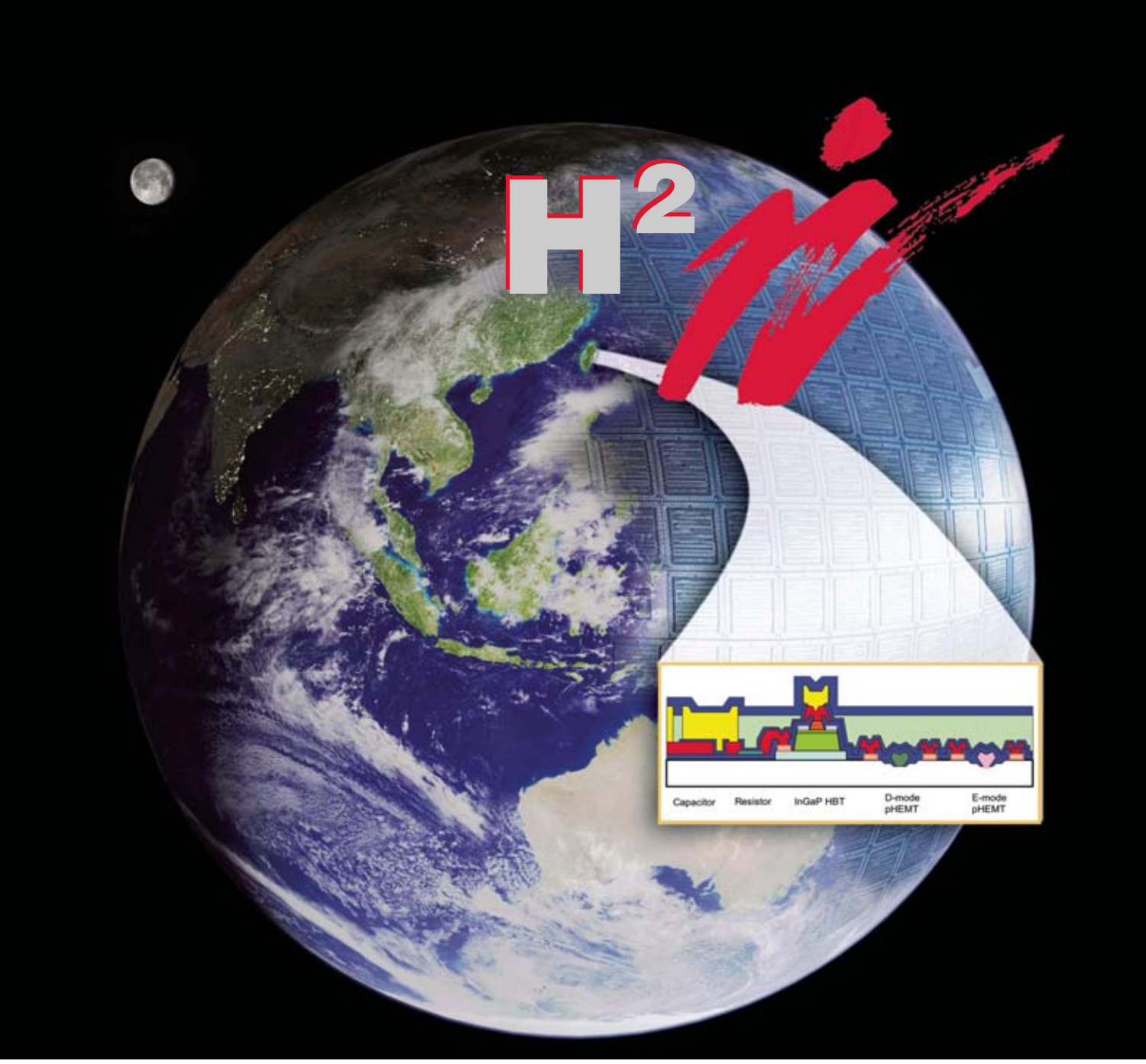
General Information

There will be an information booth in the registration area at the convention center and guest hospitality suites in the Hilton Hawaiian Village and the Sheraton Waikiki. An IEEE/MTT-S membership booth will be near the registration area. There will also be an information booth for IMS 2008 in Atlanta, GA.

Free coffee, tea and soft drinks will be available in the refreshment areas on the exhibition floor.

IEEE policy prohibits recruiting of attendees during the symposium. Exhibitors may not post information on job opportunities or recruit for prospective employees.

Smoking is not permitted in the convention center except on designated outdoor terraces and a portion of the roof garden. Children under the age of 14 will not be admitted to the exhibition halls at any time. ■



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	Ft	30 GHz
	Fmax	90 GHz
D-PHEMT	Gm	330 mS/mm
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Description	Frequency Range (GHz)	P1dB (Psat) (dBm)	Gain (dB)	PAE (%)	Voltage / Current (V / mA)	Package Style	Part Number
Driver Amp, SB	11 - 17	17	23	18	6 / 75	SM-06-12	TGA2507-SM
Driver Amp, SB	12 - 18	20	28	21	6 / 80	Die	TGA2507-EPU
HPA	12 - 19	29	25	24	5 - 7 / 435	SM-06-12	TGA2508-SM
2W HPA	12.5 - 16	(32)	32	22	6 - 7 / 680	SM-01-24	TGA2503-SM
2W HPA	12.5 - 17	(34)	26	25	7.5 / 650	Die	TGA2510-EPU
2W HPA	12.5 - 17	(33.5)	25	25	7.5 / 650	SG-A1-6	TGA2510-EPU-SG
4W HPA	13 - 15	(36)	25	30	7 / 1300	FL-A1-10	TGA8659-FL
6.5W HPA	13 - 16	(38)	24	23	8 / 2600	FL-A2-10	TGA2514-FL
2W HPA	13 - 17	(34)	33	29	5 - 8 / 680	FL-A1-10	TGA2904-FL
2W HPA	13 - 17	(34)	33	29	5 - 8 / 680	SG-A1-6	TGA8658-EPU-SG
2W HPA, PD	13 - 17	(34)	26	30	7.5 / 650	SG-A1-6	TGA2902-1-SCC-SG
2W HPA, PD	13.75 - 14.5	(34)	26	30	7.5 / 650	SG-A1-6	TGA2902-2-SCC-SG
HPA	24 - 31	35.5 (36)	23	18	6 / 2100	Die	TGA4505
HPA	25 - 31	35.5 (36)	22	18	6 / 2100	CP-A1-8	TGA4905-CP
MPA	25 - 35	25	18	–	6 / 220	SM-A4-20	TGA4902-SM
7W HPA	26 - 31	(38.5)	22	17	6 / 4200	CP-A3-8	TGA4915-EPU-CP
2W HPA	27 - 31	32.5 (33)	20	25	6 / 840	Die	TGA4513
2W HPA	27 - 31	32.5 (33)	22	25	6 / 840	CP-A2-8	TGA4513-CP
1W HPA	28 - 31	30	19	25	6 / 420	SM-A4-20	TGA4509-SM
4W HPA	28 - 31	36 (36.5)	22	22	6 / 1600	Die	*TGA4906**
7W HPA	28 - 31	(38.5)	22	20	6 / 3200	Die	*TGA4916**
Driver Amp	29 - 31	16 (17)	15	14	6 / 60	SM-A4-20	TGA4510-SM

NOTES: * = New, SB = Self Biased, PD = Power Detector

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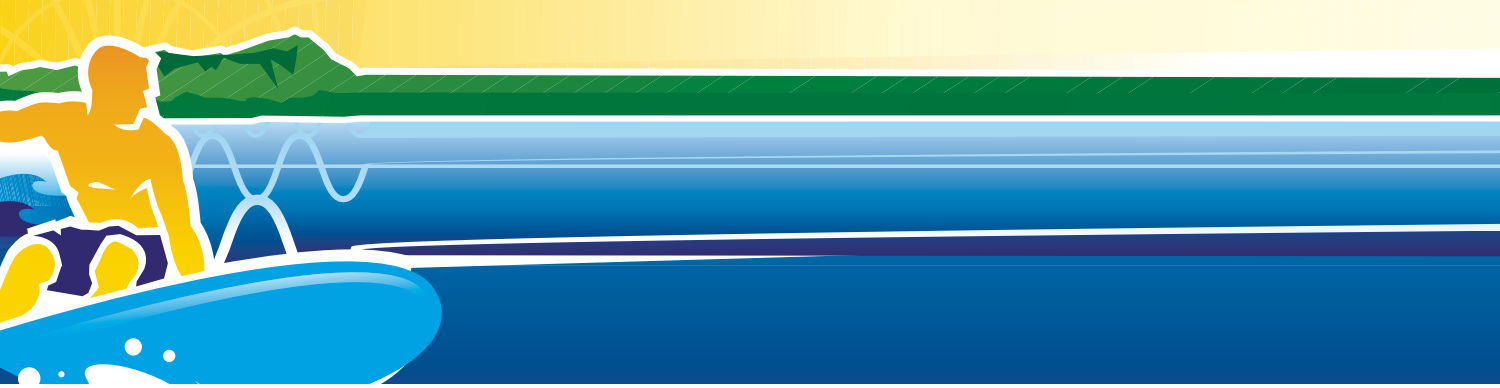

Hawai`i: Where Aloha Lives

Aloha! Hawai`i welcomes all participants of the 2007 International Microwave Symposium (IMS). The traditional Hawaiian greeting of aloha is often accompanied with song (mele) and dance (hula) and the adornment of fragrant garlands of flowers (lei). However, aloha is more than just a salutation; it embodies the essence of Hawai`i.

The origins of aloha begin with the origin of Hawai`i in its volcanic birth. The eight islands that form the main Hawaiian archipelago are what remain of an ancient dance between magma and the sea. They are the tips of dormant volcanoes, sprouted from the ocean floor long ago, as tectonic plates shifted. As activity cooled, life began to form on these islands. Spores and seeds found their way through wind, sea and wayward birds. On the islands, they settled and evolved in a pristine environment, isolated from natural predators. This lush environment existed in isolation, until discovered by seafaring voyagers who dared to cross the Pacific Ocean in canoes (wa`a). The early Marquesan settlers to Hawai`i enjoyed and embraced all the life found on these islands. They were a collectivistic people, who valued community and family (`ohana). They were bound together by the beliefs of cooperation, hard work and love of the land (aloha `aina).

The cornerstone of Hawaiian culture is the land. Wedges of land from mountain to ocean (ahupua`a) were divided amongst communities so that each would have full resources of the earth, from mountain to sea. Spears and pounding tools were made from stone. Fishing nets were made from shrubs. The abundance and diversity of flora provided clothing (kapa). Wooden gourds were made to hold water.

The land and sea did not only provide sustenance, but also a joyous culture, rich in spirituality, language, art, craft and music. The ancient Hawaiians believed in demigods and spirits of nature that crafted the natural world. They passed on their legends through story telling (mo`olelo) and chant (oli), often accompanied by music and dance. People took to the sea for wave sliding (he`e nalu), or what today is known as surfing.

Sadly, such a time would not last indefinitely. The indigenous Hawaiians were conquered by other Polynesians. The conquerors set up a caste system with a monarch (ali`i). The Hawaiians lived this

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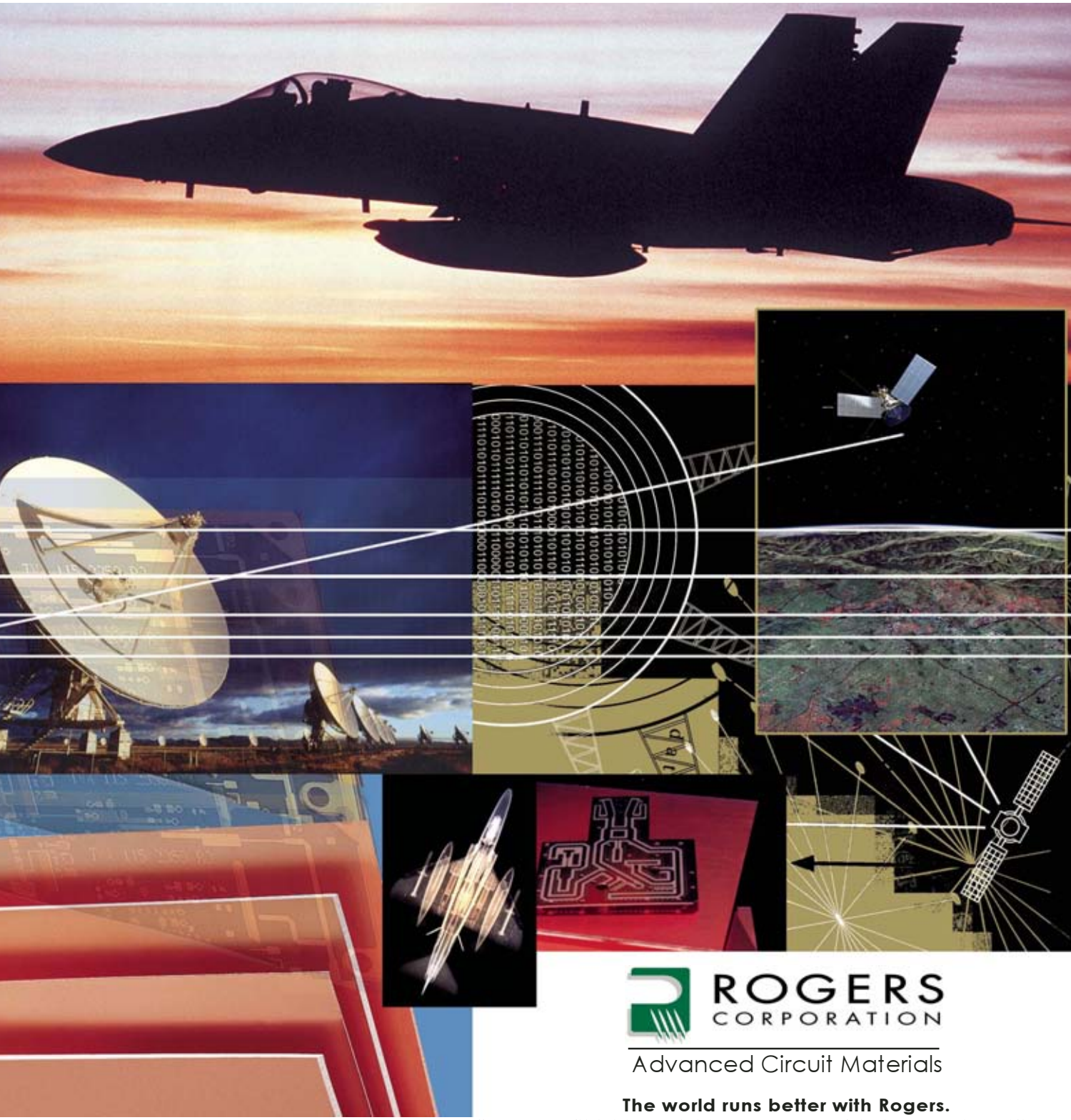

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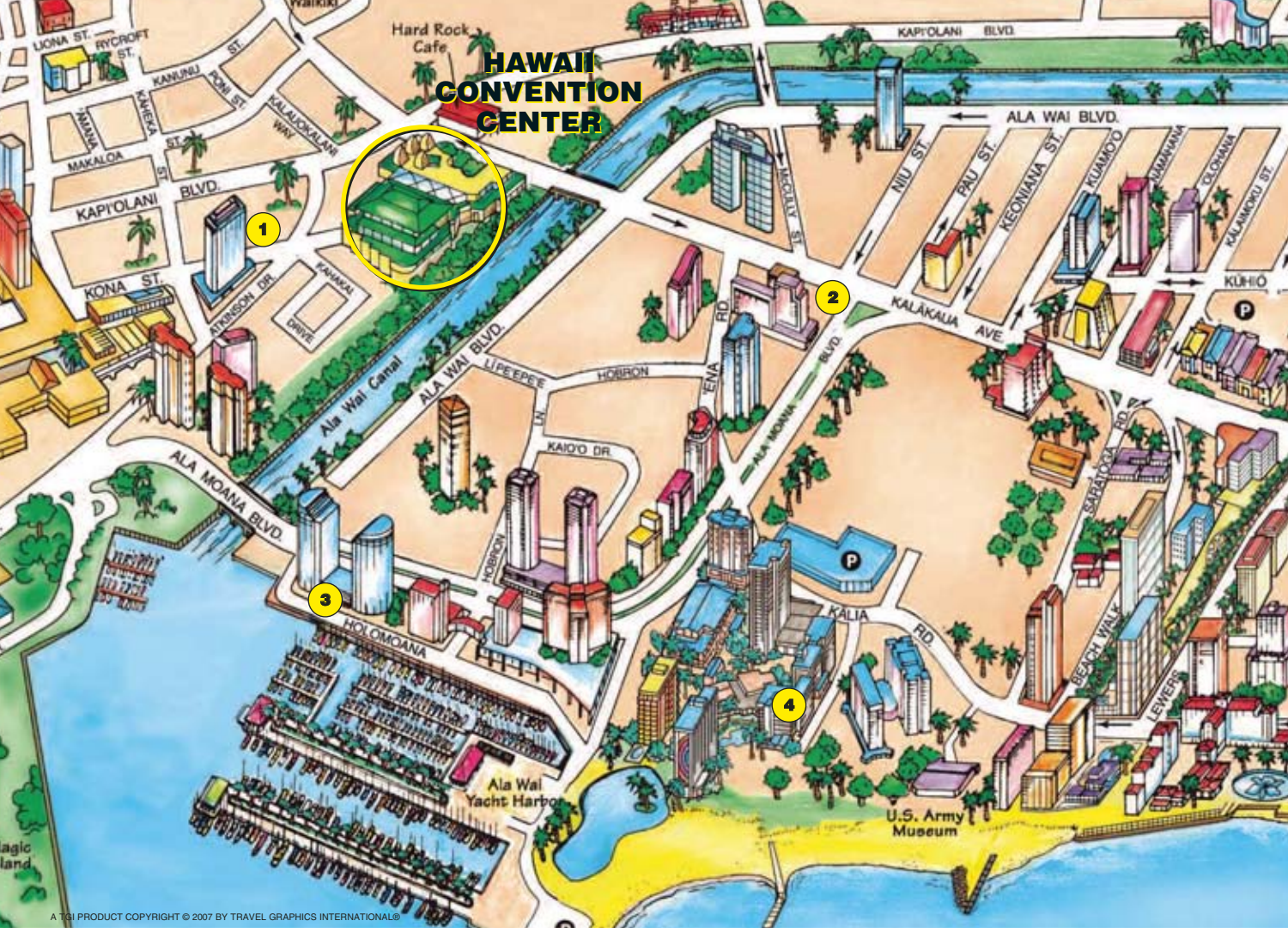

Map of Waikiki area provided courtesy of CTT, Inc.

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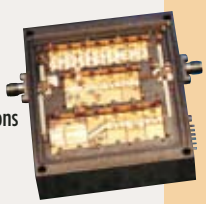

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AMO/020-1032	0.5 – 2.0	32	1.0	1.0	8
AMX/0220-4510	2.0 – 20.0	10	2.0	4.5	8

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way for years until 1778, when British explorer Captain James Cook made the first European contact with the Hawaiian Islands. However, it was not until 1810 that the great monarch Kamehameha I conquered and unified all the Hawaiian Islands, establishing a dynasty that would rule Hawaii for the majority of the 1800s. Lunalilo succeed the last of the Kamehamehas (Kamehameha V). He was later succeeded by Kalakaua, who was succeeded by Lili`uokalani. Overthrown in 1893, Queen Lili`uokalani was the last of Hawai`i's monarchy.

The 19th century was not just about conquest. External influences began to morph Hawaiian culture. The Europeans introduced Hawaiians to many new things such as Christianity, the `ukulele and written language. Where the Hawaiians saw culture in the land, the new settlers to Hawai`i saw commerce. Beginning in the mid-1800s, plantation production of sugar ruled Hawai`i's economy, and would do so for the next 100 years. The labor requirements of these plantations brought an influx of immigrants from around the Pacific and beyond: Japan, Phillipines, Portugal, China, Korea and Puerto Rico.

In 1898, Hawai`i became a US territory. Hawai`i's location in the Pacific made it an optimal base for US military operations in the Pacific. On December 7, 1941, "a date which will live in infamy," the Pearl Harbor naval base on O`ahu was bombed by Japanese aircraft, spurring the US entrance into War World II. Hawai`i became a Republic of the United States before eventu-

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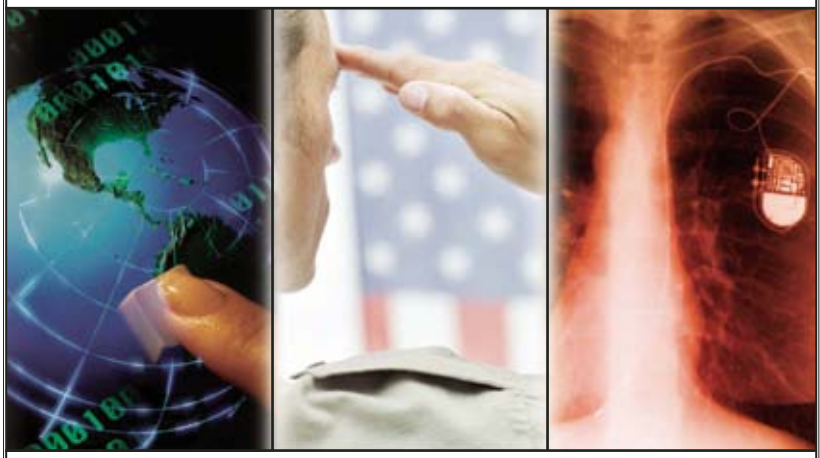

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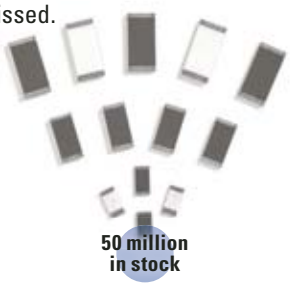

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1S4G11 1 Watt 4-10.6 GHz	40S4G11 40 Watt 4-10.6 GHz	450S1G3 450 Watt 0.8-3.0 GHz	40T18G26A 40 Watt 18-26.5 GHz	200T2G8A 200 Watt 2.5-7.5 GHz	1000T8G18B 1000 Watt 7.5-18 GHz	2000TP2G8B 2000 Watt Pulse 2.5-7.5 GHz
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5S4G11 5 Watt 4-10.6 GHz	60S4G8 60 Watt 4-8 GHz	600S1G3 590 Watt 0.8-3.0 GHz	50T4G18 50 Watt 4.2-18 GHz	200T8G18A 200 Watt 7.5-18 GHz	1000TP2G8 1000 Watt Pulse 2.5-7.5 GHz	2000TP8G18 2000 Watt Pulse 7.5-18 GHz
5S10G20 5 Watt 10-20 GHz	60S4G11 60 Watt 4-10.6 GHz	700S1G4 700 Watt 0.8-4.2 GHz	70T26G40 70 Watt 26.5-40 GHz	250T1G3 250 Watt 1-2.5 GHz	1000TP8G18 1000 Watt Pulse 7.5-18 GHz	4000TP1G2 4000 Watt Pulse 1 - 2 GHz
10S1G4A 10 Watt 0.8-4.2 GHz	80S4G11 80 Watt 4-10.6 GHz	800S1G3 800 Watt 0.8-3.0 GHz	70T18G26 75 Watt 18-26.5 GHz	250T8G18 250 Watt 7.5-18 GHz	1000TP1G3* 1000/500 Watt Pulse 1.15-3.1 GHz	4000TP2G4 4000 Watt Pulse 2-4 GHz
10S4G11A 10 Watt 4-10.6 GHz	90S4G8 90 Watt 4-8 GHz	10ST1G18A 10 Watt 0.8-18 GHz	120T40G40 120 Watt 40-45 GHz	300T2G8 300 Watt 2.5-7.5 GHz	1500T1G3A 1500 Watt 1-2.5 GHz	4000TP4G8 4000 Watt Pulse 4-8 GHz
15S1G3 15 Watt 0.8-3.0 GHz	100S1G4 100 Watt 0.8-4.2 GHz	20ST1G18A 20 Watt 0.8-18 GHz	125T18G26 125 Watt 18-26.5 GHz	500T1G2 500 Watt 1-2.5 GHz	1500T2G8A 1500 Watt 2.5-7.5 GHz	4000TP8G12 4000 Watt Pulse 8-12 GHz
15S4G8A 15 Watt 4-8 GHz	120S1G3 120 Watt 0.8-3.0 GHz	35ST1G18 35 Watt 0.8-18 GHz	125T26G40 125 Watt 26.5-40 GHz	500T2G8 500 Watt 2.5-7.5 GHz	1500T8G18 1500 Watt 7.5-18 GHz	4000TP12G18 4000 Watt Pulse 12-18 GHz
20S4G11A 20 Watt 4-10.6 GHz	120S4G8 120 Watt 4-8 GHz	50ST1G18 50 Watt 0.8-18 GHz	125T40G45 125 Watt 40-45 GHz	500T8G18 500 Watt 7.5-18 GHz	2000T1G3 2000 Watt 1-2.5 GHz	
25S1G4A 25 Watt 0.8-4.2 GHz	200S1G4A 200 Watt 0.8-4.2 GHz	15T4G18A 15 Watt 4.2-18 GHz	200T1G2 200 Watt 1-2 GHz	750TP1G3/200T *750/500 Watt Pulse 1.15-3.1 GHz	2000T2G8 2000 Watt 2.5-7.5 GHz	
30S1G3 30 Watt 0.8-3.0 GHz	240S1G3A 240 Watt 0.8-3.0 GHz	20T4G18A 20 Watt 4.2-18 GHz	200T1G3A 200 Watt 0.8-2.8 GHz	1000T1G2B 1000 Watt 1-2.5 GHz	2000T8G18 2000 Watt 7.5-18 GHz	

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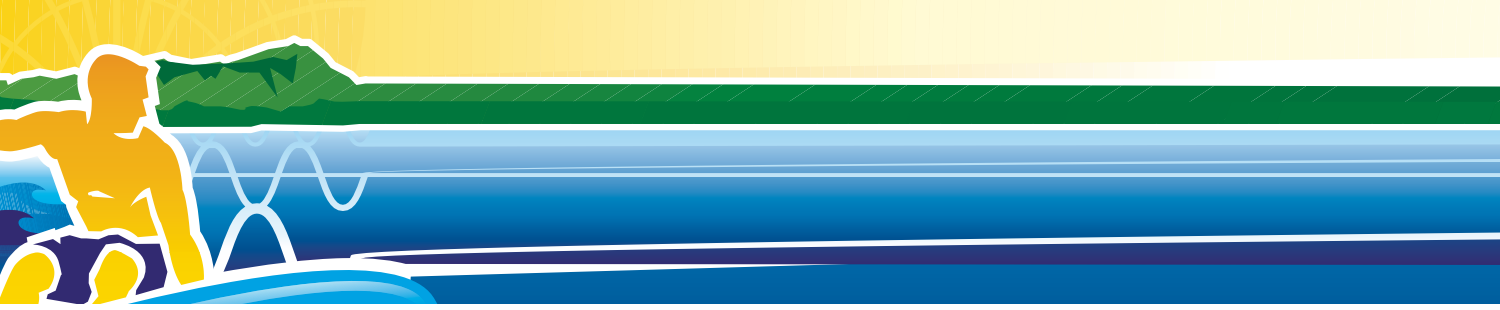

ally becoming its 50th state in 1959. Air technology not only ushered a military presence to Hawai`i, but also allowed for Hawai`i's next economic power, tourism.

Today, Hawai`i ranks amongst the most popular of tourist destinations and is regarded as one of the most beautiful places on Earth. It is home to the world's most active volcano and the world's tallest sea mountain. The state consists of eight major islands: Hawai`i (Big Island), Maui, Kaho`olawe, Lana`i, Moloka`i, O`ahu, Kaua`i and Ni`ihau. Hawai`i only experiences two seasons year round, dry and rainy, both of which are warm. During the spring and summer months, the temperature is between 75° and 88° F. During the winter months, the temperature is between 68° and 80° F. Because of its location in the tropics, Hawai`i weather is somewhat humid, and visitors are encouraged to wear casual and breathable clothes.

Honolulu, located on the island of O`ahu, is the state capital and is the state's economic, academic and political center. About 900,000 of Hawaii's 1.2 million total population reside in the City and County of Honolulu (12 miles wide and 26 miles long). Most of the residents live in the city proper, but there are a number of surrounding suburbs that also serve as residential neighborhoods.

Although tourism is definitely Hawai`i's "claim to fame," Hawai`i also holds a place in other areas, such as business, research and innovation, and sport. Hawai`i's prime location in the Pacific makes it ideal for Asia-Pacific and western business collaboration, and is acknowledged as the "Crossroads of the Pacific." Business in New York and Singapore can be conducted in the same business day. Mauna Kea, located on the Big Island, is one of the Earth's largest mountains and is home to arguably the best observatory site in the world. Hawai`i is also a center for maritime and geological research. Every year, Kona, Hawai`i hosts one of the world's most elite triathlon events, the Ironman World Championship.

Although Hawai`i continues to be urbanized, its natural beauty remains intact over the centuries, and its position and reputation continue to expand into other areas. However, what is truly astonishing is de-

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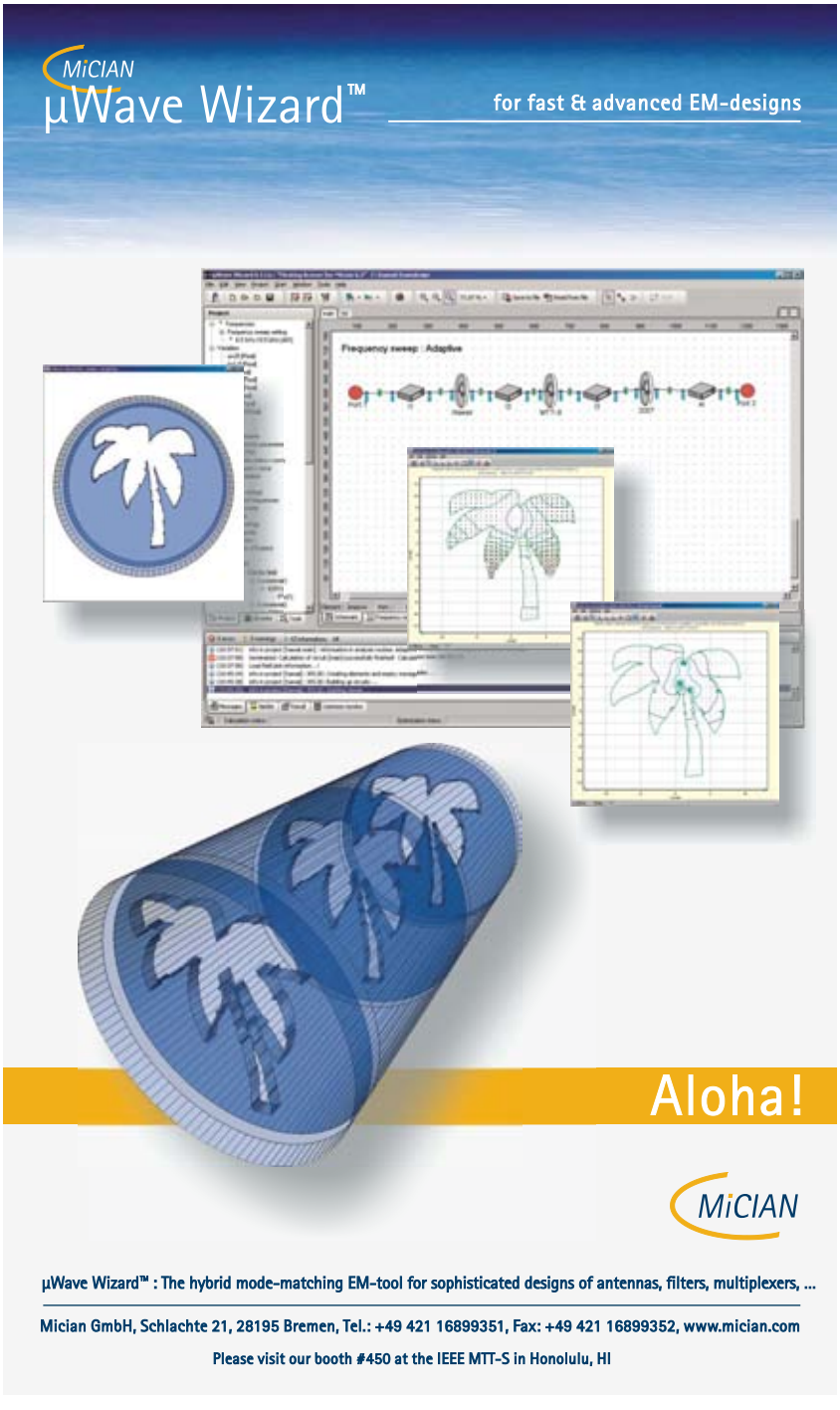
spite the conquests over the last 200 years, Hawai`i's cultural beauty remains intact. From its conquest and plantation days, Hawai`i's population is one of the most ethnically diverse and tolerant in the world. "Aloha" does not merely mean "hello" and "goodbye." It is an expression of the warmth and sense of community that has survived the test of time. It binds everything that represents this beautiful state. Aloha opens its arms to all visitors. Welcome to the "Aloha State," and enjoy "Microwaves Across the Pacific."



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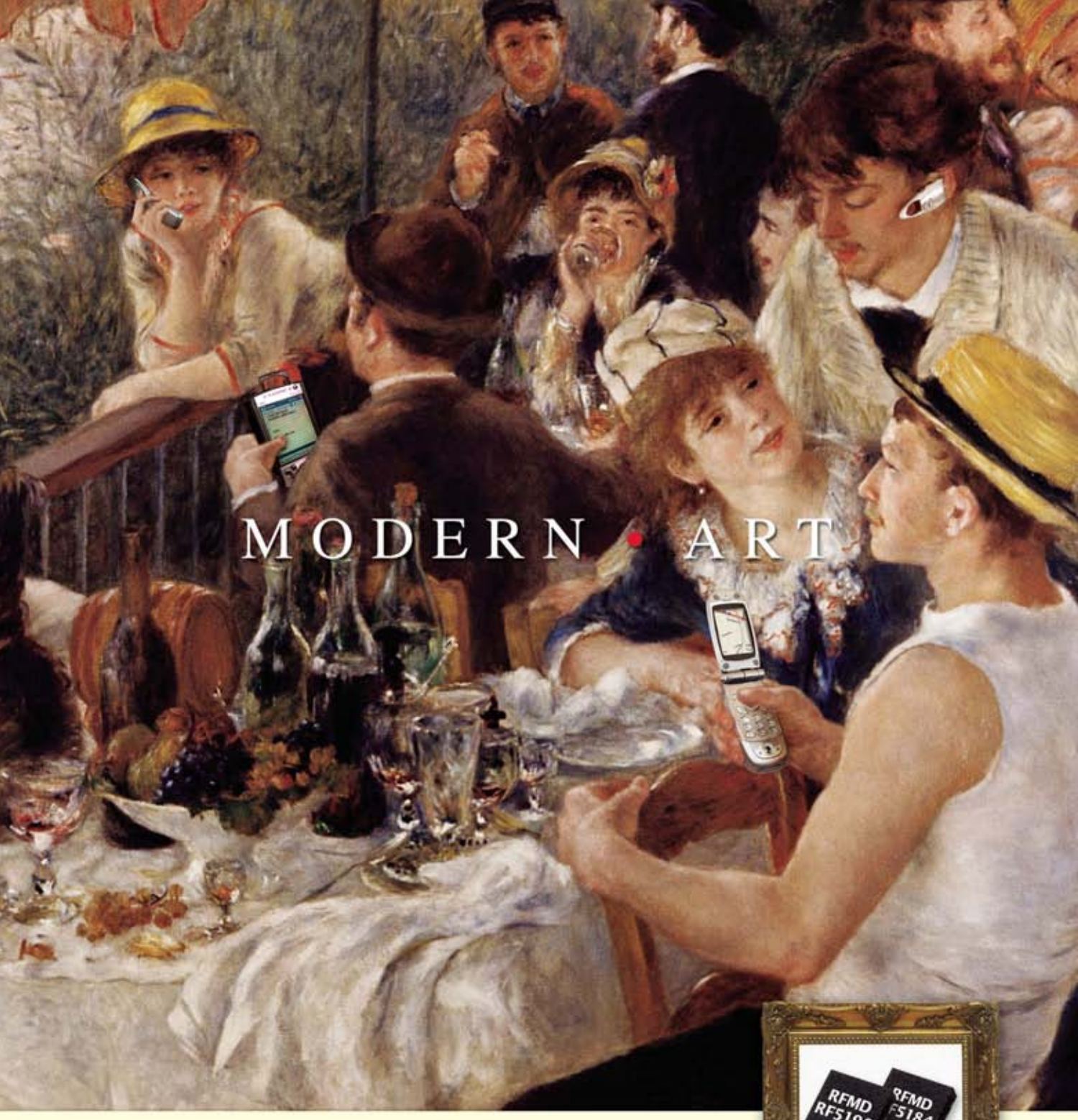

With innovation and functionality, RFMD® paints a broad stroke across mobile technology. Created by RFMD, the RF5198 and RF5184 are two ultra-small, low profile linear power amplifier modules that help improve heat dissipation to increase mean time to failure. In addition, they both use a digital control line to optimize talk time in low power conditions. When it comes to cellular solutions, the canvas is never blank with RFMD.

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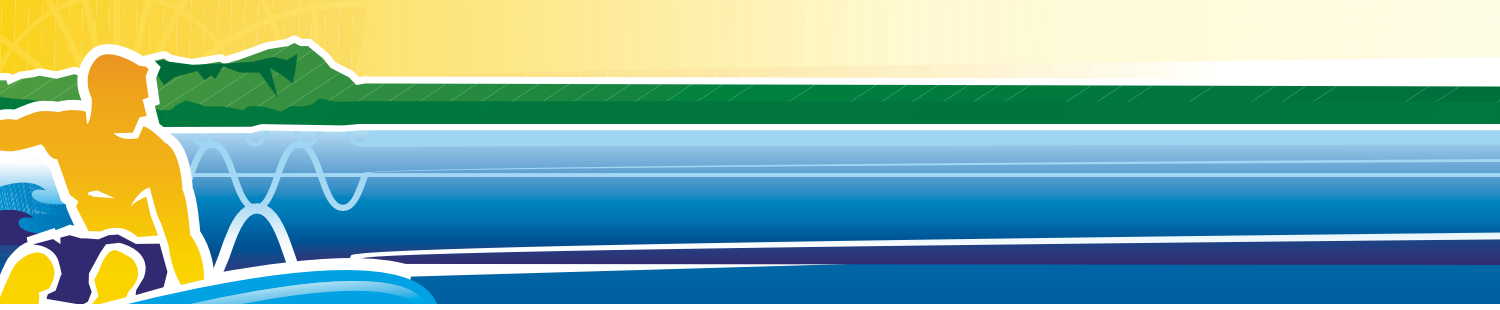


backdrop of such Hollywood blockbusters as *Jurassic Park*, *Windtalkers*, *George of the Jungle*, *Tears of the Sun*, *50 First Dates*, *You Me and Dupree*, and the series *Lost*. With the magnificent Koolau Mountains as your backdrop, it makes for the perfect setting for horseback tours, ATV tours, jungle expedition tours, a movie set tour and more.

Arizona Memorial and USS Missouri

Celebrate the honor, valor and courage of the US servicemen who served during World War II on this special Stars and Stripes tour. It's a nostalgic journey to the two historic places that marked the beginning and end of the war for the United States—Pearl Harbor and the USS Missouri.

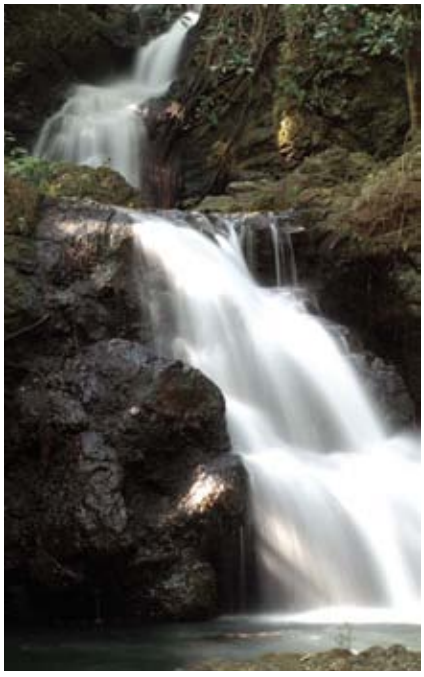
At the site of Pearl Harbor, you'll view the Arizona Memorial where the remains of the USS Arizona lay silent beneath the waves. The events of the 1941 attack on Pearl Harbor are unfolded through detailed narrations and photos. While at Pearl Harbor, you'll travel across the Ford Island Bridge to the historic USS Missouri battleship, otherwise known as the "Mighty Mo." It was on the decks of this celebrated warship that the Japanese surrender ceremony took place, signaling the end of their involvement in World War II. Explore the passages, rooms and corridors on a special guided tour.

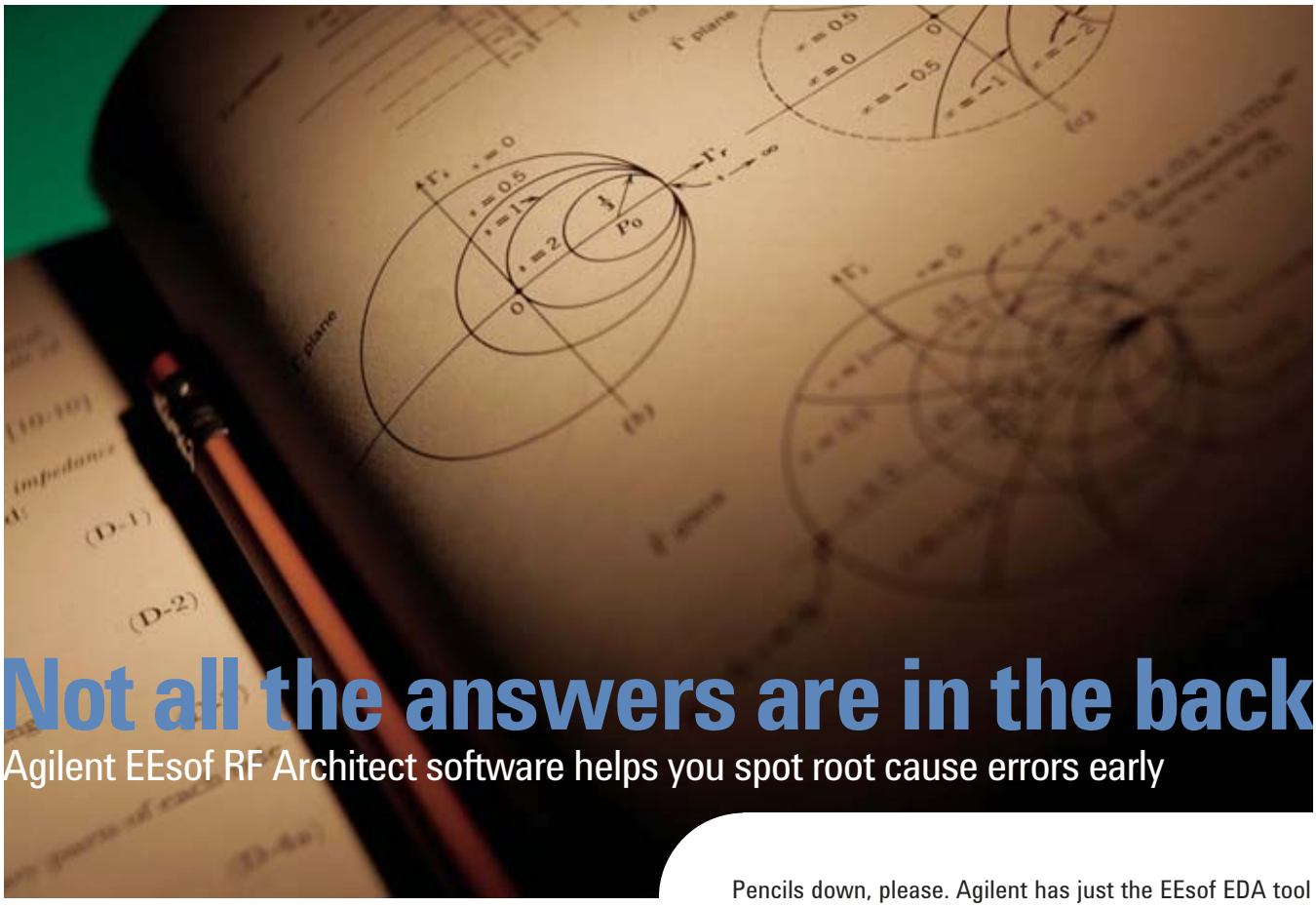
Big Island

From raging volcanoes to serene snow-capped mountaintops, the Big Island of Hawaii is an island of extreme power and beauty. Come visit the legendary Volcanoes National Park to witness the workings of Madame Pele (Hawaiian goddess of fire). You'll trek though miles of recent lava flows at Kalapana and the mysterious Halemaumau Fire Pit. The tour continues with a stop at the tranquil town of Hilo, home to the beautiful Rainbow Falls. While you gaze at the thundering waters, glistening rainbows float in and out of its mist. At your next stop you'll uncover the secrets of how Hawaii's favorite nut, the macadamia, is made into a variety of mouthwatering treats. For a viewing of true tropical elegance in bloom, an abundance of fragrant orchids await your discovry at a local orchid nursery.

Sea Life Park

Sea Life Park offers the island's most beautiful setting for a traditional Hawaiian Luau. Overlooking the ocean above Maka-





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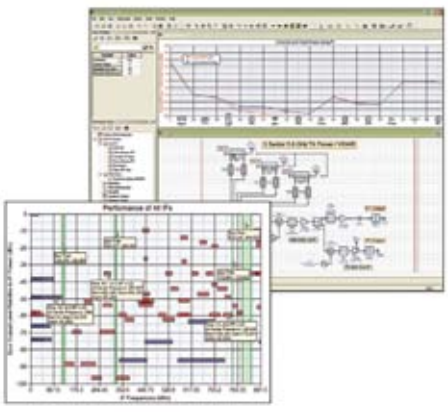
Agilent EEsof RF Architect software helps you spot root cause errors early



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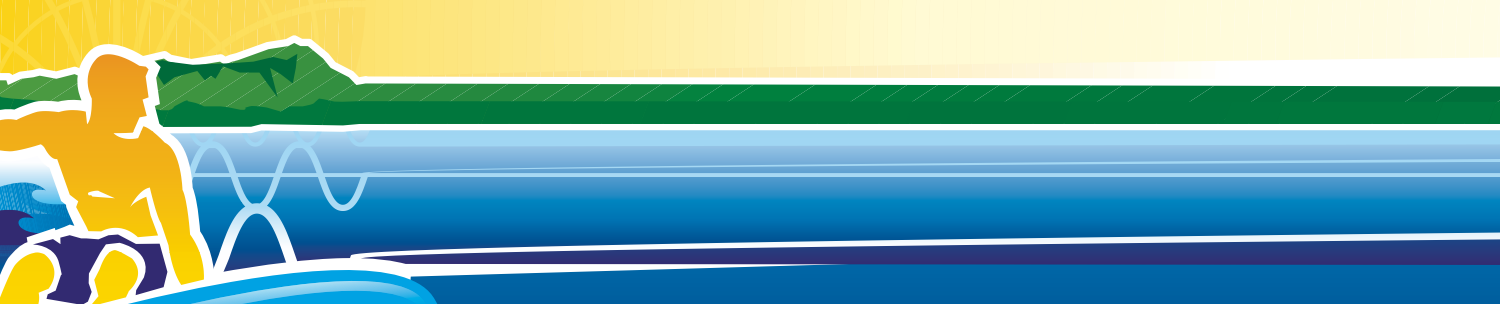

pu'u Point, the Sea Life Park luau is held in an unparalleled location revealing breathtaking views of Rabbit Island, the historic lighthouse and the cliffs adjacent to the park. Only at the Sea Life Park Luau can guests witness a spectacular nighttime dolphin show, enjoy delicious traditional Hawaiian food, and a sensational Polynesian Revue provided by the famed performers of Tihat—all of this in an easily accessible location. Luau price includes park admission, enabling guests to experience the daily shows, activities, and educational displays on the day of their luau or on another day within 30 days of the luau. With the traditional sound of the conch shell, you will be transported to a magical world of music, food, dancing and dolphins in true Seal Life Park style.

Grand Circle Island

Get to know Hawaii from the inside out with an all-day tour that covers 120 miles of Oahu's best sight-seeing spots. You'll circle the entire island, beginning with a tour of the stunning, world-famous Diamond Head Crater. For a close-up view of a seawater eruption, you'll visit Hawaii's own Old Faithful known as the "Blow Hole," where you'll witness oceanside water play at full-force. Besides a stop at Sandy Beach—a favorite for body surfers—you'll venture to the most celebrated surfing zones in the world along the North Shore—Waimea Bay, Sunset Beach and the spectacular Banzai Pipeline. In colorful contrast to the brilliant blue of the crystalline waters, you'll also find emerald oceans of shimmering pineapple and sugar cane fields waving gently in the breeze. Take a glimpse into the Hawaii of long ago as you pass remnants of old homesteads on your return to Waikiki.

Polynesian Cultural Center

Polynesia comes alive in a celebration of song, dance and culture at Hawaii's most popular attraction—the Polynesian Cultural Center. Nestled along the island's scenic North Shore, this is one must-see event. Travel across the South Pacific in a day, as you take an escorted tour through seven authentic Polynesian island villages—Tahiti, Tonga, Fiji, Samoa, New Zealand, the Marquesas and Old Hawaii. Meet real Pacific Islanders and see them demon-

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Model	Frequency (GHz)	Gain (dB)	Flatness (dB) max	NF (dB) max	P1dB (dBm) min	VSWR (In/Out)	DC Current @ +12/+15VDC
Broadband Low Noise Amplifiers							
AML016L2802	0.1 – 6.0	28	±1.25	1.3*	+7	2.0:1	190
AML48L3001	4.0 – 8.0	30	±1.0	1.2	+10	1.8:1	150
AML412L3002	4.0 – 12.0	30	±1.5	1.5	+10	1.8:1	150
AML218L0901	2.0 – 18.0	9	±1.0	2.2	+5	2.5:1	60
AML0518L1601-LN	0.5 – 18.0	16	±1.0	2.7	+8	2.2:1	100
AML0126L2202	0.1 – 26.5	22	±2.25	3.5*	+8	2.2:1	170
AML1226L3301	12.0 – 26.5	33	±2.0	2.8	+8	2.5:1	200
Broadband Medium Power Amplifiers							
AML0016P2001	0.01 – 6.0	21	±1.25	3.2*	+23*	2.0:1	480
AML26P3001-2W	2.0 – 6.0	28	±2.5	6	+33	1.8:1	1500
AML28P3002-2W	2.0 – 8.0	30	±2.0	5.5	+33	2.0:1	2000
AML218P3203	2.0 – 18.0	32	±2.5	4	+25	2.0:1	450
AML618P3502-2W	6.0 – 18.0	35	±2.5	4	+33	2.0:1	1850
Narrow Band Low Noise Amplifiers							
AML23L2801	2.8 – 3.1	28	±0.75	0.7	+10	1.8:1	150
AML1414L2401	14.0 – 14.5	24	±0.75	1.5	+10	1.5:1	130
AML1718L2401	17.0 – 18.0	24	±0.75	1.6	+10	1.8:1	150

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

High Dynamic Range Amplifiers					
Part Number	Frequency (MHz)	Gain (dB)	P1dB (dBm)	OIP3 (dBm)	DC
AR01003251X	2 – 32	21	32	52	+28V @ 470mA
AFL30040125	50 – 500	23	28	53	+28V @ 700mA
BP60070024X	20 – 2000	32	30	43	+15V @ 1100mA

*Above 500MHz.

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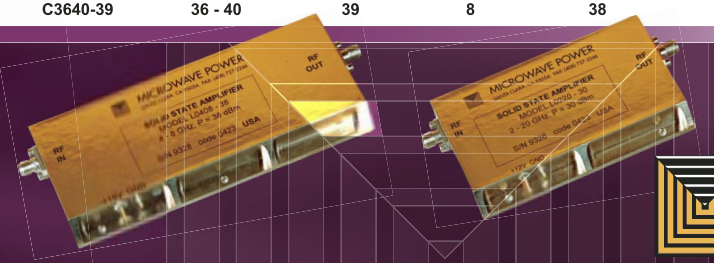
Broadband Microwave Power Amplifiers						
L0104-43	1 - 4	42.5	17.8	41.5	45	14
L0204-44	2 - 4	44	25	42.5	45	14
L0206-40	2 - 6	40	10	38.5	40	8.5
L0208-41	2 - 8	41	12	40	40	17
L0218-32	2 - 18	32	1.4	31	35	5
L0408-43	4 - 8	43	20	41.5	45	17
L0618-43	6 - 18	43	20	41.5	45	22
L0812-46	8 - 12	46	40	45	45	28
Millimeter-Wave Power Amplifiers						
L1826-34	18 - 26	34	2.5	33	35	4
L1840-27	18 - 40	27	0.5	26	30	2
L2240-28	22 - 40	28.5	0.7	27	30	3
L2630-39	26 - 30	39	8.0	38	40	15
L2632-37	26 - 32	37	5.0	36	38	10
L2640-31	26 - 40	31	1.2	30	30	5
L3040-33	30 - 40	33	2.0	32	33	9
L3337-36	33 - 37	36	4.0	35	40	12
L3640-36	36 - 40	36	4.0	35	40	10

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



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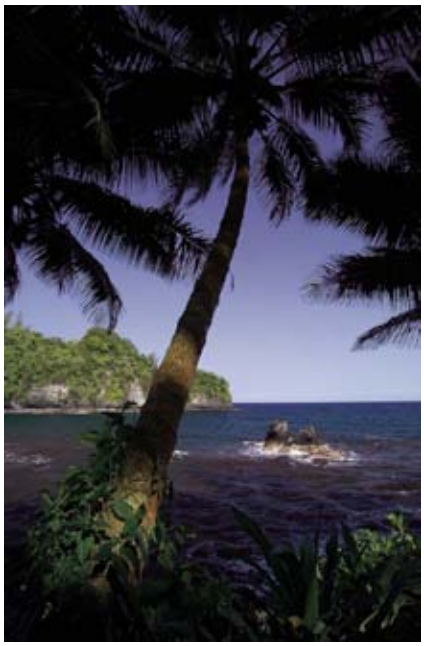

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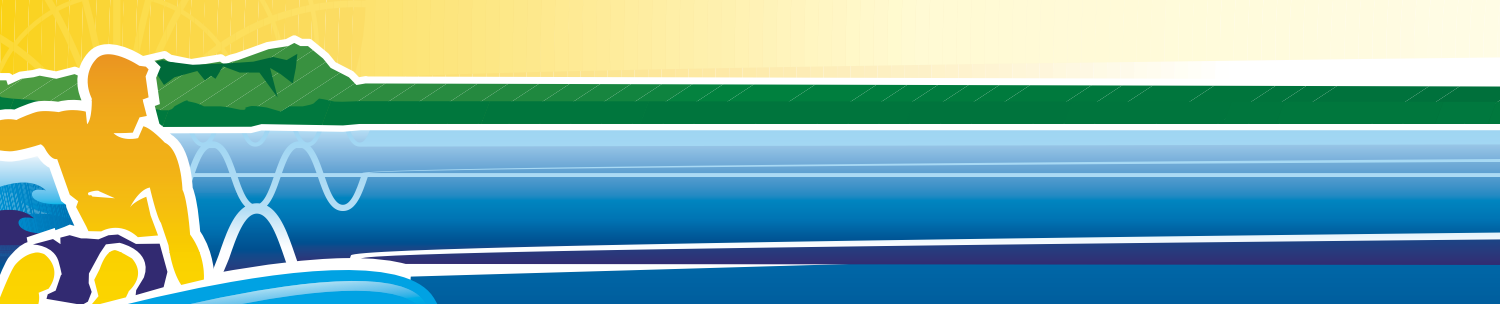

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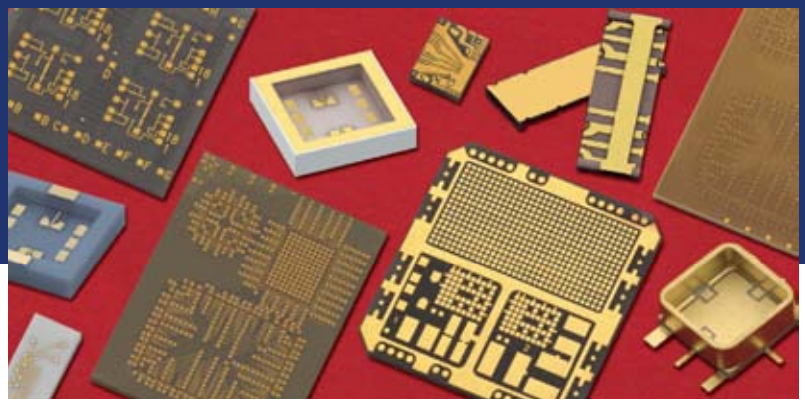

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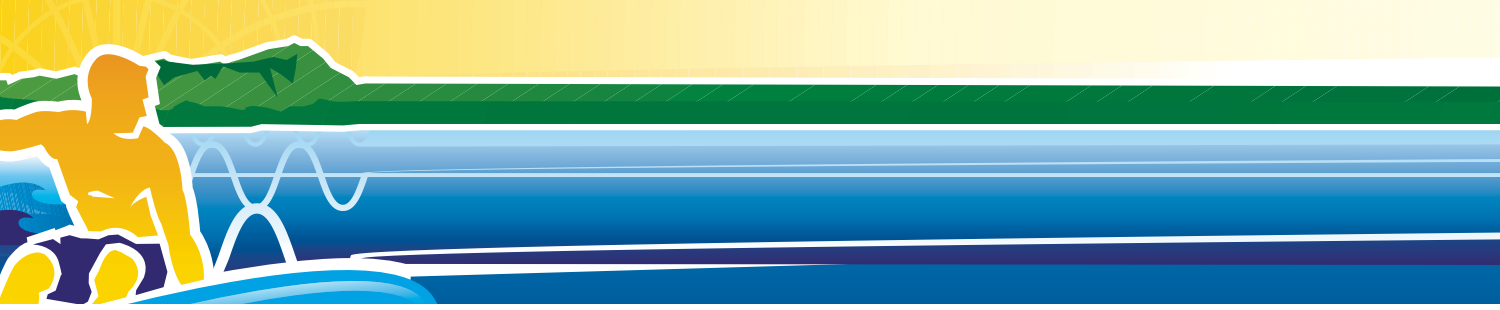

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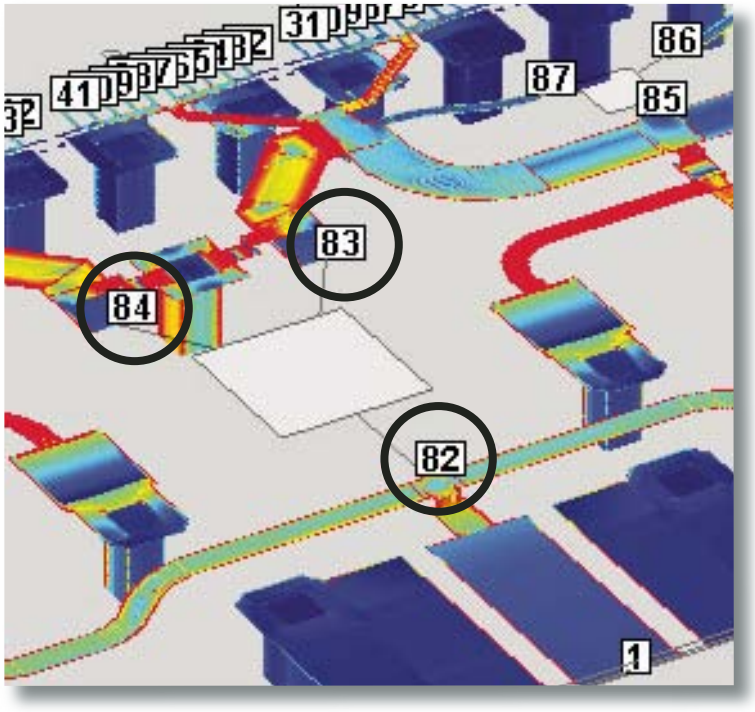

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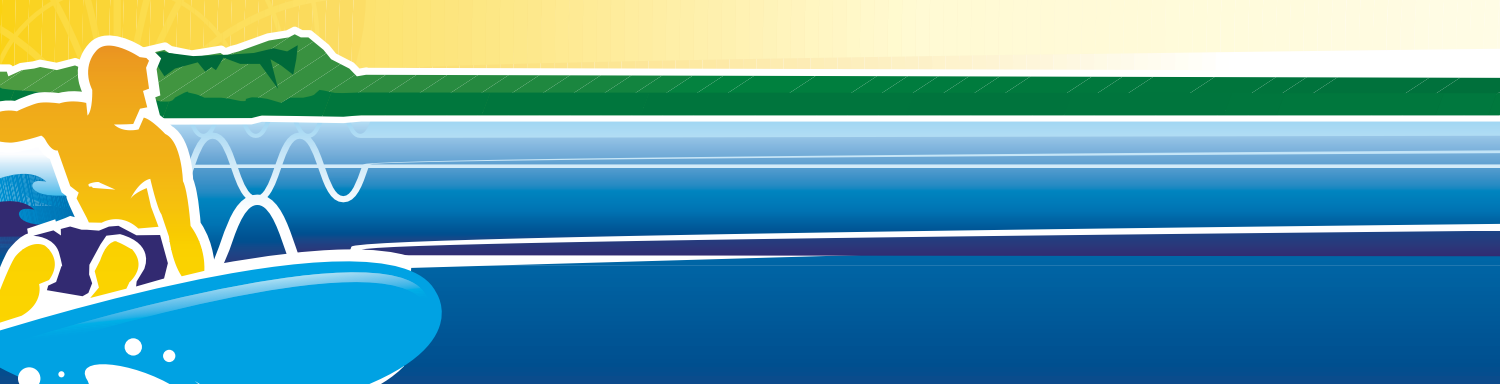

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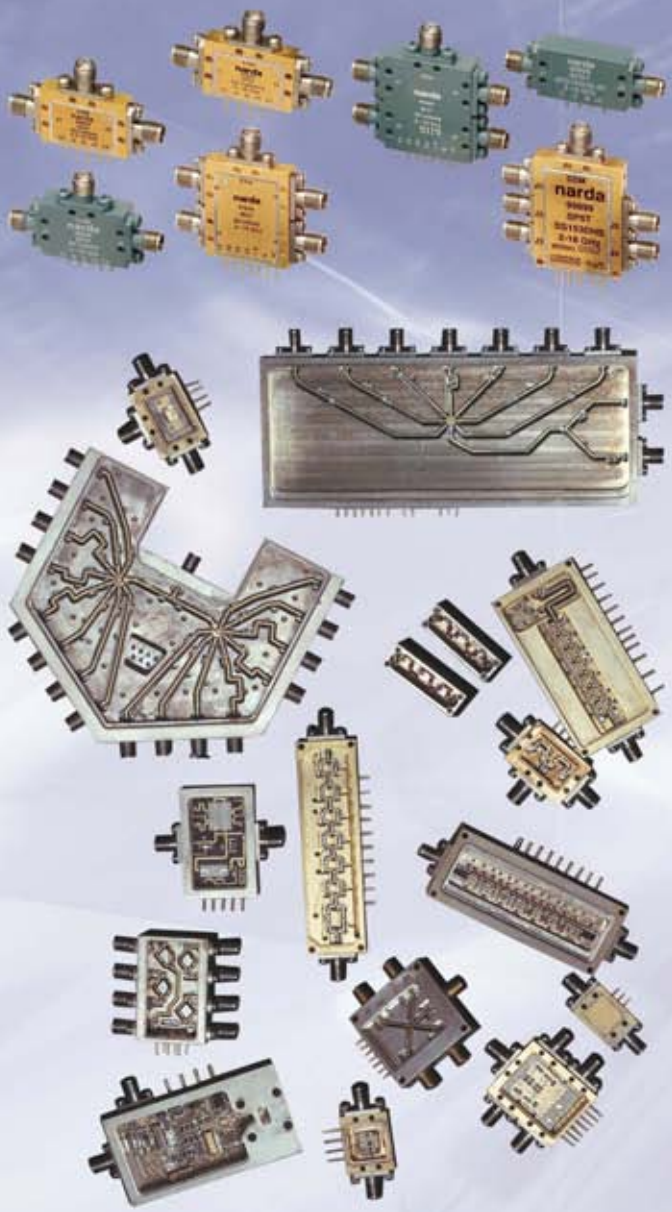

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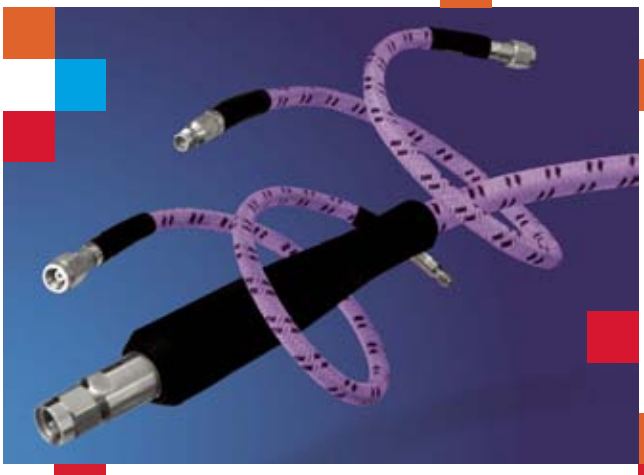

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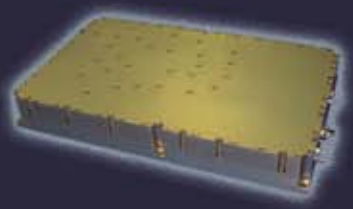

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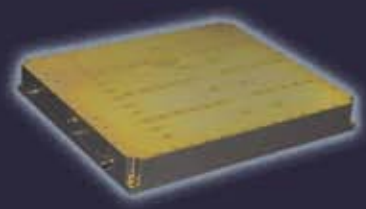

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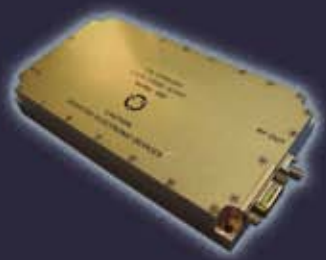
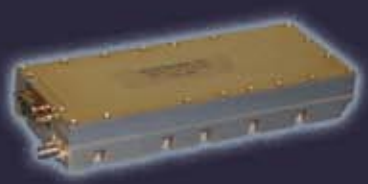
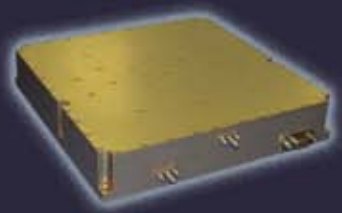


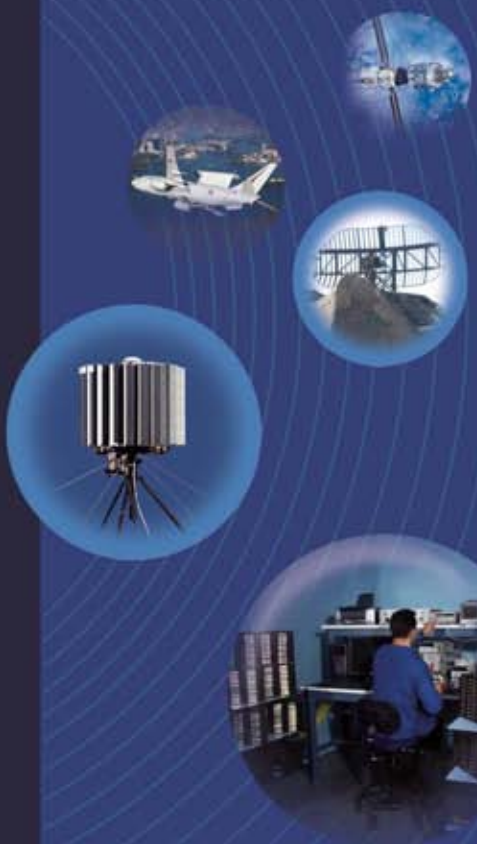
SSPA 0.020-1.000-100
20 MHz - 1000 MHz
100 - 200 Watts P3dB
3.4"W x 6.4"L x 1.0"H



SSPA 2.5-6.0-50
2500 MHz - 6000 MHz
50 Watts P3dB
2.5"W x 6.4"L x 1.0"H



SSPA 0.8-2.5-200
800 MHz - 2500 MHz
200 Watts P3dB
8.0"W x 8.0"L x 2"H



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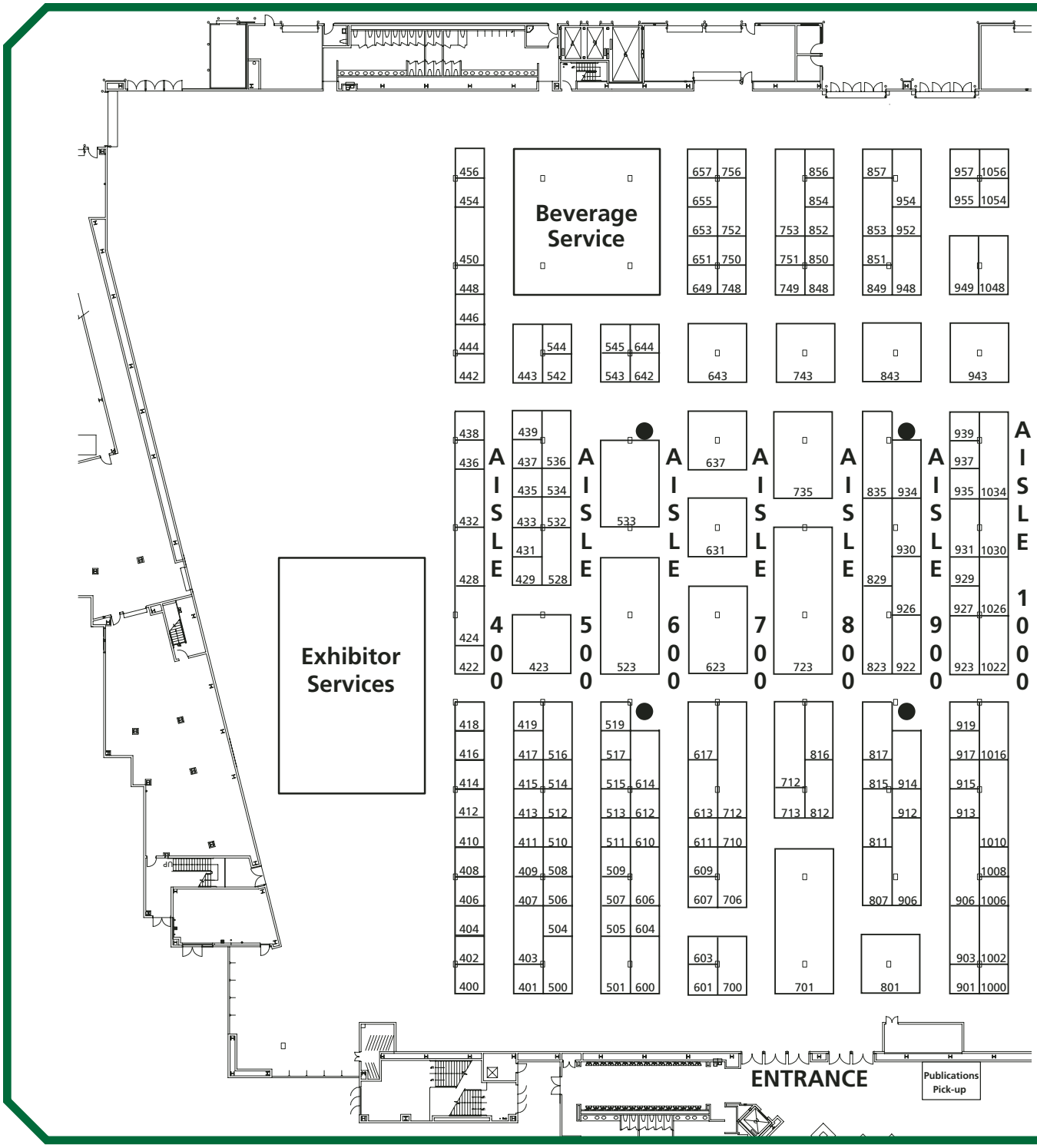

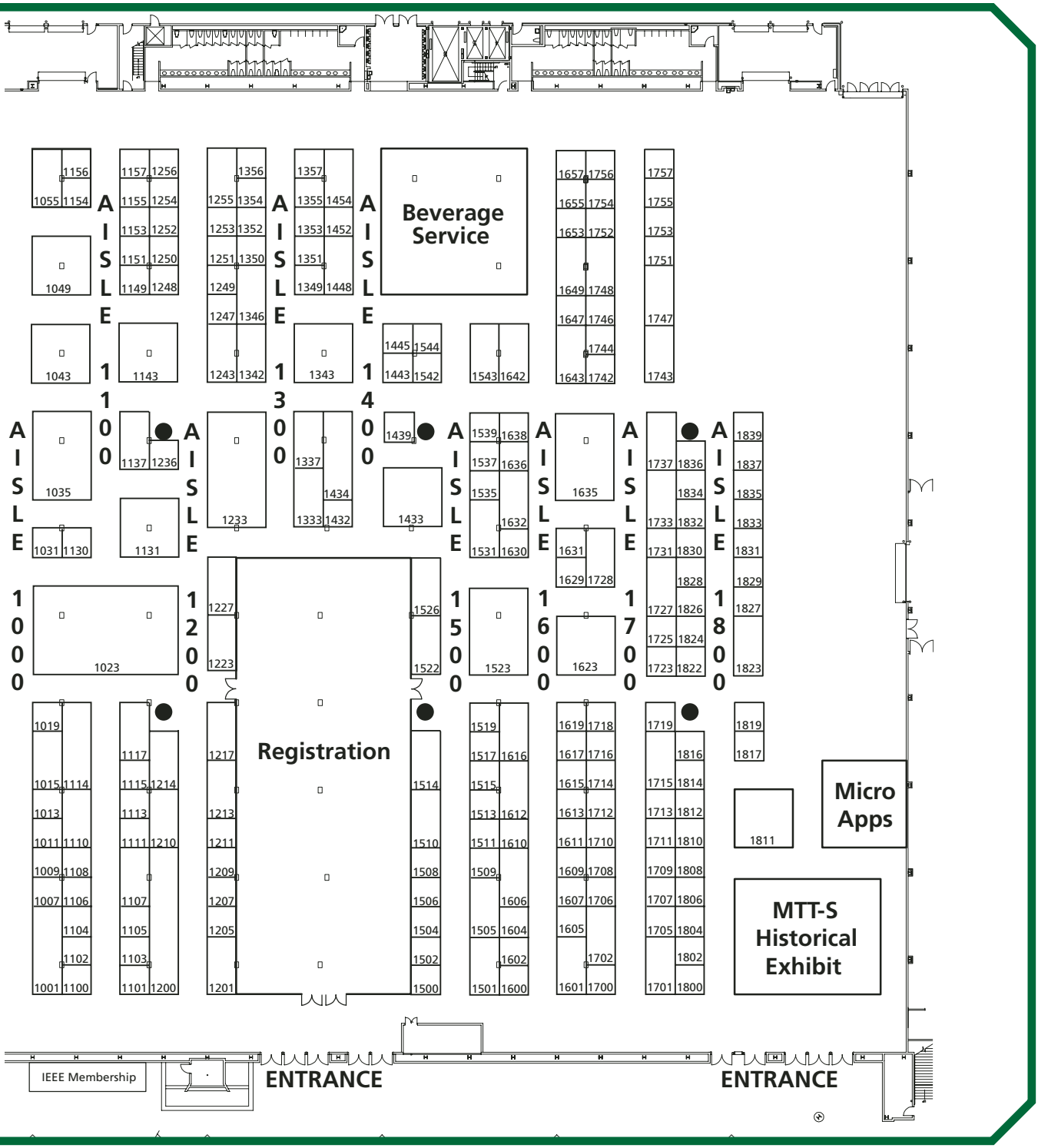
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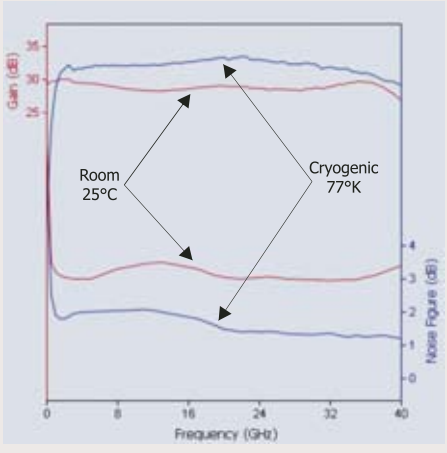
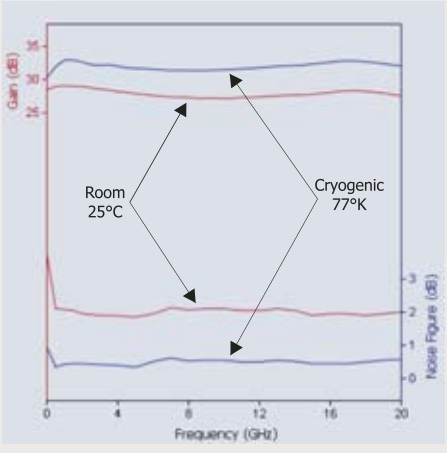
Model: BZP140UD1 *0.1 - 40 GHz*



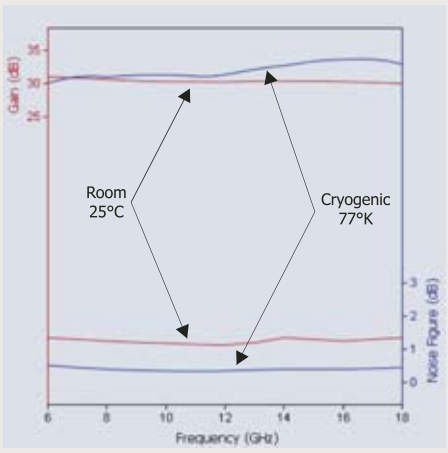
Typical Group Delay ±20pS

Model: BZP120UC1 *0.1 - 20 GHz*



Typical Group Delay ±10pS

Model: BZ0618LC1 *6 - 18 GHz*



Typical Group Delay ±10pS

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Ultra Wideband Low Noise Amplifiers

Model	Freq (GHz)	Noise Fig* (dB Max)	Gain (dB Min)	Gain Var. (±dB Max)	Pout 1dB (dBm Min)	VSWR In/Out
BZP140UD1	0.1 - 40	4.0	25	1.5	6	2.7:1/2.5:1
BZP140UD2	0.1 - 40	4.5	24	2.0	8	2.5:1/2.5:1
BZP130UD1	0.1 - 30	3.5	27	1.5	8	2.0:1/2.0:1
BZP126UD1	0.1 - 26	3.3	27	1.5	10	2.0:1/2.0:1
BZP120UD1	0.1 - 20	2.2	31	1.7	8	2.3:1/2.3:1
BZP120UC1	0.1 - 20	2.3	26	1.5	5	2.3:1/2.3:1
BZP118UD1	0.1 - 18	2.0	32	1.3	8	2.0:1/2.0:1
BZP118UC1	0.1 - 18	2.1	27	1.0	5	2.0:1/2.0:1
BZP114UB1	0.1 - 14	1.9	23	1.2	8	2.0:1/2.3:1
BZP112UB1	0.1 - 12	1.7	24	1.2	8	2.0:1/2.0:1
BZP110UB1	0.1 - 10	1.5	25	1.0	8	2.0:1/2.0:1
BZP108UB1	0.1 - 8	1.4	25	1.0	8	2.0:1/2.0:1
BZP106UB1	0.1 - 6	1.0	27	1.0	10	2.0:1/2.0:1
BZP104UB1	0.1 - 4	0.9	28	1.0	10	2.0:1/2.0:1
BZP102UB1	0.1 - 2	0.7	28	1.0	10	2.0:1/2.0:1
BZP102UB2	0.1 - 2	1.0	26	1.0	10	2.0:1/2.0:1

Wideband Low Noise Amplifiers

Model	Freq (GHz)	Noise Fig* (dB Max)	Gain (dB Min)	Gain Var. (±dB Max)	Pout 1dB (dBm Min)	VSWR In/Out
BZ4060LD1	40 - 60	6.0	20	2.5	5	2.7:1/2.7:1
BZ1230LD1	12 - 30	3.0	27	1.5	8	2.0:1/2.0:1
BZ1840LD1	18 - 40	2.7	25	2.0	8	2.3:1/2.3:1
BZ2640LD1	26 - 40	2.5	25	1.8	8	2.0:1/2.0:1
BZ1428LD1	14 - 28	2.5	28	1.5	8	2.0:1/2.0:1
BZ1226LD1	12 - 26	2.3	30	1.6	8	2.0:1/2.0:1
BZ1822LD1	18 - 22	1.4	30	1.0	7	2.0:1/2.0:1
BZ0618LC1	6 - 18	1.4	27	1.5	5	2.0:1/2.0:1
BZ0818LC1	8 - 18	1.2	27	1.2	8	2.0:1/2.0:1
BZ1218LC1	12 - 18	1.2	28	1.0	8	1.5:1/1.5:1
BZ0612LC1	6 - 12	0.9	30	1.3	5	2.0:1/2.0:1
BZ0208LB1	2 - 8	1.0	22	1.5	5	2.0:1/2.0:1

Wideband Medium Power Amplifiers

Model	Freq (GHz)	Noise Fig* (dB Max)	Gain (dB Min)	Gain Var. (±dB Max)	Pout 1dB (dBm Min)	VSWR In/Out
BZP530MD1	0.5 - 30	4.8	26	1.8	13	2.5:1/2.5:1
BZP526MD1	0.5 - 26	4.5	28	1.5	15	2.5:1/2.5:1
BZP520MD1	0.5 - 20	4.5	30	2.5	20	2.3:1/2.3:1
BZP518MD1	0.5 - 18	4.3	30	2.5	22	2.0:1/2.0:1
BZP518MD2	0.5 - 18	3.7	30	2.5	20	2.0:1/2.0:1
BZP518MC1	0.5 - 18	3.5	28	1.7	17	2.0:1/2.0:1
BZP518MB1	0.5 - 18	3.5	17	1.5	17	2.3:1/2.3:1
BZP512MC1	0.5 - 12	2.0	32	1.5	15	2.0:1/2.3:1
BZ0218MD1	2 - 18	4.3	30	2.0	23	2.0:1/2.3:1
BZ0618MD1	6 - 18	3.7	30	1.8	23	2.0:1/2.3:1
BZ1218MD1	12 - 18	3.5	30	1.0	23	2.0:1/2.3:1
BZ0212MD1	2 - 12	3.3	30	1.5	23	2.0:1/2.3:1
BZ0212MC1	2 - 12	2.0	32	1.3	17	2.0:1/2.0:1
BZ0412MD1	4 - 12	3.8	30	1.8	24	2.0:1/2.0:1
BZ0510MD1	5 - 10	3.6	32	1.5	25	2.0:1/2.0:1
BZ0408MD1	4 - 8	3.5	33	1.5	26	2.0:1/2.0:1

Wideband High Power Amplifiers

Model	Freq (GHz)	Noise Fig* (dB Max)	Gain (dB Min)	Gain Var. (±dB Max)	Pout 1dB (dBm Min)	VSWR In/Out
BZ0218PA1	2 - 18	9	10	2	25	2.5:1/2.5:1
BZ0218PA2	2 - 18	9.5	9	2	29	2.5:1/2.5:1
BZ0218PD1	2 - 18	6	25	2.3	25	2.5:1/2.5:1
BZ0218PD2	2 - 18	6.5	24	2.5	29	2.5:1/2.5:1
BZ0618PA1	6 - 18	10	13	2	25	2.5:1/2.5:1
BZ0618PD1	6 - 18	6	30	2.3	29	2.5:1/2.5:1
BZ0618PD2	6 - 18	6.5	30	2.5	32	2.5:1/2.5:1
BZ0618PD3	6 - 18	8	30	2.7	35	2.5:1/2.5:1

Ultra Wideband Fiber Optics Amplifiers

Model	Freq (GHz)	Noise Fig* (dB Max)	Gain (dB Min)	Gain Var. (±dB Max)	Pout 1dB (dBm Min)	VSWR In/Out
BZ0020FB1	0.0005 - 20	5	17	1.8	13	2.5:1/2.5:1
BZ0020FB2	0.0005 - 20	6	16	2.0	15	2.5:1/2.5:1
BZ0026FB1	0.0005 - 26	6.5	16	2.0	8	2.5:1/2.5:1
BZ0026FB2	0.0005 - 26	7	15	2.0	12	2.5:1/2.5:1

Wideband High Dynamic Range Amplifiers

Model	Freq (GHz)	Noise Fig* (dB Max)	Gain (dB Min)	Gain Var. (±dB Max)	Pout 1dB (dBm Min)	VSWR In/Out
BZP526HA1	0.5 - 26	4.5	10	1.2	10	2.3:1/2.3:1
BZP526HB1	0.5 - 26	4.5	15	1.5	15	2.3:1/2.3:1
BZP518HA1	0.5 - 18	2.3	10	1.0	10	2.3:1/2.3:1
BZP518HB1	0.5 - 18	3.2	17	1.3	17	2.0:1/2.0:1
BZ0618HA1	6 - 18	2.3	10	1.0	12	2.0:1/2.0:1
BZ0618HB1	6 - 18	3.5	17	1.0	20	2.0:1/2.0:1
BZP506HB1	0.5 - 6	2.0	20	1.2	20	2.2:1/2.2:1
BZ0510HB1	5 - 10	2.3	20	0.5	20	2.0:1/2.0:1

Wideband Cryogenic Amplifiers

Model	Freq (GHz)	Noise Temp* (°K)	Gain (dB Min)	Gain Var. (±dB Max)	Volt, Cur (V, mA)	VSWR In/Out
BZP502CR1	0.5 - 2.5	12	28	1.5	3,35	2.0:1/2.0:1
BZ0205CR1	2.5 - 5	12	25	1.5	4,40	2.0:1/2.0:1
BZ0408CR1	4 - 8	12	24	1.5	4,40	2.0:1/2.0:1
BZ0812CR1	8 - 12	15	24	1.5	4, 40	2.0:1/2.0:1
BZ0818CR1	8 - 18	25	30	1.5	4, 40	2.0:1/2.0:1
BZ1840CR1	18 - 40	75	25	2.5	3, 45	2.5:1/2.5:1

Most models can be optimized to meet exact requirements at reasonable cost.
All models have internal DC regulators, except Cryogenic Amplifiers.

* Noise Figure and other parameters degrade below 500 MHz.
* Noise Temperature for Cryogenic Amplifiers measured at 77 °K.
* Wideband High Power Amplifiers require larger housings.

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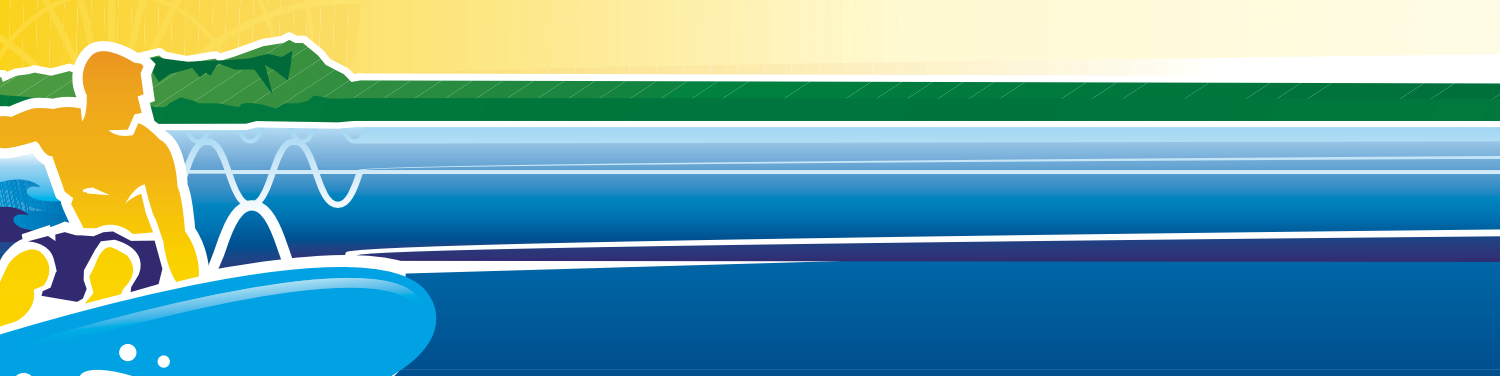

2007 IEEE MTT-S Technical Program

TUESDAY, JUNE 12, 2007

1:20 PM TO 3:00 PM

TU3A ADVANCES IN RF POWER AMPLIFIER TECHNOLOGY
Chair: A. Moussessian
Co-chair: Y. Nikawa

This session will present the latest advances in RF power amplifiers from 1 to 1000 MHz. The presentations include semiconductor technologies based on GaAs, SiC, Si Bipolar and LDMOS. High efficiency class E and F and balanced amplifier topologies are represented. Efficiencies up to 85% and power levels of up to 500 W are achieved. Applications for ground, radar and space are discussed. This session also includes a paper on broadband ferrite transformers, an important supporting technology for HF and UHF power amplifiers.

TU3A-01: A Highly Efficient UHF Power Amplifier Using GaAs FETs for Space Applications
A. Katz, J.L. Martinetti, M.J. Franco

TU3A-02: Model for the Low-Frequency Performance of Ferrite-Loaded Balun Transformers
F.H. Raab

TU3A-03: Technique to Extend Class-E Mode Operation to Broadband UHF Amplifiers
J.B. Call, Z. Chen, W. Taylor

TU3A-04: Class E Amplifier Design Equations for Maximizing the Frequency Utilization of a Device
A. Mediano, P. Molina-Gaudo, C. Bernal

TU3A-05: UHF-band Long-pulse Radar Power Amplifiers using Push-pull and Balanced Configurations
J. Park, J. Burger, J. Titizian

TU3A-06: Class-E Silicon Carbide VHF Power Amplifier
M.J. Franco, A. Katz

TU3B HYBRIDS AND COUPLERS I
Chair: I. Bahl
Co-chair: J. Owens

This session deals with hybrid and couplers using different circuit configurations and geometries to reduce circuit size. These components include compact rat-race hybrid, miniature hybrids with harmonic suppression, SiGe-based miniature hybrids and a compact low-loss magic T. A six-port circuit architecture using power dividers is also presented.

TU3B-01: Compact Rat-race Hybrid Coupler Implemented Through Artificial Left Handed and Right Handed Lines
G. Siso, J. Bonache, M. Gil, J. Garcia-Garcia, F. Martin

TU3B-02: Miniaturized Branch-line Coupler with Harmonic Suppression for RFID Applications using Artificial Transmission Lines
C. Wang, T. Ma, C. Yang

TU3B-03: A New Miniaturized Type of Three-Dimensional SiGe 90° Hybrid Coupler at 20 GHz using the Meandering TFMS and Stripline Shunt Stub Loading
K. Hettak, M. Stubbs, G. Morin

TU3B-04: A Compact Low-loss Magic-T using Microstrip-slotline Transitions
K. U-yen, E.J. Wollack, S.H. Moseley, J. Papapolymerou, J. Laskar

TU3B-05: A New Six-port Circuit Architecture using Only Power Dividers/Combiners
L. Gerardi, M. Bozzi, L. Perregrini, Y. Xu, Y. Zhao, K. Wu, R.G. Bosisio

TU3D MICROWAVE PHOTONIC LINKS
Chair: E. Rezek
Co-chair: D. Novak

This session includes six papers that cover different aspects of microwave photonic links and radio over fiber techniques. Methods for frequency upconversion are also covered.

TU3D-01: Coherent Optical Receiver for Linear Optical Phase Demodulation
L.A. Johansson, H. Chou, A. Ramaswamy, L.A. Coldren, J.E. Bowers

TU3D-02: Signal-to-Noise Performance of Two Analog Photonic Links Using Different Noise Reduction Techniques
E.I. Ackerman, G.E. Betts, W.K. Burns, C.H. Cox, J.L. Prince, M.D. Regan, H.V. Roussell, J.C. Campbell, N. Duan

TU3D-03: Link Characterization for Optical Single Sideband Modulation with Linearization Technique Incorporating RF Nonlinearity
C. Lim, A. Nirmalathas, D. Novak, R. Waterhouse

TU3D-04: Dual Band LTCC-based Wireless Transceiver with Optical Interface using Polymer Fiber
L. Pergola, R. Vahldieck, M. Buelters, R. Gindera, I. Moellers, D. Jaeger

TU3D-05: 1.25 Gbps Optical Data Channel Up-conversion in 20 GHz-band via a Frequency-doubling Optoelectronic Oscillator for Radio-over-fiber Systems
M. Shin, P. Kumar

TU3D-06: All-optical Frequency Up-conversion Technique using Four-wave Mixing in Semiconductor Optical Amplifiers for Radio-over-fiber Applications
J. Song, H. Kim, H. Song

TU3E DIGITAL MICROWAVE ARCHITECTURES
Chair: J.F. Luy
Co-chair: S. Narahashi

Digital techniques enable the design of transmitters which may operate with different modulation schemes and under multimode conditions. The first paper discusses a Polar Delta-Sigma Modulation Scheme for applications in high efficiency transmitters. Key design issues for the implementation of a hybrid quadrature polar modulation scheme are investigated in a second paper. Then a complete implementation of a Delta-Sigma digitized transmitter is demonstrated for wireless CDMA applications. These novel RF techniques are strongly related to signal processing topics—areas which are covered by the last two papers in this session. One paper covers offset and mismatch compensation techniques in a WLAN transmitter, the last paper covers calibration aspects in six-port receivers.

TU3E-01: A Polar Delta-Sigma Modulation (PDSM) Scheme for High Efficiency Wireless Transmitters
Y.E. Wang

TU3E-02: System Design Issues in a HQPM-based Transmitter
C. Li, T. Horng, J. Jau, J. Li

TU3E-03: A Delta-Sigma-Digitized RF Transmitter
J. Choi, J. Yim, J. Yang, J. Cha, B. Kim, J. Kim

TU3E-04: A New DC-offset and I/Q-mismatch Compensation Technique for a CMOS Direct-conversion WLAN Transmitter
K. Yanagisawa, N. Matsuno, T. Maeda, S. Tanaka

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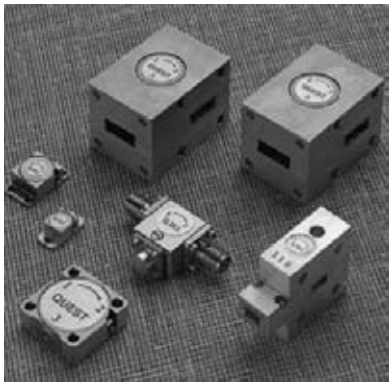

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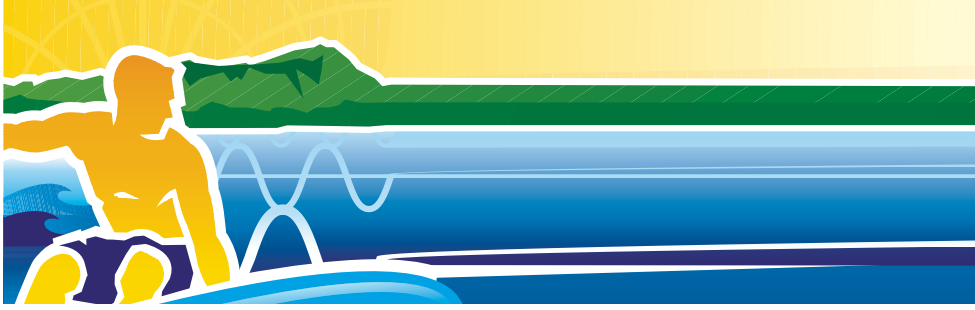

TU3E-05: Reduction of Six-port Calibration to Linear Equalization
T. Eireiner, Q. Lu, T. Muller, M. Wetz, C. Pietsch, I. Perisa

TU3F Advances in CAD Techniques
Chair: A.K. Sharma
Co-chair: J.E. Rayas-Sanchez

Recent advances in computer-aided design encompassing simulation, modeling, optimization and synthesis are included.

TU3F-01: Moments Based Computation of Intermodulation Distortion of Mixer Circuits
D. Tannir, R. Khazaka

TU3F-02: Real-part Sufficiency and Its Application to the Rational Function Fitting of Passive Electromagnetic Responses
A.Y. Woo, A.C. Cangellaris

TU3F-03: Parallel Automatic Model Generation Technique for Microwave Modeling
L. Zhang, Y. Cao, S. Wan, H. Kabir, Q. Zhang

TU3F-04: Coarse and Surrogate Model Assessment for Engineering Design Optimization with Space Mapping
S. Koziel, J.W. Bandler

TU3F-05: EM-based Space Mapping Optimization of Left-handed Coplanar Waveguide Filters with Split Ring Resonators
L.J. Rogla, V.E. Boria, J. Carbonell, J.E. Rayas-Sanchez

TU3F-06: Optimal Synthesis for Multi-band Microwave Filters
V. Lunot, F. Seyfert, S. Bila

TU3G Microwave/Millimeter-wave Activities in the Pacific Rim
Special Session
Chair: O. Boric-Lubecke
Co-chair: K. Mizuno

This special session brings together talks on microwave and millimeter-wave activities in the Pacific Rim, from China, Japan and Australia. A range of topics, including recent cellular infrastructure development, microwave and millimeter-wave technology, and defense satellite communication networks in Asia will be included.

TU3G-01: Research Advances on RF Technologies for 3G/B3G Mobile Communications
H. Wei, J. Zhou, W. Jiang, H. Wang, J. Liu, X. Zhou, J. Zhao, L. Zhang

TU3G-02: Microwave Activities in Taiwan
R. Wu, H. Wang, C. Chen, S. Chung, C. Lu

TU3G-03: The Secure Satellite IP Network – SSATIN
C.J. Cocks, T.M. Cox, P. Van Barneveld, P.A. Stimson, G.T. O'Shea

TU3G-04: Millimeter-wave Activities in Japan
K. Araki

3:30 PM to 5:00 PM

TU4A Advanced Techniques for Wireless Power Amplifier Efficiency and Linearity Enhancement
Chair: C. Weitzel
Co-chair: V. Krishnamurthy

The proliferation of high data rate wireless mobile handset applications has spurred the need for higher efficiency and improved linearity. Battery life and data rate will be the two dominant metrics for determining the success of next generation wireless mobile devices. In this session seven papers will be presented that detail the current state-of-the-art advancements in PA linearity and efficiency in Si and GaAs technologies. The first five papers address PA efficiency and linearity improvement through the use of: envelope feedback techniques, optimization of switch-mode waveforms, novel PA cells, and high efficiency distributed amplifier topologies. The final two papers detail advanced GaAs and Si PA designs featuring dual-mode WLAN/WiMAX and quad-band GSM applications with excellent efficiency and linearity performance.

TU4A-01: A Gated Envelope Feedback Technique for Automatic Hardware Conditioning of RFIC PAs at Low Power Levels
N.G. Constantin, M.N. El-Gamal, P.J. Zampardi

TU4A-02: Design Approach for Realization of Very High Efficiency Power Amplifiers
C. Roff, J. Benedikt, P.J. Tasker

TU4A-03: A Novel High Efficiency and Linearity Power Amplifier with Over-voltage Protection
H. Zhang, H. Gao, G. Li, Y. Ma

TU4A-04: An HBT 4-cell Monolithic Stacked Power Amplifier
Z. Tsai, M. Lei, H. Wang

TU4A-05: Distributed Amplifier with Narrowband Amplifier Efficiency
S.A. Olson, B.M. Thompson, B.E. Stengel

TU4A-06: Single-chip Dual-Mode Power Amplifier MMIC using GaAs E-pHEMT for WiMAX/WLAN Applications
Y. Hsu, S. Wang, C. Chen, W. Ho, C. Lin

TU4A-07: Quad-band GSM Silicon PA Module on LTCC Embedding a Coupler-based RF Power Controller
A. Pallotta, F. Pidala, L. Labate, A. Moscatelli

TU4B Hybrids and Couplers II
Chair: P. Russer
Co-chair: G. Macchiarella

Several different types of hybrids and couplers using hybrid MICs, LTCCs, Si ICs and substrate integrated waveguide technologies are presented. These include miniature rat-race couplers, broadband directional couplers, dual band rat-race couplers, low loss broadside couplers, a coupler with a programmable coupling coefficient, and an 180 degree phase shift coupler.

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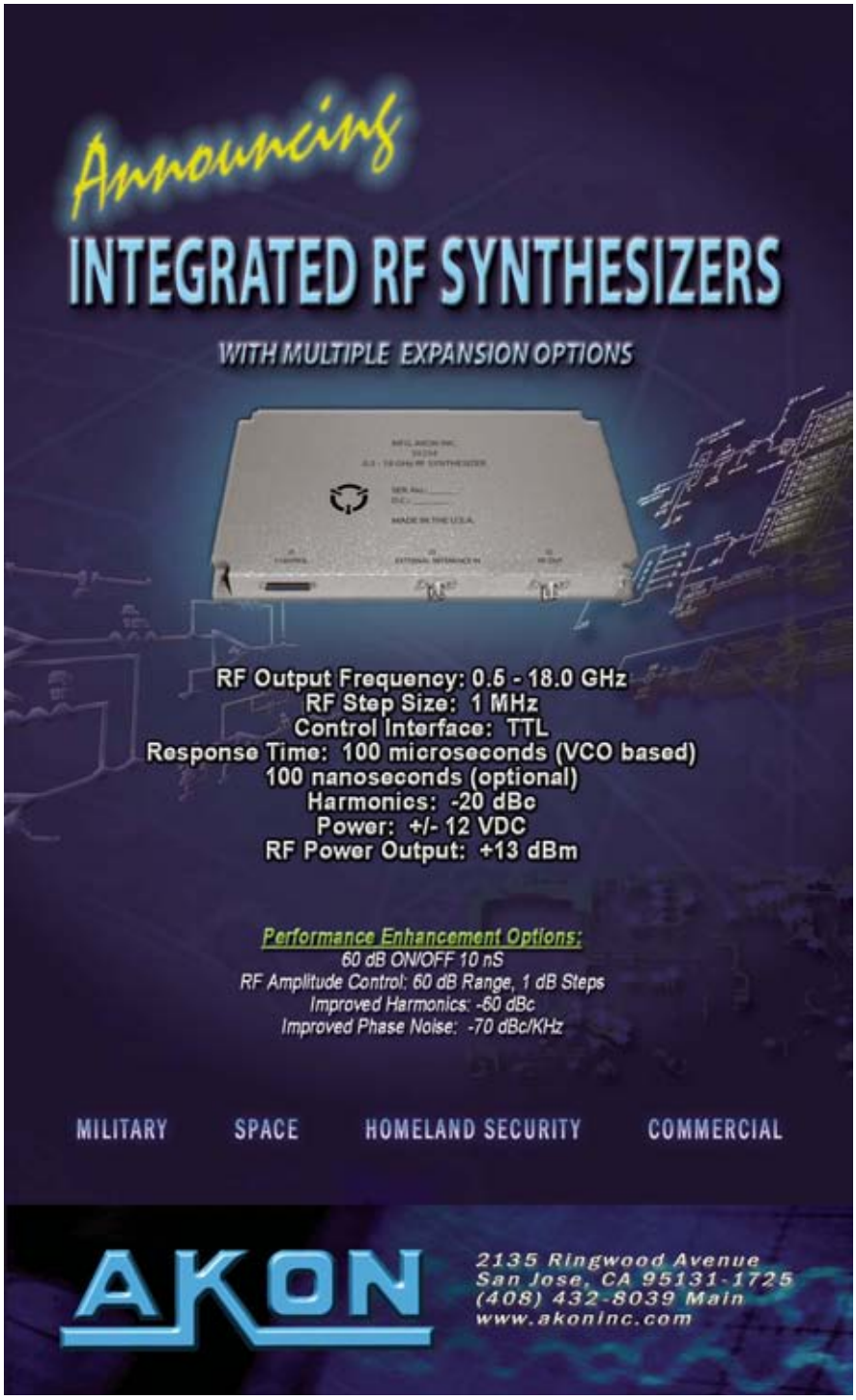
TU4B-01: **Miniaturized Rat Race Coupler with Microstrip-to-CPW Broadside-coupled Structure and Stepped-impedance Sections**
J. Kuo, Y. Chiou, J. Wu

TU4B-02: **Multilayer Multi-section Broadband LTCC Stripline Directional Couplers**
M.M. Fahmi, K.A. Zaki, J.A. Ruiz-Cruz, A.J. Piloto

TU4B-03: **Design of Dual-band Microstrip Rat Race Coupler with Circuit Miniaturization**
C. Hsu, C. Chang, J. Kuo

TU4B-04: **Low Insertion Losses Broadside Coupler in a Multilayer Above IC Technology for K-band Applications**
N. Do, D. Dubuc, K. Grenier, R. Plana



TU4B-05: **A Software Configurable Coupler with Programmable Coupling Coefficient**
S. Wang, C. Chang, J. Lin

TU4B-06: **Novel Substrate Integrated Waveguide Fixed Phase Shifter for 180° Directional Coupler**
C. Yujian, H. Wei, W. Ke

TU4C Multi-GHz Circuits and Systems for Communication and Instrumentation
Chair: Konczykowska
Co-chair: K. Murata

This session presents multi-GHz circuits for wireless and optical communications and high-speed waveform digitization. The session will discuss in particular a novel 18 GHz bandwidth 60 GS/s real-time waveform digitizing system, an antenna based signal processor with reconfigurable receiver, electrical dispersion compensation circuits for 10 Gbit/s 300-m multi-mode optical communication and for 1.25 Gbit/s 15 km passive optical access, a 2 GS/s 1 bit delta-sigma modulator for wireless link, and an ultra low-power high-frequency divider.

TU4C-01: **An 18 GHz Bandwidth, 60 GS/s Sample Rate Real-time Waveform Digitizing System**
P.J. Pupalaikis

TU4C-02: **Antenna Based Signal Processor using Reconfigurable Receiver**
L. Zhou, A.S. Daryoush

TU4C-03: **A Novel Analog Decision-feedback Equalizer for 10 Gb/sec Multi-mode Fiber Dispersion Compensation**
S. Chandramouli, F. Bien, H. Kim, E. Gebara, J. Laskar, C. Scholz

TU4C-04: **Electrical Dispersion Compensator for a Giga-bit Passive Optical Network System with Fabry-Perot Laser**
H. Kim, F. Bien, S. Chandramouli, J. de Ginestous, C. Scholz, E. Gebara, J. Laskar

TU4C-05: **A 2 Gb/s Delta Sigma Directly Driven Wireless Link**
Q. Mu, L. Sankey, Z. Popovic

TU4C-06: **Odd Phase Switching Prescaler Based on Injection Locked Frequency Divider**
X. Yan, X. Yu, M. Do, W. Lim, K. Yeo

TU4D Microwave Photonic Devices
Chair: D. Jaeger
Co-chair: A. Madjar

This session includes six papers describing different devices for microwave photonic applications. Opto-electronic mixers, optical delay lines, photonic analog to digial converters and a novel all-dielectric wireless receiver are described.

TU4D-01: **All-Dielectric Wireless Receiver**
R.C. Hsu, A. Ayazi, B. Houshmand, B. Jalali

TU4D-02: **Traveling Wave Spatial Quantized Analog-to-Digital Conversion**
M. Jarrahi, T.H. Lee

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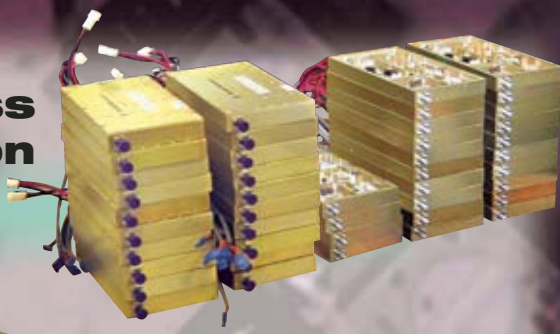
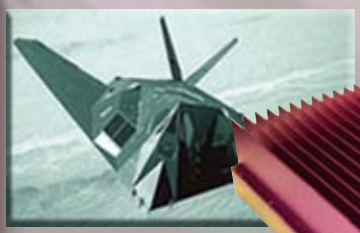
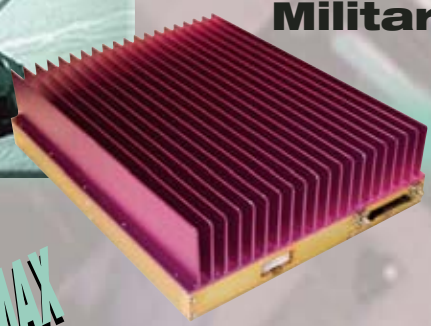
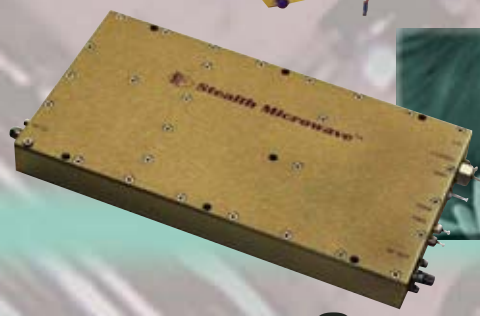




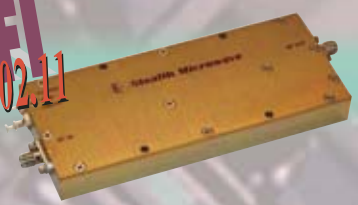
Military



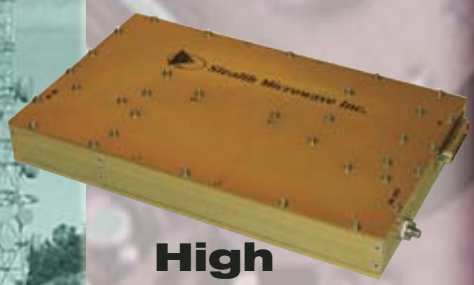


Commercial

802.16 WIMAX WI-FI 802.11



Low Power



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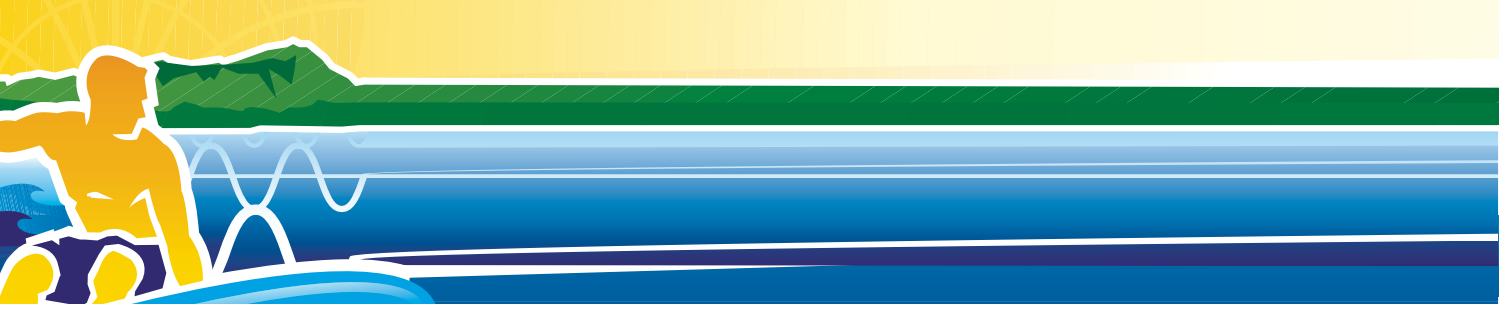

TU4D-03: **Second Order Distortion Cancellation in Photonic Time Stretch Analog-to-digital Converter**
S. Gupta, B. Jalali

TU4D-04: **CMOS-compatible 60 GHz Harmonic Optoelectronic Mixer**
H. Kang, W. Choi

TU4D-05: **Optically Injection-locked Self-oscillating HBT MMIC Optoelectronic Mixer for Bi-directional Fiber-fed Wireless Links**
J. Kim, W. Choi, H. Kamitsuna, M. Ida, K. KurishimĬa

TU4D-06: **Optimization of Optical Delay Lines Based on Photonic Crystal Coupled Cavity Waveguides**
A. Gujjula, J. Sabarinathan

TU4E Advanced Components for Wireless Systems
Chair: B.D. Geller
Co-chair: C.H. Lee

This session focuses on novel components and RF module techniques for wireless systems. Topics include an ultra-linear front-end module, a highly integrated CMOS front-end module, co-existence of multiple services in mobile phones, a compact tri-band antenna, complementary bipolar devices for base stations, and high-level integrated front-end ICs for WiMAX applications.

TU4E-01: **Ultra Linear Dual-band WLAN Front-end Module for 802.11 a/b/g/n Applications with Wide Voltage and Temperature Range Operation**
C.P. Huang, C. Masse, C. Zelley, C. Christmas, T. Ted Whittaker, J. Soricelli, W. Vaillancourt, A. Parolin

TU4E-02: **A Complete Antenna-to-CMOS 4 × 6 mm Front End Module for Dual Band 802.11abgn WLAN**
H.T. Morkner, M. Vice, M. Karakucuk, W. Abey, L.D. Nguyen, J.F. Kessler, G. Carr

TU4E-03: **Co-existence of an Electronically Tunable DVB-H Antenna with the GSM Transmitter in a Mobile Phone**
L. Huang, W.L. Schroeder, P. Russer

TU4E-04: **A Compact Tri-band PIFA with Multiple-Folded Parasitic Elements**
D. Kim, J. Lee, C. Cho, J. Kim

TU4E-05: **Complementary Bipolar Devices for Base Station Applications**
E. Tiiliharju, H. Pellikka

TU4E-06: **High Level Integrated ICs for Low Cost, Compact, WiMax Dual-band RF Modules**
C. Yuen, K. Laursen, D. Chu, M. Adams, H. Nguyen

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TU4F Applied Frequency Domain Techniques
Chair: A. Omar
Co-chair: L. Perregrini

This session deals with advanced numerical electromagnetic simulation techniques applicable to the frequency domain. The main objective of the presented techniques is to increase the simulation accuracy and/or to reduce the computational costs (CPU time and storage requirements).

TU4F-01: **Short-open Calibration Technique for Field Theory-based Parametric Extraction of Planar Discontinuities with Nonuniform Feed lines**
S. Sun, L. Zhu

TU4F-02: **A New SCN-based Frequency-domain TLM Node and Its Applications with the Diakoptic Method**
K. Sung, Z.D. Chen

TU4F-03: **A Non-Disjoint Hexahedral Space Discretization for the Finite-Volume Technique**
K. Krohne, R. Vahldieck

TU4F-04: **Fully Automatic HP Adaptivity for Electromagnetics. Application to the Analysis of H-plane and E-plane Rectangular Waveguide Discontinuities**
L.E. Garcia-Castillo, L.F. Demkowicz, D. Pardo-Zubiaur

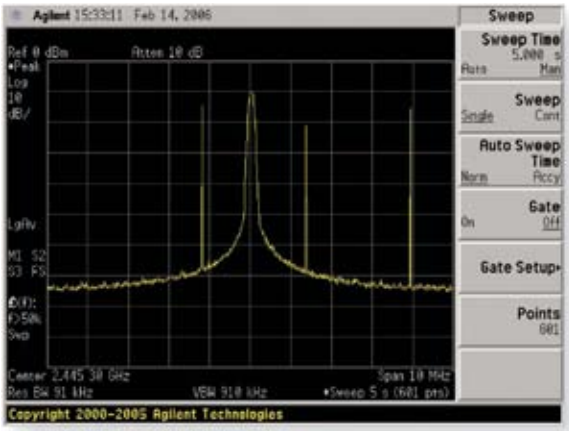
TU4F-05: **An Incremental Fullwave EM Simulator for RF and Microwave Design**
F. Ling, W. Harris, X. Wang, A. Dengi

TU4F-06: **Optimizing the FDFD Method in Order to Minimize PML-related Numerical Problems**
P.K. Talukder, F. Schmuckle, W. Heinrich, R. Schlundt

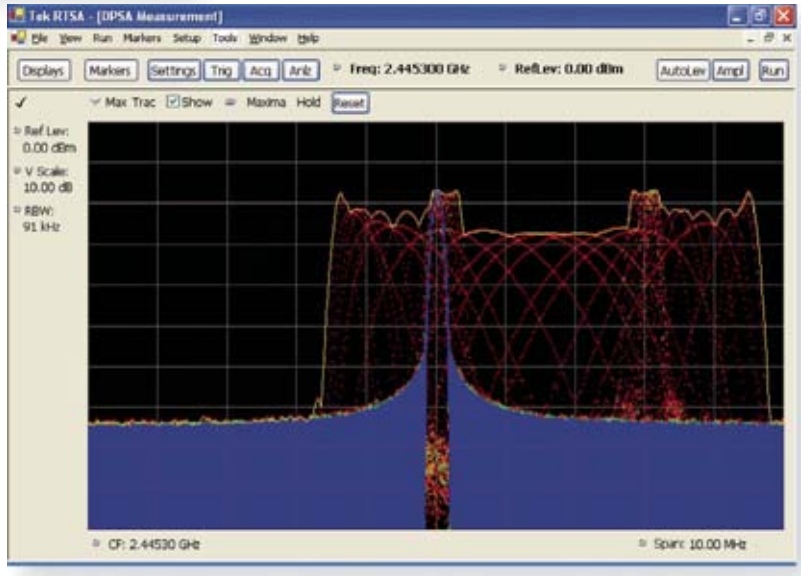
TU4G A Tribute to Dr. Leo Young
Special Session
Chair: R.J. Trew

Dr. Leo Young passed away at the age of 80 in September 2006. Dr. Young pioneered the development of microwave filter technology, published 14 books and over 100 technical articles and 20 patents on various aspects of microwave technology. In 1964 Leo, along with his colleagues George Matthaei and E.M.T. Jones, wrote *Microwave Filters, Impedance-Matching Networks and Coupling Structures* included in the Microwave Hall of Fame and is generally considered "the bible" for microwave filter design. Leo's extensive professional activities included election as president of the IEEE and of the MTT Society. He received numerous awards, including the Microwave Prize, Distinguished Service Award, and the Microwave Career Award. Leo was a Life Fellow of IEEE, a member of the National Academy of Engineering and a Foreign Member of the UK Royal Academy of Engineering. Leo was the US DoD's Director of Research and established many of its policies and programs that define support for basic research.

TU4G-01: **A Tribute to Dr. Leo Young**
R. Trew



Agilent 5 seconds



Tektronix 5 seconds

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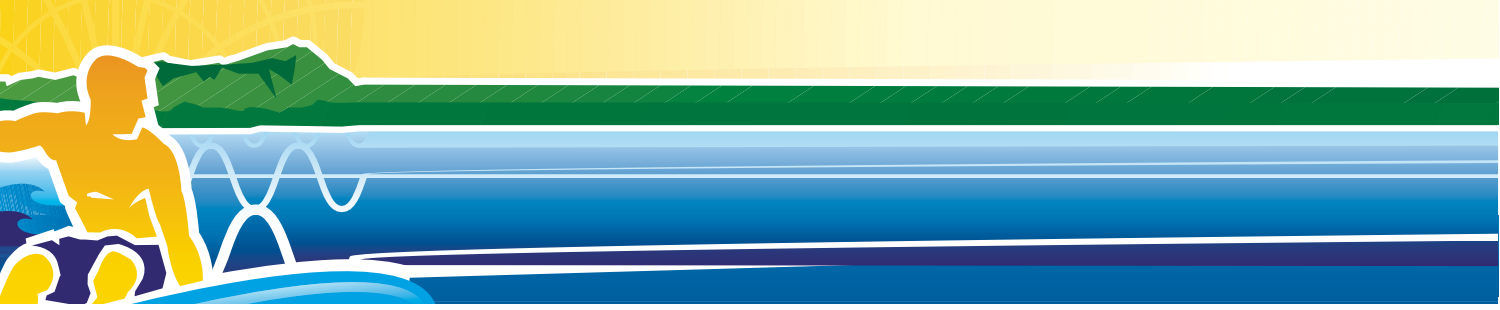


WEDNESDAY, JUNE 13, 2007
8:00 AM TO 9:40 AM

WE1A POWER CHARACTERISTICS AND PERFORMANCE ENHANCEMENT TECHNIQUES FOR III-V AND SILICON-BASED DEVICES
Chair: Z. Bardai
Co-chair: P. Watson

This session presents operating characteristics of high power devices with emphasis on voltage, survivability, reliability and robustness. In addition, advanced techniques for improved power handling in silicon based technologies will also be presented.

WE1A-01: Voltage Dependent Characteristics of 48 V AlGaN/GaN High Electron Mobility Transistor Technology on Silicon Carbide
J.D. Brown, S. Lee, J. Martin, R. Vetury, M. Poulton, J. Shealy

WE1A-02: Survivability of AlGaN/GaN HEMT
Y. Chen, R. Coffie, W. Luo, M. Wojtowicz, I. Smorchkova, B. Heying, Y. Kim, M.V. Aust, A. Oki

WE1A-03: FET Gate Length Impact on Reliability
A.M. Darwish, A. Bayba, A. Hung

WE1A-04: Robustness of GaAs Field Plate Based MESFETs
T.A. Winslow

WE1A-05: Varactor Topologies for RF Adaptivity with Improved Power Handling and Linearity
K. Buisman, C. Huang, A. Akhnoukh, M. Marchetti, L.C. de Vreede, L.K. Nanver, L.E. Larson

WE1A-06: Design for Integration of RF Power Transistors in 0.13 μm Advanced CMOS Technology
S. Huang, C. Chang, K. Chen, G. Huang, C. Hung, V. Liang

WE1B INNOVATIVE ACTIVE CIRCUITS OPERATING ABOVE 100 GHz
Chair: R. Emrick
Co-chair: E. Niehenke

Interest in the use of frequencies above 100 GHz continues to grow. Some of the drivers in this growing interest include specialized scientific applications, biomedical diagnostics and applications requiring wide bandwidth and fine resolutions. Technologies highlighted include many of the key components required to implement advanced systems at these frequencies.

WE1B-01: A 245 GHz MMIC Amplifier with 80 micron Output Periphery and 12 dB Gain
W.R. Deal, X.B. Mei, V. Radisic, W. Yoshida, P.H. Liu, J. Uyeda, M. Barsky, R. Lai, T. Gaier, A. Fung, L. Samoska

WE1B-02: A SiGe Monolithically Integrated 278 GHz Push-push Oscillator
R. Wanner, G.R. Olbrich, P. Russer, R. Lachner

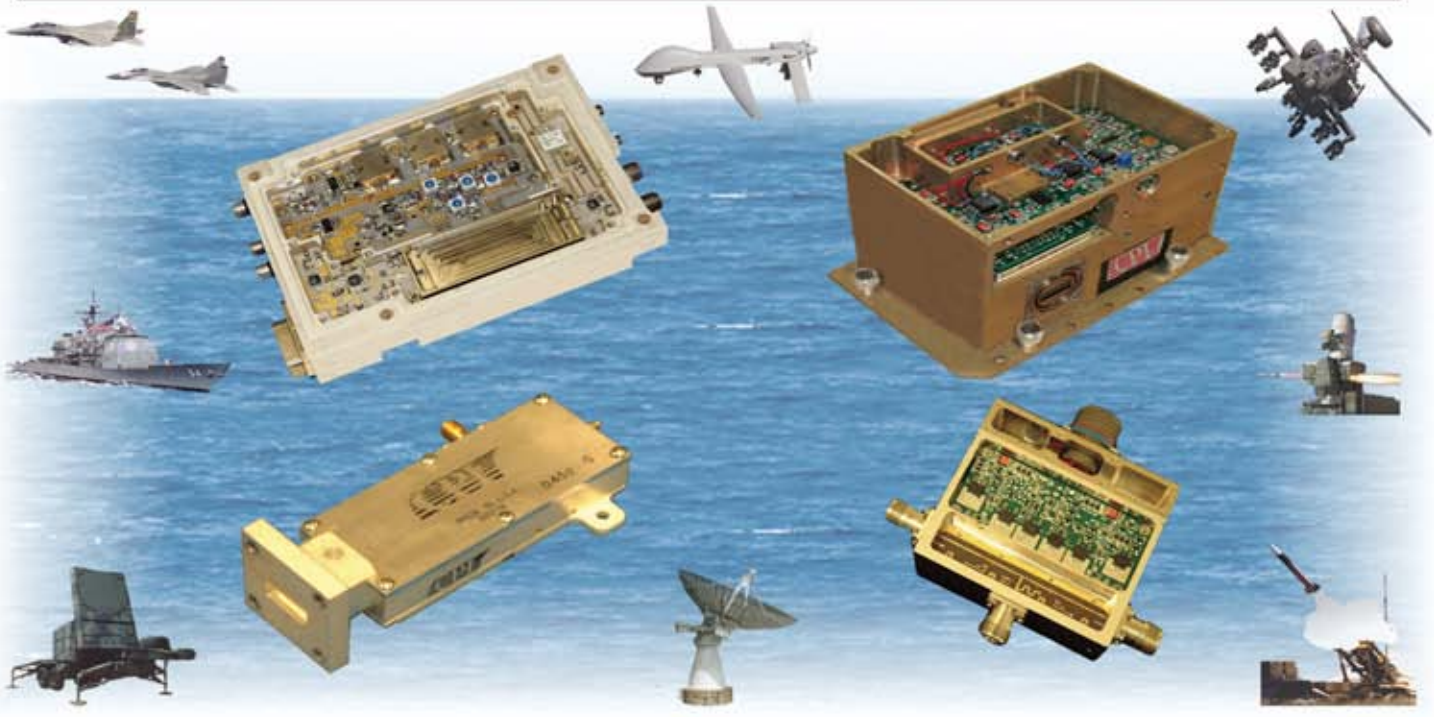
WE1B-03: High-Efficiency Terahertz Frequency Triplers
D.W. Porterfield

WE1B-04: Highly Efficient Harmonically Tuned InP D-HBT Push-Push Oscillators Operating up to 287 GHz
Y. Baeyens, N. Weimann, V. Houtsma, J. Weiner, Y. Yang, J. Frackoviak, P. Roux, A. Tate, Y. Chen

WE1B-05: New Trend in THz Detection: High T_c Superconducting Hot Electron Bolometer Technology May Exhibit Advantage vs. Low T_c Devices
A.J. Kreisler, A.F. Degardin, M. Aurino, C. Peroz, J. Villegier, G. Beaudin, Y. Delorme, M. Redon, A. Sentz

WE1B-06: A 100 GHz Tunable Photonic Millimeter-wave Synthesizer for the Atacama Large Millimeter Array Radiotelescope
J. Cliche, M. Tetu, M. Poulin, B. Shillue

Integrated Microwave Assemblies



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WE1B-07: **Metamorphic H-band Low-noise Amplifier MMICs**
A. Tessmann, A. Leuther, H. Massler, M. Schlechtweg

WE1C Innovative Design and Construction of RF MEMS Switches
Chair: C. Goldsmith
Co-chair: J. Ebel

This session highlights a variety of novel designs and materials used for construction broadband and high-power RF MEMS switches.

WE1C-01: **Coplanar-Waveguide Embedded Mechanically-bistable DC-to-RF MEMS Switches**
M. Sterner, N. Roxhed, G. Stemme, J. Oberhammer

WE1C-02: **Non-Toxic Liquid-Metal 2–100 GHz MEMS Switch**
C. Chen, J. Whalen, D. Peroulis

WE1C-03: **Thermally Actuated Nanocrystalline Diamond Micro-bridges for Microwave and High Power RF Applications**
S. Balachandran, J. Kusterer, D. Maier, M. Dipalo, E. Kohn, R. Connick, T.M. Weller

WE1C-04: **Design of a 20 GHz Low Loss Ohmic Contact RF MEMS Switch**
D.A. Goins, R.D. Nelson, J.S. McKillop

WE1C-05: **Carbon Nanotube Based Dielectric for Enhanced RF MEMS Reliability**
C. Bordas, K. Grenier, D. Dubuc, S. Pacchini, E. Flahaut, M. Paillard, J.L. Cazaux

WE1C-06: **Schottky Contact RF MEMS Switch Characterization**
B.W. Pillans, F. Morris, P. Chahal, G. Frazier, J. Lee

WE1F Microwave Sensors for Object and Presence Detections
Chair: I. Gresham
Co-chair: R. Sudbury

This session reviews innovative work in a broad variety of micro- and millimeter-wave sensor applications. Two examples of human presence detection are presented. First, the passive detection of human presence by use of a correlation radiometer will be described, followed by a 24 GHz intrusion detector radar that can detect a range of target velocities from 0.01 m/sec to 10 m/sec with beam-switched area coverage. This session also features an application of a left-handed transmission line resonator for a material density measurement sensor for measuring the flow of materials in various industrial applications. The use of a 24 GHz spread spectrum radio location system for 3-D high precision measurements is discussed, as is a very interesting electro-optic imaging system that has been developed to provide real-time display of electric field patterns. Lastly, an in-built polarizer that reduces road clutter-noise by 20 dB has been added to a patch array antenna for a 76 GHz automotive radar and will be presented. This diverse session is sure to have something of interest for anybody active in the microwave sensor field, and will be of general interest to others.

WE1F-01: **A Ka-band Correlation Radiometer for Human Presence Detection from a Moving Platform**
J.A. Nanzer, R.L. Rogers

WE1F-02: **24 GHz Intruder Detection Radar with Beam-switched Area Coverage**
M. Morinaga, T. Nagasaku, H. Shinoda, H. Kondoh

WE1F-03: **New Microwave Flow Sensor Based on a Left-handed Transmission Line Resonator**
A. Penirschke, M. Schubler, R. Jakoby

WE1F-04: **A Robust 3D High Precision Radio Location System**
C. Meier, S. Lindenmeier, A. Terzis

WE1F-05: **Live Electro-optic Imaging of Microwave Near-fields via Ultra-parallel Photonic Heterodyne**
K. Sasagawa, A. Kanno, T. Kawanishi, M. Tsuchiya

WE1F-06: **Composite Patch Array Antenna with Built-in Polarizer for Reducing Road Clutter Noises of 76 GHz Automotive Radars**
H. Shinoda, H. Kondoh

WE1G Power Dividers and Combiners
Chair: M. Salazar-Palma
Co-chair: M. Abouzahra

This session presents novel power dividers and combiners fabricated in planar, waveguide and hybrid technologies. In two of the papers emphasis is placed on the broadband performance and the miniaturization of the device. Other papers pay attention to the split ratio and present novel designs for variable split ratio. A device with high power capability in connection with low intermoduliation distortion is presented.

WE1G-01: **An Unequal Wilkinson Power Divider with Variable Dividing Ratio**
S. Oh, J. Koo, M. Hwang, C. Park, J. Lim, K. Choi, D. Ahn, Y. Jeong

WE1G-02: **A Broadband Traveling-wave Power Divider/Combiner using Asymmetric Tapered-line Power Dividers**
Y. Tahara, H. Oh-hashi, Y. Tarui, M. Miyazaki

WE1G-03: **Compact Multi-way Power Dividers Similar to the Bagley Polygon**
I. Sakagami, T. Wuren, M. Fujii, M. Tahara

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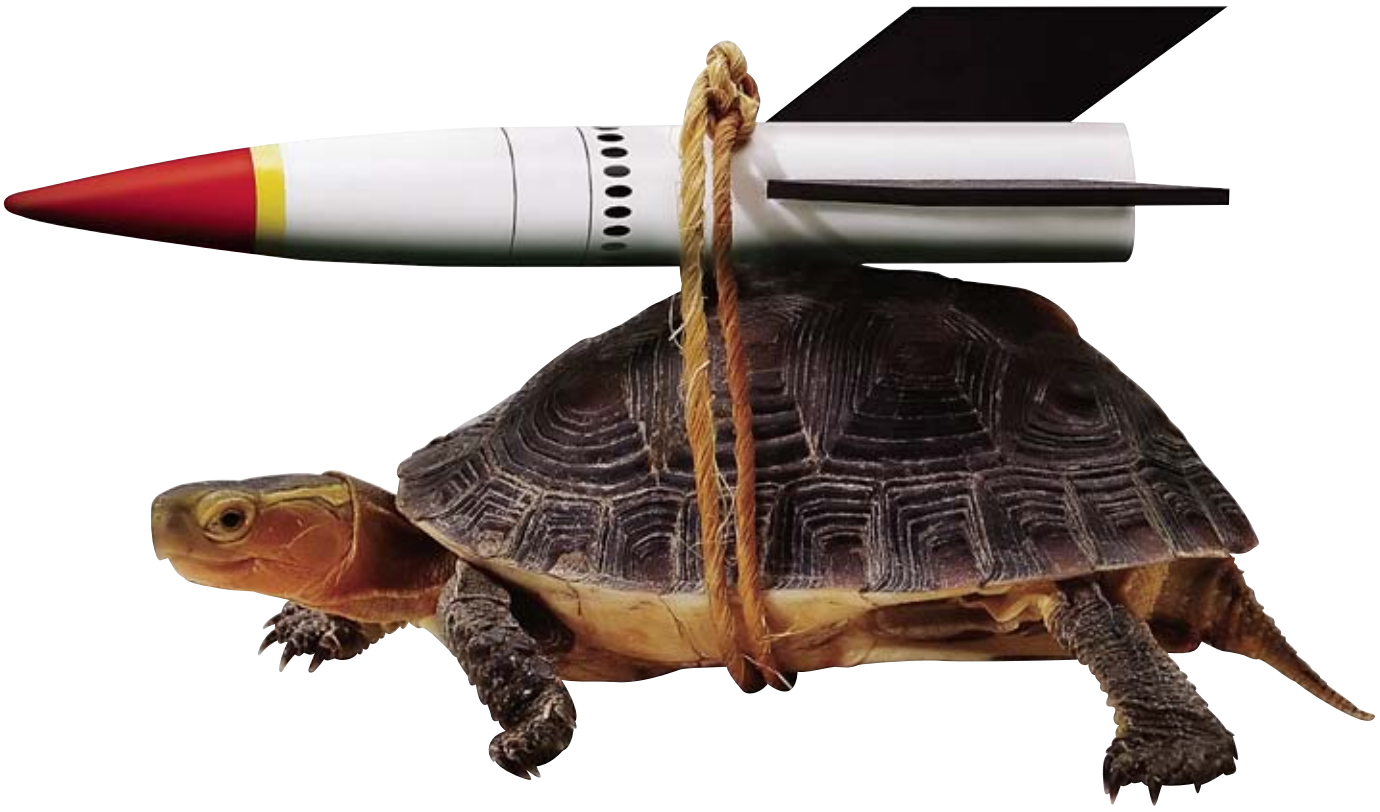

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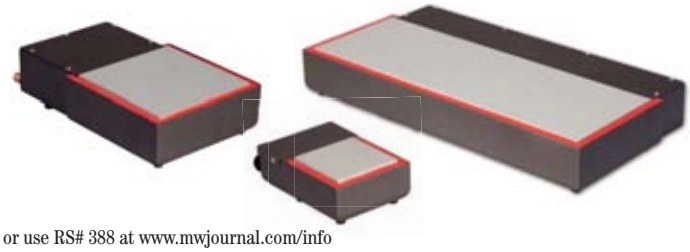

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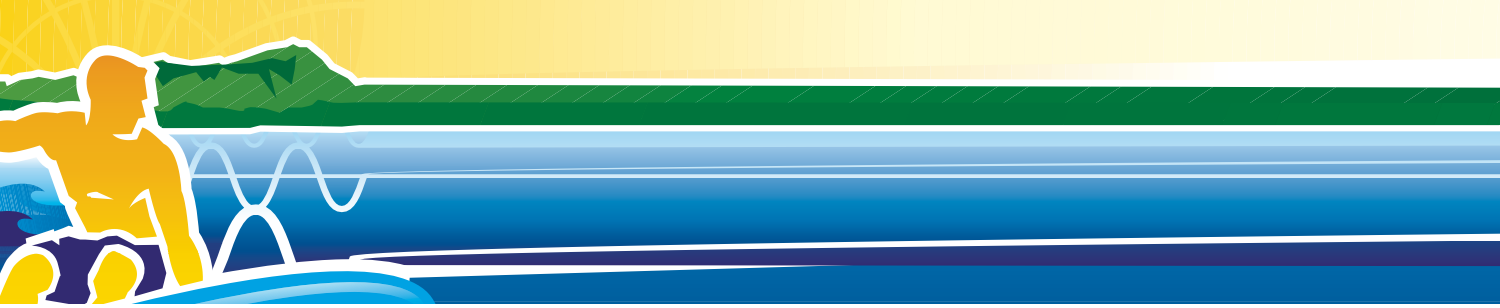

WE1G-04: **A Novel Compact Dual Band Reconfigurable Power Divider for Smart Antenna Systems**
R.V. Gatti, A. Ocera, S. Bastioli, L. Marcaccioli, R. Sorrentino

WE1G-05: **Synthesis of an Arbitrary Power Split Ratio Divider Using Substrate Integrated Waveguides**
S. Yang, A. Fathy

WE1G-06: **Universal Single-layer Waveguide Power Divider for Slot Array Antenna Applications**
D. Deslandes, F. Boone, K. Wu

WE1G-07: **Modeling and Implementation of a Novel Coaxial Line Multi-octave High Power Combiners with Low Intermodulation Distortion**
S. Lin, A.E. Fathy, G.M. Hegazi, T.T. Chu

10:00 AM TO 11:50 AM

WE2A LOW NOISE CMOS AND LOW POWER HEMT TECHNOLOGIES
Chair: T. Tokumitsu • Co-chair: Ho C. Huang

This session emphasizes low noise CMOS technology and low power AlSb/InAs HEMT. In addition, III-nitride and ferrite thin film deposition technologies are presented for possible applications as switch and MMIC inductor.

WE2A-01: **Edge-extended Design for Improved Flicker Noise Characteristics in 0.13 μm RF NMOS**
C. Chan, Y. Lin, Y. Huang, S. Hsu, Y. Juang

WE2A-02: **A Silicon RFCMOS SOI Technology for Integrated Cellular/WLAN RF TX Modules**
J. Costa, M. Carroll, J. Jorgenson, T. Mckay, T. Ivanov, T. Dinh, D. Kozuch, G. Remoundos, D. Kerr, A. Tombak, J. McMacken, M. Zybura

WE2A-03: **Low Loss Low Cost All Silicon CMOS NLTLs for Pulse Compression**
M. Li, R.E. Amaya, R.G. Harrison, G.N. Tarr, J. Duchamp, P. Ferrari

WE2A-04: **1.8 dB Insertion Loss 200 GHz CPW Band Pass Filter Integrated in HR SOI CMOS Technology**
F. Gianesello, D. Gloria, S. Montusclat, S. Boret, B. Martineau, R. Pilard, C. Raynaud, G. Dambrine, S. Lepilliet

WE2A-05: **High-power III-Nitride Integrated Microwave Switch with Capacitively-coupled Contacts**
G. Simin, Z. Yang

WE2A-06: **Manufacturable and Reliable 0.1 μm AlSb/InAs HEMT MMIC Technology for Ultra-low Power Applications**
Y. Chou, J. Yang, C. Lin, J. Lee, M. Lange, R. Tsai, N. Peter, N. Matt, A. Gutierrez, H. Quach, R. Lai, D. Farkas, M. Wojtowicz, P. Chin, M. Barsky, A. Oki

WE2A-07: **Ni-Zn Ferrite Film Coated on-Chip RF Inductor Fabricated by a Novel Powder-Mixed-Photoresist Coating Technique**
C. Yang, F. Liu, T. Ren, L. Liu, G. Chen, X. Guan, A.Z. Wang, Z. Yue

WE2B MODULES AND CHIPSETS FOR MM-WAVE COMMERCIAL APPLICATIONS
Chair: D. Choudhury • Co-chair: J. Wiltse

This session presents some of the recent developments on mm-wave applications, employing modules and chipsets for wireless links, phased arrays and automotive radar. The papers include 30–100 GHz technologies to implement different aspects of commercial applications.

Mission-Capable Microwave Assemblies

- Amplifiers
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- Phase Shifters
- Limiting Amplifiers
- Synthesizers
- Limiters
- Delay Lines
- Analog and Digital Circuits
- Switches
- Filters
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- Oscillators
- Hybrid Circuits
- Equalizers
- Couplers

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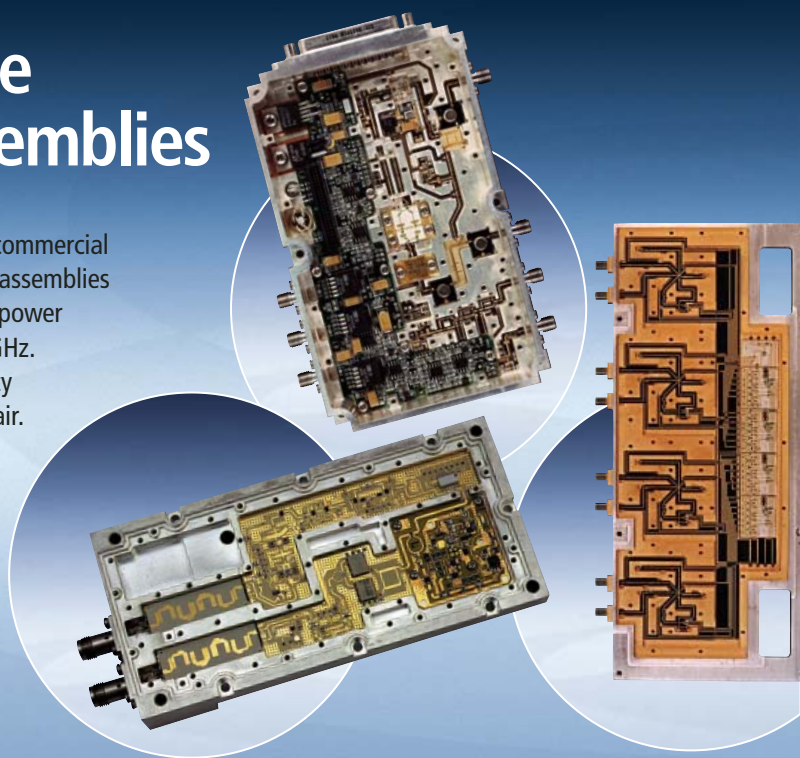

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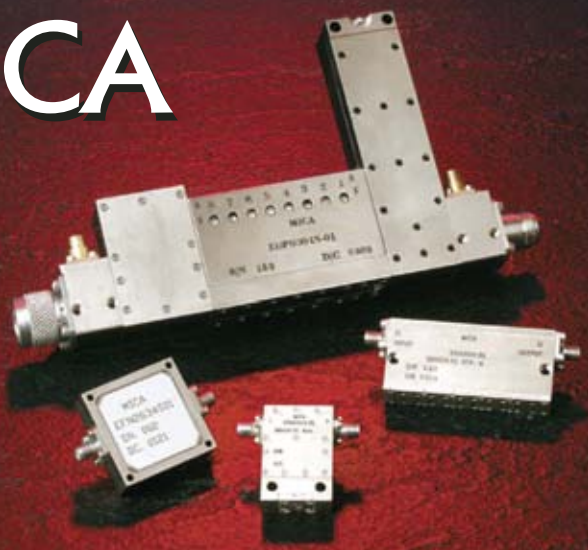
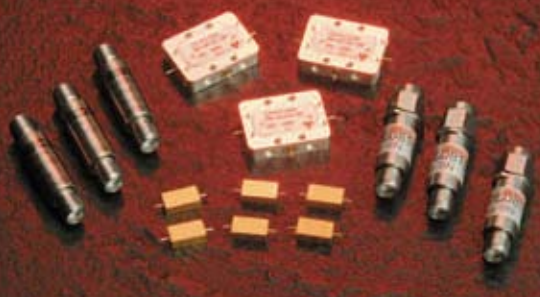


Equalizer Products

- Gain Equalizers – 0.5 to 26.5 GHz
- Linear Slope Positive/Negative
- Fine Grain Equalizers
- Harmonic Phase Shifters – 0.5 to 26.5 GHz
- Integrated Equalizer Assemblies



Detector & Limiter Products

- PIN Diode Limiters – 1.0 to 18.0 GHz
- Tunnel Diode Detectors – 0.5 to 18.0 GHz
- Schottky Diode Detectors – 0.5 to 18.0 GHz
- Zero-Bias Schottky Detectors – 0.5 to 18.0 GHz
- SMA Connectorized Coaxial Packages
- Hermetically Sealed Stripline & Microstrip

Mixer & Doubler Products

- Double Balanced Mixers – 2 to 26.5 GHz
- Frequency Doublers – 1.5 to 13 GHz
- Triple Balanced Mixers – 2 to 26.5 GHz
- Iso Mixers
- Hermetic Pin & Coaxial Packages
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- I.Q. Mixers – 2 to 18 GHz

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WE2B-01: **A 6 Gbps Millimetre-wave Wireless Link with 2.4 bit/Hz Spectral Efficiency**
V. Dyadyuk, O. Sevimli, J. Bunton, J. Pathikulangara, L. Stokes

WE2B-02: **A Single-Chip 25 pJ/bit Multi-Gigabit 60 GHz Receiver Module**
S. Sarkar, J. Laskar

WE2B-03: **Ka-band BiCMOS 4-bit Phase Shifter with Integrated LNA for Phased Array T/R Modules**
B. Min, G.M. Rebeiz

WE2B-04: **A 40 GHz MMIC SPDT Bandpass Filter Integrated Switch**
S. Chao, C. Kuo, Z. Tsai, H. Wang

WE2B-05: **A 2.5 V, 77 GHz Automotive Radar Chipset**
S.T. Nicolson, K.A. Tang, K.H. Yau, S.P. Voinigescu, P. Chevalier, B. Sautreuil

WE2C RF MEMS Tunable Circuits
Chair: Y. Kwon
Co-chair: T. Weller

This session presents recent advances in the tunable components using RF MEMS technology including programmable time delay, frequency-selective surface, reconfigurable power divider and tunable filters.

WE2C-01: **Fully Packaged 4 bit 100 ps RF MEMS Time Delay**
J.B. Muldavin, C.O. Bozler, S. Rabe, C. Keast

WE2C-02: **A MEMS-tunable Frequency-selective Surface Monolithically Integrated on a Flexible Substrate**
G.M. Coutts, R.R. Mansour, S.K. Chaudhuri

WE2C-03: **A MEMS-Reconfigurable Power Divider on High Resistivity Silicon Substrate**
A. Ocera, P. Farinelli, F. Cherubini, P. Mezzanotte, R. Sorrentino, B. Margesin, F. Giacomozzi

WE2C-04: **An Integrated Tunable Bandpass Filter Using MEMS Parallel-Plate Variable Capacitors Implemented with 0.35 micron CMOS Technology**
S. Fouladi, M. Bakri-Kassem, R. Mansour

WE2C-05: **Narrow-band Monolithic Piezoelectric-on-Substrate Filter Technology**
R. Abdolvand, F. Ayazi

WE2D Material Measurement
Chair: B. Szendrenyi
Co-chair: M. Janezic

This session focuses on innovative measurement techniques for the broadband characterization of material. Methods include conductivity measurement of copper-cladded laminates, broadband permittivity and permeability characterization of liquids, and non-destructive measurement of dielectric and magnetic substrates.

WE2D-01: **Measurements of the Surface Resistance and the Effective Conductivity of Copper Cladded Laminates Employing Dielectric Resonator Technique**
J. Krupka

WE2D-02: **A High Temperature Capable Planar-type Coaxial Probe for Complex Permittivity Measurements Up to 40 GHz**
N. Kim, J. Yoon, D. Kim, Y. Kwon, J. Cho, C. Cheon

WE2D-03: **Extracting the Broadband Permittivity of Liquids from Transmission Line Measurements with Microfluidic Channels**
J. Mateu, N. Orloff, M. Rinehart, J. Booth

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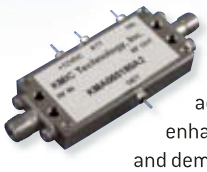

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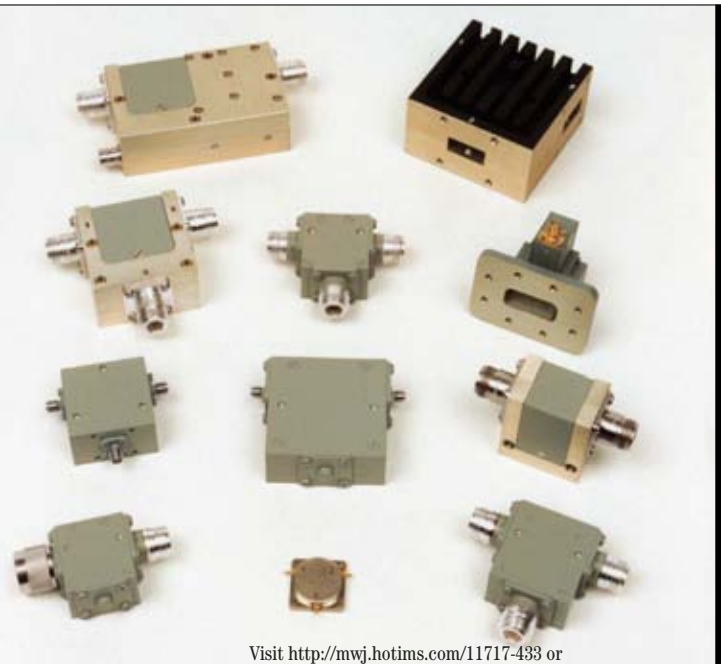

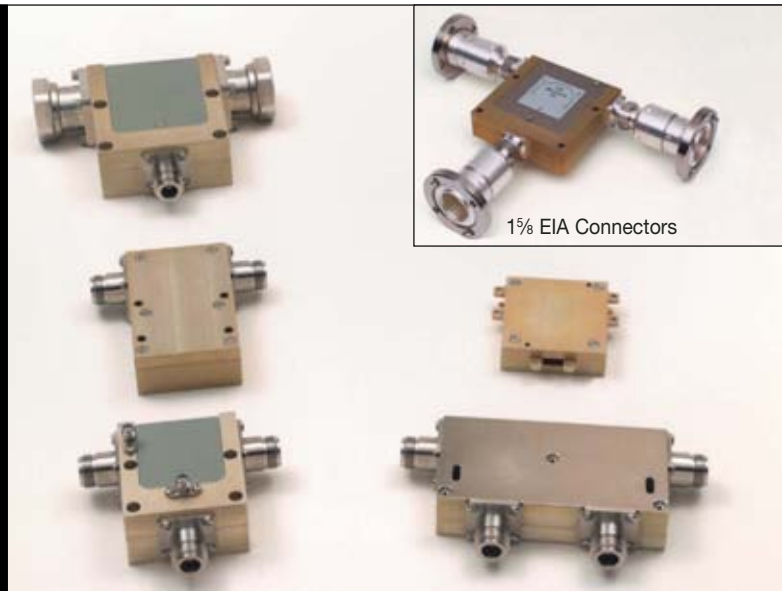

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WE2D-05: Measurement of Complex Permittivity and Permeability using Two Flanged Rectangular Waveguides
M.W. Hyde, M.J. Havrilla

WE2E Design and Synthesis of Planar Filters
Chair: C. Wang
Co-chair: K.A. Zaki

This session presents papers on design and synthesis of planar filters including dual mode, multilayer and corrugated type configurations.

WE2E-01: Exact Synthesis of Microwave Filters with Nonuniform Dissipation
A.C. Guyette, I.C. Hunter, R.D. Pollard

WE2E-02: TEM Mode-matching Analysis of Multi-coupled Strip-line Filters
J.A. Ruiz-Cruz, Y. Zhang, K.A. Zaki, J.M. Rebollar, J.R. Montejo-Garai, A.J. Piloto

WE2E-03: Non-reflective Transmission-line Filters for Gain Slope Equalization
M.A. Morgan, T.A. Boyd, T.L. Newton, R.H. Hayward

WE2E-04: Multilayer Quasi-elliptic Filters using Dual Mode Resonators on Liquid Crystal Polymer Technology
R. Bairavasubramanian, J. Papapolymerou

WE2E-05: Novel Corrugated Coupled Stages with Multi-harmonic Suppression and Its Application to Bandpass Filter Design
J. Kuo, U. Lok, M. Wu

WE2E-06: Two-bit Switchable Bandpass Filter for 0.3–0.6 GHz
M. Koochakzadeh, A. Abbaspour-Tamijani

WE2F Sensors and Sensor Systems
Chair: H. Kondoh
Co-chair: A. Jenkins

Wireless sensor networks generally consist of a large number of wirelessly connected, often geographically distributed nodes. The functionality of the nodes is driven by the system application and can vary from simple identification (RFID) to complex environmental monitoring. However, the core philosophy is to engineer a system that has cost a effective and generally energy efficient node structure and deploy the more complex functions within the information gathering component (often referred to as the reader in an RFID application). This session brings together a set of papers that address both the system level aspects of sensor nets as well as node architecture and design (at the IC level) for low power and long life operation.

WE2F-01: Millimeter-wave Imaging Sensor Nets: A Scalable 60 GHz Wireless Sensor Network
M. Seo, B. Ananthasubramaniam, M. Rodwell, U. Madhow

WE2F-02: Passive RF Receiver Design for Wireless Sensor Networks
P.V. Kolinko, L.E. Larson

WE2F-03: A 1 Mbps, 1.6 μA Micro-power Active-RFID CMOS LSI for the 300 MHz Frequency Band
K. Suzuki, M. Ugajin, M. Harada

WE2F-04: FMCW Based Readout System Accuracy Enhancement Techniques for Surface Acoustic Wave RFID sensors
G.A. Hofbauer

WE2F-05: Non-contact Measurement of Periodic Movements by a 22-40 GHz Radar Sensor Using Nonlinear Phase Modulation
C. Li, J. Lin

WE2G Nonlinear Transistor Modeling
Chair: M. Rudolph • Co-chair: R. Mallavarpu

This session has seven transistor modeling papers covering the following devices: PHEMTS, GaN HFET, MOSFET and GaAs HBT.

WE2G-01: DC and Large Signal Microwave MOSFET Model Applicable to Partially-depleted, Body-contacted SOI Technology
D.R. Burke, T.J. Brazil, M. El Kaamouchi, D. Vanoenacker-Janvier

WE2G-02: A New Nonlinear HEMT Model Allowing Accurate Simulation of Very Low IM3 Levels for High Frequency Highly Linear Amplifiers Design
J. Lhortolary, C. Chang, M. Camiade, J. Obregon, T. Reveyrand, M. Campovecchio

WE2G-03: Large Signal FET Modeling based on Pulsed Measurements
R.G. Brady, G. Rafael-Valdivia, T.J. Brazil

WE2G-04: RF Linearity and Nonlinear Source Resistance in AlGaN/GaN HFETs
Y. Liu, R.J. Trew, G. Bilbro

WE2G-05: A Drain-lag Model for AlGaN/GaN Power HEMTs
O. Jardel, F. De Groote, T. Reveyrand, J. Teyssier, R. Quere, C. Charbonniaud, D. Floriot

WE2G-06: Virtual Gate Large Signal Model of GaN HFETs
A.M. Conway, P.M. Asbeck

WE2G-07: Modeling and Characterization of Sub-nanosecond Impulse Response of High Voltage Heterojunction Bipolar Transistors
S. Halder, R. Jin, J.C. Hwang

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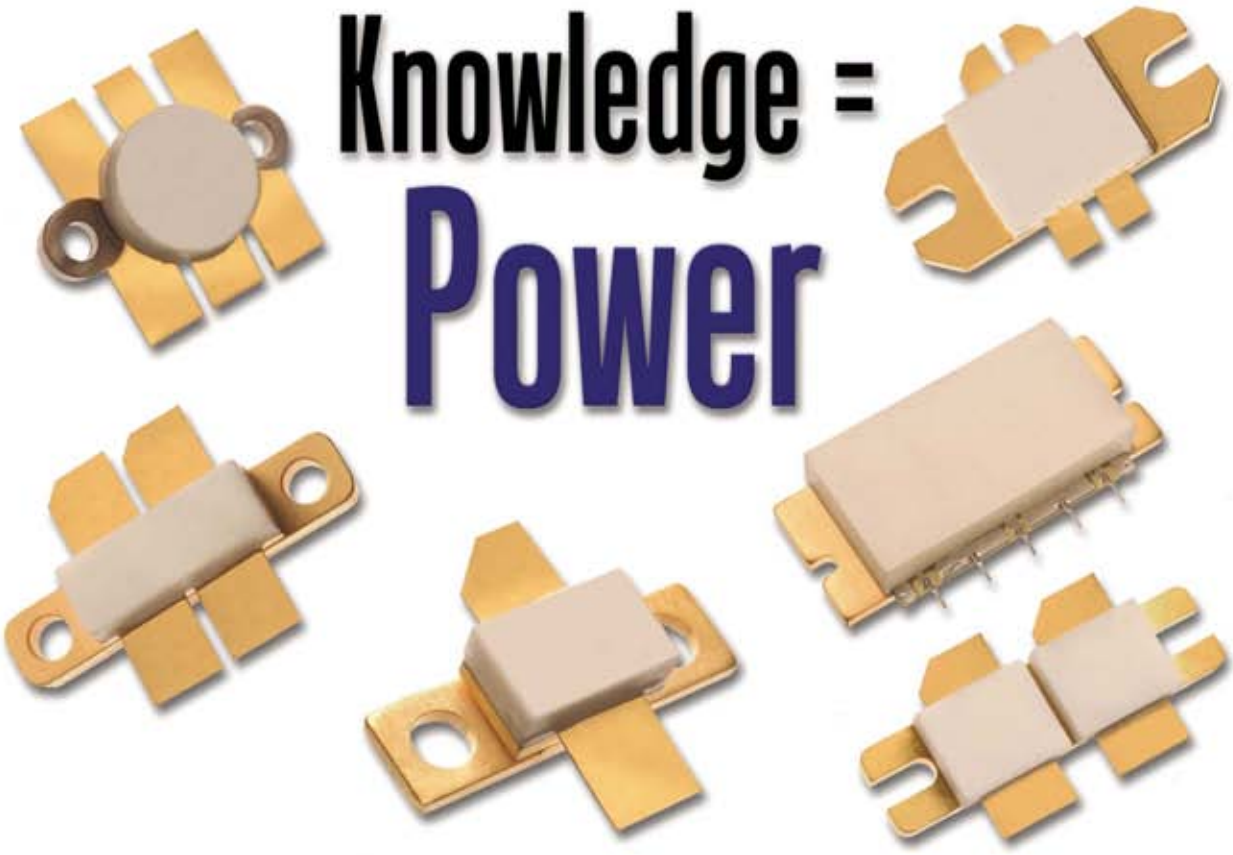

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1:20 PM TO 3:00 PM

WE3A ADVANCES IN GAN TECHNOLOGY

Focused Session

Chair: A. Platzker
Co-chair: J.L. Heaton

This focused session highlights advances in GaN MMIC power and low noise performance and maturation of the technology to enable multiple commercial applications. New broadband power and efficiency benchmarks are reported for designs in NDPA distributive technology. Wideband sub-dB noise figure has been achieved in a broad band L-C band amplifier with 2 W output power, and over 50% PA efficiency is reported at 35 GHz. Devices packaged in commercial plastic packaging have achieved 18 W output at 3.5 GHz. GaN device reliability improvement is addressed through reduction in early current drop degradation.

WE3A-01: Wideband, High Efficiency GaN Power Amplifiers Utilizing a Non-uniform Distributed Topology
J. Gassmann, P. Watson, L. Kehias, G. Henry

WE3A-02: A 2 W, Sub-dB Noise Figure GaN MMIC LNA-PA Amplifier with Multi-octave Bandwidth from 0.2–8 GHz
K.W. Kobayashi, Y. Chen, I. Smorchkova, R. Tsai, M. Wojtowicz, A. Oki

WE3A-03: Deep Recessed GaN HEMTs using Selective Etch Technology Exhibiting High Microwave Performance Without Surface Passivation
L. Shen, Y. Pei, L. McCarthy, C. Poblenz, A. Corrion, N. Fichtenbaum, S. Keller, S.P. Denbaars, J.S. Speck, U.K. Mishra

WE3A-04: AlGaN/GaN HEMTs with PAE of 53% at 35 GHz for HPA and Multi-function MMIC Applications
M. Kao, C. Lee, R. Hajji, P. Saunier, H. Tserng

WE3A-05: Multi Watt Wideband MMICs in GaN and GaAs
D.E. Meharry, R.J. Lender, K. Chu, L.L. Gunter, K.E. Beech

WE3A-06: A Comparison of AlGaN/GaN HFETs on Si Substrates in Ceramic Air Cavity and Plastic Overmold Packages
R.J. Therrien, A. Chaudhari, S. Singhal, C. Snow, A. Edwards, C. Park, W. Nagy, J.W. Johnson, A.W. Hanson, K.J. Linthicum, I.C. Kizilyalli

WE3A-07: Degradation-mode Analysis for Highly Reliable GaN-HEMT
Y. Inoue, S. Masuda, M. Kanamura, T. Ohki, K. Makiyama, N. Okamoto, K. Imanishi, H. Shigematsu, T. Kikkawa, N. Hara, K. Joshin

WE3B ADVANCES IN MICROWAVE AND MM-WAVE VCOS

Chair: S. Wetenkamp
Co-chair: P. Shastry

With the ever-increasing demand for bandwidth, the pressure to move to higher frequencies is pushing VCO performance to new limits. This session presents VCOs from X-band to 120 GHz employing a variety of semiconductor technologies and techniques and should be of major interest for designers.

WE3B-01: A Fundamental VCO with Integrated Output Buffer Beyond 120 GHz in SiGe Bipolar Technology
S. Trotta, H. Knapp, K. Aufinger, T.F. Meister, J. Bock, W. Simbuerger, A.L. Scholtz

WE3B-02: Fundamental W-band InP DHBT-based VCOs With Low Phase Noise and Wide Tuning Range
R.E. Makon, R. Driad, K. Schneider, R. Aidam, M. Schlechtweg, G. Weimann

WE3B-03: A PLL-Stabilized W-band MHEMT Push-Push VCO with Integrated Frequency Divider Circuit
R. Weber, M. Kuri, M. Lang, A. Tessmann, M. Seelmann-Eggebert, A. Leuther

WE3B-04: A 26 GHz Integrated Differential DRO Implemented Using SiGe-HBT Technology
K.W. Hamed, A.P. Freundorfer, Y.M. Antar

WE3B-05: An X-band Low Noise InP HBT VCO with Separate Varactor Layers
T. Magrisso, D. Elad, N. Buadana, S. Kraus, D. Cohen Elias, A. Gavrilov, S. Cohen, D. Ritter

WE3C FERRITE AND FERROELECTRIC COMPONENTS

Chair: M. Steer
Co-chair: D. Adam

Ferrite and ferroelectric components are essential elements of adaptive, tunable multifunctional systems. The first four papers describe subsystems using ferroelectric devices and the fifth describes their nonlinear modeling. The second set of five papers describe components based on magnetic effects including novel isolator and packaging concept. Two papers describe the use of magnetic devices in high power applications including a 500 kW phase shifter. The last paper describes numerical modeling of a circulator using magnetic nanowires.

WE3C-01: Compact Analog Phase Shifters using Thin-Film (Ba,Sr) TiO_3 Varactors
L. Chen, R. Forse, T.C. Watson, R.A. York

WE3C-02: A DC Voltage Dependent Switchable Thin Film Bulk Wave Acoustic Resonator Using Ferroelectric Thin Film
X. Zhu, J.D. Phillips, A. Mortazawi

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WE3C-03: **Frequency Agile 90° Hybrid Coupler Using Barium Strontium Titanate Varactors**
E.A. Fardin, A.S. Holland, K. Ghorbani

WE3C-04: **Tunable IF Filter using Thin-Film BST Varactors**
G. Sanderson, T.C. Watson, D. Chase, M. Roy, J.M. Paricka, R.A. York

WE3C-05: **Experimental Characterization of the Third Order Nonlinearities in Thin Film Parallel-plate Ferroelectric Varactors**
A. Deleniv, P. Rundqvist, A. Vorobiev, E. Kollberg, S. Gevorgian

WE3C-06: **6–18 GHz Edge Mode Isolator**
J.D. Adam, S.N. Stitzer, S. Gaglione

WE3C-07: **Microwave and Magnetostatic Characterization of Ferrite LTCC for Tunable and Reconfigurable SiP Applications**
A. Shamim, L. Roy, N. Hojjat, J. Bray, R.A. Elasoued, D. Baillargeat

WE3C-08: **A High Power Single-bridge SP4T Waveguide Reciprocal Ferrite Switch**
C.R. Boyd, Jr.

WE3C-09: **Development of High Power Fast RF Vector Modulator with TEM Ferrite Phase Shifters**
Y.W. Kang, J.L. Wilson, T.W. Hardek, A.V. Vassioutchenko

WE3C-10: **Numerical Modeling of Unbiased Microstrip Circulators Based on Magnetic Nanowired Substrate: Use of a Ferrite-equivalent Model**
J. Allaeys, J. Mage

WE3D Accuracy Evaluation and Enhancement in TD EM Modeling

Chair: Z.D. Chen • Co-chair: M. Tentzeris

This session deals with new approaches in time domain modeling. It introduces new ideas about radial absorbers, non-uniform meshing for higher order FDTD, a Lagrangian approach for curved boundary handling, a Z-transform technique for conformal FDTD modeling, FDTD dispersion in gyrotropic media, and performance analysis of ADI-FDTD including lumped models.

WE3D-01: **Radial Absorbers for Conformal Time-Domain Methods: A Solution to Corner Problems in Mesh Truncation**
K. Sankaran, C. Fumeaux, R. Vahldieck

WE3D-02: **A Non-uniform Mesh High-order Finite-difference Time Domain Method based on Biorthogonal Interpolating Functions**
C.D. Sarris

WE3D-03: **A Lagrangian Approach for the Handling of Curved Boundaries in the Finite-difference Time Domain Method**
J.A. Russer, P.S. Sumant, A.C. Cangellaris

WE3D-04: **A High Resolution Z-transform Tensor Formulation of the FDTD Method**
D.M. Sullivan, J. Nadobny

WE3D-05: **Numerical Stability Analysis of FDTD Algorithms in Gyrotropic**
M. Celuch, A. Moryc, W.K. Gwarek

WE3D-06: **Numerical Dispersion of the ADI-FDTD Technique Including Lumped Models**
Z. Chen, Q. Chu

WE3E Wideband Planar Filters

Chair: S. Kanamaluru
Co-chair: R. Sorrentino

This session focuses on wideband planar filters, the wide bandwidth achieved using SIR, Hybrid, Rat-Race and Ring resonator structures. Applications include UWB and MMW.

WE3E-01: **A Wideband CPS Bandpass Filter with Ultra-wide Upper Stopband Using Stepped-impedance Rat-race Hybrid Couplers**
C. Chi, C. Chang

WE3E-02: **Wideband Microwave Bandpass Filters with Hybrid Rings**
R. Gomez-Garcia

WE3E-03: **A Novel Millimeter-wave Ultra-wideband Bandpass Filter Using Microstrip Dual Mode Ring Resonators Loaded with Open Tuning Stubs of Different Lengths**
Z. Ma, Y. Kobayashi, P. Cai, X. Guan, T. Anada, G. Hagiwara

WE3E-04: **Folded Compact Ultra-wideband Stepped-impedance Resonator Filters**
M. Mokhtaari, J. Bornemann, S. Amari

WE3E-05: **A Novel Compact Ultra-wideband Bandpass Filter Using a Microstrip Stepped-impedance Four-modes Resonator**
P. Cai, X. Guan, Z. Ma, Y. Kobayashi, T. Anada, G. Hagiwara

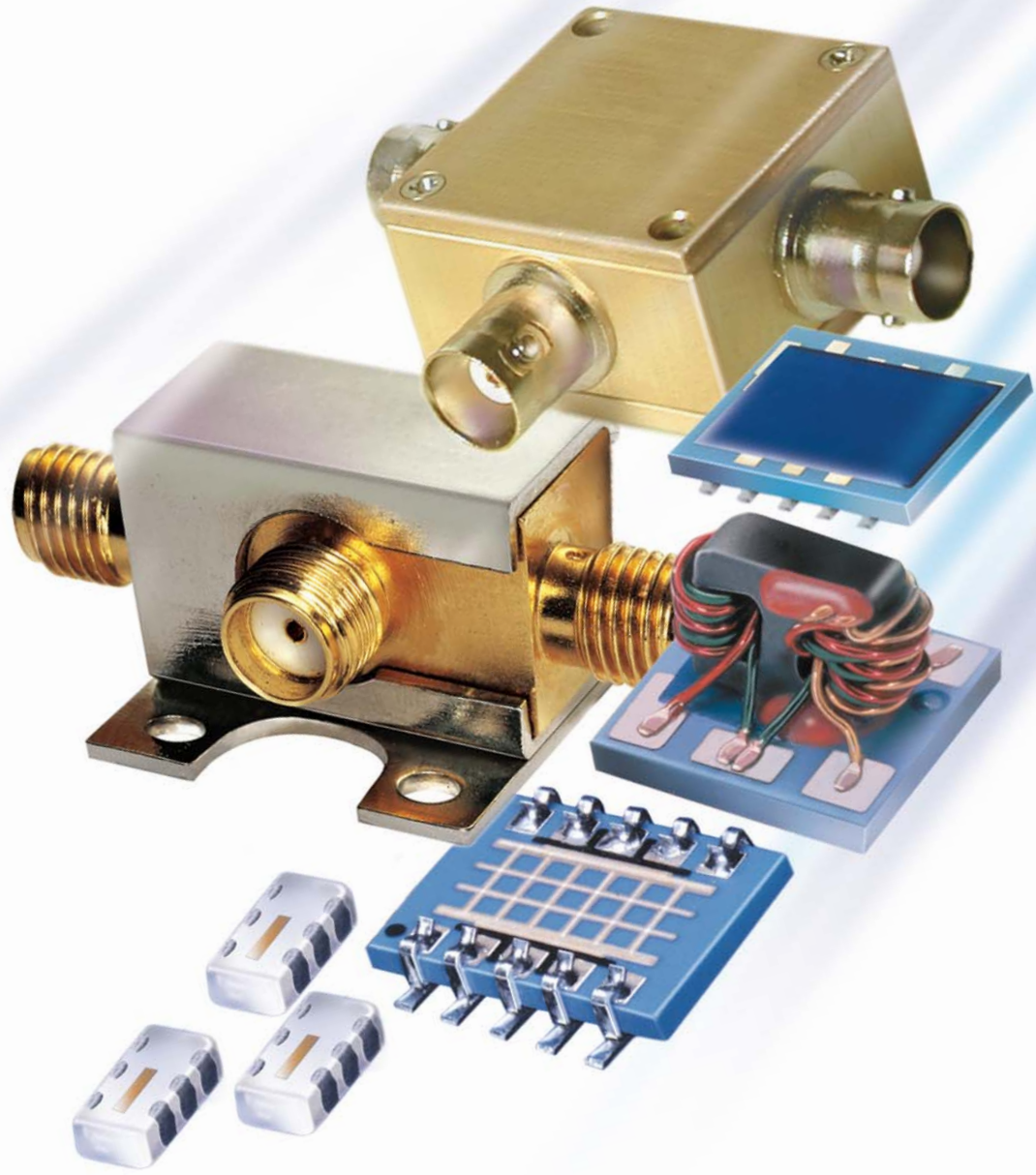
WE3E-06: **Broadband and Compact Double Stepped-impedance CPS Filters with Coupled-resonance Enhanced Selectivity**
N. Yang, C. Christophe, K. Wu, Z. Chen

WE3F Microwaves in Support of Societal Security

Focused Session

Chair: E. Niehenke
Co-chair: K. Breuer/B. Spielman

Microwaves play a key role in support of societal security. The frequency range used extends from the MHz region to 100 GHz for various communication and detection systems. Threat detection, counter threat techniques, and first response technology to man made as well as natural disasters will be considered. This session will present detection technology that is under development to



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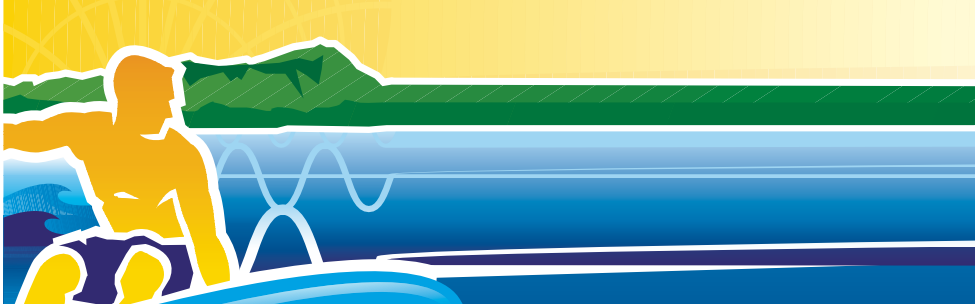

protect societies against threats as experienced by multiple nations from terrorists. Passive imaging, radar, and ultra wide band sensors will be presented that have a variety of applications of great use to make life safer and provide a key advantage under low-visibility conditions.

WE3F-01: Advances in Security Technologies: Imaging, Anomaly Detection and Target and Biometric Recognition
J.A. O'Sullivan, R. Pless

WE3F-02: Radar Based Concealed Threat Detector
J. Hausner, N.M. West

WE3F-03: Through-the-wall Radar Life Detection and Monitoring
V.M. Lubecke, O. Boric-Lubecke, A. Host-Madsen, A. Fathy

WE3F-04: Imaging Through the Atmosphere at Terahertz Frequencies
M.J. Rosker, H.B. Wallace

WE3F-05: Retrodirective Radar for Small Projectile Detection
E.R. Brown, E.B. Brown, R.F. Sinclair

WE3G Linear Device Modeling
Chair: W. Struble
Co-chair: P. Aaen

This session contains five papers, starting with an improved approach for modeling of GaAs PHEMTs. This is followed by three papers on GaN HFET modeling, including physics based, circuit based and an application to Class D PA design. The session closes with paper showing a novel surrogate modeling methodology.

WE3G-01: Robust Extraction of Access Elements for Broadband Small Signal FET Models
A.E. Parker, S.J. Mahon

WE3G-02: A New Physics-based Compact Model for AlGaN/GaN HFETs
H. Yin, G.L. Bilbro, R.J. Trew

WE3G-03: A New and Better Method for Extracting the Parasitic Elements of On-wafer GaN Transistors
A Zarate-de Landa, J.E. Zuniga-Juarez, J.A. Reynoso-Hernadez, M.C. Maya-Sanchez, E.L. Piner, K.J. Linthicum

WE3G-05: Microwave Device Modeling Using Space-mapping and Radial Basis Functions
S. Koziel, J.W. Bandler

3:30 PM to 5:00 PM

WE4A X-band and Millimeter-wave Devices and Power Amplifiers
Chair: A.V. Pham
Co-chair: E.D. Cohen

This session includes papers on devices and amplifiers operating from X- to Ka-band. The first paper describes a compact InP power amplifier which makes use of BCB layers to minimize transmission line dimensions which achieving low loss. The second paper describes a 20 GHz InP HBT monolithic power amplifier which provides both high efficiency and linearity. Next, two X-band amplifiers are presented, one fabricated from GaInP and the other from SiGe. The fifth paper in this session presents a new GaAs PHEMT structure which affords both high power density at Ka-band and high breakdown voltage. Next, a highly linear 17 to 27 GHz GaAs PHEMT amplifier with on-chip ESD protection is discussed. The final paper covers 2 and 4 W Ka-band power amplifiers, housed in low cost SMT packages.

WE4A-01: Compact InP HBT Power Amplifiers using Integrated Thick BCB Dielectrics
J.B. Hacker, W. Ha, C. Hillman, M. Urteaga, R. Pierson, B. Brar

WE4A-02: A High Efficiency and High Linearity 20 GHz InP HBT Monolithic Power Amplifier for Phased Array Applications
M.V. Aust, A.K. Sharma, A.T. Chau, A.L. Gutierrez-Aitken

WE4A-03: A Robust 11 W High Efficiency X-band GaInP HBT Amplifier
A. Couturier, S. Heckmann, V. Serru, T. Huet, P. Chaumas, J. Fontecave, M. Camiade, J. Viaud, S. Piotrowicz

WE4A-04: A High Gain, Two Stage, X-band SiGe Power Amplifier
J.M. Andrews, J.D. Cressler, M. Mitchell

WE4A-05: A High Power and High Breakdown Voltage Millimeter-wave GaAs PHEMT with Low Nonlinear Drain Resistance
H. Amasuga, A. Inoue, S. Goto, T. Kunii, Y. Yamamoto, T. Oku, T. Ishikawa

WE4A-06: A K-band Low Cost Plastic Packaged High Linearity Power Amplifier with Integrated ESD Protection for Multi-band Telecom Applications
B. Lefebvre, D. Bouw, J. Lhortolary, C. Chang, S. Tranchant, M. Camiade

WE4A-07: Ka-band 2 W and 4 W MMIC Power Amplifier In 7 ×7 mm Low-cost SMT Package
K. Fujii, H. Morkner

WE4B Novel Signal Generation Techniques and Applications
Chair: K. Nishikawa
Co-chair: J. Kuno

This session presents novel design techniques and applications in the RF and microwave areas. It covers UWB, CMOS QVCOs, phase control as well as a new transmitter for medical applications.

WE4B-01: Novel Phase Difference Control Between Output Signals using Fractional-N PLL Synthesizers by Cyclic Shift of Control Data
K. Tajima, R. Hayashi

WE4B-02: UWB Pulse Oscillator at 24 GHz with 2.1 GHz Bandwidth for Industrial Radar Sensor Applications
T. Wuchenauer, M. Nalezinski, W. Menzel

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WE4B-03: **New Frequency Plan and Reconfigurable 6.6/7.128 GHz CMOS Quadrature VCO for MB-OFDM UWB Application**
T. Huang, J. Wang

WE4B-04: **A 1.1 V Low Phase Noise CMOS Quadrature LC VCO with 4-way Center-tapped Inductor**
P. Upadhyaya, D. Heo, D.M. Rector, Y.E. Chen

WE4B-05: **A Low Phase Noise 9 GHz CMOS Quadrature-VCO using Novel Source-follower Coupling Technique**
H. Chen, S. Lu, D. Chang, Y. Juang

WE4B-06: **Low Power OOK Transmitter for Wireless Capsule Endoscope**
J. Ryu, S. Nam, J. Lee, M. Kim, B. Kim, M. Lee

WE4C SAW and FBAR RF Filters and Modules
Chair: R. Weigel • Co-chair: C. Ruppel

High-performance SAW duplexers, their integration into LTCC RF front-end modules, and the design of low-loss RF SAW filters are reported. Then, the session presents innovative FBAR devices fabricated using $LiNbO_3$ and $LiTaO_3$ layers as well as micromachined GaN membranes.

WE4C-01: **High Performance Single-Balanced Duplexer**
P. Girard, M. Solal

WE4C-02: **Characterization of SAW Duplexer Inserts for LTCC RF Front-end Modules by Simulation and Measurement**
R.D. Koch, R. Weigel, F.M. Pitschi, J.E. Kiwitt

WE4C-03: **Low Loss, Narrowband SAW Filters on Leaky Substrates**
J. Meltaus, O. Holmgren, K. Kokkonen, S. Hong, V.P. Plessky

WE4C-04: **Single Crystal FBAR with $LiNbO_3$ and $LiTaO_3$ Piezoelectric Substance Layers**
Y. Osugi, T. Yoshino, K. Suzuki, T. Hirai

WE4C-05: **Microwave FBAR Structures Fabricated using Micromachined GaN Membranes**
D. Neculoiu, A. Muller, D. Vasilache, G. Konstantinidis, A. Kosopoulos, K. Mutamba, C. Sydlo, H.L. Hartnagel, L. Bary, R. Plana

WE4D Problems of Scale and Hybrid Modeling in Time Domain Electromagnetics
Chair: M. Celuch • Co-chair: A. Elsherbeni

New ways of improving the FDTD simulation efficiency of large scale and resonant problems. The techniques of Laguerre FDTD, multiregion FDTD, dual grid FDTD and spectral expansion are considered. Additionally, a hybrid EM charge transport solution is presented as well as advancements in adjoint sensitivity extraction.

WE4D-01: **A New Multiresolution FDTD Approach Based on the Hybridization of MR-FDTD and DG-FDTD Methods**
R. Pascaud, R. Gillard, R. Loison, J. Wiart, M. Wong

WE4D-02: **FDTD Modeling of Finite Electromagnetic Source over Periodic Structure via a Spectral Expansion Approach**
R. Qiang, J. Chen, F. Yang

WE4D-03: **Overcoming Limitations of Laguerre-FDTD for Fast Time-domain EM Simulation**
K. Srinivasan, M. Swaminathan, E. Engin

WE4D-04: **Central-node Approach for Accurate Self-adjoint Sensitivity Analysis of Dielectric Structures**
Y. Song, N.K. Nikolova

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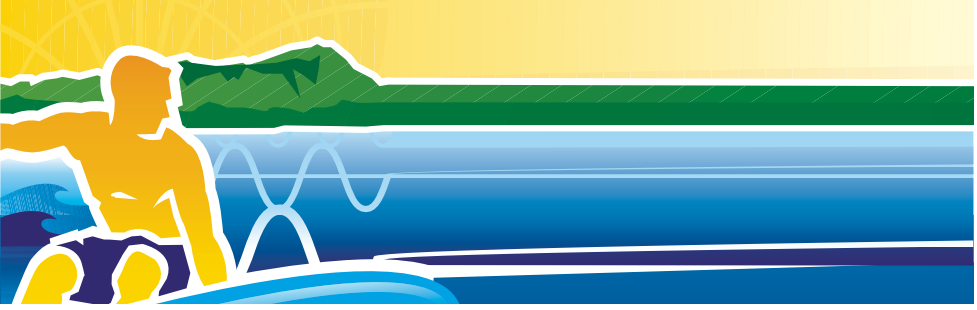

WE4D-05: 2D Particle-in-Cell Simulation on Rising-Sun Magnetron
N. Faure, P. Leveque

WE4E Planar Dual-mode and Dual Band-pass Filters
Chair: R. Chen • Co-chair: T. Nishikawa

Multi-frequency bands are used in modern global communication systems. Compact planar dual-band/dual-mode filters using microstrip, coplanar waveguide and suspended strip-lines are discussed.

WE4E-01: Compact Dual-band Bandpass Filters Using Dual-mode Resonators
A. Gorur, C. Karpuz

WE4E-02: Analytical Synthesis Algorithm of Dual-band Filters with Asymmetric Pass Bands and Generalized Topology
A. Garcia-Lamperez

WE4E-03: Multi-bandpass Filters Using Multi-armed Open Loop Resonators with Direct Feed
M.H. Awida, A.M. Safwat, H. El-Hennawy, A. Boutejdar, A.S. Omar

WE4E-04: A Novel Broadband Suspended Substrate Stripline Filter using Resonators with T-shaped Open-circuited Stubs
J.S. Kim, N.S. Kim, W.G. Moon

WE4E-05: A Novel Compact Dual-mode Filter Using Cross-slotted Patch Resonator for Dual-band Applications
W. Min-Hang, W. Sean, J. Shih-Bin, L. Maw-Shung, C. Yu-Chi

WE4E-06: A Compact Size and High Isolation Dual-band Coplanar-waveguide Bandpass Filter
H. Cheng-Yuan, Y. Ru-Yuan, S. Yan-Kuin, Y. Chang-Sin, H. Chun-Yueh, W. Min-Hang

WE4F Advances in Microwave Systems for Deep Space Missions
Focused Session
Chair: C.C. DeBoy
Co-chair: T. Pham

Current and planned deep-space missions depend on advanced techniques in microwave/RF design to accomplish demanding science and telecommunications requirements. This session focuses on advances in microwave systems and technologies in recently launched missions, including the New Horizons Mission to Pluto and the MESSENGER mission to Mercury, on planned improvements to NASA's Deep Space Network, and on the technologies that future missions to the Moon, to Mars, and beyond are depending on to achieve their goal.

WE4F-01: Engineering the Next Generation Deep Space Network
B.J. Geldzahler, J.J. Rush, L.J. Deutsch, J.I. Statman

WE4F-02: Microwave Technologies for the New Horizons Mission to Pluto
C.B. Haskins, C.C. DeBoy

WE4F-03: Advances in Microwave/RF Design for the MESSENGER Mission to Mercury
R.E. Wallis, S. Cheng, P.M. Malouf, R.K. Stilwell

WE4F-04: Polarization Combining in the DSN—Recent Results
T.T. Pham, C.C. DeBoy

WE4F-05: Advanced RF Systems for ESA Deep Space Missions
P. Schmitz, M. Lanucara, R. Madde

WE4G Nonlinear Circuit Analysis and System Simulation
Chair: S. Maas • Co-chair: K. Gard

This session explores the latest developments in the field of nonlinear circuit analysis and system simulation, which is of increasing importance in emerging high-capacity microwave communication systems. The papers presented describe behavioral modeling and nonlinear CAD techniques.

WE4G-01: Fast Nonlinear Analysis of Reconfigurable Microwave Systems by a Behavioral Model of MEMS Switches
V. Rizzoli, D. Masotti, F. Mastri

WE4G-02: Nonlinear Distortion Analysis of Polar Transmitters
J.C. Pedro, P.M. Cabral, J.A. Garcia

WE4G-03: The Impact of Long Term Memory Effects in Wireless QPSK Modulated Signals
R.E. Santos, N.B. Carvalho, K.G. Gard

WE4G-04: Distortion Evaluation of RF Power Amplifiers Using Dynamic Deviation Reduction Based Volterra Series
A. Zhu, J.C. Pedro

WE4G-05: Multi-tone, Multi-port and Dynamic Memory Enhancements to PHD Nonlinear Behavioral Models from Large-signal Measurements and Simulations
J. Verspecht, Jan Verspecht, D. Gunyan, J.M. Horn, J. Xu, A. Cognata, D.E. Root

WE4G-06: Semi-analytical Formulation for the Stability Analysis of Coexisting Solutions in Coupled-Oscillator Systems
A. Collado, A. Suarez, S. Sancho

2:00 PM to 4:00 PM

WEP1 WEDNESDAY INTERACTIVE FORUM I
Chair: E. Bryerton • Co-chair: S. Barker

WEP1A Transmission Line Elements

WEP1A-01: Dark and Bright Solutions in Left-handed Nonlinear Transmission Line Metamaterials
S. Gupta, C. Caloz

WEP1A-02: Characterizing and Modeling Conductor-backed CPW Periodic Band Stop Filter with Miniaturized Size
K. Chan, S. Xiao, J. Ma, K. Ma, K. Yeo, M. Do

WEP1B Passive Circuit Elements

WEP1B-01: Compact Size Directional Coupler for Mobile RFID Reader
J. Jung, K. Nae, J.P. Thakur, H. Oh, Y. Seong, J. Park

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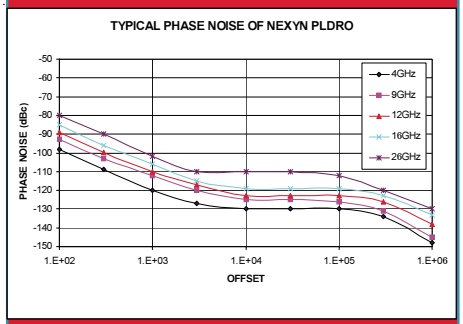

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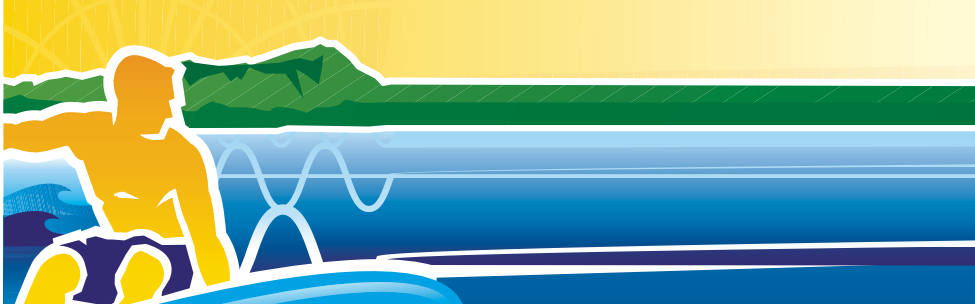

WEP1B-02: HTS Microstrip Hybrid Couplers for Radio Astronomy C-band Receivers
G. Zhang, M.J. Lancaster, N. Roddis

WEP1B-03: Realization of Ultra-compact Planar Microstrip Branch-line Couplers with High Impedance Open Stubs
C. Tang, M. Chen, J. Wu

WEP1B-04: Design of a Compact Microwave Six-port Vector Voltmeter for UWB Applications
M.E. Bialkowski, A.M. Abbosh, J. Swayn

WEP1B-05: A Parallel-crossed H-plane Waveguide Eight-port Hybrid and Its Application to a Planar Magic Tee
K. Toda, I. Ohta, M. Kishihara

WEP1B-06: Miniaturized Ultra-wideband Self-complementary Antennas Using High Permittivity Thick Resin Material
A. Saitou, C. Quan, K. Watanabe, K. Aoki, K. Honjo

WEP1B-07: A Six Port Receiver's Analog Front-end of Reduced Size Based on a Multilayer Layout
A. Koelpin, S. Winter, R. Weigel

WEP1B-08: LTCC Broadside Coupler Design with Branch Lines for Enhanced Performances
Y. Noh, M. Uhm, I. Yom

WEP1B-09: Novel Reconfigurable Isolator
T. Furuta, A. Fukuda, H. Okazaki, S. Narahashi

WEP1B-10: Compacted Ka-band CMOS Rat-Race Hybrid Using Synthesized Transmission Lines
S. Wang, C.C. Tzuang

WEP1B-11: Flexible RF Switch-PIN Diodes using Single-Crystal Si-Nanomembranes
H. Yuan, Z. Ma, G.K. Celler

WEP1B-12: A Fully Micromachined W-band Coplanar Waveguide to Rectangular Waveguide Transition
Y. Li, B. Pan, M.M. Tentzeris, J. Papapolymerou

WEP1C Active and Integrated Filters

WEP1C-01: Piezoelectric Transducer-Controlled Reconfigurable Dual-Mode Switchable Bandpass Filter
W. Tu, S. Hsu, K. Chang

WEP1C-02: LTCC Multi-layer Coupled Strip-Resonator Filters
Y. Zhang, K.A. Zaki

WEP1C-03: Nonlinear Matched Reflection Mode Bandstop Filters for Frequency Selective Limiting Applications
P. Phudpong, I.C. Hunter

WEP1D HF/VHF/UHF Technologies and Applications

WEP1D-01: Low-pass Active Filter Enabling DVB-H/T and GSM Standard Coexistence
D. Lo Hine Tong, R. Lababidi, F. Baron, A. Louzir

WEP1D-02: Adjacent Channel Power Contributions of Silicon MOSFET Switches in RF and Microwave Systems
R.H. Caverly

WEP1D-03: High Frequency Power Amplifiers Without Ground
R.L. Campbell

WEP1D-04: 0.25 micron CMOS Dual Feedback Wideband UHF Low Noise Amplifier
I.I. Lo, O. Boric-Lubecke, V. Lubecke

WEP1E Power-Amplifier Devices and Integrated Circuits

WEP1E-01: High Gain, High Efficiency 12 V PHEMT Power Transistors for WiMAX Applications
M. Bokatius, M. Miller

WEP1E-02: Overcoming PHEMT Linearity Dependence on Fundamental Input Tuning by Digital Pre-Distortion
M. Bokatius, M. Lefevre, M. Miller

WEP1E-03: Ka-band SiGe HBT Power Amplifier for Single-Chip T/R Module Applications
P.J. Riemer, J.S. Humble, J.F. Prairie, J.D. Coker, B.A. Randall, B.K. Gilbert, E.S. Daniel

WEP1E-04: 20 W LDMOS Power Amplifier IC for Linear Driver Application
R. Bagger, P. Andersson, C.D. Shih

WEP1E-05: A 6–18 GHz Push-Pull Power Amplifier with Wideband Even-Order Distortion Cancellation in LCP Module
A.C. Chen, A.H. Pham, R.E. Leoni

WEP1E-06: Linearity of X-band Class-E Power Amplifiers in a Digital Polar Transmitter
N. Wang, N.D. Lopez, V. Yousefzadeh, J. Hoversten, D. Maksimovic, Z. Popovic

WEP1E-07: A 2.4 GHz GaAs-HBT Class-E MMIC Amplifier with 65% PAE
C. Meliani, M. Rudolph, P. Kurpas, W. Heinrich, L. Schmidt, C. Rheinfelder

WEP1E-08: H-Bridge Class-D Power Amplifiers for Digital Pulse Modulation Transmitters
T. Hung, J. Rode, L.E. Larson, P.M. Asbeck

WEP1E-09: Variable-Voltage Class-E Power Amplifiers
M. Acar, A.J. Annema, B. Nauta

WEP1F High-Power Amplifiers

WEP1F-01: Applications of GaN HEMTs and SiC MESFETs in High Efficiency Class-E Power Amplifier Design for WCDMA Applications
Y. Lee, Y. Jeong

WEP1F-02: Negative Group Delay Circuit for Feed-Forward Amplifier
H. Noto, K. Yamauchi, M. Nakayama, Y. Isota

WEP1F-03: Analogue Dynamic Supply Voltage L-band GaN High Power Amplifier with Improvement of Efficiency and Linearity
K. Matsunaga, M. Tanomura, T. Nakayama, Y. Ando, H. Miyamoto, H. Shimawaki

WEP1F-04: A 2.5 W, 3.3–3.9 GHz Power Amplifier for WiMAX Applications using a GaN HEMT in a Small Surface-Mount Package
S.M. Wood, A. Prejs, R.S. Pengelly, W. Pribble, E.J. Crescenzi, Jr.

WEP1F-05: Cross Post-distortion Balanced Power Amplifier
H. Choi, Y. Jeong, J. Kenny, C. Kim

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Announcing the new AU4550 Pulsed IV/RF Instrument from Auriga Measurement Systems.

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WEP2 WEDNESDAY INTERACTIVE FORUM II

Chair: Eric Bryerton
Co-chair: Matthew Morgan

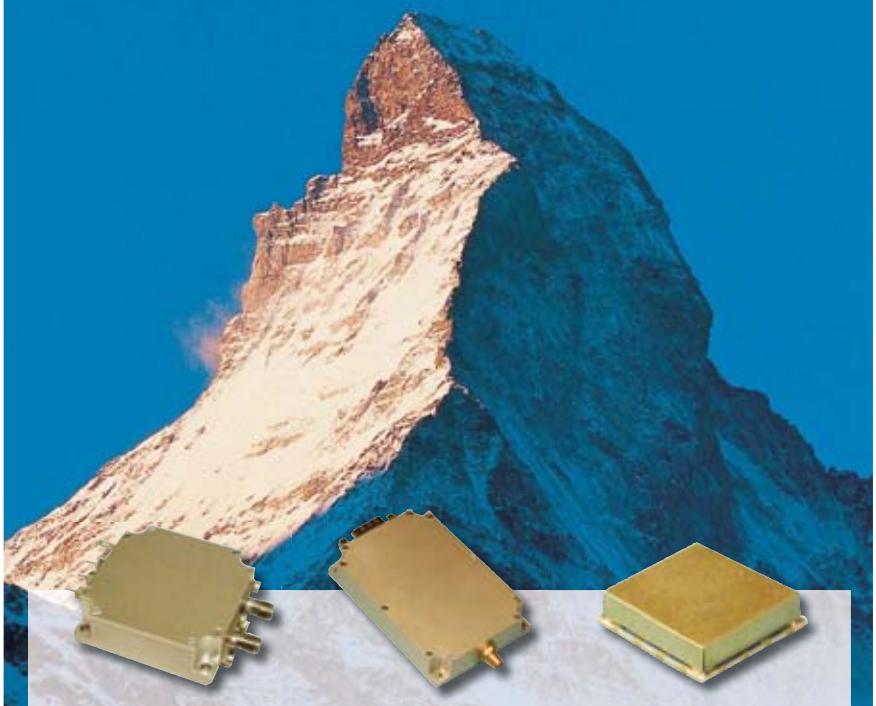
WEP2A Millimeter-wave and Terahertz Components and Technologies

WEP2A-01: An Analogue, 4:2 MUX/DEMUX Front-End MIMIC for Wireless 60 GHz Multiple Antenna Transceivers
S. Koch, M. Uno, I. Kallfass, R. Weber, A. Leuther, M. Schlechtweg

WEP2A-02: Measurement of Terahertz Refractive Index for Plasmon Waveguides
H. Yasuda

WEP2A-03: A 90 nm CMOS Broadband and Miniature Q-band Balanced Medium Power Amplifier
J. Tsai, Y. Lee, T. Huang, C. Yu, J. Chern

PEAK PERFORMANCE
PLL's and Synthesizers



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WEP2A-04: A Miniature 38–48 GHz MMIC Sub-Harmonic Transmitter with Post-distortion Linearization
J. Tsai, H. Yang, T. Huang

WEP2A-05: Effective Medium Theory for Carbon Nanotube Composites and their Potential Applications as Metamaterials
S.M. Mikki, A.A. Kishk

WEP2A-06: Silicon Micromachined Multiplier Utilizing Heterostructure Barrier Varactor Diode
P.L. Kirby, Y. Li, J. Papapolymerou, Q. Xiao, J. Hesler

WEP2A-07: Microfabricated Left-handed Transmission Line Operating at 50 GHz
C. Qin, A. Kozyrev, A. Karbassi, V. Joshkin, D.W. van der Weide

WEP2A-08: Simulations of Quasi-Optical Output Systems for High Power Gyrotrons Based on the Electric Field Integral Equation
O. Prinz, M. Thumm

WEP2A-09: Integrated 585 GHz Hot-Electron Mixers Based on Annular Slot Antennas
L. Liu, Q. Xiao, A.W. Lichtenberger, R.M. Weikle II

WEP2A-10: Balanced Low-Loss Ka-band μ-Coaxial Hybrids
K.J. Vanhille, D.S. Filipovic, Z. Popovic, C. Nichols, D.L. Fontaine, W. Wilkins, E. Daniel

WEP2A-11: A Reflection Based, Pulsed THz Imaging System with 1 mm Spatial Resolution
Z.D. Taylor, R.S. Singh, E.R. Brown, J.E. Bjarnason, M.P. Hanson, A.C. Gossard

WEP2A-12: Integrated Microbolometer Antenna Characterization from 95 to 650 GHz
C.R. Dietlein, J.D. Chisum, M.D. Ramirez, Z. Popovic, E.N. Grossman, A. Luukanen

WEP2B Packaging, Interconnects, MCMs and Hybrid Manufacturing

WEP2B-01: A 30 GHz Waveguide-to-Microstrip-Transition
F.J. Schmueckle, W. Heinrich, W. Gross, K. Hirche, M. Rostewitz

WEP2B-02: Integrated Passive Technology for Wireless Basestation Applications
L. Liu, C. Ramiah, Q. Li, S. Pacheco, S. Kuo, M. Miller, S. Marshall, M. Watts, P. Piel

WEP2C Instrumentation and Measurement Techniques

WEP2C-01: Broadband Characterization of Multilayer Dielectric Thin-Films
J.C. Booth, N.D. Orloff, M. Murakami, I. Takeuchi, J. Mateu

WEP2C-02: Characterization of Multi-Walled Carbon Nanotube (MWNT) Papers using X-band Waveguides
H. Xin, L. Wang, D. Carnahan

WEP2C-03: Microstrip Resonator Technique for Measuring Dielectric Permittivity of Liquid Solvents and for Solution Sensing
K. Saeed, A.C. Guyette, I.C. Hunter, R.D. Pollard

WEP2C-04: High Power Microwave Device Temperature Measurement— Methodology and Applications for Pulsed Devices

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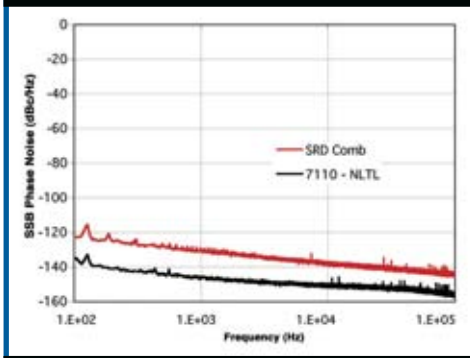

Model 7110 and SRD residual phase noise comparison. 200MHz, 19dBm input. Measured at 2GHz or 10th harmonic.

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7102	20-24 dBm	300 MHz	700 MHz	20 GHz
7103	20-24 dBm	500 MHz	1.2 GHz	30 GHz
7110	25-29 dBm	100 MHz	300 MHz	20 GHz
7112	25-29 dBm	300 MHz	700 MHz	20 GHz
7113	25-29 dBm	500 MHz	1.2 GHz	30 GHz
7123	25-29 dBm	800 MHz	1.4 GHz	50 GHz
7124	25-29 dBm	1.6 GHz	2.4 GHz	50 GHz

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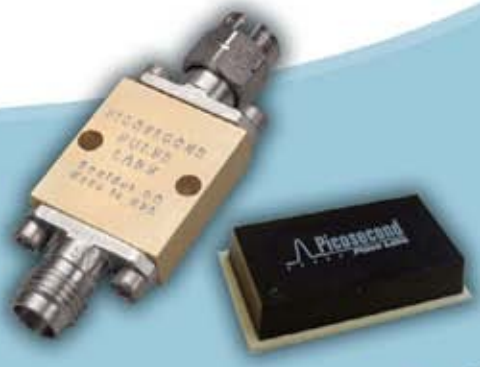

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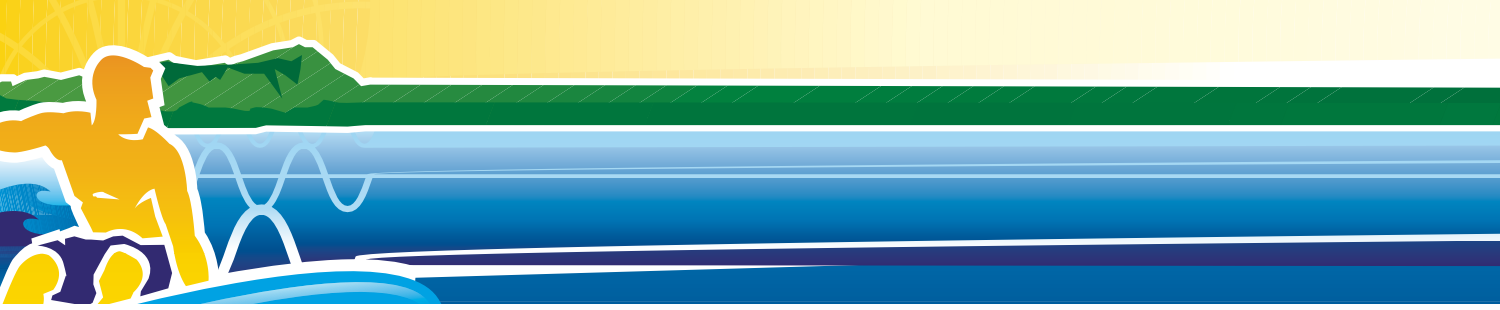

M. Mahalingam, E. Mares, W. Brakensiek, K. Burger, C. Hsu

WEP2C-05: Gaining Advanced Insight in the Phase Stability of Comb Generators using a Large-Signal Network Analyzer
G. Pailloncy, F. Verbeyst, M. Vanden Bossche

WEP2D Smart Antennas, Spatial Power Combining and Phased Arrays

WEP2D-01: A Tunable Quasi-Lumped Microstrip Coupler and RF Applications
F. Ferrero, G. Jacquemod

WEP2D-02: Active Integrated Antenna Based on Planar Dielectric Resonator with Tuning Ferroelectric Varactor
O.Y. Buslov, A.A. Golovkov, V.N. Keis, A.B. Kozyrev, S.V. Krasilnikov, T.B. Samoilova, A.Y. Shimko, D. Ginley, T. Kaydanova

WEP2D-03: Analysis and Experimental Study of Wideband Dielectric Resonator Antenna Arrays for Waveguide-based Spatial Power Combining
Y. Zhang, A.A. Kishk, A.B. Yakovlev, A.W. Glisson

WEP2D-04: A Low Profile Twin-PIFA Laptop Reconfigurable Multi-band Antenna for Switchable and Fixed Services Wireless Applications
C. Zhang, S. Yang, S. Lee, S.M. El-Ghazaly, A.E. Fathy, H.K. Pan, V.K. Nair

WEP2E Radars and Broadband Communication Systems

WEP2E-01: Balancing Target Noise Against Thermal Noise—On the Optimum Beamwidth for Mean Radar Reflectivity Estimation
F. Gerbl, E.M. Biebl

WEP2E-02: Concurrent Circuit-Level/System-Level Optimization of a 24 GHz Mixer for Automotive Applications using a Hybrid Electromagnetic/Statistical Technique
F.P. Placentino, A. Scarponi, D. Staiculescu, S. Nikolaou, M.M. Tentzeris, L.J. Martin

WEP2F Wireless and Cellular Communication Systems

WEP2F-01: Design of an Overmoded-Waveguide Directional Antenna for use in In-Building Ventilation Duct Wireless Networks
J.C. Hess, B.E. Henty, D.D. Stancil

WEP2F-02: Adaptive Linearization of Frequency Doubler Using DGS
S.M. Kang, K.H. Koo, S.W. Nam

WEP2F-03: Distributed Body-worn Transceiver System with the Use of Electro-textile Antennas
Y. Ouyang, W.J. Chappell

WEP2G Sensors and Sensor Systems

WEP2G-01: Non-invasive Determination of Temperature Trajectories During a Defrosting Process using Microwave Radiometry
P. Cresson, L. Dubois, J.P. Pribetich

WEP2G-02: A 5.8 GHz Local Positioning and Communication System
R. Mosshammer, M. Huemer, R. Szumny, K. Kurek, J. Huttner, R. Gierlich

WEP2G-03: Sensor Nodes for Doppler Radar Measurements of Life Signs
I. Mostafanezhad, B. Park, O. Boric-Lubecke, V. Lubecke, A. Host-Madsen

Thursday, June 7, 2007
8:00 AM to 9:40 AM

TH1A High Power Amplifiers I
Chair: Wayne Kennan • Co-chair: Kiki Ikossi

New circuit technologies and circuit techniques continue to push the envelope on PA output power, efficiency, and linearity. In this session, five papers based on Gallium Nitride and one based on TWT demonstrate state-of-the-art performance levels for their respective applications. Paper 1 describes a WiMax infrastructure amplifier with 73% drain efficiency at +31 dBm. Papers 2 and 3 present C-band GaN HEMT PAs achieving 220 W output power with thermal management and 60 W output power with 50% drain efficiency, respectively. In papers 4 and 5, Doherty efficiency enhancement is applied to GaN HEMT technology to produce excellent W-CDMA basestation power amplifiers. In paper 6, the input power envelope is used to modulate the collector voltages of a TWT amplifier at 5.25 GHz.

TH1A-01: High Efficiency GaN HEMT Power Amplifier Optimized for OFDM EER Transmitter
S. Hong, Y.Y. Woo, I. Kim, J. Kim, J. Moon, B. Kim, H.S. Kim, J.S. Lee

TH1A-02: C-band GaN HEMT Power Amplifier with 220 W Output Power
K. Yamanaka, K. Mori, K. Iyomasa, H. Ohtsuka, H. Noto, M. Nakayama, Y. Isota, Y. Tsuyama, Y. Kamo

TH1A-03: GaN HEMT 60 W Output Power Amplifier with Over 50% Efficiency at C-band 15% Relative Bandwidth using Combined Short and Open Circuited Stubs
K. Iyomasa, K. Yamanaka, K. Mori, H. Noto, H. Ohtsuka, M. Nakayama, S. Yoneda, Y. Isota, Y. Tsuyama, Y. Kamo

TH1A-04: A 80 W 2-stage GaN HEMT Doherty Amplifier with –50 dBc ACLR, 42% Efficiency 32 dB Gain with DPD for W-CDMA Base Station
N. Ui, H. Sano, S. Sano

TH1A-05: 50% Drain Efficiency Doherty Amplifier with Optimized Power Range for W-CDMA Signal
T. Yamamoto, T. Kitahara, S. Hiura

TH1A-06: Efficient Operation of Traveling-Wave Tube Amplifier with Dynamically Adjusted Collector Bias Voltages
J.X. Qiu, D.K. Abe, B.G. Danly, B. Levush, T.M. Antonsen, Jr., R.E. Myers

TH1B Non-Planar Filters and Multiplexers
Chair: Dick Snyder
Co-chair: Clark Bell

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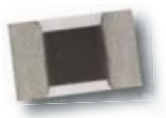

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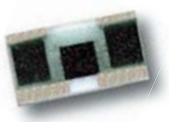

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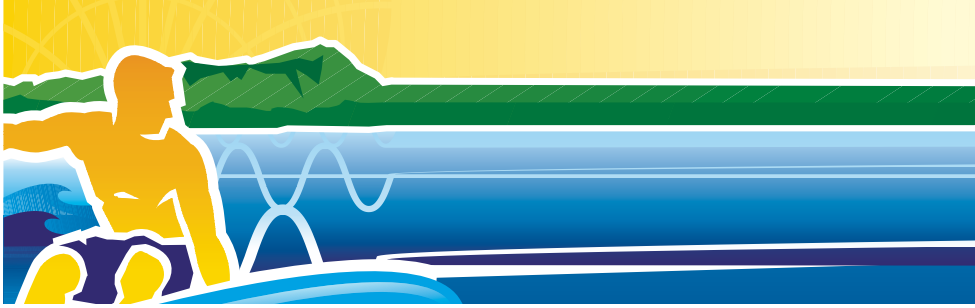


This session covers the synthesis and implementation of non-planar microwave filters and diplexers.

TH1B-01: **Analytical Synthesis of Generalized Multi-band Microwave Filters**
Y. Zhang, K.A. Zaki, J.A. Ruiz-Cruz, A.E. Atia

TH1B-02: **Novel Folded Resonators and Filters**
H. Lin

TH1B-03: **Design of a Bandpass Transversal Filter Employing a Novel Hybrid Waveguide-Printed Structure**
M. Martinez-Mendoza, J.S. Gomez-Diaz, D. Canete-Rebenaque, J.L. Gomez-Tornero, A. Alvarez-Melcon

TH1B-04: **Miniature High Power Combline Filters**
S. Mehta, P. Petre, J. Foschaar

TH1B-05: **Dual-band Filters for Base Station Multi-band Combiners**
G. Macchiarella, S. Tamiazzo

TH1B-06: **Design and Testing of a Thermally Stable Filter Using Bimetal Compensation**
B.F. Keats, R.R. Mansour, R.B. Gorbet

TH1B-07: **Synthesis and Design Procedure for High Performance Waveguide Filters Based on Nonresonating Nodes**
S. Cogollos, V.E. Boria, R.J. Cameron, M. Yu, R.R. Mansour

TH1B-08: **CMOS-Compatible Encapsulated Silver Bandpass Filters**
M. Rais-Zadeh, H.M. Lavasani, F. Ayazi

TH1C Advances in Radar Systems

Chair: Arne F. Jacob • Co-chair: Roger Kaul

Automotive radars operating near 77 and 24/26 GHz continue to evolve. An integrated SiGe-BiCMOS demonstrator at 77 GHz using FMCW has been developed. A method for improving the performance of a 77 GHz FMCW radar by linearizing the sweep is provided. Two papers discuss 24/26 GHz automotive radars. One paper uses FMCW for precision location and spread-spectrum for data transmission. The second 24 GHz automotive paper utilizes a narrow-band monopulse waveform. Wireless units use FMCW to estimate their offset in time and frequency providing improved distance accuracy. The radar Doppler technique is used for remote detection of cardiopulmonary activity.

TH1C-01: **Fully Integrated SiGe-BiCMOS Receiver (RX) and Transmitter (TX) Chips for 76.5 GHz FMCW Automotive Radar Systems Including Demonstrator Board Design**
J. Feige, P.Wennekers, C. Trigas, J. Kirchge, R. Reuter, H. Li, Y. Yin, A. Ghazinour, I. To, D. Morgan, P. Welch, S. Braithwaite, B. Knappenberger, D.G. Scheitlin, J.P. John, M. Huang, M. Tutt, D. Jahn

TH1C-02: **A 26 GHz Short-Range UWB Vehicular-Radar Using 2.5 Gcps Spread Spectrum Modulation**
T. Fukuda, N. Negoro, S. Ujita, S. Nagai, M. Nishijima, H. Sakai, T. Tanaka, D. Ueda

TH1C-03: **Method for High Precision Radar Distance Measurement and Synchronization of Wireless Units**
S. Roehr, P. Gulden, M. Vossiek

TH1C-04: **Adaptive Frequency Sweep Linearisation Based on Phase Accumulator Principle**
C. Wagner, H. Jaeger, A. Stelzer

TH1C-05: **Center Tracking Quadrature Demodulation for a Doppler Radar Motion Detector**
B. Park, V.M. Lubecke, O. Boric-Lubecke

TH1C-06: **A Low-Cost 24 GHz Long-Range, Narrow-band Monopulse Radar Front End for Automotive ACC Applications**
V. Cojocaru, D. Humphrey, B. Clarke, T. Young, V. Napijalo, M. Chinn, S. Seawright, H. Kurata, T. Yokoyama, H. Shimoda, H. Ikeda, T. Adachi, T. Honya, Y. Yamashita

TH1D Biological Effects and Medical Applications

Chair: Arye Rosen
Co-chair: Joseph Pribetich

In comparison with past sessions stretching over at least the last 15 years, the coverage of the papers is the most diverse. The session covers the traditional subjects such as a therapeutic modality, detection, and imaging, and novel subjects such as a large scale electromagnetic simulation of an open MRI system, and the microwave effects on DNA in a plant model.

TH1D-01: **A 433 MHz Hyperthermia System using Rotating Spiral Antennas for Uniform Treatment of Large Superficial and Sub-superficial Tumors**
O. Arabe

TH1D-02: **Role of Microwave Accelerators in Cancer Treatment**
S.M. Hanna

TH1D-03: **High Frequency Dielectric Characteristics of Tumorous and Non-tumorous Breast Tissues**
U.A. Khan, N. Al Moayed, N. Nguyen, M. Obol, K. Korolev, M.N. Afsar, S. Naber

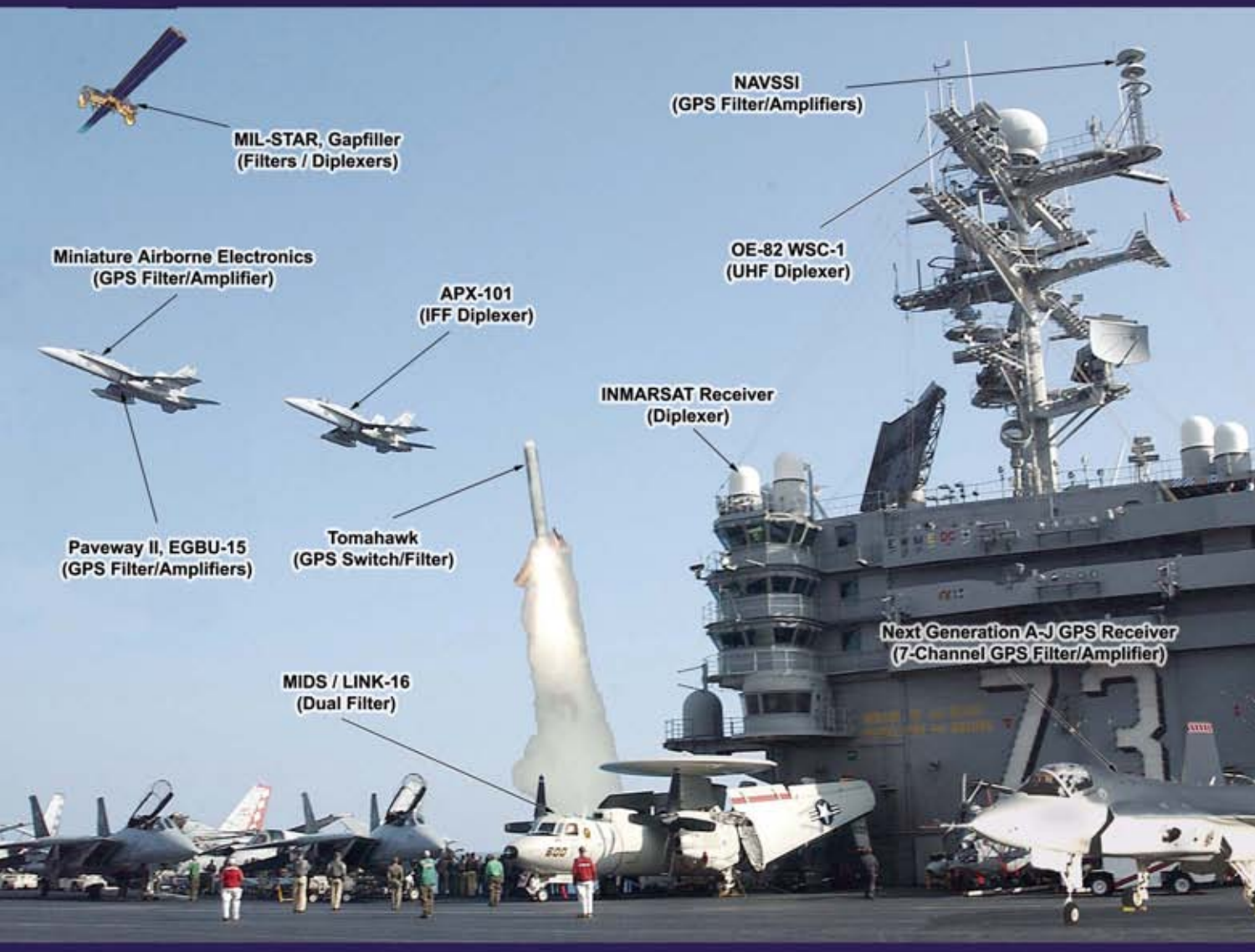
TH1D-04: **Large-Scale Simulations Including a Human-Body Model for MRI**
M.H. Vogel, R.P. Kleihorst

TH1D-05: **Specific Absorption Rate (SAR) Numerical Evaluation: a Critical Discussion**
L. Catarinucci, L. Tarricone

TH1D-06: **Design Considerations for the Implanted Antennas**
A. Mahanfar, S. Bila, M. Aubourg, S. Verdeyme

TH1E Components, Systems and Applications for mm-wave and THz Imaging

Chair: John Cunningham
Co-chair: Robert Weikle



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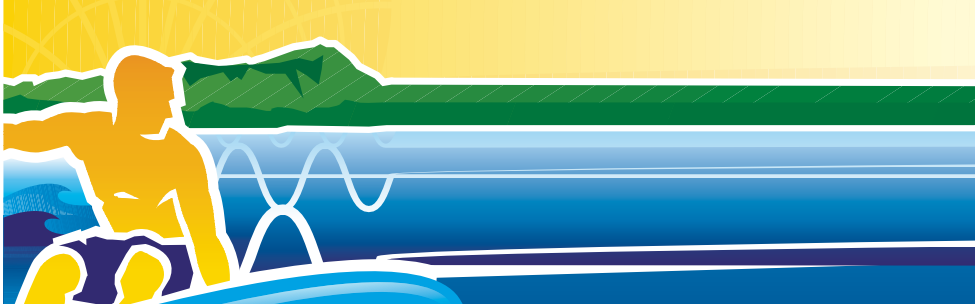

Imaging modalities for frequencies in the 10 GHz to several THz range are becoming increasingly important for emerging applications as diverse as security scanning, pharmaceutical characterization, and medical imaging. This session focuses on new components and systems across a diverse range of technologies, from radar to near-field probes, with a particular emphasis on new detection schemes.

TH1E-01: **Multi-Channel Receiver for an E-band FMCW Imaging Radar**
J. Schellenberg, R. Chedester, J. McCoy

TH1E-02: **A Low Noise Chipset for Passive Millimeter-wave Imaging**
H.P. Moyer, J.J. Lynch, J.N. Schulman, R.L. Bowen, J.H. Schaffner, A.K. Kurdoghlian, T.Y. Hsu

TH1E-03: **Ultra Sensitive ErAs/InGaAlAs Direct Detectors for Millimeter-wave and THz Imaging Applications**
H. Kazemi, G. Nagy, L. Tran, E. Grossman, E.R. Brown, A.C. Gossard, A.C. Young, J.D. Zimmerman, G.D. Boreman, B. Lial

TH1E-04: **600 GHz Imaging Radar with 2 cm Range Resolution**
R.J. Dengler, K.B. Cooper, G. Chattopadhyay, I. Mehdi, E. Schlecht, A. Skalare, P.H. Siegel, C. Chen

TH1E-05: **A Micromachined 94 GHz Dielectric Resonator Antenna for Focal Plane Array Applications**
D. Karlen, P. Enoksson, L. Huss, J. Svedin, C. Rusu

TH1E-06: **Application of Finite Difference Time Domain Methods to Terahertz Spectroscopy Measurements of Breast Cancer**
E. Pickwell-MacPherson, T. Lo, A. Fitzgerald, V. Wallace, E. Provanzano, S. Pinder, A. Purushotham

TH1E-07: **Broadband Microwave-to-Terahertz Near-Field Imaging**
S.V. Danylyuk, U. Poppe, N. Klein, F. Kadec, P. Kuzel, M. Berta, R.C. Pullar, H. Romanus

TH1F Frequency Conversion and Control
Chair: Huei Wang
Co-chair: Mohammad Madihian

This session highlights advanced technologies including switches, mixers and dividers.

TH1F-01: **An S-band 100 W GaN Protection Switch**
M. Hangai, T. Nishino, Y. Kamo, M. Miyazaki

TH1F-02: **A Novel Multi-Stack Device Structure and its Analysis for High Power CMOS Switch Design**
M. Ahn, J. Laskar, C. Lee, B. Kim

TH1F-03: **A 35–50 GHz IQ-Demodulator in 0.13 μm CMOS Technology**
C. Lin, P. Wu, K. Lin, H. Wang, H. Chang

TH1F-04: **A Planar Image Rejection Mixer with 135/45° Power Dividers**
K. Nishida, H. Mizutani, M. Tsuru, K. Kawakami, M. Miyazaki, Y. Isota

TH1F-05: **K-band LTCC Star Mixer with Broadband IF Output Network**
T. Baras, J. Mueller, A.F. Jacob

TH1F-06: **A 44 GHz 0.18 micron CMOS Superharmonic Frequency Divider**
T. Luo, Y.E. Chen

TH1G Periodic Structures and Applications
Chair: Branka Jokanovic
Co-chair: George E. Ponchak

In recent years, periodic structures have found wide applications in left-handed transmission lines and metamaterials. These structures may exhibit new features such as multi-mode operation, tri-band performance, etc., that can be efficiently used to build new devices. Finally, one paper describes a synthesized waveguide structure based on EBG woodpile.

TH1G-01: **Superconducting Tunable Composite Right/Left-Handed Transmission Lines Using Ferroelectric Thin Films with a Resistive Bias Network**
Y. Wang, M.J. Lancaster, F. Huang, P.M. Suherman, D.M. Holdom, T.J. Jackson

TH1G-02: **New Left Handed Microstrip Lines with Complementary Split Rings Resonators (CSRRs) Etched in the Signal Strip**
M. Gil Barba, J. Bonache, J. Garcia-Garcia, F. Martin

TH1G-03: **Dual-Mode Metamaterial with Backward and Forward Wave Selectivity**
A. Lai, K.M. Leong, T. Itoh

TH1G-04: **Double-Lorentz Transmission Line Metamaterial and its Application to Tri-band Devices**
A. Rennings, T. Liebig, I. Wolff, C. Caloz

TH1G-05: **Large Experimental Bandpass Waveguide in 3D EBG Woodpile Manufactured by Layer-by-Layer Ceramic Stereolithography.**
N. Delhote, D. Baillargeat, S. Verdeyme, M. Thevenot, C. Delage, C. Chaput

10:10 AM to 11:50 AM

TH2A Power Amplifier Linearization
Chair: James Komiak
Co-chair: F.M. Ghannouchi

In this session, state-of-the-art linearization techniques that consider high power efficiency are described. These techniques include Chireix, three examples of digital predistortion, and analysis and suppression of memory effects in EER power amplifiers.

TH2A-01: **A 20 W Chireix Outphasing Transmitter for WCDMA Base Stations**
A. Huttunen, R. Kaunisto

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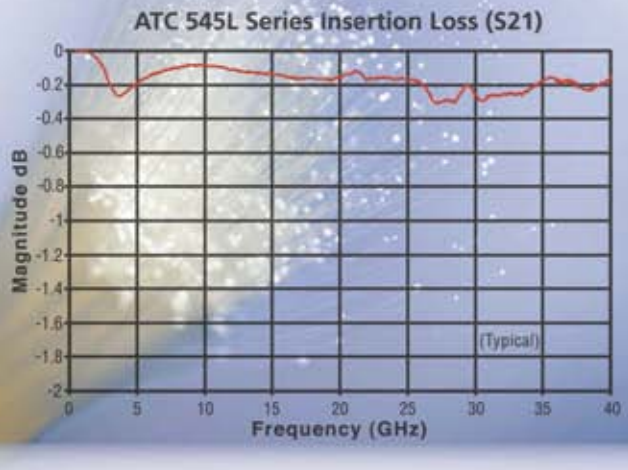

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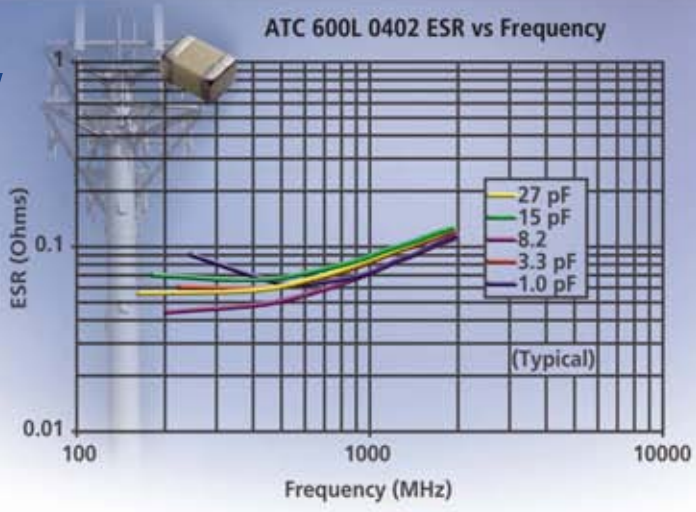

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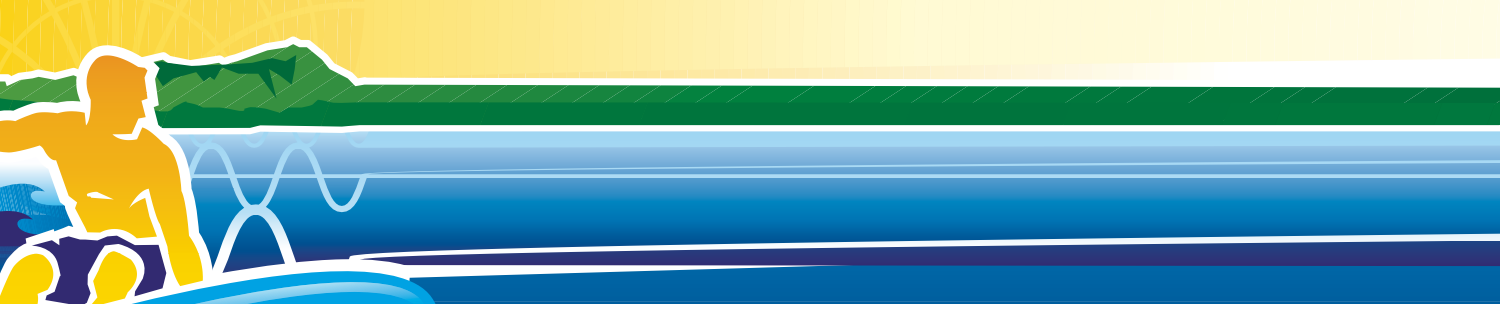

TH2A-02: **Spline-Based Model for Digital Predistortion of Wide-band Signals for High Power Amplifier Linearization**
N. Safari, T. Roste, P. Fedorenko, J. Kenney

TH2A-03: **A New Adaptive Digital Predistortion Technique Employing Feedback Technique**
Y.Y. Woo, J. Kim, S. Hong, I. Kim, J. Moon, B. Kim, J. Yi

TH2A-04: **Open-Loop Digital Predistortion Using Cartesian Feedback for Adaptive RF Power Amplifier Linearization**
S. Chung, J.W. Holloway, J.L. Dawson

TH2A-05: **Analysis and Suppression of Memory Effects in Envelope Elimination and Restoration (EER) Power Amplifiers**
P. Fedorenko, J.S. Kenney

TH2C Imaging and Ultra-Wideband Radars
Chair: Gregory Lyons
Co-chair: Alfred Hung

Advances in imaging and ultra-wideband (UWB) radar systems are described. The session includes MMW and UWB microwave imaging radar technology and algorithm improvements, UWB radar techniques and synthetic aperture radar (SAR) algorithm developments.

TH2C-01: **An E-band Electronically Scanned Imaging Radar System**
K. Miyashiro, J. Schellenberg, J. Loveberg, V. Kolinko, J. McCoy

TH2C-02: **An UWB Wall Scanner Based on a Shape Estimating SAR Algorithm**
S. Hantscher, A. Reisenzahn, C.G. Diskus

TH2C-03: **Design and Implementation of a Low-Cost Real-Time Ultra-Wide Band See-Through-Wall Imaging Radar System**
Y. Yang, A. Fathy

TH2C-04: **FCC Compliant 3.1–10.6 GHz UWB Pulse Radar System using Correlation Detection**
J. Dederer, B. Schleicher, F. De Andrade Tabarani Santos, A. Trasser, H. Schumacher

TH2C-05: **On the Design of Radar Absorbing Materials Using Left-Handed Transmission Line**
H. Wang, W. Tang, Z. Shen

TH2C-06: **Synthetic Aperture Radar Ghost Image Cancellation Using Broadband Time Reversal Averaging Techniques**
Y. Jiang, J. Zhu

TH2D Nonlinear and Linear Measurement
Chair: Jon Martens
Co-chair: Dominique Schreurs

This session starts by exploring advanced large-signal balanced measurement methods and improvements in load-pull techniques. Also, enhancements to on-wafer network measurement accuracy are covered.

TH2D-01: **Complete Pure-Mode Balanced Measurement System**
J. Dunsmore, K. Anderson, D. Blackham

TH2D-02: **A Smart Load-Pull Method to Safely Reach Optimal Matching Impedances of Power Transistors**
T. Reveyrand, D. Barataud, S. Mons, J. Nebus, T. Gasseling

TH2D-03: **New Ultra-fast Real-time Active Load-pull Measurements for High Speed RF Power Amplifier Design**
P. Roblin, S. Doo, X. Cui, G.H. Jessen, D. Chaillot, J. Strahler

TH2D-04: **Singular-Value-Decomposition Based Four Port De-embedding and Single Step Error Calibration for On-Chip Measurement**
X. Wei, G. Niu

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TH2E Advanced Signal Processing Techniques for Microwave Photonics

Focused Session

Chair: Young-Kai Chen • Co-chair: Charlie Cox

The microwave photonic links promise low loss and high bandwidth which are essential for many wireless applications such as antenna remoting and low loss backhaul of wireless base stations to central offices. Recently significant progress has been made in utilizing digital signal processing techniques to significantly enhance the signal integrity of microwave analog and digital signal which is transported using an optical carrier either in silica fiber or via free space. In this focused session, we will survey several emerging optical signal processing techniques in the signal generation, signal integrity and coherent detection of microwave signals utilizing innovative optical means in combination with electronic processing.

TH2E-01: **Real-time Digital Carrier & Data Recovery for a Synchronous Optical Quadrature Phase Shift Keying Transmission System**
R. Noe, T. Pfau, O. Adamczyk, R. Peveling, V. Herath, S. Hoffmann, M. Porrmann, S.K. Ibrahim, S. Bhanda

TH2E-02: **DSP-based Highly Linear Microwave Photonic Link**
T.R. Clark, M.L. Dennis

TH2E-03: **Feed-Forward Phase and Frequency Estimation in Coherent Digital and Analog Photonic Links Using Digital Signal Processing**
A. Leven, U. Koc, Y. Chen, N. Kaneda

TH2E-04: **2-Dimensional Spatio-Temporal Signal Processing for Dispersion Compensation in Optical Systems**
A. Tarighat, B. Jalali

TH2E-05: **Low Noise Figure Microwave Photonic Link**
A. Karim, J. Devenport

TH2F New Trends in High Frequency Signal Generation

Chair: Paul Khanna
Co-chair: John Papapolymerou

This session presents new trends in high frequency signal generation. It covers low noise design techniques, switchable VCOs, mm-wave Gunn oscillators, frequency synthesizers for digital TV tuners and phase-hit immunity methods.

TH2F-01: **Design of Low Phase Noise Dielectric Resonator Oscillators with GaInP HBT Devices Exploiting a Non-linear Noise Model**
C. Florian, P.A. Traverso, F. Filicori, G. Vannini

TH2F-02: **An X-band Low Phase Noise Oscillator Employing a Four-pole Elliptic-Response Microstrip Bandpass Filter**
J. Choi, M. Chen, A. Mortazawi

TH2F-03: **A 2.4/5 GHz Dual-band VCO using a Variable Inductor and Switched Resonator**
H.L. Kao, D.Y. Yang, A. Chin, S.P. McAlister

TH2F-04: **A Second-Harmonic Oscillator Using an Overmoded-Waveguide Resonator with Gunn Diodes**
J. Bae, M. Ikeda

TH2F-05: **Phase-hit Immunity Methods for High Speed Communication Systems**
Y. Qin, F. Matsumoto, D. Pham, C. Easaw

TH2F-06: **A Single-VCO Fractional-N Frequency Synthesizer for Digital TV Tuners**
Y. Yang, F. Lee, S. Lu

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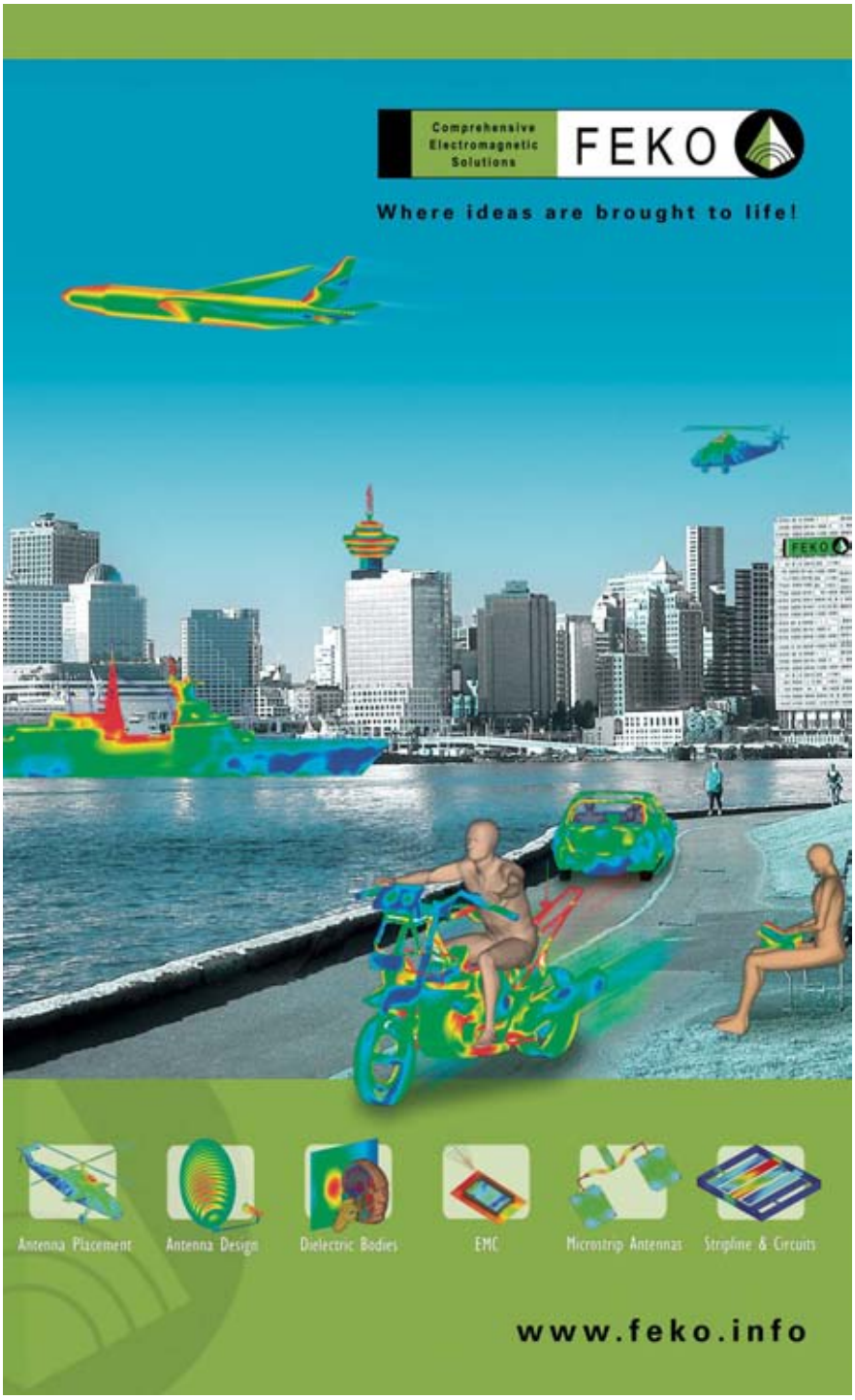
TH2G Transmission Line and Waveguide Transitions
Chair: Charles Buntschuh • Co-chair: Ke Wu

Transitions between various types of transmission lines and waveguides are required for microwave and millimeter-wave systems. This session presents several novel transitions. Additionally, one paper on low loss transmission lines for CMOS RFICs is presented.

TH2G-01: **94 GHz Broadband Transition from Coplanar Waveguide to Substrate Integrated Image Guide (SIIG)**
A. Patrovsky, K. Wu

TH2G-02: **Substrate Integrated Waveguide-to-Microstrip Transition in Multilayer Substrate**
Y. Ding, K. Wu



TH2G-03: **A Novel Approach for a Periodic Structure Shielded Microstrip Line to Rectangular Waveguide Transition**
F. Poprawa, A. Ziroff, F. Ellinger

TH2G-04: **A New Ultra-wideband Microstrip-to-CPS Transition**
Y. Kim, D. Woo, K.W. Kim, Y. Cho

TH2G-05: **Multilayer Coplanar Waveguide Transmission Lines Compatible with Standard Digital Silicon Technologies**
Y. Zhu, S. Wang, H. Wu

1:20 PM TO 3:00 PM

TH3A High Power Amplifiers II
Chair: S.C. Cripps • Co-chair: B. Kim

This session presents some new industry breakthroughs for solid state RF PAs, with papers reporting 1 kW at 450 MHz, 500 W at 900 MHz and 100 W RFIC. Three other papers describe novel development on the Doherty PA configuration and there is a paper on hybrid amplifier for L-band space applications.

TH3A-01: **Advanced Design of Linear Doherty Amplifier for High Efficiency using Saturation Amplifier**
J. Kim, B. Kim, Y.Y. Woo

TH3A-02: **A 900 MHz, 500 W Doherty Power Amplifier Using Optimized Output Matched Si LDMOS Power Transistors**
C. Burns, A. Chang, D. Runton

TH3A-03: **N-Way Distributed Doherty Amplifier with an Extended Efficiency Range**
K. Cho, W. Kim, S.P. Stapleton, D. Kim, J. Kim

TH3A-04: **Industry First 100 W Two-Stage RFIC for 900 MHz GSM EDGE Base Station Applications**
X. Moronval, P. Peyrot

TH3A-05: **Hybrid High Power Amplifiers for L-band Space Application**
C. Florian, I. Melczarsky, R. Cignani, F. Filicori, F. Scappaviva, M. Pirazzini, G. Vannini, R.P. Paganelli, R. Giordani, M. Feudale

TH3A-06: **1 KW Push-Pull High Efficiency RF BJT Transistor for Radar Applications**
T. Shi, J. Chang, L. Leverich, M. Mallinger, C. Leader

TH3B Reconfigurable and Active Filters
Chair: Har Dayal
Co-chair: Yoji Kotsuka

The papers presented in this session cover two basic things. The first five papers present recent advances in tunable and reconfigurable filters. Methods described include Q enhanced CMOS filters, BAW filters, reconfigurable doublets, thermal and piezoelectric actuator tuning techniques. The final three papers concentrate on novel realization of passive filters, including balanced multilayer and metamaterial techniques.

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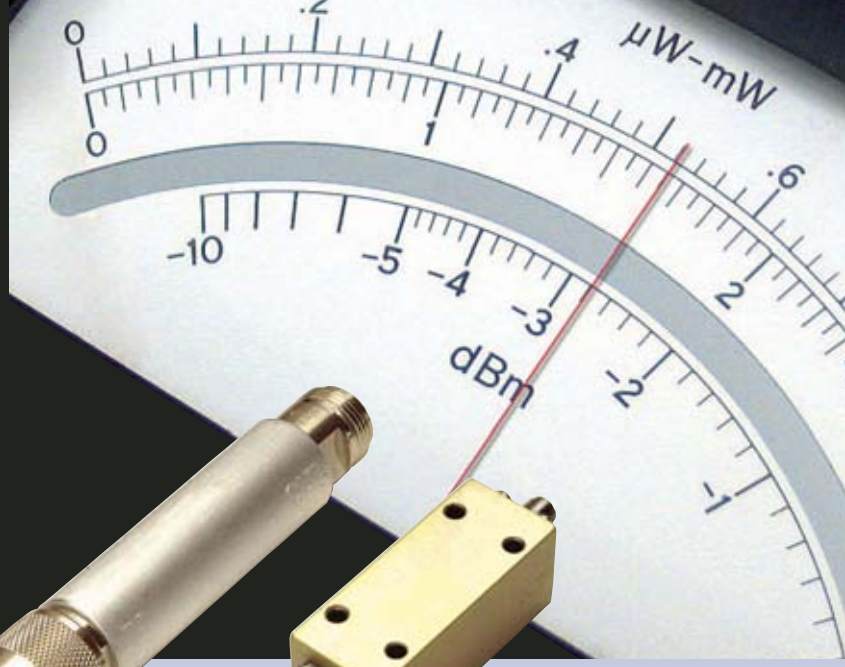

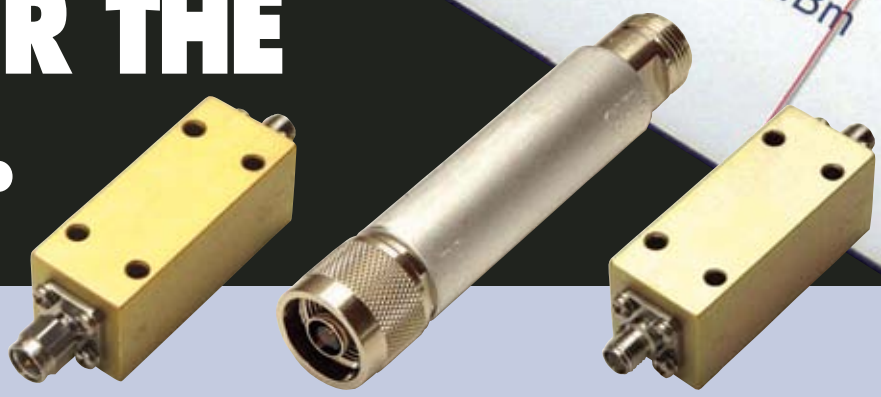

High Power RF Limiters

Frequency Range (MHz)	Part Number	Peak Input Power (kW)	CW Input Power (Watts)	Maximum Flat Leakage (CW Power +dBm)	Maximum Insertion Loss (+dB)	Maximum VSWR
0.5 - 30	ACLM-4869H	1	100	14	0.1	1.25:1
30 - 100	ACLM-4870H	1	100	14	0.1	1.25:1
10 - 500	ACLM-4827H	1	100	14	0.1	1.25:1
100 - 1300	ACLM-4871H	1	100	14	0.2	1.25:1
2 - 1500	ACLM-4932H	1	100	14	0.25	1.25:1
0.1 - 2000	ACLM-4897H	1	100	14	0.3	1.25:1
0.1 - 3000	ACLM-4896H	1	100	13	0.4	1.25:1
600 - 3100	ACLM-4891H	1	100	13	0.5	1.25:1
2000 - 4000	ACLM-4943H	1	100	13	1.2	2.0:1

* 60 W Version Also Available

RF & Microwave Limiters

Frequency Range (GHz)	Part Number	Peak Input Power (W)	CW Input Power (Watts)	Maximum Flat Leakage (CW Power +dBm)	Maximum Insertion Loss (+dB)	Maximum VSWR
0.5 - 2	ACLM-4538	100	2	18	0.4	1.4:1
0.1 - 4	ACLM-4637	100	2	17	0.5	1.4:1
1 - 4	ACLM-4581	100	2	17	0.5	1.4:1
2 - 4	ACLM-4531	100	2	17	0.5	1.4:1
1 - 8	ACLM-4597	100	2	17	0.9	1.5:1
2 - 12	ACLM-4535	100	2	18	1.5	1.6:1
2 - 18	ACLM-4537	100	1	18	1.8	1.9:1
18 - 26	ACLM-4765	100	1	21	2.5	2.0:1

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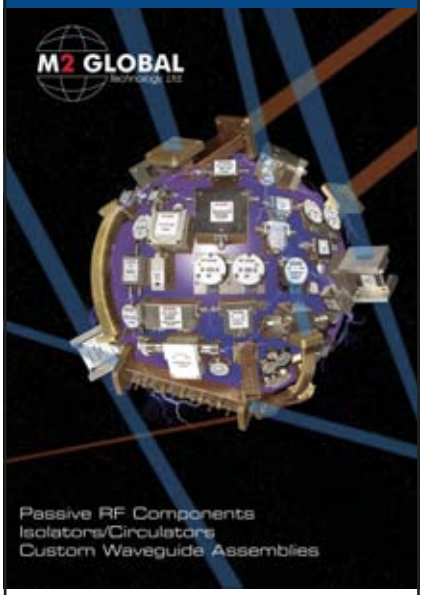

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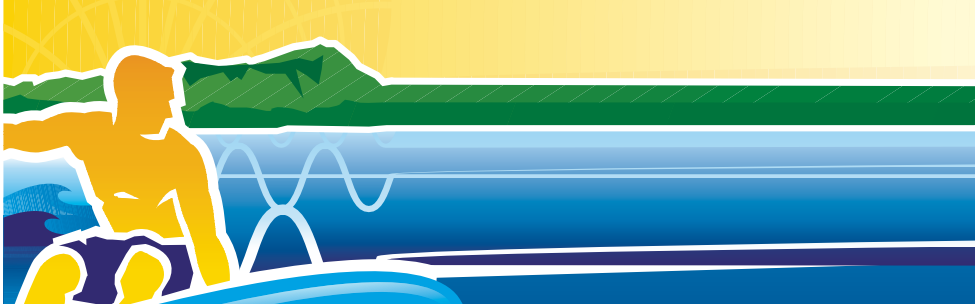

TH3B-01: 2 GHz Automatically Tuned Q-Enhanced CMOS Bandpass Filter
J.K. Nakaska, J.W. Haslett

TH3B-02: A New Method to Reconfigure BAW-SMR Filters Using CMOS Transistors
M.H. El Hassan, E. Kerherve, Y. Deval, D. Belot

TH3B-03: A Reconfigurable Filter Based on Doublet Configuration
C. Liao, C. Chang, J. Lin

TH3B-04: Compact Tunable Bandstop Filter Integrated with Large Deflected Actuators
W.D. Yan, R.R. Mansour

TH3B-05: 0.8 GHz to 2.4 GHz Tunable Ceramic Microwave Bandpass Filters
R. Matz, P. Russer, M. Al Ahmad

TH3B-06: High Performance and Compact Balanced-Filter Design for WiMAX Front-end Modules (FEM) Using LCP-based Organic Substrates
R. Wu, C. Mmasi, V. Govind, S. Dalmia, C. Ghiu, G. White

TH3B-07: Fixed Frequency and Tunable Metamaterial-based Ring Resonators with Narrowly Spaced Resonances
C.A. Allen, K.M. Leong, T. Itoh

TH3B-08: Novel Computer Controllable Metamaterial Beyond Conventional Configurations and its Microwave Absorber Application
Y. Kotsuka, C. Kawamura

TH3C Advanced Packaging

Chair: Kavita Goverdhanam
Co-chair: Clive Tzuang

The advanced packaging techniques covered in this session range from novel paper-based ink-jet printed RFIDs to flip-chip and LTCC techniques at millimeter-wave frequencies to integration of compact integrated dielectric antennas in system-in-package realizations.

TH3C-01: Design and Characterization of Novel Paper-based Inkjet-Printed RFID and Microwave Structures for Telecommunication and Sensing Applications
L. Yang, M.M. Tentzeris

TH3C-02: An Ultra-Wideband BGA-Via Transition for High-Speed Digital and Millimeter-wave Packaging Applications
T. Kangasvieri, J. Halme, J. Vahakangas, M. Lahti

TH3C-03: Demonstration of a Low Loss W-band Interconnect and Circuit Isolation Structure for Wafer Scale Assembly
D.S. Farkas, T. Luna, P.P. Chang-Chien, K. Tornquist, O. Fordham, R. Tsai

TH3C-04: Broadband Flip-Chip Interconnects for Millimeter-wave Si-Carrier System-on-Package
C. Li, C. Fu, T. Chao, C. Kuo, Y. Cheng, D.C. Chang

TH3C-05: Compact 60 GHz LTCC Stripline Parallel-Coupled Bandpass Filter with Parasitic Elements for Millimeter-wave System-on-Package
K. Nishikawa, T. Seki, I. Toyoda, S. Kubota

TH3C-06: Integrated Hybrid Dielectric Resonator Antenna for System-in-Package Application
A.P. Popov, B. Ooi, M. Leong, Y. Gao

TH3D Novel Radiation and Propagation Effects on Waveguiding Structures

Chair: David Jackson • Co-chair: Tapan Sarkar

This session introduces new radiation and propagation effects involving EBG and metamaterial structures. New analysis methods for treating waveguiding structures are also included. In addition, novel guiding structures that reduce loss at high frequency or exhibit other new effects are discussed.

TH3D-01: Effects of Frequency Selective Surface (FSS) on Enhancing the Radiation Efficiency of Metal Surface Mounted Dipole Antenna
S. Zhan, R.J. Weber, J. Song

TH3D-02: Leaky Modes on a Grounded Wire-Medium Slab
P. Burghignoli, G. Lovat, F. Capolino, D.R. Jackson, D.R. Wilton

TH3D-03: Full-Wave Analysis of Periodic Microstrip Lines Excited by an Aperiodic Delta-Gap Source
R. Rodriguez-Berral, F. Mesa, G. Valerio, P. Baccarelli, P. Burghignoli, A. Galli

TH3D-04: Loss Reduction Technique of Printed Transmission Line at Millimeter-wave Frequency
F. Kuroki, R. Tamaru, R. Masumoto, K. Miyamoto

TH3D-05: Full Wave Analysis of Arbitrary Polygonal Section Waveguides
M. Lucido, G. Panariello, F. Schettino

TH3D-06: Full Wave Analysis of Image Lines
M. Lucido, G. Panariello, F. Schettino

TH3D-07: Frequency Deviation Due to a Sample Insertion Hole in a Cylindrical Cavity by Circuital Analysis
F.L. Penaranda-Foix, J.M. Catala-Civera, A.J. Canos-Marin, B. Garcia-Banos

TH3E Millimeter and Submillimeter-wave Imaging

Focused Session

Chair: Peter H. Siegel
Co-chair: Koji Mizuno

Millimeter- and submillimeter-wave imaging is a rapidly developing area mainly due to renewed interests in security screening, but also because of advances in technology that have enabled video rate detection and display capability up to and beyond 100 GHz. Both small and large companies as well as government and university research labs have been actively pursuing a wide range of available techniques and accompanying source and sen-

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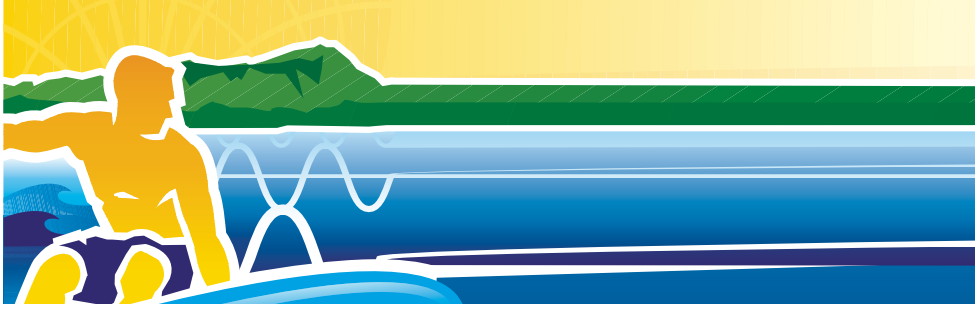

sor technologies. The variety and quality of the images is growing each year. These systems bring together the whole range of microwave components, techniques and data processing schemes. This focused session will cover active and passive imaging at frequencies from 100 GHz to over 1 THz.

TH3E-01: **Video-Rate Passive Millimeter-wave Imaging Using Phased Arrays**
J.A. Lovberg, C. Martin, V. Kolinko

TH3E-02: **Near Field Imaging at Microwave and Millimeter-wave Frequencies**
D.M. Sheen, D.L. McMakin, T.E. Hall

TH3E-03: **Terahertz Time Domain Spectroscopy; Present and Future Modalities**
J. Cunningham, C. Wood, A. Burnett, P. Uphadya, W. Fan, E. Linfield, G. Davies

TH3E-04: **THz Generation and Applications with Photonic Sources**
C. Otani, K. Kawase, Y. Ogawa

TH3E-05: **Practical Challenges for the Commercialisation of Terahertz Electronics**
C.M. Mann

TH3F Smart Antenna Technologies and Applications
Chair: Nicholas E. Buris • Co-chair: Glenn Hopkins

Smart antennas provide additional degrees of freedom that can be optimized for various performance metrics and applications. This session includes presentations on retrodirective arrays and target detection applications using MIMO. Other presentations address practical systems integration implementation issues such as antenna coupling.

TH3F-01: **A New Millimeter-wave Broadband Retrodirective Antenna Array**
Y. Ren, K. Chang

TH3F-02: **A Retrodirective Array-based on Phase Detection and Frequency Scanning**
M.K. Watanabe, G.S. Shiroma, B.O. Takase, J.M. Akagi, W.A. Shiroma

TH3F-03: **Interleaved Retrodirective Sub-Arrays for Null-Steering Interference Rejection**
D.S. Goshi, K.M. Leong, T. Itoh

TH3F-04: **A Supergain Beamforming Approach with Closely Spaced Antennas**
T. Lee, Y.E. Wang

TH3F-05: **Design of Coupled Oscillator Arrays for Second Harmonic Radiation**
A. Georgiadis

TH3F-06: **Antenna Array Detection in Highly Cluttered Environment Using Time Reversal Method**
Y. Jiang, D.D. Stancil, J. Zhu

TH3F-07: **Experimental Evaluation of Multiple Antenna Techniques for Remote Sensing of Physiological Motion**
D. Samardzija, T. Sizer, B. Park, O. Boric-Lubecke, V.M. Lubecke

TH3G Innovative Passive Components
Chair: Vicente-Enrique Boria-Esbert
Co-chair: Aly Fathy

This session describes several passive components developed using different types of materials such as metamaterials, micromachined structures, MICs, hybrid and silicon. Components include time-domain impedance adapters, broadband quadrature hybrids, broadband waveguide transitions, a Marchand balun, hybrid coupled-resonator bandpass filters, MIM capacitors, silicon nanowires and a ring hybrid balun.

TH3G-01: **Time-Domain Impedance Adaptors for Pulse-Based Systems with High Q RC Loads**
X. Wang, D. Peroulis, L.P. Katehi

TH3G-02: **Broadband Quadrature Hybrid Design Using Metamaterial Transmission Line and Its Application in the Broadband Continuous Phase Shifter**
C. Lee, K.M. Leong, T. Itoh

TH3G-03: **Broadband Transitions for Micro-machined Waveguides**
E.J. Wollack, F.M. Vanin

TH3G-04: **A Novel DGS-Marchand Balun from 40–80 GHz with IF-tap for Mixer Design**
R. Rehner, D. Schneiderbanger, M. Sterns, S. Martius, L.P. Schmidt

TH3G-05: **A Hybrid Coupled-Resonator Bandpass Filter Topology Implemented on Lossy Semiconductor Substrates**
R. Frye, K. Liu, G. Badakere, Y. Lin

TH3G-06: **Optimization of RF Performance of MIM Damascene Capacitors in Backend of Line**
J. Piquet, C. Bermond, T. Lacrevaz, T. VoB. Flechet, M. Thomas, A. Farcy, J. Torres,

TH3G-07: **Microwave Dissipation Spectra in Arrays of Silicon Nanowires**
M. Lee, C. Highstrete, A.L. Vallett, S.M. Dilts, J.M. Redwing, T.S. Mayer

TH3G-08: **Ring Hybrid Balun with Good Amplitude and Phase Balance**
M. Lee, W. Na, J. Song, I. Cho, K. Ryu

3:30 PM to 5:10 PM

TH4A Low Noise Devices, Amplifiers and Receivers
Chair: Terry Cisco
Co-chair: Francois Danneville

The session starts with a state-of-the-art InP 94 GHz amplifier and moves quickly to mm-wave and X-band results in silicon including CMOS and SiGe HBT amplifiers, followed by a 24 GHz fully integrated receiver on chip. Additionally, NF analysis is presented which extends predictions to include high frequency noise in HBT large-signal models.

TH4A-01: **94 GHz Band High-Gain and Low-Noise Amplifier Using InP-HEMTs for Passive Millimeter Wave Imager**
M. Sato, T. Hirose, T. Ohki, H. Sato, K. Sawaya, K. Mizuno

TH4A-02: **A Broadband 42–63 GHz Amplifier Using 0.13 microns CMOS Technology**
T. Wang, H. Wang

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TH4A-03: **On Compact HBT RF Noise Modeling**
M. Rudolph, P. Heymann

TH4A-04: **Ultra-Low-Power X-band SiGe HBT Low-Noise Amplifiers.**
P. Roux, Y. Baeyens, J. Weiner, Y. Chen

TH4A-05: **A SiGe-BiCMOS UWB Receiver for 24 GHz Short-Range Automotive Radar Applications**
H. Veenstra, E. van der Heijden, M. Notten, G. Dolmans

TH4A-06: **A 108 GHz CMOS Low-Noise Amplifier Using Parallel-Resonant Inductor**
K. Sun, Z. Tsai, K. Lin, H. Wang

TH4B High Reliability RF-MEMS Switches
Chair: N. Scott Barker
Co-chair: Dimitrios Peroulis

This session covers the design of RF-MEMS switches for high-power handling and/or high reliability.

TH4B-01: **High-Power High-Reliability Sub-Microsecond RF MEMS Switched Capacitors**
B. Lakshminarayanan, G.M. Rebeiz

TH4B-02: **High-Cycle Life Testing of RF MEMS Switches**
C.L. Goldsmith, D.I. Forehand, Z. Peng, J.C. Hwang

TH4B-03: **Hot-Switching Test of Non-Contact Type MEMS Switches**
E. Shim, J. Park, W. Choi, Y. Kim, U. Kim, Y. Kwon, D. Cho

TH4B-04: **A Novel Warped-Beam Design that Enhances RF Performance of Capacitive MEMS Switches**
R. Al-Dahleh, R.R. Mansour

TH4B-05: **Dielectric Charging of RF MEMS Capacitive Switches under Bipolar Control-Voltage Waveforms**
Z. Peng, J. Hwang, X. Yuan, D. Forehand, C.L. Goldsmith

TH4D Novel Metamaterial Elements: Their Characteristics and Applications
Chair: Jan Zehentner • Co-chair: Kai Chang

Several new metamaterial elements have been revealed, and their characteristics have been identified, both theoretically and experimentally. These new elements are used as unit cells to create metamaterials having novel magnetic, electric or left-handed properties. Some applications for these new structures are envisaged. Experimental results confirm the behavior of the new media and the validity of the concepts.

TH4D-01: **Composite Right/Left Handed Metamaterial Structures Composed of Dielectric Resonators and Parallel Mesh Plates**
T. Ueda, T. Itoh, N. Michishita

TH4D-02: **Circuital and Experimental Demonstration of a 3D Isotropic LH Metamaterial Based on the Rotated TLM Scheme**
M. Zedler, P. Russer, C. Caloz

TH4D-03: **Isotropic Epsilon-Negative Particles**
J. Machac, P. Protiva, J. Zehentner

TH4D-04: **Theoretical and Experimental Analysis of Magnetic Inclusions for the Realization of Metamaterials at Different Frequencies**
F. Bilotti, A. Toscano, L. Vegni, K. Aydin, K.B. Alici, E. Ozbay

TH4D-05: **Band-Pass Filtering by Below Cut-off Waveguides Loaded with Split-Ring Resonators: Relevance to the Lefthandedness**
E. Semouchkina, S. Mudunuri, G. Semouchkin, R. Mittra

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TH4E Submillimeter-wave Radio Astronomy and Mauna Kea
Special Session

Chair: Paul Goldsmith
Co-chair: Peter H. Siegel

The historic role that Mauna Kea has played in the development of radio astronomy as well as the historic role that radio astronomy has played in the MTT society will be highlighted in this very special focus session on submillimeter-wave instrumentation, techniques and astronomy. A wide range of talks will cover both current topics in millimeter- and submillimeter-wave astronomy and technology, as well as a look backwards at some of the major contributions this field has had in microwave theory and techniques. The session chair and co-chair are active long time members of the radio astronomy community and past participants in this conference series.

TH4E-01: **Submillimeter Astronomy and Mauna Kea—An Overview**
P.F. Goldsmith

TH4E-02: **The Caltech Submillimeter Observatory**
T.G. Phillips

TH4E-03: **Submillimeter Astronomy with the James Clerk Maxwell Telescope**
G. Davis, A. Chrysostomou

TH4E-04: **The Submillimeter Array**
R. Blundell

TH4E-05: **Technology for Submillimeter Astronomy**
J. Zmuidzinas

TH4F Phased-Array Systems and Enabling Technologies
Chair: William R. Deal
Co-chair: Ryan Miyamoto

Phased array antennas are the building block of radar and advanced communications systems. Critical issues for a phased array system are component performance, size, weight and power. Phased array architecture topics in this session include a phased array using true-time delay MMICs, and advanced techniques for achieving beam-steering or phase and phase shifter elements using injection locking, and a beam-steering antenna using a piezoelectric transducer. Finally, a compact and lightweight wafer level packaged (WLP) 4-element array which integrates antenna, phase shifter and power amplifier in a hermetic GaAs package.

TH4F-01: **Wideband Antenna Arrays with Reconfigurable Beamforming and Beamshaping**
A. Ouacha, R. Erickson, R. Gunnarsson, B. Carlegrim, C. Samuelsson, S. Leijon

TH4F-02: **A Monopulse Rotman Lens Phased Array for Enhanced Angular Resolution**
L. Schulwitz, A. Mortazawi

TH4F-03: **An Active Electronic Ka-band Antenna Beam-Forming Network-based on Injection-Locked Local Oscillators**
H. Grubinger, H. Barth, R. Vahldieck

TH4F-04: **Wafer Level Integrated Antenna Front End Module For Low Cost Phased Array Implementation**
J.M. Yang, Y. Chung, M. Nishimoto, M. Battung, T. Long, P. Chang-chien, K. Tornquist, M. Siddiqui, R. Lai

TH4F-05: **A Two-Dimensional Beam Scanning Antenna Array Using Composite Right/Left Handed Microstrip Leaky-Wave Antennas**
D. Lee, S. Lee, Y. Kwon, C. Cheon

TH4F-06: **20 GHz to 40 GHz Beam Shaping/ Steering Phased Antenna Array System using Fermi Tapered Slot Antenna**
L. Yang, C.W. Domier, N.C. Luhmann, N. Ito, A. Mase

TH4G New Developments in Transformers and Inductors
Chair: Jesse Taub • Co-chair: Tapan K. Sarkar

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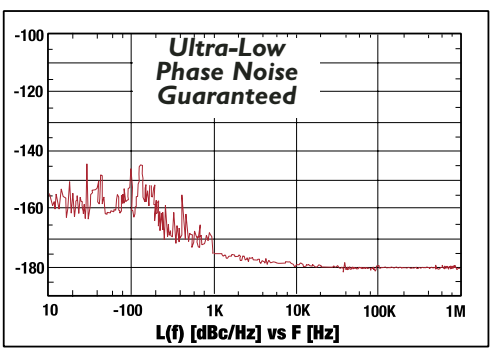

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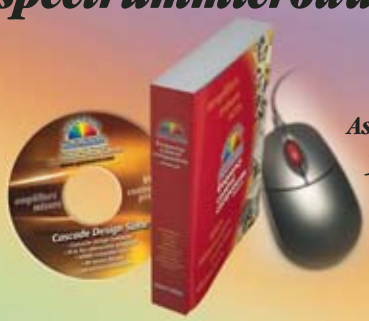

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This session begins with papers on novel techniques for lumped element and distributed broadband transformers. This is followed by novel inductor designs and manufacturing processes applicable to a variety of integrated circuits.

TH4G-01: **Broadband Impedance Transformer Based on Asymmetric Coupled Transmission Lines in Nonhomogeneous Medium**
V. Zhurbenko, V. Krozer, P. Meincke

TH4G-02: **High Performance 3-D Helical RF Transformers**
D. Weon, S. Mohammadi

TH4G-03: **Fully Embedded 2.4 GHz LC-Balun into Organic Package Substrate with Series Resonant Tank Circuit**
J. Park, H. Seo, J. Park

TH4G-04: **High-Q Solenoidal Inductive Elements**
Z. Feng, M.B. Steer, C.A. Bower, J. Carlson, M. Lueck, D. Temple

TH4G-05: **Symmetric Monolithic T-coils for Broadband IC Design**
M.T. Reiha, J.R. Long

TH4G-06: **High Value Passive Component Integration in LTCC Technology**
E.E. Hoppenjans, W.J. Chappell

2:00 PM TO 4:00 PM

THP1 THURSDAY INTERACTIVE FORUM I

Chair: Eric Bryerton
Co-chair: Michael Forman

THP1A FIELD ANALYSIS AND GUIDED WAVES

THP1A-01: **Transient Analysis of Mode Structures and Quantification of Crosstalk in Printed Metal Strips**
S. Ahmed, D. Linton

THP1A-02: **Rigorous Mode Matching Method for Circular to Off-Centre-Rectangular Side-Coupled Waveguide Junctions**
J. Zheng, M. Yu

THP1A-03: **Modeling of Spurious Coupling Between Modes in Metal Packages and Embedded Circuits**
T. Bolz, S. Held, M. Neinhus, A. Beyer, K. Solbach

THP1A-04: **Analysis of Post-Wall Waveguide by H-Plane Planar Circuit Approach**
M. Kishihara, K. Yamane, I. Ohta

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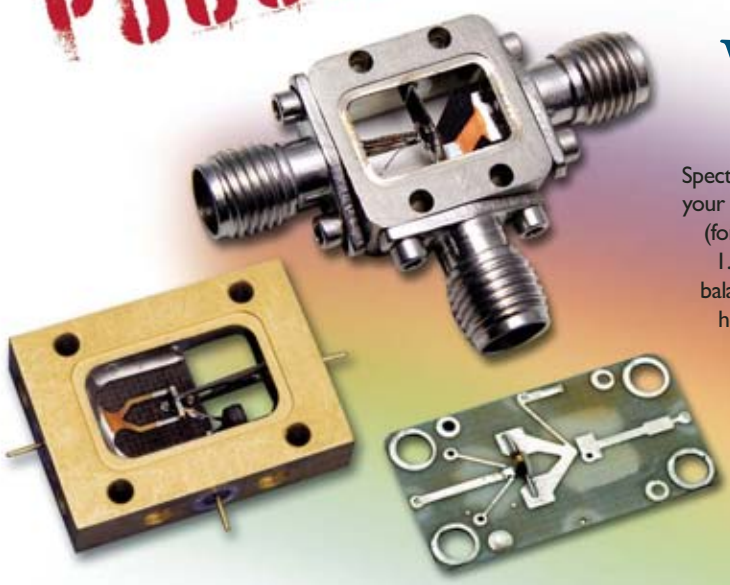

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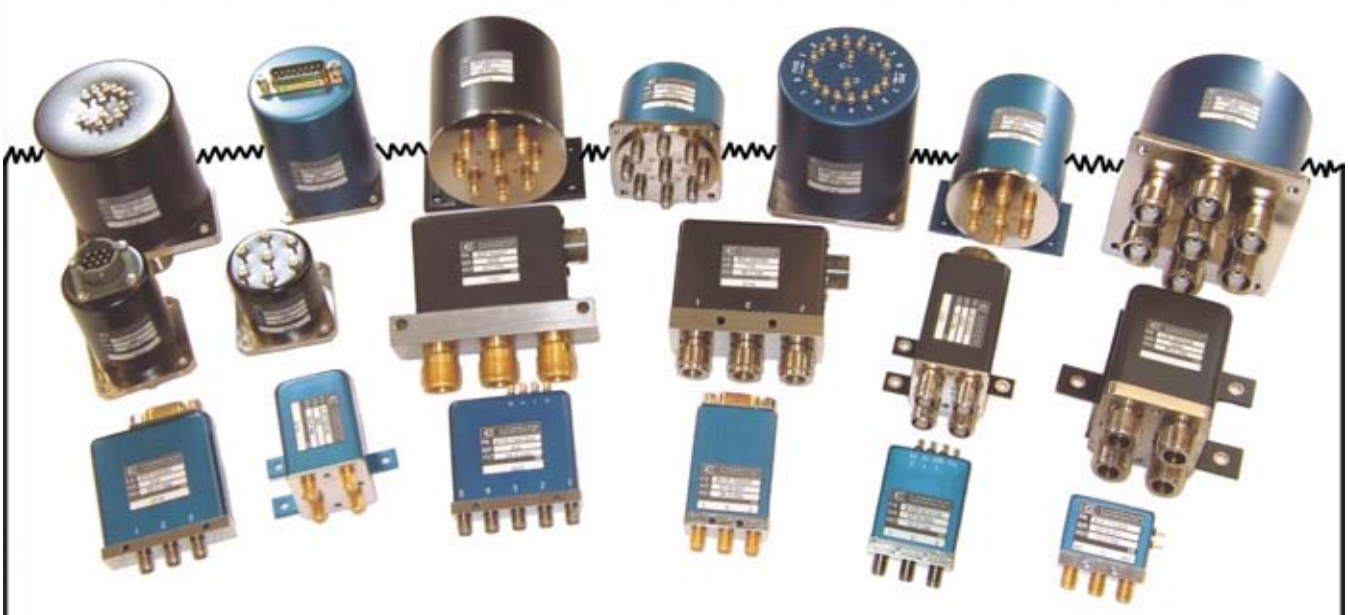

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Microwave Link Antenna Aiming

Operating at high frequencies, microwave antennas need to be aimed precisely or the connection is lost. Worse, you may violate local laws with stray signals. Antennas are typically located high on buildings or towers for maximum line-of-sight range. All this makes aiming a delicate yet tedious task you want to get done with as quickly as you can.

Microwave antenna aiming is a breeze with the Anritsu Spectrum Master MS2724B...
See other side.

FIELD REFERENCE COLLECTOR CARD

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Cellular Fifth Harmonic Measurements

A high harmonic, even though it may be out of the range measurable by many electronic instruments, can violate legal limits. In some regions, CDMA cell phone carriers test for interference as high as the fifth harmonic—far beyond the range of most handheld spectrum analyzers.

See other side **for 2 easier ways to test it with the Anritsu Spectrum Master MS2723B...**

FIELD REFERENCE COLLECTOR CARD

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AM Broadcast Proofing

Measurement required in the USA to prove broadcast signals meet regulatory requirements. Traditional method: Lug bench top analyzer and AC generator to job site. Using a notch filter, take measurements of carrier and six different measurements on the sidebands. Correct reading for attenuation of the notch filter. Try to convince FCC inspector you did it right.

Or do it with the Anritsu Spectrum Master MS2721B... no external notch filter required. ***See other side.***

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9 kHz to 7.1 GHz

The new generation of our flagship Spectrum Master ... ideal for broadcast measurements (including new digital standards), wireless LAN and cellular signals (including WiMAX), and wireless medical patient monitoring systems.

- Dynamic Range >100 dB typical
- Low Phase Noise (-100 dBc/Hz at 10 kHz offsets)
- DANL of < -163 dBm in a 1 Hz RBW at 1 GHz

Spectrum Master MS2723B
9 kHz to 13 GHz

The performance you need for the most demanding measurements in harsh RF and physical environments, perfectly suited for microwave links and satellite verification. Excellent for 3G base station harmonic measurements.

- Dynamic Range >106 dB typical
- Low Phase Noise (-104 dBc/Hz at 10 kHz offset at 2 GHz)
- DANL of < -154 dBm in a 1 Hz RBW at 4 GHz

Spectrum Master MS2724B
9 kHz to 20 GHz

The ultimate tool for satellite, security or commercial communications systems, this high performance handheld is ideal for spectrum monitoring, installation and testing as well as RF and microwave signal measurements.

- Dynamic Range >106 dB typical
- Low Phase Noise (-104 dBc/Hz at 10 kHz offset at 2 GHz)
- DANL of < -154 dBm in a 1 Hz RBW at 4 GHz

Find out more about the new Spectrum Master lineup... and get more FREE Collector Cards. Call 1-800-ANRITSU or visit www.anritsu.us/Cards824

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AM Broadcast Proofing with the MS2721B

Spectrum Master MS2721B
9 kHz to 7.1 GHz

1. Set spectrum analyzer span to 200 kHz centered on the AM carrier.
2. Set RBW to 300 Hz and VBW to 3 MHz.
3. Select peak detector.
4. Connect AM loop antenna to RF input and adjust antenna position to maximize received signal.
5. Set spectrum analyzer trace A to maximum hold.
6. Place reference marker on the carrier.
7. Place delta markers at ±10.2 kHz, ±25 kHz and ±75 kHz.
8. Wait 10 minutes and read marker values.

Go to www.anritsu.us/Cards824 to find out more.

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FIELD REFERENCE COLLECTOR CARD

Cellular Fifth Harmonic Measurements with the MS2723B

Spectrum Master MS2723B
9 kHz to 13 GHz

Method 1.

1. Set center frequency to cover the fundamental frequency with a span of 6 MHz.
2. Set RBW to auto.
3. Use channel power measurement to get the integrated signal power and record the value for each measurement.
4. Set the CF to tune to each harmonic and record the amplitude.

Method 2.

1. Select channel scanner mode and set 6 channels to be received.
2. Set channel width to 3.4 MHz.
3. Set channel 1 to the fundamental signal.
4. Set channel spacing to the fundamental signal frequency.
5. Measure the fundamental signal amplitude on channel 1 and the harmonics on channels 2 through 6.

Go to www.anritsu.us/Cards824 to find out more.

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FIELD REFERENCE COLLECTOR CARD

Microwave Link Antenna Aiming with the MS2724B

Spectrum Master MS2724B
9 kHz to 20 GHz

1. Set the far end to transmit a CW signal at the center frequency.
2. Set RBW and VBW to auto.
3. Tune spectrum analyzer to place the CW signal on the display.
4. Carefully rotate the antenna to get maximum signal.
5. Set antenna elevation to maximize the signal.
6. Repeat steps 4 and 5 to make sure the antenna is precisely aimed.
7. If necessary, move to the far end of the link and repeat steps 1 through 5 to be sure both antennas are properly aimed.

Go to www.anritsu.us/Cards824 to find out more.

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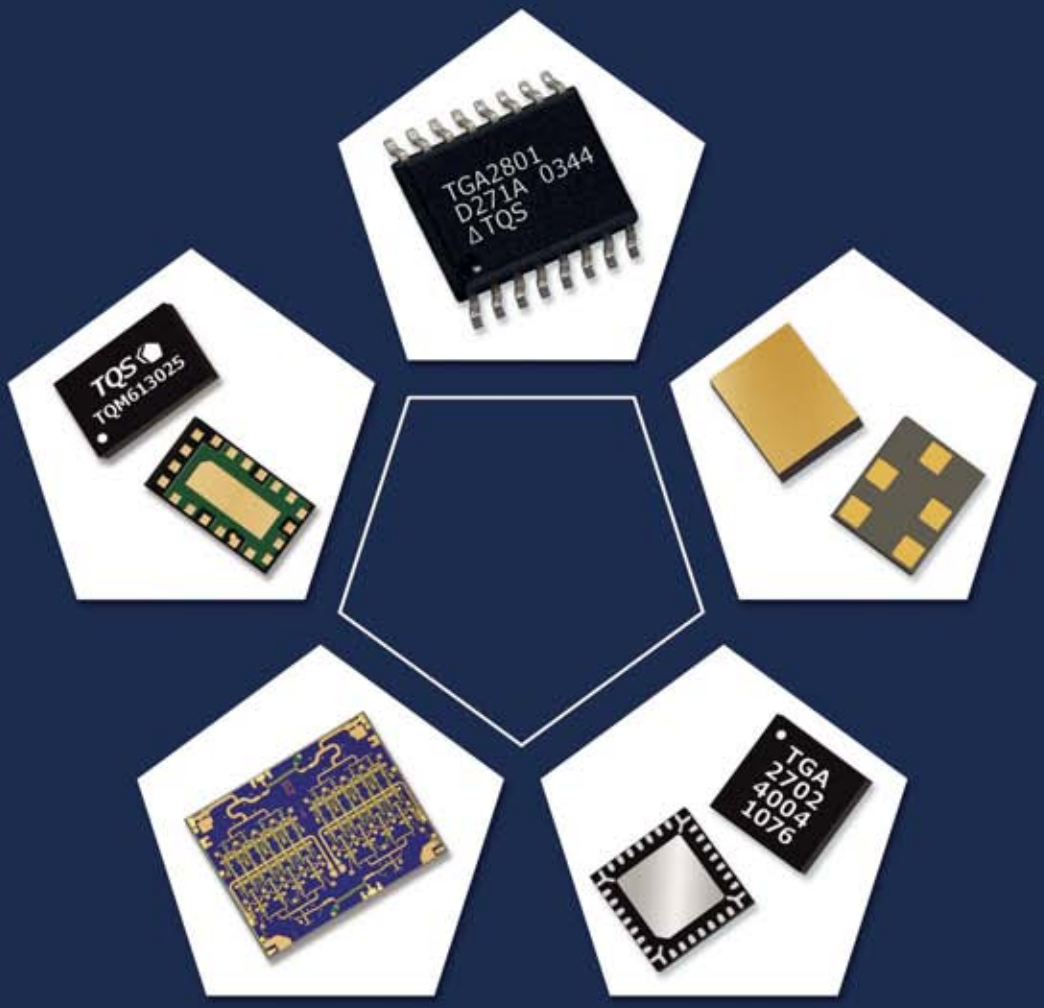

PRODUCT SELECTION GUIDE

MAY 2007

AMPLIFIERS • GAIN BLOCKS • LOW NOISE AMPLIFIERS • DISCRETE TRANSISTORS

SWITCHES • FREQUENCY CONVERTERS & MIXERS • OPTICAL COMPONENTS

CONTROL PRODUCTS • INTEGRATED PRODUCTS • FILTERS

TriQuint SEMICONDUCTOR

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

ABOUT TRIQUINT SEMICONDUCTOR

Corporate Headquarters – Hillsboro, OR

TriQuint Semiconductor is a leading supplier of high-performance RF components used by global customers to design and manufacture leading-edge communications networks and devices. TriQuint products are based on expertise in key process technologies that include Gallium Arsenide (GaAs), Surface Acoustic Wave (SAW) and Bulk Acoustic Wave (BAW). Our leadership in these areas enables TriQuint to offer customers a unique portfolio of products that are matched to the demanding requirements of *Connecting the Digital World to the Global Network®*.

TriQuint is headquartered in Hillsboro, Oregon and has three additional design and manufacturing centers in North America, plus design centers in New England, North Carolina and Munich. Additional field application support and sales offices are located throughout the world. We are also represented by a global network of sales professionals who serve the needs of our customers wherever they are located.

TriQuint's heritage in custom design applications makes us one of the world's leading GaAs foundries; serving the custom circuit needs of companies large and small. Through our years of process and product development, TriQuint has amassed a large portfolio of innovative devices ideally suited to the needs of the communications designers and manufacturers. The process technologies used to make many of the power amplifiers, switches, SAW and BAW filters in use around the world today were developed initially in TriQuint laboratories.

TriQuint has brought all of its standard products together into one easy-to-use Product Selection Guide. Here you will find a wide variety of products to suit your needs, from DC to 100 GHz. When designing new products or looking for a new spin on an established design, you can depend on our uncompromising quality and superior service. Take a look through our Product Selection Guide and discover just how easy it is to include high-performance, quality products from TriQuint in your next design.

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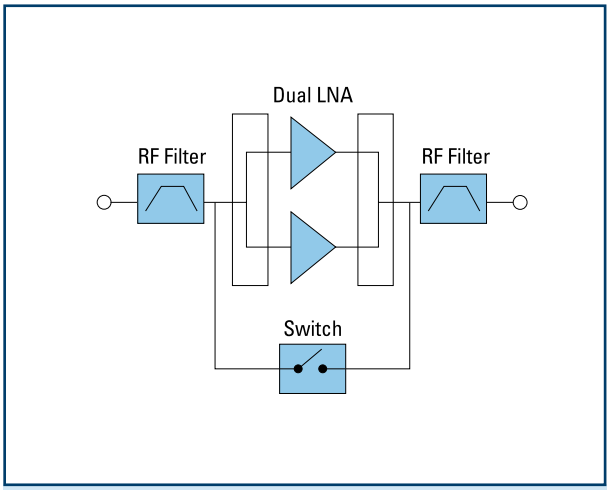
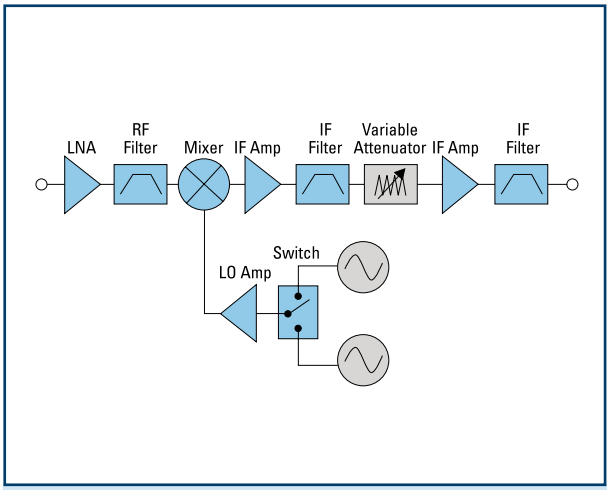
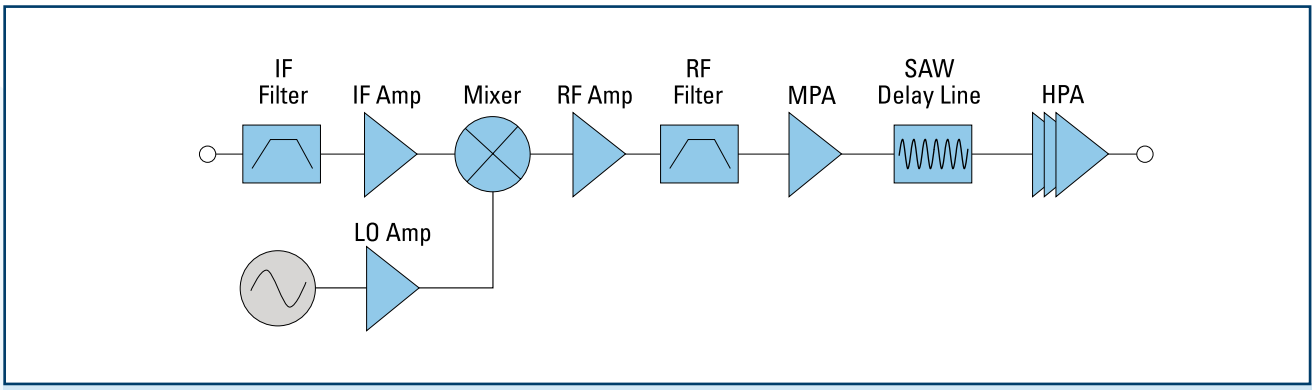


Tower Mounted LNA



Base Station Receiver



Base Station Transmitter and PA

BASE STATION AMPLIFIERS

Description	Frequency Range (GHz)	P1dB / OIP3 (dBm)	Gain (dB)	NF / PAE (dB) / (%)	Voltage / Current (V / mA)	Package Style	Part Number
Gain Block	0.8 - 2.5	17 / 27	16	4.1 / –	5 / 85	SO-8	TQ9132
MESFET	DC - 2.5	26.5 / –	11	1.72 / 55	2 - 6 / 350	SOT-223	CLY5
MESFET	DC - 3	23.5 / –	15.5	1.48 / 55	2 - 6 / 180	MW6	CLY2
0.5W HFET	DC - 6	28 / 40	18	3.2 / –	8 / 100	SOT89	***TGF2960-SD****
1W HFET	DC - 6	31 / 43	16	4 / –	8 / 200	SOT89	***TGF2961-SD****

*NOTES: * = New*

BASE STATION LOW NOISE AMPLIFIERS

Description	Frequency Range (GHz)	P1dB / IIP3 (dBm)	Gain (dB)	NF / PAE (dB) / (%)	Voltage / Current (V / mA)	Package Style	Part Number
MESFET	DC - 2.5	26.5 / –	11	1.72 / 55	2 - 6 / 350	SOT-223	CLY5
MESFET	DC - 3	23.5 / –	15.5	1.48 / 55	2 - 6 / 180	MW6	CLY2
LNA, Discrete	DC - 4	– / 13	17	0.5 / –	3 / 30	SOT-343	CFH800
LNA, Balanced FET	0.8 - 3	21 / 11	22	0.7 / –	4 / 100	SM-02-6	TGA2602-SM

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BASE STATION SWITCHES

Description	Frequency (GHz)	Insertion Loss (dB)	Isolation (dB)	P1dB (dBm)	Control Voltage (V)	Package Style	Part Number
SP3T High Power CDMA	DC - 2	0.45	28	>36.5	2.6 / 0	MLP12	TQP4M3018
SP3T High Power CDMA	DC - 2	0.6	22	>34.5	2.6 / 0	STSLP12	TQP4M3019
SP2T General Purpose	DC - 2.5	0.3	24	30	3 / 0	SOT-363	CSH210R
SP4T High Power EDGE, Dec.	DC - 4.5	0.5	33	38	2.7 / 0	SLIM17	TQP4M4010
SPDT High Power GSM	DC - 6	0.5	27	37	2.5 / 0	SLIM7	TQP4M4003
SP2T 802.11a/b/g	DC - 6	0.6	28	31.5	3 / 0	SLIM7	TQS5200
Diversity Switch 802.11a/b/g	DC - 6	0.8	33	33	3 / 0	MLP12	TQS5202

NOTES: Dec. = Integrated Decoder

BASE STATION MIXERS

Description	RF Frequency Range (GHz)	Conversion Gain (dB)	LO / RF Isolation (dB)	IIP3 (dBm)	Voltage / Current (V / mA)	Package Style	Part Number
WB Mixer, LO	0.5 - 2.5	-5.7	8	24	3 - 6 / 6	MW6	CMY210
WB Mixer, LO, IF	0.5 - 2.5	10	8	9	3 - 6 / 12	SCT598	CMY212
WB Mixer, LO, IF, Low Current	0.5 - 2.5	9.5	10	10	3 - 6 / 8	SCT598	CMY213

NOTES: LO = LO Amplifier, IF = IF Amplifier

BASE STATION RF FILTERS

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
FRS RF or GPS IF Filter	465	6	1.43	SE / SE	40 @ 445.00	3.0 x 3.0	856288
RF Filter, Cell Band	836.5	25	1.8	SE / SE	30 @ 869.00	3.0 x 3.0	855779
RF Filter, Cell Band	836.5	25	1.9	SE / SE	35 @ 869.00	3.0 x 3.0	855821
Duplexer, Cell Band	836.5 / 881.5	25 / 25	2 / 2.4	SE / SE	–	3.8 x 3.8	856563
RF Filter, Cell Band	881.5	25	2.7	SE / SE	40 @ 849.00	3.0 x 3.0	855728
RF Filter, Cell Band	881.5	25	1.8	SE / SE	35 @ 849.00	3.0 x 3.0	855782
RF Filter, EGSM	897.5	35	1.9	SE / SE	14 @ 930.00	3.0 x 3.0	***856671****
RF Filter, EGSM	942.5	35	2	SE / SE	5 @ 915.00	3.0 x 3.0	855820
RF Filter, EGSM	942.5	35	3.2	SE / SE	12 @ 915.00	3.0 x 3.0	855810
RF Filter, EGSM	942.5	35	2.5	SE / SE	25 @ 915.00	3.0 x 3.0	856528
RF Filter, DCS	1747.5	75	2	SE / SE	22 @ 1676.00	3.0 x 3.0	***856654****
RF Filter, DCS	1842.5	75	1.9	SE / SE	10 @ 1785.00	3.0 x 3.0	855860
RF Filter, PCS	1880	60	2.4	SE / SE	7 @ 1930.00	3.0 x 3.0	855849
RF Filter, PCS	1880	60	2.8	SE / SE	30 @ 1930.00	3.0 x 3.0	856530
RF Filter, UMTS	1950	60	2.2	SE / SE	40 @ 2110.00	3.0 x 3.0	856532
RF Filter, PCS	1960	60	2.1	SE / SE	10.3 @ 1910.00	3.0 x 3.0	855817
RF Filter, PCS	1960	60	2.3	SE / SE	8 @ 1910.00	3.0 x 3.0	855850
RF Filter, PCS	1960	60	2.9	SE / SE	15 @ 1910.00	3.0 x 3.0	855859
RF Filter, PCS	1960	60	2.25	SE / SE	14 @ 1910.00	3.0 x 3.0	856531
UMTS Delay Filter	2140	60	25	SE / BAL	N/A	7.0 x 5.5	856059
RF Filter, UMTS	2140	60	3.2	SE / SE	33 @ 1980.00	3.0 x 3.0	855937

*NOTES: *** = New***

BASE STATION IF FILTERS

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
CDMA IF Filter	69.99	1.26	19	SE / BAL	35 @ 1.50	DIP	854550-1
CDMA IF Filter	69.99	1.26	17.1	SE / SE	25 @ 1.68	24.6 x 9.0	856199
CDMA IF Filter	70	1.26	19	SE / BAL	35 @ 1.50	DIP	854747-1
CDMA IF Filter	73.59	1.2	11.9	SE / SE	45 @ 79.58	19.0 x 6.5	856111
GSM IF Filter	86.6	0.4	5.3	SE / BAL	28 @ 1.58	19.0 x 6.5	854823
GSM IF Filter	87	0.4	4.4	BAL / BAL	28 @ 1.59	19.0 x 6.5	855500
CDMA IF Filter	114.99	1.4	21.5	SE / SE	50 @ 6.00	DIP	854733-1
CDMA IF Filter	114.99	1.4	21.1	SE / SE	50 @ 6.00	20.1 x 9.8	855783
CDMA IF Filter	118.58	3.69	17.4	SE / SE	43 @ 123.48	13.3 x 6.5	855958
GSM IF Filter	125	0.4	5.9	SE / SE	20 @ 2.40	9.1 x 4.8	856444
Low Loss IF Filter	140	10	11	SE / SE	35 @ 15.00	13.3 x 6.5	***856656****
Low Loss IF Filter	140	15	11	SE / SE	35 @ 22.00	13.3 x 6.5	***856684****

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GUIDE BY MARKET – BASE STATION

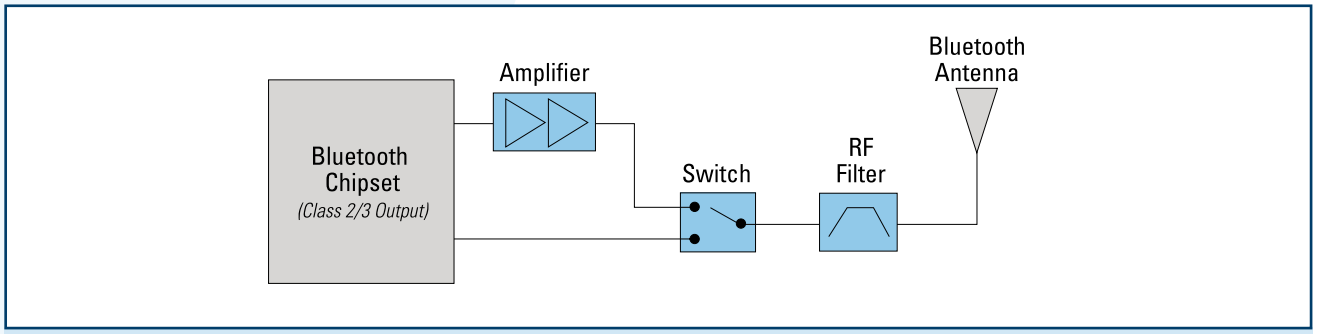
BASE STATION IF FILTERS *(cont.)*

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
Low Loss IF Filter	140	20	11	SE / SE	35 @ 24.00	13.3 x 6.5	856592
CDMA IF Filter	141	1.18	11.7	SE / SE	42.5 @ 2.50	19.0 x 6.5	855395
CDMA IF Filter	150	1.18	18.6	SE / BAL	30 @ 4.50	19.0 x 6.5	854833-1
CDMA IF Filter	150	8	12.1	SE / SE	35 @ 14.25	13.3 x 6.5	855678
CDMA IF Filter	153.6	3.75	12.04	SE / SE	45 @ 9.80	13.3 x 6.5	856048
CDMA IF Filter	160	1.18	19.5	SE / BAL	30 @ 4.50	19.0 x 6.5	855049
GSM IF Filter	160	0.2	3.3	BAL / BAL	30 @ 12.00	7.0 x 5.5	855626
CDMA IF Filter	167.1	1.18	10.9	SE / SE	15 @ 2.00	19.0 x 6.5	855394
CDMA IF Filter	167.1	11	13.1	SE / SE	40 @ 16.00	13.3 x 6.5	855753
WCDMA IF Filter	168.96	3.84	11.5	SE / SE	30 @ 16.00	9.1 x 4.8	856320
WCDMA IF Filter	169	4	10.4	SE / SE	40 @ 10.00	9.1 x 4.8	855927
GSM IF Filter	170.6	0.3	7.6	SE / BAL	40 @ 1.60	15.3 x 6.5	855756
GSM IF Filter	170.6	0.18	5.6	SE / SE	47 @ 6.40	13.3 x 6.5	856447
WCDMA IF Filter	172.8	8.84	12.5	SE / BAL	32 @ 16.00	7.0 x 5.5	856620
GSM IF Filter	175	0.66	6.5	SE / BAL	30 @ 2.38	13.3 x 6.5	854622
WCDMA IF Filter	190	5.5	9.8	SE / BAL	30 @ 7.60	13.3 x 6.5	855529
WCDMA IF Filter	190	5	8	SE / SE	25 @ 9.00	5.0 x 5.0	855770
GSM IF Filter	190	0.2	4.2	BAL / BAL	30 @ 12.00	7.0 x 5.5	855625
WCDMA IF Filter	190	3.84	10	SE / SE	30 @ 7.75	7.0 x 5.5	856386
GSM IF Filter	199	0.2	6	SE / SE	45 @ 1.60	19.0 x 6.5	855131
GSM IF Filter	199	0.5	6.8	SE / SE	30 @ 47.00	13.3 x 6.5	855780
GSM IF Filter	201	0.22	6.1	BAL / BAL	27 @ 0.80	13.3 x 6.5	856541
GSM IF Filter	208	0.4	5.9	SE / SE	20 @ 2.40	9.1 x 4.8	856445
WCDMA IF Filter	208	3.84	11.5	BAL / BAL	17 @ 5.03	9.1 x 4.8	856496
GSM IF Filter	211	0.2	5.2	SE / SE	25 @ 0.80	13.3 x 6.5	856378
WCDMA IF Filter	230	4	16.2	SE / SE	40 @ 10.00	13.3 x 6.5	855832
CDMA IF Filter	240	3.6	14.3	SE / SE	12 @ 5.00	13.3 x 6.5	855992
CDMA IF Filter	240	1.1	13	SE / SE	10 @ 1.80	19.0 x 6.5	856151
CDMA IF Filter	249.6	3.84	16.11	SE / SE	40 @ 11.00	7.0 x 5.5	855915
WCDMA IF Filter	261.1	3.84	9.2	SE / SE	15 @ 8.032	13.3 x 6.5	855787
CDMA IF Filter	326.4	15	12.61	SE / SE	40 @ 25.00	7.0 x 5.5	855914
WCDMA IF Filter	380	5.4	15.4	SE / BAL	30 @ 8.30	13.3 x 6.5	855530
WCDMA IF Filter	380	3.84	12	SE / SE	30 @ 8.30	9.1 x 4.8	856392
WCDMA IF Filter	398	4.3	9.9	SE / SE	50 @ 36.00	9.1 x 4.8	855561
WCDMA / WiMAX IF Filter	398	15	7.5	SE / SE	30 @ 60.00	9.1 x 4.8	855559
WCDMA IF Filter	398	35	12	SE / SE	50 @ 368.00	9.1 x 4.8	856097

NOTES: **** = New***

The filters in the previous table represent a fraction of the total number of base station filters available from TriQuint.
If you are unable to locate the filter you need, please contact your local sales representative or the factory for more information.

GUIDE BY MARKET – BLUETOOTH



Bluetooth Application

GUIDE BY MARKET – BLUETOOTH

BLUETOOTH SWITCHES

Description	Frequency (GHz)	Insertion Loss (dB)	Isolation (dB)	P1dB (dBm)	Control Voltage (V)	Package Style	Part Number
SP2T General Purpose	DC - 2.5	0.3	24	30	3 / 0	SOT-363	CSH210R
SP2T 802.11a/b/g	DC - 6	0.6	28	31.5	3 / 0	SLIM7	TQS5200

BLUETOOTH RF FILTERS

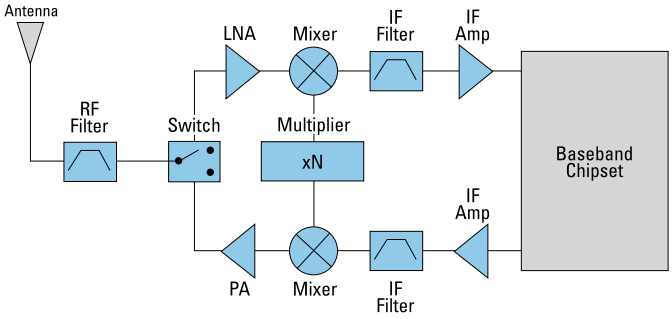
Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
Bluetooth RF Filter	2441	83.5	2	SE / SE	20 @ 2300.00	1.4 x 1.2	856539
Bluetooth RF Filter	2441	83.5	2.7	SE / BAL	40 @ 2170.00	1.4 x 1.2	856548
Bluetooth RF Filter	2441	83.5	2.8	SE / SE	26 @ 2200.00	3.0 x 3.0	855916
Bluetooth RF Filter	2441	83.5	2.5	SE / SE	20 @ 2300.00	1.5 x 1.5	856486
Bluetooth RF Filter	2441	83.5	2.7	SE / BAL	35 @ 2250.00	1.5 x 1.5	856435
Bluetooth RF Filter	2441	83.5	3	SE / SE	15 @ 2200.00	2.0 x 2.0	856166
Bluetooth & GPS Filter	2441 / 1575.42	83.5 / 2	2 / 1.2	SE / SE	–	2.0 x 1.5	856646

BLUETOOTH POWER AMPLIFIERS

Description	Frequency Range (GHz)	P1dB (dBm)	Gain (dB)	PAE (%)	Voltage / Current (V / mA)	Package Style	Part Number
Bluetooth PA	DC - 2.5	22.5	26	50	0 - 5.5 / 200	SLIM-7	CGB241
Bluetooth PA	DC - 2.5	22.5	26	50	0 - 5.5 / 200	MSOP-10	CGB240
Bluetooth Class 1 PA	2.4 - 2.5	21.5	27	50	0 - 3.3 / 160	STSLP-12	TQP770001
ISM Band Matched PA, PD	2.4 - 2.5	25	30	–	3.3 / 200	VQFN-16	TQP777002

NOTES: PD = Power Detector

GUIDE BY MARKET – BWA / WiMAX



Broadband Transceiver

BWA / WiMAX AMPLIFIERS

Description	Frequency Range (GHz)	P1dB / OIP3 (dBm)	Gain (dB)	NF (dB)	Voltage / Current (V / mA)	Package Style	Part Number
0.5W HFET	DC - 6	28 / 40	18	3.2	8 / 100	SOT89	***TGF2960-SD****
1W HFET	DC - 6	31 / 43	16	4	8 / 200	SOT89	***TGF2961-SD****
WiMAX Driver Amp / PA, SB	2.3 - 2.8	29 / 40	28	–	6 / 710	SM-05-28	TGA2702-SM
ISM Band Matched PA, PD	2.4 - 2.5	25 / –	30	–	3.3 / 200	VQFN-16	TQP777002
10W HPA, HFET	2.6	40 / 51	12	–	8 / 1200	SG-A4-2	TGA2924-SG
10W HPA, HFET	3.3 - 3.8	40 / 51	9	–	7 - 9 / 1200	SG-A3-2	TGA2923-SG
WiMAX Driver Amp / PA, SB	3.4 - 3.8	30 / 42	24	–	6 / 770	SM-05-28	TGA2703-SM
5W HPA, HFET	3.5	37.5 / 49	11	–	8 / 750	SG-A4-2	TGA2925-SG
4W HPA, HFET	4.9 - 6	36 / –	11	–	7 - 9 / 700 - 800	SG-A2-2	TGA2921-SG
2W HPA, HFET	4.9 - 6	34 / 47	11	–	7 - 9 / 480	SG-A2-2	TGA2922-SG

*NOTES: *** = New**, SB = Self Biased, PD = Power Detector*

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BWA / WiMAX LOW NOISE AMPLIFIERS

Description	Frequency Range (GHz)	P1dB / IIP3 (dBm)	Gain (dB)	NF (dB)	Voltage / Current (V / mA)	Package Style	Part Number
LNA, Dual-Band	2.4 / 4.9 - 6	8 / 6, 12.5 / 1	16.5, 22.5	1.2, 1.5	3.3 / 11.5, 3.3 / 18.5	VQFN12	TQM3M7001
LNA	4.9 - 6	5 / -3	18	1.3	3.0 / 8	SLIM-7	TQL5000

BWA / WiMAX SWITCHES

Description	Frequency (GHz)	Insertion Loss (dB)	Isolation (dB)	P1dB (dBm)	Control Voltage (V)	Package Style	Part Number
SP2T General Purpose	DC - 2.5	0.3	24	30	3 / 0	SOT-363	CSH210R
SP4T High Power EDGE, Dec.	DC - 4.5	0.5	33	38	2.7 / 0	SLIM17	TQP4M4010
SPDT High Power GSM	DC - 6	0.5	27	37	2.5 / 0	SLIM7	TQP4M4003
SP2T 802.11a/b/g	DC - 6	0.6	28	31.5	3 / 0	SLIM7	TQS5200

NOTES: Dec. = Integrated Decoder

BWA / WiMAX FILTERS

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
BWA IF Filter	70	8	12.95	SE / SE	35 @ 3.20	13.3 x 6.5	855677
BWA IF Filter	80	8	11.7	SE / SE	35 @ 14.25	13.3 x 6.5	855679
BWA IF Filter	240	2	9.8	SE / BAL	45 @ 10.50	7.0 x 5.5	855091
BWA IF Filter	240	10	11	SE / BAL	40 @ 35.00	7.0 x 5.5	855092
BWA IF Filter	280	34	8.2	BAL / BAL	45 @ 15.00	7.0 x 5.5	855393
BWA IF Filter	280	17	8.95	SE / BAL	38 @ 60.00	5.0 x 5.0	855975
WiMAX IF Filter	325	10	9.6	BAL / BAL	40 @ 35.00	7.0 x 5.5	855094
BWA IF Filter	330	5.45	18.26	SE / SE	50 @ 13.60	15.3 x 6.5	855730
BWA IF Filter	350	2.4	13.1	SE / BAL	35 @ 12.00	7.0 x 5.5	855398
BWA IF Filter	350	1.7	13.7	SE / BAL	45 @ 6.00	13.3 x 6.5	855399
BWA IF Filter	350	1	8.2	SE / BAL	45 @ 15.00	7.0 x 5.5	855377
WiMAX IF Filter	374	10	9	BAL / BAL	10 @ 25.00	3.8 x 3.8	856466
WiMAX IF Filter	380	13.75	9.4	SE / SE	40 @ 367.00	7.0 x 5.5	856272
General Purpose IF Filter	380	3.75	10	SE / SE	35 @ 8.00	7.0 x 5.5	856279
WiMAX IF Filter	380	3.75	11	BAL / BAL	30 @ 8.30	7.0 x 5.5	856464
WiMAX IF Filter	380	7	10	BAL / BAL	40 @ 20.00	7.0 x 5.5	856490
WiMAX IF Filter	380	10	8.7	BAL / BAL	40 @ 36.00	7.0 x 5.5	856631
WCDMA / WiMAX IF Filter	398	15	7.5	SE / SE	30 @ 60.00	9.1 x 4.8	855559
WiMAX IF Filter	398	10	11.2	BAL / BAL	35 @ 388.50	5.0 x 5.0	856652
BWA IF Filter	426	5.16	18.02	SE / SE	50 @ 14.00	13.3 x 6.5	855731
WiMAX IF Filter	456	3.5	9.1	BAL / BAL	40 @ 6.70	7.0 x 5.5	856494
WiMAX IF Filter	456	7	12	BAL / BAL	33 @ 449.30	7.0 x 5.5	856498
WiBRO IF Filter	456	8.75	7.9	BAL / BAL	36 @ 443.25	5.0 x 5.0	856549
WiMAX IF Filter	456	10	8.3	BAL / BAL	37 @ 440.00	7.0 x 5.5	856672
WiMAX IF Filter	456	10	8.3	BAL / BAL	37 @ 440.00	5.0 x 5.0	856638
General Purpose IF Filter	460	13.75	8.2	SE / SE	40 @ 447.00	7.0 x 5.5	856273
General Purpose IF Filter	460	3.75	11.1	SE / SE	35 @ 8.00	7.0 x 5.5	856282
BWA IF Filter	479.75	9	19.5	SE / SE	35 @ 22.00	7.0 x 5.5	855271
WiMAX IF Filter	479.75	23	9.8	BAL / BAL	35 @ 36.00	7.0 x 5.5	855272
WiMAX IF Filter	580	10	10.7	BAL / BAL	40 @ 36.00	5.0 x 5.0	856665
WLAN IF Filter	770	17	3	BAL / BAL	32.5 @ 750.00	5.0 x 5.0	855942
WiMAX IF Filter	810	5	4.6	SE / SE	10 @ 26.00	3.0 x 3.0	856534
WiMAX IF Filter	810	10	3.5	SE / SE	10 @ 31.00	3.0 x 3.0	856526

GUIDE BY MARKET – CABLE

CABLE AMPLIFIERS

Description	Frequency Range (GHz)	P1dB / OIP3 (dBm)	Gain (dB)	NF (dB)	Voltage / Current (V / mA)	Package Style	Part Number
CATV TIA / Gain Block, SB	0.04 - 1	27 / 46	20	1.5	8 / 350	SM-08-20	TGA2803-SM
CATV Ultra Linear HPA	0.04 - 1	28.5 / 47	12	2.6	12 / 425	SG-01-16	TGA2801B-SG
CATV Ultra Linear HPA	0.04 - 1	31.5 / 55	12	2.75	12 / 510	SG-01-16	TGA2801D-SG

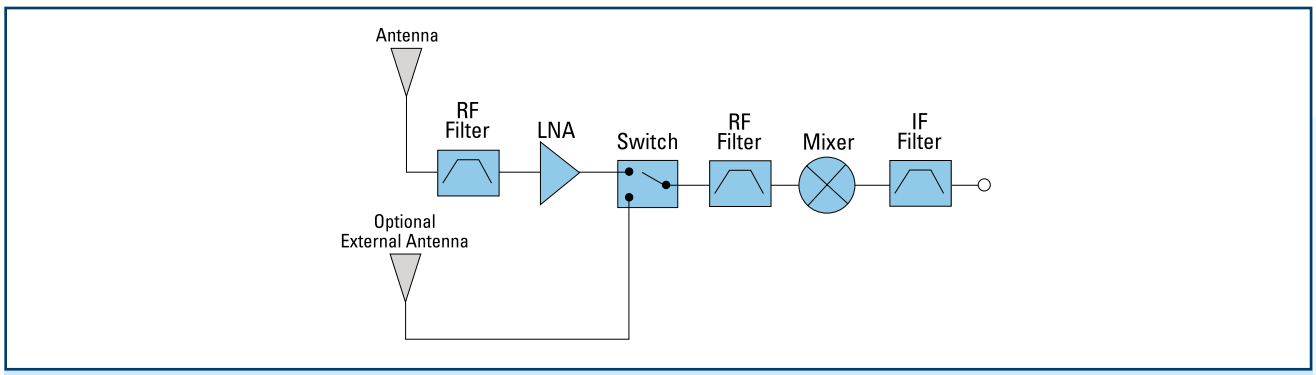
NOTES: SB = Self Biased

CABLE FILTERS

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
Cable IF Filter	36.15	8	19.7	SE / SE	38 @ 10.23	DIP	855748
Cable IF Filter	44	6	20.4	SE / SE	38 @ 7.60	DIP	855079
Cable IF Filter	44	6	20.8	SE / SE	38 @ 7.40	24.6 x 9.0	856129
Cable IF Filter	202.75	1.2	6.6	SE / SE	40 @ 10.00	13.3 x 6.5	855068
Cable IF Filter	499.25	1	7	SE / SE	35 @ 6.00	9.0 x 7.0	855104
Tuner IF Filter	1086	10	4	BAL / BAL	40 @ 1046.00	3.0 x 3.0	855964
Tuner IF Filter	1086	10	4	BAL / BAL	50 @ 1046.00	3.0 x 3.0	856257
Tuner IF Filter	1086	10	4	BAL / BAL	40 @ 1046.00	3.0 x 3.0	856330
Tuner IF Filter	1090	10	5	BAL / BAL	50 @ 1050.00	3.8 x 3.8	856096
Tuner IF Filter	1216	8	3.75	BAL / BAL	12 @ 24.00	3.0 x 3.0	856365
Tuner IF Filter	1220	10	4.5	BAL / BAL	30 @ 70.00	3.8 x 3.8	856182
Tuner IF Filter	1220	8	4.5	BAL / BAL	20 @ 1245.00	3.0 x 3.0	856183
Tuner IF Filter	1220	8	4.5	BAL / BAL	15 @ 1240.00	3.8 x 3.8	856184
Tuner IF Filter	1220	10	4.5	BAL / BAL	30 @ 60.00	3.0 x 3.0	856298
Tuner IF Filter	1220	50	3.9	BAL / BAL	33 @ 96.00	3.8 x 3.8	***856598****
Tuner IF Filter	1892	8	4.2	BAL / BAL	23 @ 1932.00	2.5 x 2.0	856236

*NOTES: * = New*

GUIDE BY MARKET – GPS



GPS RF Subsystem

GPS SWITCHES

Description	Frequency (GHz)	Insertion Loss (dB)	Isolation (dB)	P1dB (dBm)	Control Voltage (V)	Package Style	Part Number
SP2T General Purpose	DC - 2.5	0.3	24	30	3 / 0	SOT-363	CSH210R
SP2T 802.11a/b/g	DC - 6	0.6	28	31.5	3 / 0	SLIM7	TQS5200

GPS LOW NOISE AMPLIFIERS

Description	Frequency Range (GHz)	P1dB / IIP3 (dBm)	Gain (dB)	NF (dB)	Voltage / Current (V / mA)	Package Style	Part Number
LNA, Discrete	DC - 4	– / 13	17	0.5	3 / 30	SOT-343	CFH800
LNA, Balanced FET	0.8 - 3	21 / 11	22	0.7	4 / 100	SM-02-6	TGA2602-SM

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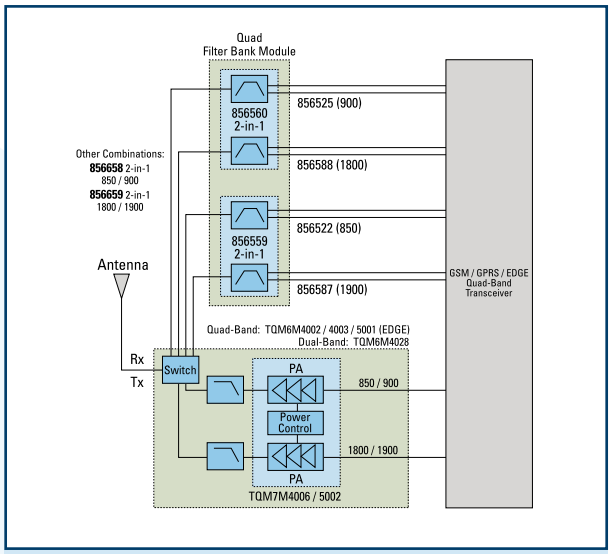
GUIDE BY MARKET – GPS

GPS FILTERS

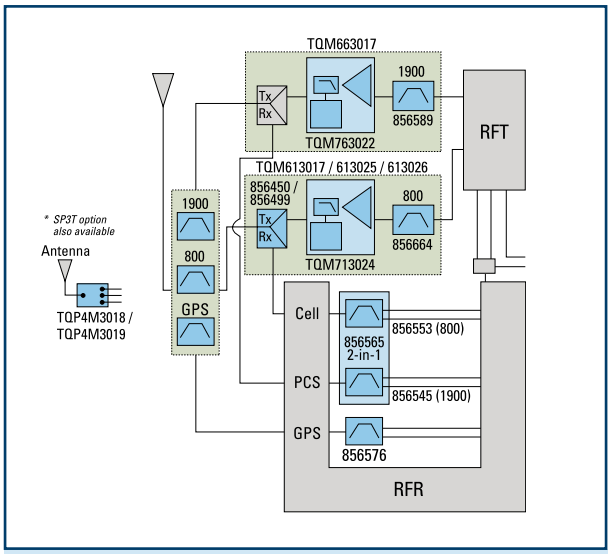
Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
GPS IF Filter	298.75	2.4	8.35	BAL / BAL	50 @ 20.00	7.0 x 5.5	856305
FRS RF or GPS IF Filter	465	6	1.43	SE / SE	40 @ 445.00	3.0 x 3.0	856288
GPS L5 RF Filter	1176	20	2.4	SE / SE	20 @ 1226.00	2.0 x 1.5	856440
GPS L2 RF Filter	1227.6	20	1.1	SE / SE	27 @ 1152.00	2.0 x 1.5	***856700****
GPS RF Filter	1575.42	2	1.3	SE / SE	30 @ 1625.00	3.0 x 3.0	855969
GPS RF Filter	1575.42	2	1.25	SE / SE	30 @ 1624.00	2.5 x 2.0	856584
GPS RF Filter	1575.42	2	1.1	SE / SE	20 @ 1628.00	2.5 x 2.0	856042
GPS RF Filter	1575.42	2	2.5	SE / SE	30 @ 1625.00	2.5 x 2.0	856049
GPS RF Filter	1575.42	2	1.4	SE / BAL	12 @ 1625.00	2.5 x 2.0	856134
GPS RF Filter	1575.42	2	0.75	SE / SE	35 @ 1635.00	1.4 x 1.2	856561
GPS RF Filter	1575.42	2	1.1	SE / SE	20 @ 1635.00	1.4 x 1.2	856576
Bluetooth & GPS Filter	2441 / 1575.42	83.5 / 2	2 / 1.2	SE / SE	–	2.0 x 1.5	856646

NOTES: **** = New***

GUIDE BY MARKET – HANDSET



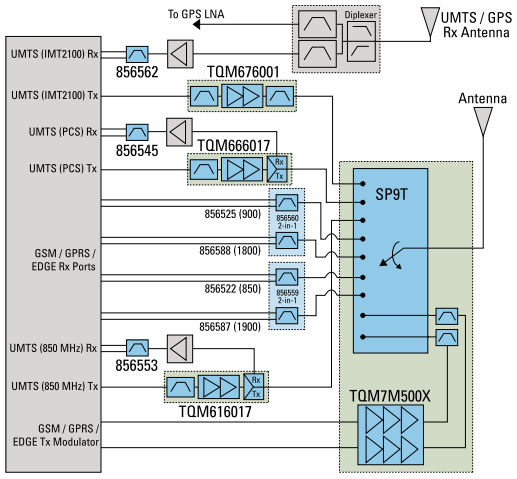
GSM Product Offering



CDMA Product Offering

HANDSET FILTERS

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
Duplexer, Cell Band	836.5 / 881.5	25 / 25	2 / 2.4	SE / SE	–	3.8 x 3.8	856495
Duplexer, Cell Band	836.5 / 881.5	25 / 25	2 / 2.4	SE / SE	–	3.8 x 3.8	856563
RF Filter, Cell Band	881.5	25	1.6	SE / BAL	35 @ 849.00	1.4 x 1.2	856522
RF Filter, Cell Band	881.5	25	1.6	SE / BAL	35 @ 849.00	1.4 x 1.2	856553
RF Filter, Cell / PCS	881.5 / 1960	25 / 60	1.8 / 1.8	SE / BAL	–	2.0 x 1.5	856559
RF Filter, Cell / PCS	881.5 / 1960	25 / 60	1.6 / 2.2	SE / BAL	–	2.0 x 1.5	856565
RF Filter, EGSM	942.5	35	1.8	SE / BAL	23 @ 915.00	1.4 x 1.2	856525
RF Filter, EGSM / DCS	942.5 / 1842.5	35 / 75	1.5 / 1.8	SE / BAL	–	2.0 x 1.5	856560
GPS RF Filter	1575.42	2	0.75	SE / SE	35 @ 1635.00	1.4 x 1.2	856561
GPS RF Filter	1575.42	2	1.1	SE / SE	20 @ 1635.00	1.4 x 1.2	856576
RF Filter, DCS	1842.5	75	1.6	SE / BAL	9 @ 1785.00	1.4 x 1.2	856575
RF Filter, DCS	1842.5	75	1.7	SE / BAL	10 @ 1785.00	1.4 x 1.2	856588
RF Filter, PCS	1880	60	2.6	SE / SE	35 @ 1930.63	1.4 x 1.2	856589



3G Product Offering – Tri-Band WCDMA

HANDSET FILTERS *(cont.)*

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
RF Filter, PCS	1960	60	1.5	SE / BAL	7 @ 1910.00	1.4 x 1.2	856577
RF Filter, PCS	1960	60	1.7	SE / BAL	9 @ 1910.00	1.4 x 1.2	856587
RF Filter, PCS	1960	60	2.2	SE / BAL	15 @ 1910.00	1.4 x 1.2	856545
RF Filter, UMTS	2140	60	2	SE / BAL	35 @ 1980.00	1.4 x 1.2	856562
Bluetooth RF Filter	2441	83.5	2	SE / SE	28 @ 2300.00	1.4 x 1.2	856539
Bluetooth RF Filter	2441	83.5	2.7	SE / BAL	39 @ 2250.00	1.4 x 1.2	856548
Bluetooth & GPS Filter	2441 / 1575.42	83.5 / 2	2 / 1.2	SE / SE	–	2.0 x 1.5	856646

HANDSET AMPLIFIERS & MODULES

Description	Frequency Bands	Package Size (mm)	Part Number
GSM Quad-Band PA, Internal Vref	Cell, PCS, EGSM, DCS	5 x 5	TQM7M4006
GSM Quad-Band Tx Module, ESD Protection	Cell, PCS, EGSM, DCS	6 x 6	TQM6M4002
GSM Quad-Band Tx Module, ESD Protection (Mirror Pinout to TQM6M4002)	Cell, PCS, EGSM, DCS	6 x 6	TQM6M4003
UMTS 2100 3V Linear PA; Low Idle Current Consumption	UMTS	4 x 4	TQM7M6001
CDMA PCS Band, PA, High Efficiency at Low-Power, 1-Bit Bias	PCS	4 x 4	TQM763022
CDMA Cellular Band PA, High Power, PAE 40%, 1-Bit Bias	Cell	4 x 4	TQM713019
CDMA Cellular Band PA, High Power, PAE 40%, 1-Bit Bias	Cell	3 x 3	TQM713024

HANDSET HADRON PA MODULE™ FAMILY

Description	Frequency Bands	Package Size (mm)	Part Number
EDGE Polar Quad-Band PAM	Cell, PCS, EGSM, DCS	7 x 7	TQM7M5002
EDGE Polar Quad-Band PAM	Cell, PCS, EGSM, DCS	7 x 7	TQM7M5003
EDGE Polar Quad-Band PAM	Cell, PCS, EGSM, DCS	7 x 7	TQM7M5008

HANDSET QUANTUM Tx MODULE™ FAMILY

Description	Frequency Bands	Package Size (mm)	Part Number
GSM / EDGE Linear Quad-Band Tx Module, Internal Vref, 1-Bit Power Control	Cell, PCS, EGSM, DCS	6 x 6	TQM6M5001
GSM Dual-Band Tx Module	EGSM, DCS	6 x 6	***TQM6M4028E****
GSM Dual-Band Tx Module	Cell, PCS	6 x 6	***TQM6M4028U****

NOTES: **** = New***

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GUIDE BY MARKET – HANDSET

HANDSET TRITIUM & TRITIUM II PA-DUPLEXER MODULE™ FAMILIES

Description	Frequency Bands	Package Size (mm)	Part Number
CDMA Ultra I, PCS PAD, 1-Bit Bias	PCS	8 x 5	TQM663017A
CDMA Ultra I, Cellular PAD, 1-Bit Bias	Cell	8 x 5	TQM613017
UMTS 800 HSDPA PA with Power Detector, Duplexer & Tx Interstage Filter	UMTS	8 x 5	TQM616017
UMTS 1900 HSDPA PA with Power Detector, Duplexer & Tx Interstage Filter	UMTS	8 x 5	TQM666017
UMTS 2100 HSDPA PA with Power Detector, Tx Front-End & Tx Interstage Filter	UMTS	6 x 5	TQM676001
CDMA Ultra I, Cellular PAD, 1-Bit Bias, BAL Input	Cell	7 x 4	TQM613025
CDMA Ultra I, Cellular PAD, 1-Bit Bias, SE Input	Cell	7 x 4	TQM613026

NOTES: PAD = PA Duplexer, SE = Single-Ended, BAL = Balanced

HANDSET BLUETOOTH AMPLIFIERS

Description	Frequency Range (GHz)	P1dB (dBm)	Gain (dB)	PAE (%)	Voltage / Current (V / mA)	Package Style	Part Number
Bluetooth PA	DC - 2.5	22.5	26	50	0 - 5.5 / 200	SLIM-7	CGB241
Bluetooth PA	DC - 2.5	22.5	26	50	0 - 5.5 / 200	MSOP-10	CGB240
Bluetooth Class 1 PA	2.4 - 2.5	21.5	27	50	0 - 3.3 / 160	STSLP-12	TQP770001

HANDSET SWITCHES

Description	Frequency (GHz)	Insertion Loss (dB)	Isolation (dB)	P1dB (dBm)	Control Voltage (V)	Package Style	Part Number
SP3T High Power CDMA	DC - 2	0.45	28	>36.5	2.6 / 0	MLP12	TQP4M3018
SP3T High Power CDMA	DC - 2	0.6	22	>34.5	2.6 / 0	STSLP12	TQP4M3019
SP2T 802.11a/b/g	DC - 6	0.6	28	31.5	3 / 0	SLIM7	TQS5200

GUIDE BY MARKET – MILITARY

MILITARY LEVEL & OTHER HI-RELIABILITY DEVICES & ASSEMBLIES

TriQuint Semiconductor products offer a wide variety of capabilities for military applications designed to perform in the most extreme of operating environments. Key niche areas in which TriQuint is considered to be a technology leader are:

- Phased Array Radar
- Communications
- GPS Navigation Systems
- Missile Systems
- EW, ECM, ECCM

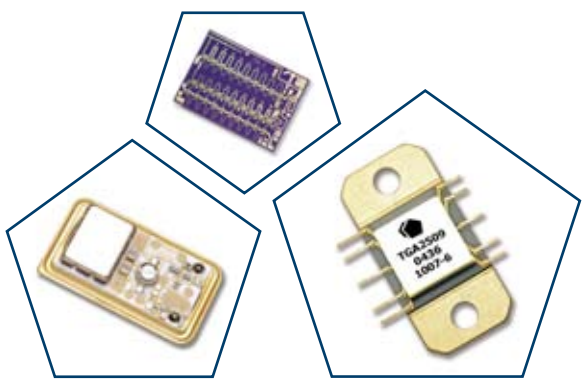
Many TriQuint products listed elsewhere in this brochure are widely used in military applications as well. Additional Class B screening is available for an added level of quality assurance for such uses. Typical MMIC products in GaAs HFET, pHEMT, mHEMT or VPIN are:

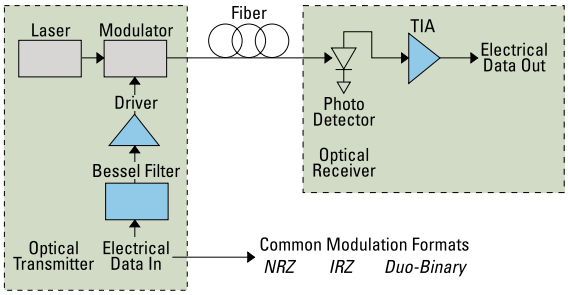
- Amplifiers
- Phase Shifters
- Switches
- Couplers

Typical SAW and BAW technology products include:

- Filtering solutions for center frequencies ranging from 30 MHz - 20 GHz in package sizes potentially as small as 1.5 x 0.8 mm.
- TriQuint oscillators offer superior phase noise as low as -180 dBc / Hz and exceptional g-Sensitivity, both considered best in class.

TriQuint continually looks for means to offer devices with ever improving performance in reduced package sizes. Our expanding module and assembly capabilities are further opportunities for customers to leverage TriQuint's superior processes and service.





Optical Systems (10 & 40 Gb/s)

OPTICAL DRIVERS

Description	Frequency (GHz)	Power (Vpp or dBm)	Gain (dB)	Noise Figure (dB)	Voltage / Current (V / mA)	Package Style	Part Number
9.9 - 12.5 Gb/s Linear Driver	DC - 8	25 dBm	20	–	8 / 310	SL-A3-18	TGA4819-SL
10.7 Gb/s Diff. TIA	DC - 10	–	8K dB ohms SE	6pA √Hz	3.3 / 80	Die	TGA4815-EPU
10.7 Gb/s Diff. TIA	DC - 10	–	1.6K dB ohms SE	6pA √Hz	3.3 / 60	Die	TGA4816-EPU
10.7 Gb/s Diff. TIA	DC - 10	–	3.2K dB ohms SE	11pA √Hz	3.3 / 70	Die	TGA4817-EPU
9.9 - 12.5 Gb/s Linear Driver	DC - 10	26 dBm	21	–	8 / 360	Die	TGA4819-EPU
9.9 - 12.5 Gb/s Mod. Driver	DC - 16	3V - 10V	35	2.5	5.5 - 8 / 210	SL-A2-18	TGA4953-SL
9.9 - 12.5 Gb/s Mod. Driver	DC - 16	3V - 10V	35	2.5	5.5 - 8 / 210	SL-A4-18	TGA4954-SL
12.5 Gb/s NRZ Driver	DC - 18	11V	16	–	8 / 285	Die	TGA4807-EPU
12.5 Gb/s NRZ Driver	DC - 18	24 dBm	16	3.5	5 - 8 / 70 - 175	Die	TGA1328-SCC
12.5 Gb/s NRZ Driver	DC - 18	8V	16	3.5	8 / 175	SL-A1-12	TGA8652-EPU-SL
12.5 Gb/s RZ Driver	DC - 25	7V	15	–	9 / 100	Die	TGA4802-EPU
43 Gb/s NRZ Driver	DC - 35	7V	15	–	6.5 / 170	Die	TGA4801-EPU
Wideband Driver (40 Gb/s)	DC - 35	4V	12	–	5 / 135	Die	TGA4832
40 Gb/s TIA, SE	DC - 40	–	250 dB ohms	15pA √Hz	5 / 30	Die	TGA4812-EPU
LNA / Gain Block	DC - 40	11.5 dBm	13	3.2	5 / 50	Die	TGA4830
LNA / Gain Block	DC - 60	13 dBm	15	3	6 / 50	Die	TGA4811
43 Gb/s Driver	DC - 78	3V	8	5	6 / 82	Die	TGA4803-EPU
10.7 - 12.5 Gb/s Linear Mod. Driver	0.03 - 8	25 dBm	20	–	8 / 310	SM-A8-28	***TGA4823-SM****
CATV TIA / Gain Block, SB	0.04 - 1	27 dBm	20	1.5	8 / 350	SM-08-20	TGA2803-SM
Single-Ended to Diff. Amp	10	2V Diff.	21 Diff.	–	5 / 72	Die	TGA2951-EPU

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

OPTICAL CONTROL PRODUCTS

Description	Frequency (GHz)	Insertion Loss (dB)	Control Range (dB)	P1dB (dBm)	Supply Voltage (V)	Package Style	Part Number
Discrete Thru (0 dB Attenuator)	DC - 65	0	0	–	N/A	Die	TGL4201-00
Analog Attenuator	DC - >50	2	17	–	0 to -2	Die	TGL4203-EPU
Analog Attenuator	DC - 30	2	17	–	0 to -2	Die	TGL4203-SM
Discrete Attenuators	DC - 65	–	2,3,6,10	–	N/A	SM-012-16	TGL4201-02, 03, 06, 10
Bessel Filter	–	6,7,8,9,10&11 Cut-off Freq	–	–	N/A	Die	TGB2010-00,-09-EPU etc.
Bessel Filter	–	5,6,6.5,7.5,8&9 Cut-off Freq	–	–	N/A	SM-02-6	TGB2010-00,-09-EPU-SM etc.

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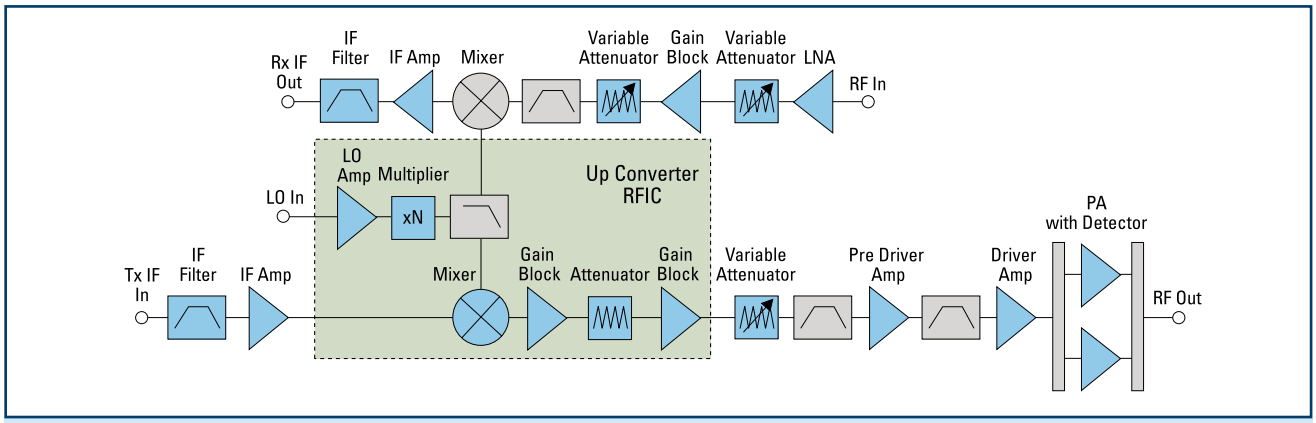

Point-to-Point Radio

PTP RADIO AMPLIFIERS

Description	Frequency Range (GHz)	P1dB (Psat) / OIP3 (dBm)	Gain (dB)	NF / PAE (dB) / (%)	Voltage / Current (V / mA)	Package Style	Part Number
24mm HFET	DC - 4	40 / –	13	– / 51	8 / 2170	Die	TGF4124-EPU
18mm HFET	DC - 6	38.5 / –	13.5	– / 53	8 / 1690	Die	TGF4118-EPU
12mm HFET	DC - 8	37 / –	14	– / 55	8 / 750	Die	TGF4112-EPU
4.8mm HFET	DC - 10.5	34 / –	8.5	– / 53	8 / 200	Die	TGF4250-SCC
9.6mm HFET	DC - 10.5	37 / –	9.5	– / 52	8.5 / 520	Die	TGF4260-SCC
1.2mm HFET	DC - 12	28.5 / –	10	– / 55	8 / 50	Die	TGF4230-SCC
2.4mm HFET	DC - 12	31.5 / –	10	– / 56	8 / 100	Die	TGF4240-SCC
1mm Pwr pHEMT	DC - 12	(31.5) / –	11	– / 55	12 / 900	Die	TGF2021-01
2mm Pwr pHEMT	DC - 12	(34.5) / –	11	– / 55	12 / 150	Die	TGF2021-02
4mm Pwr pHEMT	DC - 12	(37.5) / –	11	– / 55	12 / 300	Die	TGF2021-04
8mm Pwr pHEMT	DC - 12	(40.2) / –	11	– / 55	12 / 600	Die	TGF2021-08
12mm Pwr pHEMT	DC - 12	(42) / –	11	– / 52	12 / 900	Die	TGF2021-12
0.3mm MESFET	DC - 18	13 / –	11	1.5 / –	3 / 15	Die	TGF1350-SCC
0.6mm Pwr pHEMT	DC - 20	(29) / –	13	– / 56	12 / 45	Die	TGF2022-06
1.2mm Pwr pHEMT	DC - 20	(32) / –	13	– / 56	12 / 90	Die	TGF2022-12
2.4mm Pwr pHEMT	DC - 20	(35) / –	13	– / 58	12 / 180	Die	TGF2022-24
4.8mm Pwr pHEMT	DC - 20	(38) / –	13	– / 58	12 / 360	Die	TGF2022-48
6.0mm Pwr pHEMT	DC - 20	(39) / –	12.5	– / 53	12 / 448	Die	TGF2022-60
0.3mm pHEMT	DC - 22	16 / –	13	0.8 / –	3 / 15	Die	TGF4350-EPU
2.8W HPA	6 - 18	(34.5) / –	24	– / 20	7 - 9 / 800-1200	Die	TGA2501
HPA	7 - 8.5	(38) / –	21	– / 42	7 / 2000	Die	TGA2701
Driver Amp	7 - 13	(30) / 37	25	– / 30	9 / 450	Die	TGA2700
Wideband Driver Amp	8 - 18	13 / –	17	5 / –	4.5 / 50	Die	TGA8399C-EPU
HPA	9 - 10.5	(38) / –	20	– / >38	4 - 9 / 2000	Die	TGA2704
HPA	10.5 - 12	(38) / –	19	– / >39	4 - 9 / 2000	Die	TGA2710
Driver Amp, SB	11 - 17	17 / –	23	6 / –	6 / 75	SM-06-12	TGA2507-SM
Driver Amp, SB	12 - 18	14 / –	17	–	6 / 40	Die	TGA2506-EPU
Driver Amp, SB	12 - 18	20 / –	28	6 / –	6 / 80	Die	TGA2507-EPU
1W HPA	12 - 19	30 / –	30	–	5 - 7 / 435	Die	TGA2508
HPA	12 - 19	29 / –	25	–	5 - 7 / 435	SM-06-12	TGA2508-SM
2W HPA	12.3 - 15.7	(31) / –	33	7.0 / –	6 / 850	Die	TGA2520
2W HPA	12.5 - 16	(32) / 37	32	–	6 - 7 / 680	SM-01-24	TGA2503-SM
2W HPA	12.5 - 17	(34) / –	26	– / 25	7.5 / 650	Die	TGA2510-EPU
2W HPA	12.5 - 17	(33.5) / –	25	– / 25	7.5 / 650	SG-A1-6	TGA2510-EPU-SG
2W HPA	13 - 17	(34) / 40	32	–	6 - 7 / 680	Die	TGA2503-EPU
2W HPA	13 - 17	(34) / –	25	–	6 - 7 / 640	Die	TGA2505
2W HPA	13 - 17	(34) / –	33	–	5 - 8 / 680	FL-A1-10	TGA2904-FL
2W HPA, PD	13 - 17	(34) / 38.5	26	– / 30	7.5 / 650	SG-A1-6	TGA2902-1-SCC-SG

PTP RADIO AMPLIFIERS *(cont.)*

Description	Frequency Range (GHz)	P1dB (Psat) / OIP3 (dBm)	Gain (dB)	NF / PAE (dB) / (%)	Voltage / Current (V / mA)	Package Style	Part Number
2W HPA	13 - 17	(34) / 40	33	–	5 - 8 / 680	SG-A1-6	TGA8658-EPU-SG
4W HPA, Balanced	13 - 17	(36) / 44	25	– / 30	6 - 7 / 1300	Die	TGA2502
HPA	13.5 - 15	33 / 39	34	–	7 / 680	Die	TGA1152-SCC
2W HPA, PD	13.75 - 14.5	(34) / 38.5	26	– / 30	7.5 / 650	SG-A1-6	TGA2902-2-SCC-SG
MPA, SB	17 - 21	(22) / –	18.5	– / 25	7 / 66	Die	TGA9088A-SCC
Driver Amp	17 - 24	22 / –	19	4 / –	5 / 270	SM-09-16	***TGA2521-SM****
HPA, AGC, PD	17 - 24	(29) / 38	22	–	5 / 712	SM-010-20	***TGA2522-SM****
HPA	17 - 27	29 (31) / 37	22	–	7 / 760	Die	TGA4502-SCC
Gain Block & 2x / 3x Multiplier	17 - 37	18 (22) / 26	20	7 / –	5 / 140	SM-03-16	***TGA4030-SM****
Gain Block & 2x / 3x Multiplier	17 - 40	18 (22) / 24	22	7 / –	5 / 140	SM-A3-16	***TGA4031-SM****
Gain Block, Multiplier	17 - 43	22 / –	25	–	5 / 225	Die	TGA4040
2W HPA	18 - 23	32 (33) / 39	26	–	7 / 840	Die	TGA4022
HPA	18 - 27	29 / 37	14	–	6 / 480	Die	TGA1135-SCC
MPA	19 - 27	25 / 32	22	–	5 - 7 / 220	Die	TGA1073G-SCC
Gain Block	19 - 38	(22) / 30	20	–	5 / 160	Die	TGA4036
MPA	25 - 35	25 / –	18	–	6 / 220	SM-A4-20	TGA4902-SM
MPA	26 - 35	25 (32) / –	19	–	5 - 7 / 220	Die	TGA1073A-SCC
1W HPA	27 - 31	30 / –	22	– / 25	4 - 6 / 420	Die	TGA4509-EPU
2W HPA	27 - 31	32.5 (33) / 36.5	20	25 / –	6 / 840	Die	TGA4513
2W HPA	27 - 31	32.5 (33) / –	22	–	6 / 840	CP-A2-8	TGA4513-CP
HPA	27 - 32	28.5 / –	25	–	6 - 8 / 420	Die	TGA1073B-SCC
HPA	27 - 32	29 / –	16	–	6 - 7 / 630	Die	TGA1172-EPU
1W HPA	28 - 31	30 / –	19	– / 25	6 / 420	SM-A4-20	TGA4509-SM
Driver Amp	29 - 31	16 (17) / 22	15	–	6 / 60	SM-A4-20	TGA4510-SM
Driver Amp	29 - 37	16 / –	16	–	6 / 60	Die	TGA4510-EPU
MPA	32 - 45	24 (25) / 33	16	–	6 / 175	Die	TGA4521
MPA	33 - 47	27 (27.5) / 36	18	–	6 / 400	Die	TGA4522
HPA	36 - 40	26 / –	15	–	5 - 7 / 240	Die	TGA1073C-SCC
HPA	36 - 40	30 / –	14	–	6 - 7 / 500	Die	TGA1171-SCC

*NOTES: *** = New**, SB = Self Biased, AGC = Automatic Gain Control, PD = Power Detector*

PTP RADIO LOW NOISE AMPLIFIERS

Description	Frequency Range (GHz)	P1dB / IIP3 (dBm)	Gain (dB)	NF (dB)	Voltage / Current (V / mA)	Package Style	Part Number
LNA, AGC	2 - 20	17.5 / –	9	3.5	5 - 8 / 60	Die	TGA1342-SCC
LNA, AGC	2 - 20	16 / –	17	2.5	5 / 75	SM-07-12	TGA2513-SM
LNA, AGC	2 - 23	17 / 26	17	2	5 / 75	Die	TGA2513
LNA, SB, AGC	4 - 14	6 / 16	22	2.3	5 / 90	SM-04-12	TGA2512-1-SM
LNA, AGC, GB	4 - 14	13 / 24	25	2.3	5 / 160	SM-04-12	TGA2512-2-SM
LNA, SB, AGC	5 - 15	6 / 13	27	1.4	5 / 90	Die	TGA2512
LNA	6 - 12	2 / –	31	0.7	2.5 / 17	Die	TGA2600-EPU
LNA, SB	6 - 13	11 / –	26	1.5	5 / 65	Die	TGA8399B-SCC
LNA, SB, AGC	6 - 14	6 / 12	20	1.3	5 / 90	Die	TGA2511
LNA	20 - 27	12 / –	21	2.2	3.5 / 60	Die	TGA4506
LNA	21 - 27	10 / –	21	2.5	3.5 / 60	SM-A4-20	TGA4506-SM
LNA	23 - 29	15 / –	15	3.1	5 / 50	Die	TGA1307-EPU
LNA	28 - 36	12 / 21	22	2.3	3 / 60	Die	TGA4507-EPU
LNA	30 - 42	14 / –	21	2.8	3 / 40	Die	TGA4508-EPU
LNA	57 - 69	–	13	4	3 / 41	Die	TGA4600-EPU

NOTES: SB = Self Biased, AGC = Automatic Gain Control, GB = Gate Bias

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PTP RADIO MIXERS & FREQUENCY CONVERTERS

Description	RF Frequency Range (GHz)	Conversion Gain (dB)	LO / RF Isolation (dB)	IIP3 (dBm)	Voltage / Current (V / mA)	Package Style	Part Number
Doubler with Amplifier	16 - 30	18	30	22	5 / 150	Die	TGC4403
Doubler with Amplifier	16 - 30	18	30	19	5 / 150	SM-011-16	TGC4403-SM
Upconverting Mixer	17 - 26	-9	40	–	-0.9 / 0	SM-011-16	TGC4402-SM
Upconverting Mixer	17 - 27	-9	35	18	-0.9 / 0	Die	TGC4402
Upconverter	17 - 27	13	30	–	5 / 425	Die	TGC4405
Upconverter	17 - 27	13	30	–	5 / 425	SM-011-16	***TGC4405-SM****
Gain Block & 2x / 3x Multiplier	17 - 37	9	N/A	6	5 / 140	SM-03-16	***TGA4030-SM****
Gain Block & 2x / 3x Multiplier	17 - 40	9	N/A	2	5 / 140	SM-A3-16	***TGA4031-SM****
Doubler (Input 10 - 20 GHz)	20 - 40	-12	25	18	–	Die	TGC1430F-EPU
Tripler (Input 8.5 - 13.5 GHz)	20 - 40	-15	15	18	–	Die	TGC1430G-EPU

NOTES: **** = New***

PTP RADIO SWITCHES

Description	Frequency (GHz)	Insertion Loss (dB)	Isolation (dB)	P1dB (dBm)	Control Voltage (V)	Package Style	Part Number
SP2T 802.11a/b/g	DC - 6	0.6	28	31.5	3 / 0	SLIM7	TQS5200
SPDT FET	DC - 8	0.7	40	27	0 / -5	Die	TGS8706-SCC
SPDT FET	DC - 18	1.5	36	27	-5	Die	TGS2306-EPU
SPDT FET	DC - 18	2	39	21	-7 / 0	Die	TGS8250-SCC
SP4T FET	DC - 18	2.5	37	19	0 / -5	Die	TGS8422-SCC
SP3T VPIN	1 - 20	0.5	35	23	10 mA	Die	TGS2303-EEU
SP4T VPIN	1 - 20	0.6	38	23	10 mA	Die	TGS2304-SCC
SPDT VPIN	4 - 20	0.9	35	>20	+/- 2.7	Die	TGS2302
SP3T VPIN	4 - 18	1	35	20	+/- 2.7	Die	TGS2313
SPDT FET	8 - 11	0.9	40	27.5	-7 / 0	Die	TGS8122-SCC

PTP RADIO CONTROL PRODUCTS

Description	Frequency (GHz)	Insertion Loss (dB)	Control Range (dB)	P1dB (dBm)	Supply Voltage (V)	Package Style	Part Number
Discrete Thru (0 dB Attenuator)	DC - 65	0	0	–	N/A	Die	TGL4201-00
Analog Attenuator	DC - >50	2	17	–	0 to -2	Die	TGL4203-EPU
Analog Attenuator	DC - 30	2	17	–	0 to -2	Die	TGL4203-SM
Discrete Attenuators	DC - 65	–	2,3,6,10	–	N/A	SM-012-16	TGL4201-02, 03, 06, 10
Digital Attenuator	0.5 - 18	4	15.5	20	0 / -5	Die	TGL6425-SCC
Analog Attenuator	2 - 20	2	15	23	2.5	Die	TGL8784-SCC
Passive Wideband Limiter	3 - 25	<0.5	N/A	18	N/A	Die	TGL2201-EPU

GUIDE BY MARKET – SPACE

SPACE LEVEL DEVICES AND ASSEMBLIES

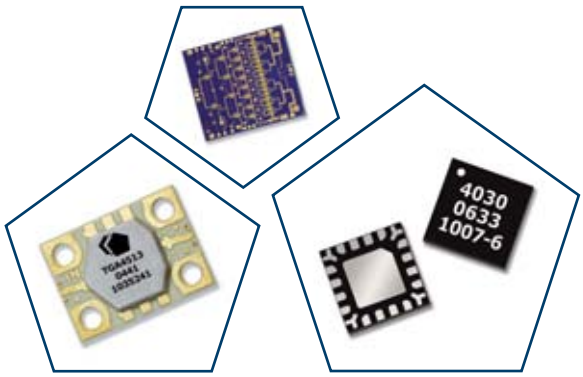
TriQuint Semiconductor has a legacy of supplying active and passive components for on-satellite applications where reliability is a must. Class S qualification, involving additional high-magnification visual inspection and Lot Acceptance Testing is available for many TriQuint products; in fact, some are already qualified and available for delivery. Typical MMIC products in GaAs HFET, pHEMT, mHEMT or VPIN are:

- Amplifiers
- Switches
- Phase Shifters
- Couplers

Typical SAW and BAW technology products include:

- Filtering solutions for center frequencies ranging from 30 MHz - 20 GHz in package sizes potentially as small as 1.5 x 0.8 mm.
- TriQuint oscillators offer superior phase noise as low as -180 dBc / Hz and exceptional g-sensitivity, both considered best in class.

TriQuint continually looks for means to offer devices with ever improving performance in reduced package sizes. Our expanding module and assembly capabilities are further opportunities for customers to leverage TriQuint's superior processes and service.



GUIDE BY MARKET – TEST EQUIPMENT

TEST EQUIPMENT AMPLIFIERS

Description	Frequency Range (GHz)	P1dB (Psat) / OIP3 (dBm)	Gain (dB)	NF / PAE (dB) / (%)	Voltage / Current (V / mA)	Package Style	Part Number
24mm HFET	DC - 4	40 / –	13	– / 51	8 / 2170	Die	TGF4124-EPU
18mm HFET	DC - 6	38.5 / –	13.5	– / 53	8 / 1690	Die	TGF4118-EPU
12mm HFET	DC - 8	37 / –	14	– / 55	8 / 750	Die	TGF4112-EPU
4.8mm HFET	DC - 10.5	34 / –	8.5	– / 53	8 / 200	Die	TGF4250-SCC
9.6mm HFET	DC - 10.5	37 / –	9.5	– / 52	8.5 / 520	Die	TGF4260-SCC
1.2mm HFET	DC - 12	28.5 / –	10	– / 55	8 / 50	Die	TGF4230-SCC
2.4mm HFET	DC - 12	31.5 / –	10	– / 56	8 / 100	Die	TGF4240-SCC
1mm Pwr pHEMT	DC - 12	(31.5) / –	11	– / 55	12 / 900	Die	TGF2021-01
2mm Pwr pHEMT	DC - 12	(34.5) / –	11	– / 55	12 / 150	Die	TGF2021-02
4mm Pwr pHEMT	DC - 12	(37.5) / –	11	– / 55	12 / 300	Die	TGF2021-04
8mm Pwr pHEMT	DC - 12	(40.2) / –	11	– / 55	12 / 600	Die	TGF2021-08
12mm Pwr pHEMT	DC - 12	(42) / –	11	– / 52	12 / 900	Die	TGF2021-12
0.3mm MESFET	DC - 18	13 / –	11	1.5 / –	3 / 15	Die	TGF1350-SCC
12.5 Gb/s NRZ Driver	DC - 18	24 / –	16	3.5 / –	5 - 8 / 70 - 175	Die	TGA1328-SCC
12.5 Gb/s NRZ Driver	DC - 18	8 Vpp	16	3.5 / –	8 / 175	SL-A1-12	TGA8652-EPU-SL
0.6mm Pwr pHEMT	DC - 20	(29) / –	13	– / 56	12 / 45	Die	TGF2022-06
1.2mm Pwr pHEMT	DC - 20	(32) / –	13	– / 56	12 / 90	Die	TGF2022-12
2.4mm Pwr pHEMT	DC - 20	(35) / –	13	– / 58	12 / 180	Die	TGF2022-24
4.8mm Pwr pHEMT	DC - 20	(38) / –	13	– / 58	12 / 360	Die	TGF2022-48
6.0mm Pwr pHEMT	DC - 20	(39) / –	12.5	– / 53	12 / 448	Die	TGF2022-60
0.3mm pHEMT	DC - 22	16 / –	13	0.8 / –	3 / 15	Die	TGF4350-EPU
Wideband Driver (40 Gb/s)	DC - 35	18 / –	12	–	5 / 135	Die	TGA4832
LNA / Gain Block	DC - 40	11.5 / 20	13	3.2 / –	5 / 50	Die	TGA4830
LNA / Gain Block	DC - 60	13 / 21	15	3 / –	6 / 50	Die	TGA4811
Gain Block	2 - 18	20 / –	7.5	5.5 / –	6 / 100	Die	TGA8300-SCC
Wideband Gain Block, AGC	2 - 20	20 / –	7.5	7 / –	6 / 150	Die	TGA8622-SCC
Wideband PA, AGC	2 - 20	26 / –	8	–	8 / 440	Die	TGA8334-SCC
Wideband PA, AGC	2 - 20	29 / 38	15	–	12 / 1100	FL-A1-10	TGA2509-EPU-FL

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TEST EQUIPMENT AMPLIFIERS *(cont.)*

Description	Frequency Range (GHz)	P1dB (Psat) / OIP3 (dBm)	Gain (dB)	NF / PAE (dB) / (%)	Voltage / Current (V / mA)	Package Style	Part Number
Wideband PA, AGC	2 - 22	28.5 (30) / 36	17	–	12 / 1100	Die	TGA2509
HPA	13.5 - 15	33 / 39	34	–	7 / 680	Die	TGA1152-SCC
Gain Block & 2x / 3x Multiplier	17 - 37	18 (22) / 26	20	7 / –	5 / 140	SM-03-16	***TGA4030-SM****
Gain Block & 2x / 3x Multiplier	17 - 40	18 (22) / 24	22	7 / –	5 / 140	SM-A3-16	***TGA4031-SM****
Gain Block, Multiplier	17 - 43	22 / –	25	–	5 / 225	Die	TGA4040
Gain Block	19 - 38	(22) / 30	20	–	5 / 160	Die	TGA4036

*NOTES: *** = New**, AGC = Automatic Gain Control*

TEST EQUIPMENT OPTICAL DRIVERS

Description	Frequency (GHz)	Power (Vpp or dBm)	Gain (dB)	Noise Figure (dB)	Voltage / Current (V / mA)	Package Style	Part Number
9.9 - 12.5 Gb/s Linear Driver	DC - 8	25 dBm	20	–	8 / 310	SL-A3-18	TGA4819-SL
9.9 - 12.5 Gb/s Linear Driver	DC - 10	26 dBm	21	–	8 / 360	Die	TGA4819-EPU
9.9 - 12.5 Gb/s Mod. Driver	DC - 16	3V - 10V	35	2.5	5.5 - 8 / 210	SL-A2-18	TGA4953-SL
9.9 - 12.5 Gb/s Mod. Driver	DC - 16	3V - 10V	35	2.5	5.5 - 8 / 210	SL-A4-18	TGA4954-SL
12.5 Gb/s NRZ Driver	DC - 18	11V	16	–	8 / 285	Die	TGA4807-EPU
12.5 Gb/s NRZ Driver	DC - 18	24 dBm	16	3.5	5 - 8 / 70 - 175	Die	TGA1328-SCC
12.5 Gb/s NRZ Driver	DC - 18	8V	16	3.5	8 / 175	SL-A1-12	TGA8652-EPU-SL
12.5 Gb/s RZ Driver	DC - 25	7V	15	–	9 / 100	Die	TGA4802-EPU
43 Gb/s NRZ Driver	DC - 35	7V	15	–	6.5 / 170	Die	TGA4801-EPU
Wideband Driver (40 Gb/s)	DC - 35	4V	12	–	5 / 135	Die	TGA4832
43 Gb/s Driver	DC - 78	3V	8	5	6 / 82	Die	TGA4803-EPU
10.7 - 12.5 Gb/s Linear Mod. Driver	0.03 - 8	25 dBm	20	–	8 / 310	SM-A8-28	***TGA4823-SM****

*NOTES: *** = New***

TEST EQUIPMENT LOW NOISE AMPLIFIERS

Description	Frequency Range (GHz)	P1dB / IIP3 (dBm)	Gain (dB)	NF (dB)	Voltage / Current (V / mA)	Package Style	Part Number
LNA, AGC	DC - 14	16 / –	11	3.1	8 / 80	Die	TGA8349-SCC
LNA / Gain Block	DC - 40	11.5 / 20	13	3.2	5 / 50	Die	TGA4830
LNA / Gain Block	DC - 60	13 / 21	15	3	6 / 50	Die	TGA4811
LNA, AGC	2 - 18	16 / –	19	4	5 / 120	Die	TGA8344-SCC
LNA, AGC	2 - 20	17.5 / –	9	3.5	5 - 8 / 60	Die	TGA1342-SCC
LNA, AGC	2 - 20	17.5 / –	9	3.5	5 - 8 / 60	Die	TGA8310-SCC
LNA, AGC	2 - 20	16 / –	17	2.5	5 / 75	SM-07-12	TGA2513-SM
LNA, AGC	2 - 23	17 / 26	17	2	5 / 75	Die	TGA2513
LNA	6 - 12	2 / –	31	0.7	2.5 / 17	Die	TGA2600-EPU

NOTES: AGC = Automatic Gain Control

TEST EQUIPMENT SWITCHES

Description	Frequency (GHz)	Insertion Loss (dB)	Isolation (dB)	P1dB (dBm)	Control Voltage (V)	Package Style	Part Number
SP2T General Purpose	DC - 2.5	0.3	24	30	3 / 0	SOT-363	CSH210R
SP4T High Power EDGE, Dec.	DC - 4.5	0.5	33	38	2.7 / 0	SLIM17	TQP4M4010
SPDT High Power GSM	DC - 6	0.5	27	37	2.5 / 0	SLIM7	TQP4M4003
SP2T 802.11a/b/g	DC - 6	0.6	28	31.5	3 / 0	SLIM7	TQS5200
SPDT FET	DC - 8	0.7	40	27	0 / -5	Die	TGS8706-SCC
SPDT FET	DC - 18	1.5	36	27	-5	Die	TGS2306-EPU
SPDT FET	DC - 18	2	39	21	-7 / 0	Die	TGS8250-SCC
SP4T FET	DC - 18	2.5	37	19	0 / -5	Die	TGS8422-SCC
SP3T VPIN	1 - 20	0.5	35	23	10 mA	Die	TGS2303-EEU
SP4T VPIN	1 - 20	0.6	38	23	10 mA	Die	TGS2304-SCC
SP3T VPIN	4 - 18	1	35	20	+/- 2.7	Die	TGS2313
SPDT VPIN	4 - 20	0.9	35	>20	+/- 2.7	Die	TGS2302
SPDT FET	8 - 11	0.9	40	27.5	-7 / 0	Die	TGS8122-SCC
SPDT VPIN	24 - 43	<2	36	27	+/- 5	Die	TGS4301-EPU
SPDT VPIN	27 - 46	0.9	30	>34	+/ -5 / 15	Die	TGS4302
SPDT VPIN Absorptive	32 - 40	1	36	>33	+/- 5 / 18	Die	TGS4304

NOTES: Dec. = Integrated Decoder

GUIDE BY MARKET – TEST EQUIPMENT

TEST EQUIPMENT FREQUENCY CONVERTERS & MIXERS

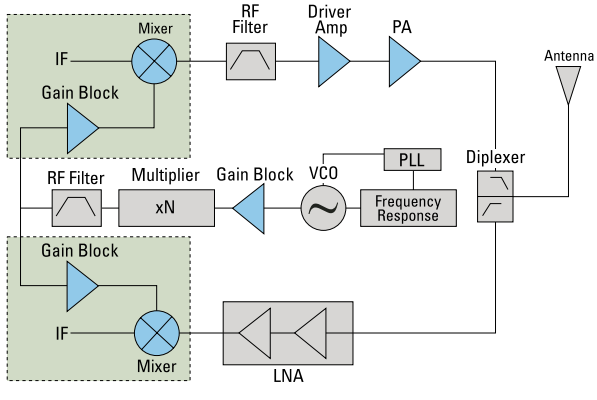
Description	RF Frequency Range (GHz)	Conversion Gain (dB)	LO / RF Isolation (dB)	IIP3 (dBm)	Voltage / Current (V / mA)	Package Style	Part Number
Doubler with Amplifier	16 - 30	18	30	22	5 / 150	Die	TGC4403
Doubler with Amplifier	16 - 30	18	30	19	5 / 150	SM-011-16	TGC4403-SM
Upconverting Mixer	17 - 26	-9	40	–	-0.9 / 0	SM-011-16	TGC4402-SM
Upconverting Mixer	17 - 27	-9	35	18	-0.9 / 0	Die	TGC4402
Upconverter	17 - 27	13	30	–	5 / 425	Die	TGC4405
Upconverter	17 - 27	13	30	–	5 / 425	SM-011-16	***TGC4405-SM****
Gain Block & 2x / 3x Multiplier	17 - 37	9	N/A	6	5 / 140	SM-03-16	***TGA4030-SM****
Gain Block & 2x / 3x Multiplier	17 - 40	9	N/A	2	5 / 140	SM-A3-16	***TGA4031-SM****
Doubler (Input 10 - 20 GHz)	20 - 40	-12	25	18	–	Die	TGC1430F-EPU
Tripler (Input 8.5 - 13.5 GHz)	20 - 40	-15	15	18	–	Die	TGC1430G-EPU

NOTES: **** = New***

TEST EQUIPMENT CONTROL PRODUCTS

Description	Frequency (GHz)	Insertion Loss (dB)	Control Range (dB)	P1dB (dBm)	Supply Voltage (V)	Package Style	Part Number
Discrete Thru (0 dB Attenuator)	DC - 65	0	0	–	N/A	Die	TGL4201-00
Analog Attenuator	DC - >50	2	17	–	0 to -2	Die	TGL4203-EPU
Analog Attenuator	DC - 30	2	17	–	0 to -2	Die	TGL4203-SM
Discrete Attenuators	DC - 65	–	2,3,6,10	–	N/A	SM-012-16	TGL4201-02, 03, 06, 10
Digital Attenuator	0.5 - 18	4	15.5	20	0 / -5	Die	TGL6425-SCC
Analog Attenuator	2 - 20	2	15	23	2.5	Die	TGL8784-SCC
Passive Wideband Limiter	3 - 25	<0.5	N/A	18	N/A	Die	TGL2201-EPU
Bessel Filter	–	6,7,8,9,10&11 Cut-off Freq	N/A	–	N/A	Die	TGB2010-00,-09-EPU etc.
Bessel Filter	–	5,6,6,5,7,5,8&9 Cut-off Freq	N/A	–	N/A	SM-02-6	TGB2010-00,-09-EPU-SM etc.
Lange Coupler	12 - 21	<0.25	–	–	N/A	Die	TGB2001-EPU
Lange Coupler	18 - 32	<0.25	–	–	N/A	Die	TGB4001-EPU
Lange Coupler	27 - 45	<0.25	–	–	N/A	Die	TGB4002-EPU

GUIDE BY MARKET – VSAT



VSAT RF Subsystem

VSAT AMPLIFIERS

Description	Frequency Range (GHz)	P1dB (Psat) / OIP3 (dBm)	Gain (dB)	NF / PAE (dB) / (%)	Voltage / Current (V / mA)	Package Style	Part Number
Driver Amp, SB	11 - 17	17 / –	23	6 / –	6 / 75	SM-06-12	TGA2507-SM
Driver Amp, SB	12 - 18	14 / –	17	–	6 / 40	Die	TGA2506-EPU

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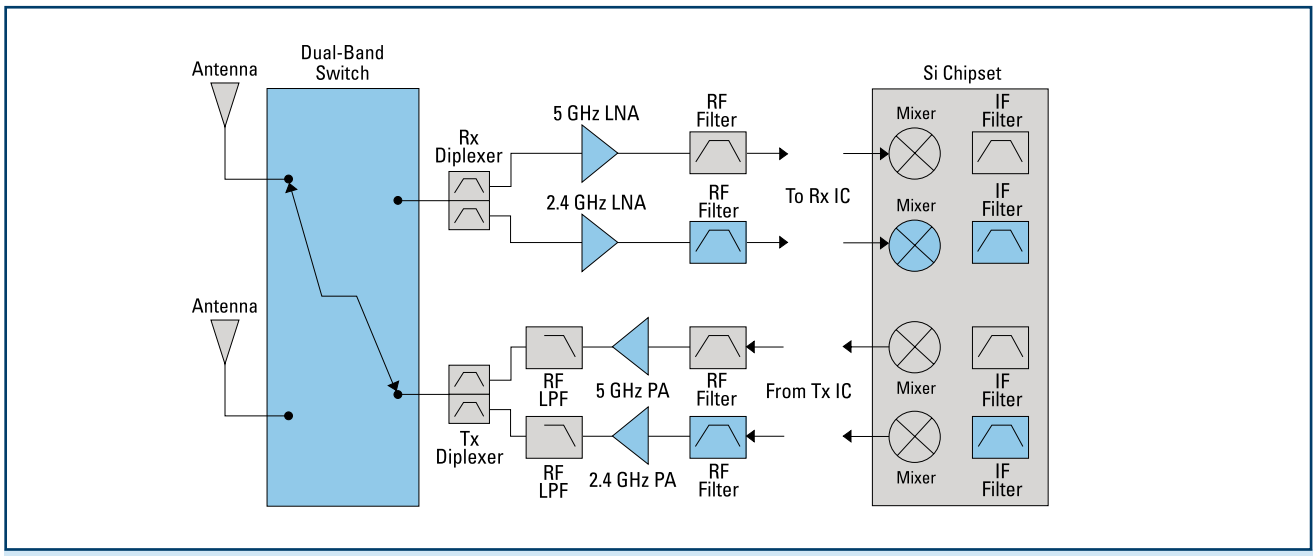
VSAT AMPLIFIERS *(cont.)*

Description	Frequency Range (GHz)	P1dB (Psat) / OIP3 (dBm)	Gain (dB)	NF / PAE (dB) / (%)	Voltage / Current (V / mA)	Package Style	Part Number
Driver Amp, SB	12 - 18	20 / –	28	6 / –	6 / 80	Die	TGA2507-EPU
1W HPA	12 - 19	30 / –	30	–	5 - 7 / 435	Die	TGA2508
HPA	12 - 19	29 / –	25	–	5 - 7 / 435	SM-06-12	TGA2508-SM
2W HPA	12.3 - 15.7	(31) / –	33	7 / –	6 / 850	Die	TGA2520
2W HPA	12.5 - 16	(32) / 37	32	–	6 - 7 / 680	SM-01-24	TGA2503-SM
2W HPA	12.5 - 17	(34) / –	26	– / 25	7.5 / 650	Die	TGA2510-EPU
2W HPA	12.5 - 17	(33.5) / –	25	– / 25	7.5 / 650	SG-A1-6	TGA2510-EPU-SG
4W HPA	13 - 15	(36) / 41	25	–	7 / 1300	FL-A1-10	TGA8659-FL
6.5W HPA	13 - 16	(38) / –	24	–	8 / 2600	FL-A2-10	TGA2514-FL
2W HPA	13 - 17	(34) / 40	32	–	6 - 7 / 680	Die	TGA2503-EPU
2W HPA	13 - 17	(34) / –	25	–	6 - 7 / 640	Die	TGA2505
2W HPA	13 - 17	(34) / –	33	–	5 - 8 / 680	FL-A1-10	TGA2904-FL
2W HPA	13 - 17	(34) / 40	33	–	5 - 8 / 680	SG-A1-6	TGA8658-EPU-SG
2W HPA, PD	13 - 17	(34) / 38.5	26	– / 30	7.5 / 650	SG-A1-6	TGA2902-1-SCC-SG
4W HPA, Balanced	13 - 17	(36) / 44	25	– / 30	6 - 7 / 1300	Die	TGA2502
6.5W HPA	13 - 18	(38) / 44	24	–	8 / 3600	Die	TGA2514-EPU
2W HPA, PD	13.75 - 14.5	(34) / 38.5	26	– / 30	7.5 / 650	SG-A1-6	TGA2902-2-SCC-SG
HPA	24 - 31	35.5 (36) / –	23	–	6 / 2100	Die	TGA4505
HPA	25 - 31	35.5 (36) / –	22	–	6 / 2100	CP-A1-8	TGA4905-CP
MPA	25 - 35	25 / –	18	–	6 / 220	SM-A4-20	TGA4902-SM
7W HPA	26 - 31	(38.5) / –	22	–	6 / 4200	CP-A3-8	TGA4915-EPU-CP
1W HPA	27 - 31	30 / –	22	– / 25	4 - 6 / 420	Die	TGA4509-EPU
2W HPA	27 - 31	32.5 (33) / 36.5	20	– / 25	6 / 840	Die	TGA4513
2W HPA	27 - 31	32.5 (33) / –	22	–	6 / 840	CP-A2-8	TGA4513-CP
1W HPA	28 - 31	30 / –	19	– / 25	6 / 420	SM-A4-20	TGA4509-SM
4W HPA	28 - 31	36 (36.5) / –	22	– / 22	6 / 1600	Die	***TGA4906****
7W HPA	28 - 31	(38.5) / –	22	– / 20	6 / 3200	Die	***TGA4916****
Driver Amp	29 - 31	16 (17) / 22	15	–	6 / 60	SM-A4-20	TGA4510-SM
Driver Amp	29 - 37	16 / –	16	–	6 / 60	Die	TGA4510-EPU

*NOTES: *** = New**, SB = Self Biased, PD = Power Detector*



WLAN Transceiver

WLAN AMPLIFIERS

Description	Frequency Range (GHz)	P1dB / OIP3 (dBm)	Gain (dB)	PAE (%)	Voltage / Current (V / mA)	Package Style	Part Number
Bluetooth PA	DC - 2.5	22.5 / –	26	50	0 - 5.5 / 200	SLIM-7	CGB241
Bluetooth PA	DC - 2.5	22.5 / –	26	50	0 - 5.5 / 200	MSOP-10	CGB240
Bluetooth Class 1 PA	2.4 - 2.5	21.5 / –	27	50	0 - 3.3 / 160	STSLP-12	TQP770001
ISM Band Matched PA, PD	2.4 - 2.5	25 / –	30	–	3.3 / 200	VQFN-16	TQP777002

NOTES: PD = Power Detector

WLAN LOW NOISE AMPLIFIERS

Description	Frequency Range (GHz)	P1dB / IIP3 (dBm)	Gain (dB)	NF (dB)	Voltage / Current (V / mA)	Package Style	Part Number
LNA, Dual-Band	2.4 / 4.9 - 6	8 / 6, 12.5 / 1	16.5, 22.5	1.2, 1.5	3.3 / 11.5, 3.3 / 18.5	VQFN12	TQM3M7001
LNA	4.9 - 6	5 / -3	18	1.3	3 / 8	SLIM-7	TQL5000

WLAN SWITCHES

Description	Frequency (GHz)	Insertion Loss (dB)	Isolation (dB)	P1dB (dBm)	Control Voltage (V)	Package Style	Part Number
SP2T General Purpose	DC - 2.5	0.3	24	30	3 / 0	SOT-363	CSH210R
SP4T High Power EDGE, Dec.	DC - 4.5	0.5	33	38	2.7 / 0	SLIM17	TQP4M4010
SPDT High Power GSM	DC - 6	0.5	27	37	2.5 / 0	SLIM7	TQP4M4003
SP2T 802.11a/b/g	DC - 6	0.6	28	31.5	3 / 0	SLIM7	TQS5200
Diversity Switch 802.11a/b/g	DC - 6	0.8	33	33	3 / 0	MLP12	TQS5202

NOTES: Dec. = Integrated Decoder

WLAN FILTERS

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
WLAN IF Filter	374	17	8.5	SE / BAL	10 @ 33.00	7.0 x 5.5	855653
WLAN IF Filter	374	17	8.5	SE / BAL	35 @ 33.00	5.0 x 5.0	855898
WLAN IF Filter	374	17	9	SE / BAL	30 @ 33.00	3.8 x 3.8	856278
WLAN IF Filter	465	17	11.9	SE / BAL	40 @ 50.00	5.0 x 5.0	855991
WLAN IF Filter	770	17	3	BAL / BAL	32.5 @ 750.00	5.0 x 5.0	855942
WLAN IF Filter	1150	16	4.4	BAL / BAL	20 @ 1170.00	3.0 x 3.0	856256
WLAN IF Filter	1290	18	3.5	BAL / BAL	30 @ 51.50	2.5 x 2.0	856366

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AMPLIFIERS – UP TO 1W

Description	Frequency Range (GHz)	P1dB (Psat) / OIP3 (dBm)	Gain (dB)	NF / PAE (dB) / (%)	Voltage / Current (V / mA)	Package Style	Part Number
Bluetooth PA	DC - 2.5	22.5 / –	26	– / 50	0 - 5.5 / 200	SLIM-7	CGB241
Bluetooth PA	DC - 2.5	22.5 / –	26	– / 50	0 - 5.5 / 200	MSOP-10	CGB240
12.5 Gb/s NRZ Driver	DC - 18	24 / –	16	3.5 / –	5 - 8 / 70 - 175	Die	TGA1328-SCC
12.5 Gb/s NRZ Driver	DC - 18	8 Vpp	16	3.5 / –	8 / 175	SL-A1-12	TGA8652-EPU-SL
Wideband Driver (40 Gb/s)	DC - 35	18 / –	12	–	5 / 135	Die	TGA4832
CATV Ultra Linear HPA	0.04 - 1	28.5 / 47	12	2.6 / –	12 / 425	SG-O1-16	TGA2801B-SG
Wideband PA, AGC	2 - 20	26 / –	8	–	8 / 440	Die	TGA8334-SCC
Wideband PA, AGC	2 - 20	29 / 38 / –	15	–	12 / 1100	FL-A1-10	TGA2509-EPU-FL
Wideband PA, AGC	2 - 22	28.5 (30) / 36	17	–	12 / 1100	Die	TGA2509
WiMAX Driver Amp / PA, SB	2.3 - 2.8	29 / 40	28	–	6 / 710	SM-O5-28	TGA2702-SM
Bluetooth Class 1 PA	2.4 - 2.5	21.5 / –	27	– / 50	0 - 3.3 / 160	STSLP-12	TQP770001
ISM Band Matched PA, PD	2.4 - 2.5	25 / –	30	–	3.3 / 200	VQFN-16	TQP777002
WiMAX Driver Amp / PA, SB	3.4 - 3.8	30 / 42	24	–	6 / 770	SM-O5-28	TGA2703-SM
PA, AGC	6 - 17	29.5 / 31	20.5	–	8 / 700	Die	TGA6316-EEU
0.5W PA	6 - 18	27 / –	11	8 / –	8 / 400	Die	TGA8014-SCC
Driver Amp	7 - 13	(30) / 37	25	– / 30	9 / 450	Die	TGA2700
Wideband Driver Amp	8 - 18	13 / –	17	5 / –	4.5 / 50	Die	TGA8399C-EPU
1W HPA	12 - 19	30 / –	30	–	5 - 7 / 435	Die	TGA2508
HPA	12 - 19	29 / –	25	–	5 - 7 / 435	SM-O6-12	TGA2508-SM
MPA, SB	17 - 21	(22) / –	18.5	– / 25	7 / 66	Die	TGA9088A-SCC
Driver Amp	17 - 24	22 / –	19	4 / –	5 / 270	SM-O9-16	***TGA2521-SM****
HPA, AGC, PD	17 - 24	(29) / 38	22	–	5 / 712	SM-O10-20	***TGA2522-SM****
HPA	17 - 27	29 (31) / 37	22	–	7 / 760	Die	TGA4502-SCC
HPA	18 - 27	29 / 37	14	–	6 / 480	Die	TGA1135-SCC
MPA	19 - 27	25 / 32	22	–	5 - 7 / 220	Die	TGA1073G-SCC
1W PA	23 - 29	30 / –	24	– / 25	7 / 400	Die	TGA9070-SCC
MPA	25 - 35	25 / –	18	–	6 / 220	SM-A4-20	TGA4902-SM
MPA	26 - 35	25 (32) / –	19	–	5 - 7 / 220	Die	TGA1073A-SCC
1W HPA	27 - 31	30 / –	22	– / 25	4 - 6 / 420	Die	TGA4509-EPU
HPA	27 - 32	28.5 / –	25	–	6 - 8 / 420	Die	TGA1073B-SCC
HPA	27 - 32	29 / –	16	–	6 - 7 / 630	Die	TGA1172-EPU
1W HPA	28 - 31	30 / –	19	– / 25	6 / 420	SM-A4-20	TGA4509-SM
Driver Amp	29 - 31	16 (17) / 22	15	–	6 / 60	SM-A4-20	TGA4510-SM
Driver Amp	29 - 37	16 / –	16	–	6 / 60	Die	TGA4510-EPU
MPA	32 - 45	24 (25) / 33	16	–	6 / 175	Die	TGA4521
HPA	33 - 36	31 (33) / –	17	–	6 - 7 / 880	Die	TGA1141-EPU
HPA	36 - 40	26 / –	15	–	5 - 7 / 240	Die	TGA1073C-SCC
HPA	36 - 40	30 / –	14	–	6 - 7 / 500	Die	TGA1171-SCC
MPA	33 - 47	27 (27.5) / 36	18	–	6 / 400	Die	TGA4522
0.5W HPA	40 - 45	28 / –	9	–	7 / 500	Die	TGA4043
Driver Amp	41 - 45	18 / –	14	–	6 / 168	Die	TGA4042-EPU

*NOTES: *** = New**, SB = Self Biased, AGC = Automatic Gain Control, PD = Power Detector*

AMPLIFIERS – 1W TO 4W

Description	Frequency Range (GHz)	P1dB (Psat) / OIP3 (dBm)	Gain (dB)	NF / PAE (dB) / (%)	Voltage / Current (V / mA)	Package Style	Part Number
CATV Ultra Linear HPA	0.04 - 1	31.5 / 55	12	2.75 / –	12 / 510	SG-O1-16	TGA2801D-SG
4W HPA, HFET	4.9 - 6	36 / –	11	–	7 - 9 / 700 - 800	SG-A2-2	TGA2921-SG
2W HPA, HFET	4.9 - 6	34 / 47	11	–	7 - 9 / 480	SG-A2-2	TGA2922-SG
2.8W HPA	6 - 18	(34.5) / –	24	– / 20	7 - 9 / 800 - 1200	Die	TGA2501
HPA	6 - 18	(34.5) / –	24	– / 20	8 / 1200	Die	TGA9092-SCC
2W HPA	12.3 - 15.7	(31) / –	33	7 / –	6 / 850	Die	TGA2520
2W HPA	12.5 - 16	(32) / 37	32	–	6 - 7 / 680	SM-O1-24	TGA2503-SM
2W HPA	12.5 - 17	(34) / –	26	– / 25	7.5 / 650	Die	TGA2510-EPU
2W HPA	12.5 - 17	(33.5) / –	25	– / 25	7.5 / 650	SG-A1-6	TGA2510-EPU-SG
4W HPA	13 - 15	(36) / 41	25	–	7 / 1300	FL-A1-10	TGA8659-FL
2W HPA	13 - 17	(34) / 40	32	–	6 - 7 / 680	Die	TGA2503-EPU
2W HPA	13 - 17	(34) / –	25	–	6 - 7 / 640	Die	TGA2505

AMPLIFIERS – 1W TO 4W *(cont.)*

Description	Frequency Range (GHz)	P1dB (Psat) / OIP3 (dBm)	Gain (dB)	NF / PAE (dB) / (%)	Voltage / Current (V / mA)	Package Style	Part Number
2W HPA, PD	13 - 17	(34) / 38.5	26	– / 30	7.5 / 650	SG-A1-6	TGA2902-1-SCC-SG
2W HPA	13 - 17	(34) / –	33	–	5 - 8 / 680	FL-A1-10	TGA2904-FL
2W HPA	13 - 17	(34) / 40	33	–	5 - 8 / 680	SG-A1-6	TGA8658-EPU-SG
HPA	13.5 - 15	33 / 39	34	–	7 / 680	Die	TGA1152-SCC
2W HPA	18 - 23	32 (33) / 39	26	–	7 / 840	Die	TGA4022
HPA	24 - 31	35.5 (36) / –	23	–	6 / 2100	Die	TGA4505
HPA	25 - 31	35.5 (36) / –	22	–	6 / 2100	CP-A1-8	TGA4905-CP
2W HPA	27 - 31	32.5 (33) / 36.5	20	– / 25	6 / 840	Die	TGA4513
2W HPA	27 - 31	32.5 (33) / –	22	–	6 / 840	CP-A2-8	TGA4513-CP
HPA	30 - 40	31.5 (33) / –	20	–	6 / 1050	Die	TGA4516
2W HPA	31 - 35	31.5 (33.5) / –	19	–	6 - 7 / 1150	Die	TGA4514-EPU
3.5W HPA	31 - 37	(35.5) / –	20	–	6 / 2000	Die	TGA4517
2W HPA	41 - 47	(33) / –	16	–	6 / 2000	Die	TGA4046

NOTES: PD = Power Detector

AMPLIFIERS – MORE THAN 4W

Description	Frequency Range (GHz)	P1dB (Psat) / OIP3 (dBm)	Gain (dB)	PAE (%)	Voltage / Current (V / mA)	Package Style	Part Number
10W HPA, HFET	2.6	40 / 51	12	–	8 / 1200	SG-A4-2	TGA2924-SG
10W HPA, HFET	3.3 - 3.8	40 / 51	9	–	7 - 9 / 1200	SG-A3-2	TGA2923-SG
5W HPA, HFET	3.5	37.5 / 49	11	–	8 / 750	SG-A4-2	TGA2925-SG
HPA	6.5 - 11.5	37 (39) / –	19	35	7 - 9 / 1200	Die	TGA9083-SCC
16W HPA	6.5 - 12.5	42 / –	27	35	12 / 3000	Die	TGA2517
HPA	7 - 8.5	(38) / –	21	42	7 / 2000	Die	TGA2701
HPA	9 - 10.5	(38) / –	20	>38	4 - 9 / 2000	Die	TGA2704
HPA	10.5 - 12	(38) / –	19	>39	4 - 9 / 2000	Die	TGA2710
6.5W HPA	13 - 16	(38) / –	24	–	8 / 2600	FL-A2-10	TGA2514-FL
4W HPA, Balanced	13 - 17	(36) / 44	25	30	6 - 7 / 1300	Die	TGA2502
6.5W HPA	13 - 18	(38) / 44	24	–	8 / 3600	Die	TGA2514-EPU
7W HPA	26 - 31	(38.5) / –	22	–	6 / 4200	CP-A3-8	TGA4915-EPU-CP
4W HPA	28 - 31	36 (36.5) / –	22	22	6 / 1600	Die	***TGA4906****
7W HPA	28 - 31	(38.5) / –	22	20	6 / 3200	Die	***TGA4916****

*NOTES: * = New*

AMPLIFIERS – GAIN BLOCK

Description	Frequency Range (GHz)	P1dB (Psat) / OIP3 (dBm)	Gain (dB)	NF (dB)	Voltage / Current (V / mA)	Package Style	Part Number
LNA / Gain Block	DC - 40	11.5 / 20	13	3.2	5 / 50	Die	TGA4830
LNA / Gain Block	DC - 60	13 / 21	15	3	6 / 50	Die	TGA4811
CATV TIA / Gain Block, SB	0.04 - 1	27 / 46	20	1.5	8 / 350	SM-08-20	TGA2803-SM
Gain Block	2 - 6	17 / –	13.5	5.5	15 / 68	Die	TGA8226-SCC
Gain Block, SB	2 - 10	17 / –	17	6	5 / 90	Die	TGA8810-SCC
Gain Block, AGC	2 - 18	22 / –	23	6	7 / 340	Die	TGA6345-EEU
Gain Block	2 - 18	20 / –	7.5	5.5	6 / 100	Die	TGA8300-SCC
Wideband Gain Block, AGC	2 - 20	20 / –	7.5	7	6 / 150	Die	TGA8622-SCC
Gain Block	6 - 18	12.5 / –	13	5	5 / 80	Die	TGA8035-SCC
Driver Amp, SB	11 - 17	17 / –	23	6	6 / 75	SM-06-12	TGA2507-SM
Driver Amp, SB	12 - 18	14 / –	17	–	6 / 40	Die	TGA2506-EPU
Driver Amp, SB	12 - 18	20 / –	28	6	6 / 80	Die	TGA2507-EPU
Gain Block & 2x / 3x Multiplier	17 - 37	18 (22) / 26	20	7	5 / 140	SM-03-16	***TGA4030-SM****
Gain Block & 2x / 3x Multiplier	17 - 40	18 (22) / 24	22	7	5 / 140	SM-A3-16	***TGA4031-SM****
Gain Block, Multiplier	17 - 43	22 / –	25	–	5 / 225	Die	TGA4040
Gain Block	19 - 38	(22) / 30	20	–	5 / 160	Die	TGA4036

*NOTES: * = New, SB = Self Biased, AGC = Automatic Gain Control*

LOW NOISE AMPLIFIERS

Description	Frequency Range (GHz)	P1dB / IIP3 (dBm)	Gain (dB)	NF (dB)	Voltage / Current (V / mA)	Package Style	Part Number
LNA, Discrete	DC - 4	– / 13	17	0.5	3 / 30	SOT-343	CFH800
LNA, AGC	DC - 14	16 / –	11	3.1	8 / 80	Die	TGA8349-SCC

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LOW NOISE AMPLIFIERS *(cont.)*

Description	Frequency Range (GHz)	P1dB / IIP3 (dBm)	Gain (dB)	NF (dB)	Voltage / Current (V / mA)	Package Style	Part Number
LNA / Gain Block	DC - 40	11.5 / 20	13	3.2	5 / 50	Die	TGA4830
LNA / Gain Block	DC - 60	13 / 21	15	3	6 / 50	Die	TGA4811
LNA, SB	0.1 - 3.5	15 / –	18	2.4	12 / 112	Die	TGA8061-SCC
LNA, Balanced FET	0.8 - 3	21 / 11	22	0.7	4 / 100	SM-02-6	TGA2602-SM
LNA, AGC	2 - 18	16 / –	19	4	5 / 120	Die	TGA8344-SCC
LNA, AGC	2 - 20	17.5 / –	9	3.5	5 - 8 / 60	Die	TGA1342-SCC
LNA, AGC	2 - 20	17.5 / –	9	3.5	5 - 8 / 60	Die	TGA8310-SCC
LNA, AGC	2 - 20	16 / –	17	2.5	5 / 75	SM-07-12	TGA2513-SM
LNA, AGC	2 - 23	17 / 26	17	2	5 / 75	Die	TGA2513
LNA, SB, AGC	4 - 14	6 / 16	22	2.3	5 / 90	SM-04-12	TGA2512-1-SM
LNA, AGC, GB	4 - 14	13 / 24	25	2.3	5 / 160	SM-04-12	TGA2512-2-SM
LNA	4.9 - 6	5 / -3	18	1.3	3 / 8	SLIM-7	TQL5000
LNA, Dual-Band	2.4 / 4.9 - 6	8 / 6, 12.5 / 1	16.5, 22.5	1.2, 1.5	3.3 / 11.5, 3.3 / 18.5	VQFN12	TQM3M7001
LNA, SB, AGC	5 - 15	6 / 13	27	1.4	5 / 90	Die	TGA2512
LNA	6 - 12	2 / –	31	0.7	2.5 / 17	Die	TGA2600-EPU
LNA, SB	6 - 13	11 / –	26	1.5	5 / 65	Die	TGA8399B-SCC
LNA, SB, AGC	6 - 14	6 / 12	20	1.3	5 / 90	Die	TGA2511
LNA	20 - 27	12 / –	21	2.2	3.5 / 60	Die	TGA4506
LNA	21 - 27	10 / –	21	2.5	3.5 / 60	SM-A4-20	TGA4506-SM
LNA	23 - 29	15 / –	15	3.1	5 / 50	Die	TGA1307-EPU
LNA	28 - 36	12 / 21	22	2.3	3 / 60	Die	TGA4507-EPU
LNA	30 - 42	14 / –	21	2.8	3 / 40	Die	TGA4508-EPU
LNA	57 - 69	–	13	4	3 / 41	Die	TGA4600-EPU

NOTES: SB = Self Biased, AGC = Automatic Gain Control, GB = Gate Bias

DISCRETE TRANSISTORS

Description	Frequency Range (GHz)	P1dB (Psat) / OIP3 (dBm)	Gain (dB)	NF / PAE (dB) / (%)	Voltage / Current (V / mA)	Package Style	Part Number
MESFET	DC - 2.5	26.5 / –	11	1.72 / 55	2 - 6 / 350	SOT-223	CLY5
MESFET	DC - 3	23.5 / –	15.5	1.48 / 55	2 - 6 / 180	MW6	CLY2
24mm HFET	DC - 4	40 / –	13	– / 51	8 / 2170	Die	TGF4124-EPU
18mm HFET	DC - 6	38.5 / –	13.5	– / 53	8 / 1690	Die	TGF4118-EPU
12mm HFET	DC - 8	37 / –	14	– / 55	8 / 750	Die	TGF4112-EPU
0.5W HFET	DC - 6	28 / 40	18	3.2 / –	8 / 100	SOT89	***TGF2960-SD****
1W HFET	DC - 6	31 / 43	16	4 / –	8 / 200	SOT89	***TGF2961-SD****
4.8mm HFET	DC - 10.5	34 / –	8.5	– / 53	8 / 200	Die	TGF4250-SCC
9.6mm HFET	DC - 10.5	37 / –	9.5	– / 52	8.5 / 520	Die	TGF4260-SCC
1.2mm HFET	DC - 12	28.5 / –	10	– / 55	8 / 50	Die	TGF4230-SCC
2.4mm HFET	DC - 12	31.5 / –	10	– / 56	8 / 100	Die	TGF4240-SCC
1mm Pwr pHEMT	DC - 12	(31.5) / –	11	– / 55	12 / 900	Die	TGF2021-01
2mm Pwr pHEMT	DC - 12	(34.5) / –	11	– / 55	12 / 150	Die	TGF2021-02
4mm Pwr pHEMT	DC - 12	(37.5) / –	11	– / 55	12 / 300	Die	TGF2021-04
8mm Pwr pHEMT	DC - 12	(40.2) / –	11	– / 55	12 / 600	Die	TGF2021-08
12mm Pwr pHEMT	DC - 12	(42) / –	11	– / 52	12 / 900	Die	TGF2021-12
0.3mm MESFET	DC - 18	13 / –	11	1.5 / –	3 / 15	Die	TGF1350-SCC
0.6mm Pwr pHEMT	DC - 20	(29) / –	13	– / 56	12 / 45	Die	TGF2022-06
1.2mm Pwr pHEMT	DC - 20	(32) / –	13	– / 56	12 / 90	Die	TGF2022-12
2.4mm Pwr pHEMT	DC - 20	(35) / –	13	– / 58	12 / 180	Die	TGF2022-24
4.8mm Pwr pHEMT	DC - 20	(38) / –	13	– / 58	12 / 360	Die	TGF2022-48
6.0mm Pwr pHEMT	DC - 20	(39) / –	12.5	– / 53	12 / 448	Die	TGF2022-60
0.3mm pHEMT	DC - 22	16 / –	13	0.8 / –	3 / 15	Die	TGF4350-EPU

*NOTES: *** = New***

SWITCHES

Description	Frequency (GHz)	Insertion Loss (dB)	Isolation (dB)	P1dB (dBm)	Control Voltage (V)	Package Style	Part Number
SP3T High Power CDMA	DC - 2	0.45	28	>36.5	2.6 / 0	MLP12	TQP4M3018
SP3T High Power CDMA	DC - 2	0.6	22	34.5	2.6 / 0	STSLP12	TQP4M3019
SP2T General Purpose	DC - 2.5	0.3	24	30	3 / 0	SOT-363	CSH210R

SWITCHES *(cont.)*

Description	Frequency (GHz)	Insertion Loss (dB)	Isolation (dB)	P1dB (dBm)	Control Voltage (V)	Package Style	Part Number
SP4T High Power EDGE, Dec.	DC - 4.5	0.5	33	38	2.7 / 0	SLIM17	TQP4M4010
SPDT High Power GSM	DC - 6	0.5	27	37	2.5 / 0	SLIM7	TQP4M4003
SP2T 802.11a/b/g	DC - 6	0.6	28	31.5	3 / 0	SLIM7	TQS5200
Diversity Switch 802.11a/b/g	DC - 6	0.8	33	33	3 / 0	MLP12	TQS5202
SPDT FET	DC - 8	0.7	40	27	0 / -5	Die	TGS8706-SCC
SPDT FET	DC - 18	1.5	36	27	-5	Die	TGS2306-EPU
SPDT FET	DC - 18	2	39	21	-7 / 0	Die	TGS8250-SCC
SP4T FET	DC - 18	2.5	37	19	0 / -5	Die	TGS8422-SCC
SP3T VPIN	1 - 20	0.5	35	23	10 mA	Die	TGS2303-EEU
SP4T VPIN	1 - 20	0.6	38	23	10 mA	Die	TGS2304-SCC
SP3T VPIN	4 - 18	1	35	20	+/- 2.7	Die	TGS2313
SPDT VPIN	4 - 20	0.9	35	>20	+/- 2.7	Die	TGS2302
SPDT FET	8 - 11	0.9	40	27.5	-7 / 0	Die	TGS8122-SCC
SPDT VPIN	24 - 43	<2	36	27	+/- 5	Die	TGS4301-EPU
SPDT VPIN	27 - 46	0.9	30	>34	+/ -5 / 15	Die	TGS4302
SPDT VPIN Absorptive	32 - 40	1	36	>33	+/- 5 / 18	Die	TGS4304
SP5T VPIN 77 GHz	71 - 80	2.5	25 / 40	–	1.3	Die	TGS4307-EPU

NOTES: Dec. = Integrated Decoder

FREQUENCY CONVERTERS & MIXERS

Description	RF Frequency Range (GHz)	Conversion Gain (dB)	LO / RF Isolation (dB)	IIP3 (dBm)	Voltage / Current (V / mA)	Package Style	Part Number
WB Mixer, LO	0.5 - 2.5	-5.7	8	24	3 - 6 / 6	MW6	CMY210
WB Mixer, LO, IF	0.5 - 2.5	10	8	9	3 - 6 / 12	SCT598	CMY212
WB Mixer, LO, IF, Low Current	0.5 - 2.5	9.5	10	10	3 - 6 / 8	SCT598	CMY213
Doubler with Amplifier	16 - 30	18	30	22	5 / 150	Die	TGC4403
Doubler with Amplifier	16 - 30	18	30	19	5 / 150	SM-011-16	TGC4403-SM
Upconverting Mixer	17 - 26	-9	40	–	-0.9 / 0	SM-011-16	TGC4402-SM
Upconverting Mixer	17 - 27	-9	35	18	-0.9 / 0	Die	TGC4402
Upconverter	17 - 27	13	30	–	5 / 425	Die	TGC4405
Upconverter	17 - 27	13	30	–	5 / 425	SM-011-16	***TGC4405-SM****
Gain Block & 2x / 3x Multiplier	17 - 37	9	N/A	6	5 / 140	SM-03-16	***TGA4030-SM****
Gain Block & 2x / 3x Multiplier	17 - 40	9	N/A	2	5 / 140	SM-A3-16	***TGA4031-SM****
Doubler (Input 10 - 20 GHz)	20 - 40	-12	25	18	–	Die	TGC1430F-EPU
Tripler (Input 8.5 - 13.5 GHz)	20 - 40	-15	15	18	–	Die	TGC1430G-EPU

*NOTES: *** = New**, LO = LO Amplifier, IF = IF Amplifier*

OPTICAL COMPONENTS

Description	Frequency (GHz)	Power (Vpp or dBm)	Gain (dB)	Noise Figure (dB)	Voltage / Current (V / mA)	Package Style	Part Number
12.5 Gb/s NRZ Driver	DC - 18	24 dBm	16	3.5	5 - 8 / 70 - 175	Die	TGA1328-SCC
12.5 Gb/s NRZ Driver	DC - 18	8V	16	3.5	8 / 175	SL-A1-12	TGA8652-EPU-SL
Wideband Driver (40 Gb/s)	DC - 35	4V	12	–	5 / 135	Die	TGA4832
9.9 - 12.5 Gb/s Linear Driver	DC - 8	25 dBm	20	–	8 / 310	SL-A3-18	TGA4819-SL
10.7 Gb/s Diff. TIA	DC - 10	–	8K dB ohms SE	6pA √Hz	3.3 / 80	Die	TGA4815-EPU
10.7 Gb/s Diff. TIA	DC - 10	–	1.6K dB ohms SE	6pA √Hz	3.3 / 60	Die	TGA4816-EPU
10.7 Gb/s Diff. TIA	DC - 10	–	3.2K dB ohms SE	11pA √Hz	3.3 / 70	Die	TGA4817-EPU
9.9 - 12.5 Gb/s Linear Driver	DC - 10	26 dBm	21	–	8 / 360	Die	TGA4819-EPU
9.9- 12.5 Gb/s Mod. Driver	DC - 16	3V - 10V	35	2.5	5.5 - 8 / 210	SL-A2-18	TGA4953-SL
9.9- 12.5 Gb/s Mod. Driver	DC - 16	3V - 10V	35	2.5	5.5 - 8 / 210	SL-A4-18	TGA4954-SL
12.5 Gb/s NRZ Driver	DC - 18	11V	16	–	8 / 285	Die	TGA4807-EPU
12.5 Gb/s RZ Driver	DC - 25	7V	15	–	9 / 100	Die	TGA4802-EPU
43 Gb/s NRZ Driver	DC - 35	7V	15	–	6.5 / 170	Die	TGA4801-EPU
40 Gb/s TIA, SE	DC - 40	–	250 dB ohms	15pA √Hz	5 / 30	Die	TGA4812-EPU
Analog Attenuator	DC - >50	–	(up to 17)	–	0 to -1 / –	Die	TGL4203-EPU
Analog Attenuator	DC - 30	–	(up to 17)	–	0 to -1 / –	SM-012-16	TGL4203-SM
43 Gb/s Driver	DC - 78	3V	8	5	6 / 82	Die	TGA4803-EPU
10.7 - 12.5Gb/s Linear Mod. Driver	30kHz - 8	25 dBm	20	–	8 / 310	SM-A8-28	***TGA4823-SM****
Single-Ended to Diff. Amp	10	2V Diff.	21 Diff.	–	5 / 72	Die	TGA2951-EPU

*NOTES: *** = New**, SE = Single-Ended*

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CONTROL PRODUCTS

Description	Frequency (GHz)	Insertion Loss (dB)	Control Range dB or (Deg.)	P1dB (dBm)	Supply Voltage (V)	Package Style	Part Number
Discrete Thru (0 dB Attenuator)	DC - 65	0	0	–	N/A	Die	TGL4201-00
Analog Attenuator	DC - >50	2	17	–	0 to -2	Die	TGL4203-EPU
Analog Attenuator	DC - 30	2	17	–	0 to -2	Die	TGL4203-SM
Discrete Attenuators	DC - 65	–	2,3,6,10	–	N/A	SM-012-16	TGL4201-02, 03, 06, 10
Digital Attenuator	0.5 - 18	4	15.5	20	0 / -5	Die	TGL6425-SCC
Analog Attenuator	2 - 20	2	15	23	2.5	Die	TGL8784-SCC
Passive Wideband Limiter	3 - 25	<0.5	N/A	18	N/A	Die	TGL2201-EPU
5-Bit Phase Shifter	6 - 18	9	(348)	–	6	Die	TGP6336-EEU
Bessel Filter	–	6,7,8,9,10&11 Cut-off Freq	N/A	–	N/A	Die	TGB2010-00,-09-EPU etc.
Bessel Filter	–	5,6,6.5,7.5,8&9 Cut-off Freq	N/A	–	N/A	SM-02-6	TGB2010-00,-09-EPU-SM etc.
6-Bit Phase Shifter	8.5 - 11	5	(354)	–	0 / -5	Die	TGP2103-EPU
Lange Coupler	12 - 21	<0.25	–	–	N/A	Die	TGB2001-EPU
5-Bit Phase Shifter	18 - 20	5	(180)	–	-2.5	Die	TGP1439-EPU
Lange Coupler	18 - 32	<0.25	–	–	N/A	Die	TGB4001-EPU
Lange Coupler	27 - 45	<0.25	–	–	N/A	Die	TGB4002-EPU
5-Bit Phase Shifter	28 - 32	6	(348)	–	5	Die	TGP2100-EPU
5-Bit Phase Shifter	33 - 37	6	(348)	–	-5	Die	TGP2102-EPU
1-Bit Phase Shifter	34 - 36	4	180	–	0 / 5	Die	TGP2104

INTEGRATED PRODUCTS

Description	Frequency Bands	Package Size (mm)	Part Number
GSM Quad-Band PA, Internal Vref	Cell, PCS, EGSM, DCS	5 x 5	TQM7M4006
GSM Quad-Band Tx Module, ESD Protection	Cell, PCS, EGSM, DCS	6 x 6	TQM6M4002
GSM Quad-Band Tx Module, ESD Protection (Mirror Pinout to TQM6M4002)	Cell, PCS, EGSM, DCS	6 x 6	TQM6M4003
UMTS 2100 3V Linear PA; Low Idle Current Consumption	UMTS	4 x 4	TQM7M6001
CDMA PCS Band, PA, High Efficiency at Low-Power, 1-Bit Bias	PCS	4 x 4	TQM763022
CDMA Cellular Band PA, High Power, PAE 40%, 1-Bit Bias	Cell	4 x 4	TQM713019
CDMA Cellular Band PA, High Power, PAE 40%, 1-Bit Bias	Cell	3 x 3	TQM713024
EDGE Polar Quad-Band HADRON PA Module™	Cell, PCS, EGSM, DCS	7 x 7	TQM7M5002
EDGE Polar Quad-Band HADRON PA Module™	Cell, PCS, EGSM, DCS	7 x 7	TQM7M5003
EDGE Polar Quad-Band HADRON PA Module™	Cell, PCS, EGSM, DCS	7 x 7	TQM7M5008
GSM / EDGE Linear Quad-Band QUANTUM Tx Module™, Internal Vref, 1-Bit Power Control	Cell, PCS, EGSM, DCS	6 x 6	TQM6M5001
GSM Dual-Band QUANTUM Tx Module™	EGSM, DCS	6 x 6	***TQM6M4028E****
GSM Dual-Band QUANTUM Tx Module™	Cell, PCS	6 x 6	***TQM6M4028U****
CDMA Ultra I, PCS TRITIUM PA-Duplexer Module™, 1-Bit Bias	PCS	8 x 5	TQM663017A
CDMA Ultra I, Cellular TRITIUM PA-Duplexer Module™, 1-Bit Bias	Cell	8 x 5	TQM613017
UMTS 800 HSDPA TRITIUM PA-Duplexer Module™ with Power Detector & Interstage Filter	UMTS	8 x 5	TQM616017
UMTS 1900 HSDPA TRITIUM PA-Duplexer Module™ with Power Detector & Interstage Filter	UMTS	8 x 5	TQM666017
UMTS 2100 HSDPA TRITIUM PA-Duplexer Module™ with Power Detector & Interstage Filter	UMTS	6 x 5	TQM676001
CDMA Ultra I, Cellular TRITIUM II PA-Duplexer Module™, 1-Bit Bias, BAL Input	Cell	7 x 4	TQM613025
CDMA Ultra I, Cellular TRITIUM II PA-Duplexer Module™, 1-Bit Bias, SE Input	Cell	7 x 4	TQM613026

*NOTES: *** = New**, PAD = PA Duplexer, SE = Single-Ended, BAL = Balanced*

SAW FILTERS

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
Cable IF Filter	36.15	8	19.7	SE / SE	38 @ 10.23	DIP	855748
Cable IF Filter	44	6	20.4	SE / SE	38 @ 7.60	DIP	855079
Cable IF Filter	44	6	20.8	SE / SE	38 @ 7.40	24.6 x 9.0	856129
CDMA IF Filter	69.99	1.26	19	SE / BAL	35 @ 1.50	DIP	854550-1
CDMA IF Filter	69.99	1.26	17.1	SE / SE	25 @ 1.68	24.6 x 9.0	856199
CDMA IF Filter	70	1.26	19	SE / BAL	35 @ 1.50	DIP	854747-1
BWA IF Filter	70	8	12.95	SE / SE	35 @ 3.20	13.3 x 6.5	855677
Low Loss IF Filter	70	0.5	7.6	SE / SE	35 @ 1.28	19.0 x 6.5	854651
Low Loss IF Filter	70	1	7.3	SE / SE	40 @ 2.80	19.0 x 6.5	854652
Low Loss IF Filter	70	1.5	7.5	SE / SE	40 @ 3.20	19.0 x 6.5	854653
Low Loss IF Filter	70	2	7.85	SE / SE	40 @ 4.25	19.0 x 6.5	854654
Low Loss IF Filter	70	2.5	8.75	SE / SE	40 @ 4.60	19.0 x 6.5	854655

SAW FILTERS *(cont.)*

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
Low Loss IF Filter	70	3	6.95	SE / SE	35 @ 6.90	13.3 x 6.5	854656
Low Loss IF Filter	70	3.5	7.25	SE / SE	35 @ 7.20	13.3 x 6.5	854657
Low Loss IF Filter	70	4	6.8	SE / SE	40 @ 8.25	13.3 x 6.5	854658
Low Loss IF Filter	70	4.5	6.8	SE / SE	35 @ 8.50	13.3 x 6.5	854659
Low Loss IF Filter	70	5	7.25	SE / SE	40 @ 9.35	13.3 x 6.5	854660
Low Loss IF Filter	70	6	7.5	SE / SE	40 @ 10.20	13.3 x 6.5	854661
Low Loss IF Filter	70	7	8.5	SE / SE	40 @ 11.55	13.3 x 6.5	854662
Low Loss IF Filter	70	8	9	SE / SE	40 @ 13.25	13.3 x 6.5	854663
Low Loss IF Filter	70	9	9.75	SE / SE	40 @ 13.90	13.3 x 6.5	854664
Low Loss IF Filter	70	10	10	SE / SE	40 @ 15.00	13.3 x 6.5	854665
Low Loss IF Filter	70	12	11.5	SE / SE	40 @ 17.35	13.3 x 6.5	854666
Low Loss IF Filter	70	14	12.5	SE / SE	40 @ 19.50	13.3 x 6.5	854667
Low Loss IF Filter	70	16	12.5	SE / SE	40 @ 21.40	13.3 x 6.5	854668
Low Loss IF Filter	70	18	13.5	SE / SE	40 @ 23.40	13.3 x 6.5	854669
Low Loss IF Filter	70	20	14.5	SE / SE	40 @ 25.40	13.3 x 6.5	854670
Low Loss IF Filter	70	22	15	SE / SE	40 @ 27.25	13.3 x 6.5	854671
Low Loss IF Filter	70	24	16.25	SE / SE	40 @ 29.65	13.3 x 6.5	854672
Low Loss IF Filter	70	26	17	SE / SE	40 @ 32.00	13.3 x 6.5	854673
Low Loss IF Filter	70	28	17.6	SE / SE	40 @ 33.75	13.3 x 6.5	854674
Low Loss IF Filter	70	30	17.5	SE / SE	40 @ 37.00	13.3 x 6.5	854675
Low Loss IF Filter	70	36	20.2	SE / SE	40 @ 43.30	13.3 x 6.5	854678
Low Loss IF Filter	70	40	21.5	SE / SE	40 @ 47.25	13.3 x 6.5	854680
High Selectivity IF Filter	70	0.3	16.36	SE / SE	40 @ 0.90	24.6 x 9.0	855735
High Selectivity IF Filter	70	0.5	21.3	SE / SE	40 @ 1.63	24.6 x 9.0	855736
High Selectivity IF Filter	70	1	22.2	SE / SE	40 @ 2.11	24.6 x 9.0	855737
High Selectivity IF Filter	70	1.5	21.6	SE / SE	40 @ 2.52	24.6 x 9.0	855738
High Selectivity IF Filter	70	2	23	SE / SE	40 @ 3.40	24.6 x 9.0	855739
High Selectivity IF Filter	70	2.5	20.25	SE / SE	40 @ 4.30	24.6 x 9.0	855740
High Selectivity IF Filter	70	3	23	SE / SE	40 @ 4.46	24.6 x 9.0	855741
High Selectivity IF Filter	70	3.5	19	SE / SE	40 @ 6.00	15.3 x 6.5	855742
High Selectivity IF Filter	70	4	23	SE / SE	40 @ 6.00	19.0 x 6.5	855743
High Selectivity IF Filter	70	4.5	23.7	SE / SE	40 @ 6.64	19.0 x 6.5	855744
High Selectivity IF Filter	70	5.5	22.2	SE / SE	40 @ 7.84	19.0 x 6.5	855745
CDMA IF Filter	73.59	1.2	11.9	SE / SE	45 @ 79.58	19.0 x 6.5	856111
BWA IF Filter	80	8	11.7	SE / SE	35 @ 14.25	13.3 x 6.5	855679
GSM IF Filter	86.6	0.4	5.3	SE / BAL	28 @ 1.58	19.0 x 6.5	854823
GSM IF Filter	87	0.4	4.4	BAL / BAL	28 @ 1.59	19.0 x 6.5	855500
CDMA IF Filter	114.99	1.4	21.5	SE / SE	50 @ 6.00	DIP	854733-1
CDMA IF Filter	114.99	1.4	21.1	SE / SE	50 @ 6.00	20.1 x 9.8	855783
CDMA IF Filter	118.58	3.69	17.4	SE / SE	43 @ 123.48	13.3 x 6.5	855958
GSM IF Filter	125	0.4	5.9	SE / SE	20 @ 2.40	9.1 x 4.8	856444
Low Loss IF Filter	140	4	10.85	SE / SE	40 @ 9.10	13.3 x 6.5	854909
Low Loss IF Filter	140	7	5.5	SE / SE	40 @ 11.10	13.3 x 6.5	854913
Low Loss IF Filter	140	10	8.3	SE / SE	35 @ 15.00	13.3 x 6.5	854916
Low Loss IF Filter	140	10	11	SE / SE	35 @ 15.00	13.3 x 6.5	***856656****
Low Loss IF Filter	140	12	8.87	SE / SE	35 @ 21.30	13.3 x 6.5	854917
Low Loss IF Filter	140	15	11	SE / SE	35 @ 22.00	13.3 x 6.5	***856684****
Low Loss IF Filter	140	16	8.4	SE / SE	35 @ 22.00	13.3 x 6.5	854919
Low Loss IF Filter	140	18	9.1	SE / SE	40 @ 48.00	13.3 x 6.5	854920
Low Loss IF Filter	140	20	11	SE / SE	35 @ 24.00	13.3 x 6.5	856592
Low Loss IF Filter	140	24	11.3	SE / SE	35 @ 33.50	13.3 x 6.5	854923
Low Loss IF Filter	140	32	11.5	SE / SE	35 @ 44.00	13.3 x 6.5	854927
High Selectivity IF Filter	140	0.8	20.8	SE / SE	40 @ 1.93	19.0 x 6.5	856062
High Selectivity IF Filter	140	1.5	21.9	SE / SE	40 @ 2.71	19.0 x 6.5	856063
High Selectivity IF Filter	140	2	21.5	SE / SE	40 @ 3.45	19.0 x 6.5	856064
High Selectivity IF Filter	140	3	22.4	SE / SE	40 @ 4.86	19.0 x 6.5	856065
High Selectivity IF Filter	140	6	23	SE / SE	40 @ 8.34	13.3 x 6.5	856066

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SAW FILTERS *(cont.)*

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
High Selectivity IF Filter	140	7	24.5	SE / SE	40 @ 9.15	13.3 x 6.5	856067
High Selectivity IF Filter	140	8	23.4	SE / SE	40 @ 11.28	13.3 x 6.5	856068
High Selectivity IF Filter	140	10	20.87	SE / SE	40 @ 13.17	13.3 x 6.5	856069
High Selectivity IF Filter	140	14	23.3	SE / SE	40 @ 18.26	13.3 x 6.5	856070
High Selectivity IF Filter	140	16	21.7	SE / SE	40 @ 20.69	13.3 x 6.5	856071
High Selectivity IF Filter	140	28	20	SE / SE	40 @ 37.00	9.0 x 7.0	856019
High Selectivity IF Filter	140	32	21.7	SE / SE	40 @ 40.70	9.0 x 7.0	856072
High Selectivity IF Filter	140	44	21.75	SE / SE	40 @ 54.10	9.0 x 7.0	856073
High Selectivity IF Filter	140	56	18.65	SE / SE	40 @ 75.60	9.0 x 7.0	856074
High Selectivity IF Filter	140	64	17.8	SE / SE	40 @ 84.00	9.0 x 7.0	856020
High Selectivity IF Filter	140	72	21	SE / SE	40 @ 102.00	9.0 x 7.0	856314
CDMA IF Filter	141	1.18	11.7	SE / SE	42.5 @ 2.50	19.0 x 6.5	855395
CDMA IF Filter	150	1.18	18.6	SE / BAL	30 @ 4.50	19.0 x 6.5	854833-1
CDMA IF Filter	150	8	12.1	SE / SE	35 @ 14.25	13.3 x 6.5	855678
CDMA IF Filter	153.6	3.75	12.04	SE / SE	45 @ 9.80	13.3 x 6.5	856048
CDMA IF Filter	160	1.18	19.5	SE / BAL	30 @ 4.50	19.0 x 6.5	855049
GSM IF Filter	160	0.2	3.3	BAL / BAL	30 @ 12.00	7.0 x 5.5	855626
CDMA IF Filter	167.1	1.18	10.9	SE / SE	15 @ 2.00	19.0 x 6.5	855394
CDMA IF Filter	167.1	11	13.1	SE / SE	40 @ 16.00	13.3 x 6.5	855753
WCDMA IF Filter	168.96	3.84	11.5	SE / SE	30 @ 16.00	9.1 x 4.8	856320
WCDMA IF Filter	169	4	10.4	SE / SE	40 @ 10.00	9.1 x 4.8	855927
GSM IF Filter	170.6	0.3	7.6	SE / BAL	40 @ 1.60	15.3 x 6.5	855756
GSM IF Filter	170.6	0.18	5.6	SE / SE	47 @ 6.40	13.3 x 6.5	856447
WCDMA IF Filter	172.8	8.84	12.5	SE / BAL	32 @ 16.00	7.0 x 5.5	856620
GSM IF Filter	175	0.66	6.5	SE / BAL	30 @ 2.38	13.3 x 6.5	854622
WCDMA IF Filter	190	5.5	9.8	SE / BAL	30 @ 7.60	13.3 x 6.5	855529
WCDMA IF Filter	190	5	8	SE / SE	25 @ 9.00	5.0 x 5.0	855770
GSM IF Filter	190	0.2	4.2	BAL / BAL	30 @ 12.00	7.0 x 5.5	855625
WCDMA IF Filter	190	3.84	10	SE / SE	30 @ 7.75	7.0 x 5.5	856386
GSM IF Filter	199	0.2	6	SE / SE	45 @ 1.60	19.0 x 6.5	855131
GSM IF Filter	199	0.5	6.8	SE / SE	30 @ 47.00	13.3 x 6.5	855780
GSM IF Filter	201	0.22	6.1	BAL / BAL	27 @ 0.80	13.3 x 6.5	856541
Cable IF Filter	202.75	1.2	6.6	SE / SE	40 @ 10.00	13.3 x 6.5	855068
GSM IF Filter	208	0.4	5.9	SE / SE	20 @ 2.40	9.1 x 4.8	856445
WCDMA IF Filter	208	3.84	11.5	BAL / BAL	17 @ 5.03	9.1 x 4.8	856496
GSM IF Filter	211	0.2	5.2	SE / SE	25 @ 0.80	13.3 x 6.5	856378
WCDMA IF Filter	230	4	16.2	SE / SE	40 @ 10.00	13.3 x 6.5	855832
CDMA IF Filter	240	3.6	14.3	SE / SE	12 @ 5.00	13.3 x 6.5	855992
CDMA IF Filter	240	1.1	13	SE / SE	10 @ 1.80	19.0 x 6.5	856151
BWA IF Filter	240	2	9.8	SE / BAL	45 @ 10.50	7.0 x 5.5	855091
BWA IF Filter	240	10	11	SE / BAL	40 @ 35.00	7.0 x 5.5	855092
CDMA IF Filter	249.6	3.84	16.11	SE / SE	40 @ 11.00	7.0 x 5.5	855915
WCDMA IF Filter	261.1	3.84	9.2	SE / SE	15 @ 8.032	13.3 x 6.5	855787
BWA IF Filter	280	34	8.2	BAL / BAL	45 @ 15.00	7.0 x 5.5	855393
BWA IF Filter	280	17	8.95	SE / BAL	38 @ 60.00	5.0 x 5.0	855975
GPS IF Filter	298.75	2.4	8.35	BAL / BAL	50 @ 20.00	7.0 x 5.5	856305
WiMAX IF Filter	325	10	9.6	BAL / BAL	40 @ 35.00	7.0 x 5.5	855094
CDMA IF Filter	326.4	15	12.61	SE / SE	40 @ 25.00	7.0 x 5.5	855914
BWA IF Filter	330	5.45	18.26	SE / SE	50 @ 13.60	15.3 x 6.5	855730
BWA IF Filter	350	2.4	13.1	SE / BAL	35 @ 12.00	7.0 x 5.5	855398
BWA IF Filter	350	1.7	13.7	SE / BAL	45 @ 6.00	13.3 x 6.5	855399
BWA IF Filter	350	1	8.2	SE / BAL	45 @ 15.00	7.0 x 5.5	855377
WLAN IF Filter	374	17	8.5	SE / BAL	10 @ 33.00	7.0 x 5.5	855653
WLAN IF Filter	374	17	8.5	SE / BAL	35 @ 33.00	5.0 x 5.0	855898
WLAN IF Filter	374	17	9	SE / BAL	30 @ 33.00	3.8 x 3.8	856278
WiMAX IF Filter	374	10	9	BAL / BAL	10 @ 25.00	3.8 x 3.8	856466
WCDMA IF Filter	380	5.4	15.4	SE / BAL	30 @ 8.30	13.3 x 6.5	855530
WCDMA IF Filter	380	3.84	12	SE / SE	30 @ 8.30	9.1 x 4.8	856392

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SAW FILTERS *(cont.)*

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
WiMAX IF Filter	380	13.75	9.4	SE / SE	40 @ 367.00	7.0 x 5.5	856272
General Purpose IF Filter	380	3.75	10	SE / SE	35 @ 8.00	7.0 x 5.5	856279
WiMAX IF Filter	380	3.75	11	BAL / BAL	30 @ 8.30	7.0 x 5.5	856464
WiMAX IF Filter	380	7	10	BAL / BAL	40 @ 20.00	7.0 x 5.5	856490
WiMAX IF Filter	380	10	8.7	BAL / BAL	40 @ 36.00	7.0 x 5.5	856631
WCDMA IF Filter	398	4.3	9.9	SE / SE	50 @ 36.00	9.1 x 4.8	855561
WCDMA / WiMAX IF Filter	398	15	7.5	SE / SE	30 @ 60.00	9.1 x 4.8	855559
WCDMA IF Filter	398	35	12	SE / SE	50 @ 368.00	9.1 x 4.8	856097
WiMAX IF Filter	398	10	11.2	BAL / BAL	35 @ 388.50	5.0 x 5.0	856652
BWA IF Filter	426	5.16	18.02	SE / SE	50 @ 14.00	13.3 x 6.5	855731
WiMAX IF Filter	456	3.5	9.1	BAL / BAL	40 @ 6.70	7.0 x 5.5	856494
WiMAX IF Filter	456	7	12	BAL / BAL	33 @ 449.30	7.0 x 5.5	856498
WiBRO IF Filter	456	8.75	7.9	BAL / BAL	36 @ 443.25	5.0 x 5.0	856549
WiMAX IF Filter	456	10	8.3	BAL / BAL	37 @ 440.00	7.0 x 5.5	856672
WiMAX IF Filter	456	10	8.3	BAL / BAL	37 @ 440.00	5.0 x 5.0	856638
General Purpose IF Filter	460	13.75	8.2	SE / SE	40 @ 447.00	7.0 x 5.5	856273
General Purpose IF Filter	460	3.75	11.1	SE / SE	35 @ 8.00	7.0 x 5.5	856282
WLAN IF Filter	465	17	11.9	SE / BAL	40 @ 50.00	5.0 x 5.0	855991
FRS RF or GPS IF filter	465	6	1.43	SE / SE	40 @ 445.00	3.0 x 3.0	856288
BWA IF Filter	479.75	9	19.5	SE / SE	35 @ 22.00	7.0 x 5.5	855271
WiMAX IF Filter	479.75	23	9.8	BAL / BAL	35 @ 36.00	7.0 x 5.5	855272
Cable IF Filter	499.25	1	7	SE / SE	35 @ 6.00	9.0 x 7.0	855104
WiMAX IF Filter	580	10	10.7	BAL / BAL	40 @ 36.00	5.0 x 5.0	856665
WLAN IF Filter	770	17	3	BAL / BAL	32.5 @ 750.00	5.0 x 5.0	855942
WiMAX IF Filter	810	5	4.6	SE / SE	10 @ 26.00	3.0 x 3.0	856534
WiMAX IF Filter	810	10	3.5	SE / SE	10 @ 31.00	3.0 x 3.0	856526
RF Filter, Cell Band	836.5	25	1.8	SE / SE	30 @ 869.00	3.0 x 3.0	855779
RF Filter, Cell Band	836.5	25	1.9	SE / SE	35 @ 869.00	3.0 x 3.0	855821
RF Filter, Cell Band	836.5	25	2.3	SE / SE	40 @ 869.00	1.4 x 1.2	856664
Duplexer, Cell Band	836.5 / 881.5	25 / 25	2 / 2.4	SE / SE	–	3.8 x 3.8	856495
Duplexer, Cell Band	836.5 / 881.5	25 / 25	2 / 2.4	SE / SE	–	3.8 x 3.8	856563
Triplexer, Cell / GPS / PCS	859 / 1575.42 / 1920	70 / 2 / 140	1.3 / 1.4 / 0.74	SE / SE / SE	–	4.0 x 4.0	890049
RF Filter, Cell Band	881.5	25	2.7	SE / SE	40 @ 849.00	3.0 x 3.0	855728
RF Filter, Cell Band	881.5	25	1.8	SE / SE	35 @ 849.00	3.0 x 3.0	855782
RF Filter, Cell Band	881.5	25	1.6	SE / BAL	35 @ 849.00	1.4 x 1.2	856522
RF Filter, Cell Band	881.5	25	1.6	SE / BAL	35 @ 849.00	1.4 x 1.2	856553
RF Filter, Cell / PCS	881.5 / 1960	25 / 60	1.8 / 1.8	SE / BAL	–	2.0 x 1.5	856559
RF Filter, Cell / PCS	881.5 / 1960	25 / 60	1.6 / 2.2	SE / BAL	–	2.0 x 1.5	856565
RF Filter, EGSM	897.5	35	1.9	SE / SE	14 @ 930.00	3.0 x 3.0	***856671****
ISM 915 Band RF Filter	915	26	2.3	SE / SE	35 @ 882.50	2.0 x 1.5	856327
RF Filter, EGSM	942.5	35	2	SE / SE	5 @ 915.00	3.0 x 3.0	855820
RF Filter, EGSM	942.5	35	3.2	SE / SE	12 @ 915.00	3.0 x 3.0	855810
RF Filter, EGSM	942.5	35	2.5	SE / SE	25 @ 915.00	3.0 x 3.0	856528
RF Filter, EGSM	942.5	35	1.8	SE / BAL	23 @ 915.00	1.4 x 1.2	856525
RF Filter, EGSM / DCS	942.5 / 1842.5	35 / 75	1.5 / 1.8	SE / BAL	–	2.0 x 1.5	856560
Tuner IF Filter	1086	10	4	BAL / BAL	40 @ 1046.00	3.0 x 3.0	855964
Tuner IF Filter	1086	10	4	BAL / BAL	50 @ 1046.00	3.0 x 3.0	856257
Tuner IF Filter	1086	10	4	BAL / BAL	40 @ 1046.00	3.0 x 3.0	856330
Tuner IF Filter	1090	10	5	BAL / BAL	50 @ 1050.00	3.8 x 3.8	856096
WLAN IF Filter	1150	16	4.4	BAL / BAL	20 @ 1170.00	3.0 x 3.0	856256
GPS L5 RF Filter	1176	20	2.4	SE / SE	20 @ 1226.00	2.0 x 1.5	856440
Tuner IF Filter	1216	8	3.75	BAL / BAL	12 @ 24.00	3.0 x 3.0	856365
Tuner IF Filter	1220	10	4.5	BAL / BAL	30 @ 70.00	3.8 x 3.8	856182
Tuner IF Filter	1220	8	4.5	BAL / BAL	20 @ 1245.00	3.0 x 3.0	856183
Tuner IF Filter	1220	8	4.5	BAL / BAL	15 @ 1240.00	3.8 x 3.8	856184
Tuner IF Filter	1220	10	4.5	BAL / BAL	30 @ 60.00	3.0 x 3.0	856298
Tuner IF Filter	1220	50	3.9	BAL / BAL	33 @ 96.00	3.8 x 3.8	***856598****
GPS L2 RF Filter	1227.6	20	1.1	SE / SE	27 @ 1152.00	2.0 x 1.5	***856700****

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SAW FILTERS *(cont.)*

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
WLAN IF Filter	1290	18	3.5	BAL / BAL	30 @ 51.50	2.5 x 2.0	856366
GPS RF Filter	1575.42	2	1.3	SE / SE	30 @ 1625.00	3.0 x 3.0	855969
GPS RF Filter	1575.42	2	1.25	SE / SE	30 @ 1624.00	2.5 x 2.0	856584
GPS RF Filter	1575.42	2	1.1	SE / SE	20 @ 1628.00	2.5 x 2.0	856042
GPS RF Filter	1575.42	2	2.5	SE / SE	30 @ 1625.00	2.5 x 2.0	856049
GPS RF Filter	1575.42	2	1.4	SE / BAL	12 @ 1625.00	2.5 x 2.0	856134
GPS RF Filter	1575.42	2	0.75	SE / SE	35 @ 1635.00	1.4 x 1.2	856561
GPS RF Filter	1575.42	2	1.1	SE / SE	20 @ 1635.00	1.4 x 1.2	856576
RF Filter, DCS	1747.5	75	2	SE / SE	22 @ 1676.00	3.0 x 3.0	***856654****
RF Filter, DCS	1842.5	75	1.9	SE / SE	10 @ 1785.00	3.0 x 3.0	855860
RF Filter, DCS	1842.5	75	1.6	SE / BAL	9 @ 1785.00	1.4 x 1.2	856575
RF Filter, DCS	1842.5	75	1.7	SE / BAL	10 @ 1785.00	1.4 x 1.2	856588
RF Filter, PCS	1880	60	2.4	SE / SE	7 @ 1930.00	3.0 x 3.0	855849
RF Filter, PCS	1880	60	2.8	SE / SE	30 @ 1930.00	3.0 x 3.0	856530
RF Filter, PCS	1880	60	2.6	SE / SE	35 @ 1930.63	1.4 x 1.2	856589
Tuner IF Filter	1892	8	4.2	BAL / BAL	23 @ 1932.00	2.5 x 2.0	856236
RF Filter, UMTS	1950	60	2.2	SE / SE	40 @ 2110.00	3.0 x 3.0	856532
RF Filter, UMTS	1950	60	2.7	SE / SE	35 @ 2110.00	1.4 x 1.2	***856661****
RF Filter, PCS	1960	60	2.1	SE / SE	10.3 @ 1910.00	3.0 x 3.0	855817
RF Filter, PCS	1960	60	2.3	SE / SE	8 @ 1910.00	3.0 x 3.0	855850
RF Filter, PCS	1960	60	2.9	SE / SE	15 @ 1910.00	3.0 x 3.0	855859
RF Filter, PCS	1960	60	2.25	SE / SE	14 @ 1910.00	3.0 x 3.0	856531
RF Filter, PCS	1960	60	1.5	SE / BAL	7 @ 1910.00	1.4 x 1.2	856577
RF Filter, PCS	1960	60	1.7	SE / BAL	9 @ 1910.00	1.4 x 1.2	856587
RF Filter, PCS	1960	60	2.2	SE / BAL	15 @ 1910.00	1.4 x 1.2	856545
UMTS Delay Filter	2140	60	25	SE / BAL	N/A	7.0 x 5.5	856059
RF Filter, UMTS	2140	60	3.2	SE / SE	33 @ 1980.00	3.0 x 3.0	855937
RF Filter, UMTS	2140	60	2	SE / BAL	35 @ 1980.00	1.4 x 1.2	856562
Bluetooth RF Filter	2441	83.5	2.8	SE / SE	26 @ 2200.00	3.0 x 3.0	855916
Bluetooth RF Filter	2441	83.5	2.5	SE / SE	20 @ 2300.00	1.5 x 1.5	856486
Bluetooth RF Filter	2441	83.5	2.7	SE / BAL	35 @ 2250.00	1.5 x 1.5	856435
Bluetooth RF Filter	2441	83.5	2	SE / SE	28 @ 2300.00	1.4 x 1.2	856539
Bluetooth RF Filter	2441	83.5	2.7	SE / BAL	39 @ 2250.00	1.4 x 1.2	856548
Bluetooth RF Filter	2441	83.5	3	SE / SE	15 @ 2200.00	2.0 x 2.0	856166
Bluetooth & GPS Filter	2441 / 1575.42	83.5 / 2	2 / 1.2	SE / SE	–	2.0 x 1.5	856646

Notes: **** = New***

BAW FILTERS

Description	Frequency (MHz)	Bandwidth (MHz)	Typical IL (dB)	I / O Configuration	Rejection [dB @ BW or Freq (MHz)]	Package Size (mm)	Part Number
RF Filter	710	20	2	SE / SE	50 @ 140.00	3.81 x 2.54	***880370****
RF Filter, ISM	915	15	3.5	SE / SE	40 @ 35.00	6.35 x 4.57	***880371****
RF Filter	1030	15	2.5	SE / SE	40 @ 45.00	3.81 x 2.54	***880367****
RF Filter	1090	15	2.5	SE / SE	40 @ 45.00	3.81 x 2.54	***880374****
GPS RF Filter, L5	1176	28	2.75	SE / SE	40 @ 140.00	3.26 x 1.60	***880364****
GPS RF Filter, L2	1227	30	2.75	SE / SE	40 @ 140.00	3.26 x 1.60	***880272****
GPS RF Filter, L2	1227	15	1.5	SE / SE	40 @ 250.00	3.26 x 1.60	***880366****
GPS RF Filter, L2	1227	15	3	SE / SE	40 @ 45.00	3.81 x 2.54	***880372****
RF Filter	1280	20	3	SE / SE	40 @ 105.00	3.81 x 2.54	***880368****
GPS RF Filter, L3 / L4	1380	30	3	SE / SE	40 @ 160.00	3.26 x 1.60	***880365****
GPS RF Filter, L1	1575	30	3	SE / SE	40 @ 160.00	3.26 x 1.60	***880273****
GPS RF Filter, L1	1575	18	1.5	SE / SE	40 @ 350.00	3.26 x 1.60	***880085****
GPS RF Filter, L1	1575	25	3	SE / SE	40 @ 60.00	3.81 x 2.54	***880373****
RF Filter	2324	38	3	SE / SE	40 @ 150.00	3.81 x 2.54	***880148****
RF Filter, MMDS	2560	30	3	SE / SE	40 @ 150.00	3.81 x 2.54	***880157****
RF Filter, ISM	5775	100	4.5	SE / SE	20 @ 350.00	3.26 x 1.60	***880369****

Notes: **** = New***

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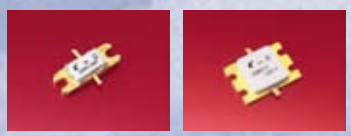

Part Number	Freq. Range (GHz)	Psat (dBm)	Gain (dB)	Eff@Psat (%)	Rth Typ. (℃/W)	Package
ES/EGN26A180IV	2.5～2.7	53.0	14	55	0.65	IV
ES/EGN26A090IV	2.5～2.7	50.0	14	55	1.2	IV
ES/EGN26A030MK	2.5～2.7	46.5	15	60	2.5	MK
ES/EGN35A180IV	3.4～3.6	53.0	12	50	0.65	IV
ES/EGN35A090IV	3.4～3.6	50.0	12	50	1.2	IV
ES/EGN35A030MK	3.4～3.6	46.0	13	55	2.5	MK

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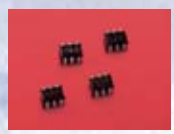

Part Number	Type	Freq. Range (GHz)	I.L (dB) @3.5GHz	Iso (dB) @3.5GHz	P1dB (dBm)	Package
FMM5317ZW	SPDT	0.1～3.5	0.65	22	35	SC70
EMM5329ZW	SPDT	0.1～6.0	0.55	18	33	SC70

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7:00 AM–8:00 AM	Attendees and Speakers' Breakfast
8:00 AM–9:45 AM	Technical Session 1
9:45 AM–10:30 AM	Exhibition and Interactive Forum
10:30 AM–11:50 AM	Technical Session 2
11:50 AM–1:00 PM	Awards Luncheon
1:00 PM–2:40 PM	Technical Session 3
2:40 PM–3:20 PM	Exhibition and Interactive Forum
3:20 PM–5:00 PM	Technical Session 4

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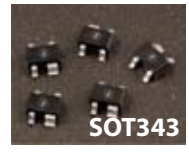

Part Number	Typical 2 GHz Performance				Typical 12 GHz Performance				VDS (Vdc)	IDSS (mA)
	Gain (dB)	P-1 (dBm)	IP3 (dBm)	NF (dB)	Gain (dB)	P-1 (dBm)	IP3 (dBm)	NF (dB)		
FPD1500DFN	18	27	42	1.2	7*	27	40	N/A	5	465
FPD750DFN	20	24	38	0.3	11.5*	24	38	N/A	5	230
FPD750SOT343	18	20	38	0.3	8*	20	38	N/A	3.3	230
FPD6836SOT343	20	20	32	0.5	9*	19	32	1.2	3	105

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Flexible, easy-to-use true-differential VNAs eliminate guesswork

Jochen Simon

As increasing numbers of RF devices depend on integrated-circuit technology, RF designs' use of differential topologies is becoming more and more commonplace. Moreover, once a project team decides to base a product on a custom RFIC (radiofrequency integrated circuit), it often becomes a "no-brainer" to have the IC perform circuit functions that, in an earlier era, would have been handled by separate passive components. In general, IC implementations of these functions use active, rather than passive, circuit elements. The result of this RFIC revolution is thus an explosion in the use of active as well as differential (also known as balanced) circuits at radio frequencies.

This situation presents a challenge for engineers who must accurately characterize RF devices. The mathematics that underlies an understanding of device characteristics assumes that the DUT (device under test) is linear. But, whereas passive devices *sometimes* exhibit nonlinearity, active devices are much more likely to be nonlinear – at least to a degree that calls into question the validity of parametric values derived through assumptions of linearity. In addition, characterizing nonlinear devices often requires larger numbers of more difficult and time-consuming measurements than does characterizing linear devices.

The assumption of linearity also forms the basis for the mathematics by which engineers have traditionally extended inherently single-ended measurements to differential devices [1]. You might say, then, that the RFIC revolution and the resulting proliferation of nonlinear, differential circuit structures has mounted a multi-pronged attack on the classical methods of RF-component characterization and on the architecture of VNAs (vector network analyzers), the instruments at the heart of most highly accurate, parametric RF measurements. Until now, nearly all such instruments have, as a practical matter, been limited to fundamentally single-ended measurements; differential results were derived virtually, which means mathematically by a linear superposition of single-ended measurements.

Although true differential VNA measurements were possible through the use of baluns and hybrids [2], or by adding two signal sources to a conventional VNA [3], these techniques were limited by the lack of components with sufficiently ideal characteristics over a wide bandwidth. Furthermore, ready-to-use systems with true differential measurement capability were not commercially available.

R&S®ZVA to the rescue

With its R&S®ZVA series of 300-kHz to 40-GHz RF VNAs (Figure 1), which offers an optional TruDi (true-differential) measurement mode, leading VNA supplier Rohde & Schwarz is coming to the rescue of RF design engineers around the world who need new tools to deal with the RFIC revolution's new measurement challenges.

TruDi operation of the R&S®ZVA is based on a second signal source that is installed in instrument versions with four test ports. This source can produce a signal whose amplitude is equal to and whose phase is opposite that of the signal from the first source. The R&S®ZVA can also produce signal pairs that have adjustable relative amplitude and phase, thus enabling the simulation of real-world signals that are not perfectly balanced – that is, signals that contain common-mode as well as normal-mode (differential mode) components or even purely common-mode components — with no differential components. It is also possible to sweep the phase difference and magnitude imbalance to quickly reveal how a device responds to signal imperfections. No such measurements were even theoretically possible through the use of baluns and hybrids.

Going deeper into the details of the new R&S®ZVA TruDi option, it is noteworthy that the user-defined amplitude and phase relationship of the signals refers to the VNA's outgoing single-ended waves, which serve as incoming (a-) waves for the DUT. This relationship is measured with full-system error correction applied at each point of each sweep. According to this measurement, signal amplitude and phase are re-adjusted before the desired measured quantity is acquired, thus taking time-varying DUT reflection into account. The error terms that are used during wave correction are derived from a conventional full n-port calibration, which also defines the reference plane where the user-defined amplitude and phase relationship is valid. DUT topology can be defined with a high degree of flexibility, which means that any two single-ended ports can be combined to form a balanced port. Because one internal R&S®ZVA source serves two single-ended test ports (ports 1 and 2 belong to one R&S®ZVA source; ports 3 and 4 to the other), the only limitation for a balanced port is the requirement that the constituent single-ended ports have different sources.

Figure 1: The Rohde & Schwarz ZVA-series of 300-kHz to 40-GHz RF vector network analyzers offers a true-differential source and measurement option that takes the guesswork out of characterizing active differential components, including structures common in modern RFICs.

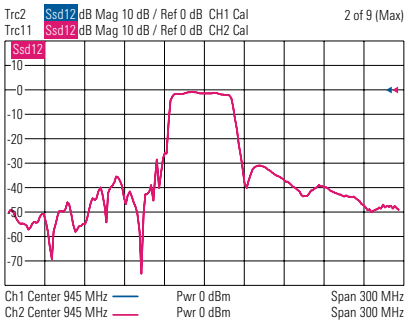

Figure 2: You can't see the transmission of a SAW filter measured in virtual-differential mode (blue trace) because the true-differential-mode measurement (red trace) completely coincides with it.

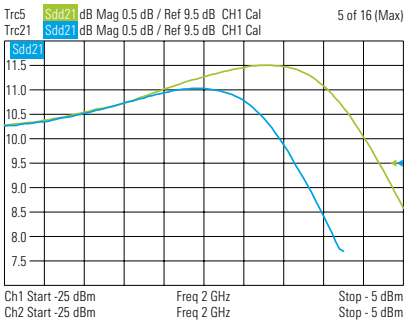

Figure 3: In this power sweep of differential-amplifier gain, hardly any difference exists between the virtual and TruDi mode results at low power, but at higher source power, the amplifier reaches 1-dB of compression at about -10.5 dBm in TruDi mode versus about -6.5 dBm in virtual mode.

An R&S®ZVA with the TruDi option supports three operating modes, which are listed below in order of increasing complexity:

1. Source of fully error-corrected differential and common-mode outgoing waves of amplitude and phase defined with respect to a reference plane that is established by conventional n-port system-error calibration. A user can shift the reference plane by defining and activating a transmission-line offset, which may be lossy. You can also sweep the amplitude and phase relationships between the single-ended signals and calibrate the signal power.
2. Source function as in 1, plus fully error-corrected measurement of all single-ended or balanced-wave quantities defined in the DUT topology. After a conventional (single-ended) power calibration, you can even determine the amplitudes of differential and common-mode wave quantities.
3. Source function as in 1, plus fully error-corrected measurement of all mixed-mode S-parameters defined for the DUT topology. For this measurement, you stimulate each balanced port in two modes (differential and common-mode) and each single-ended port in one mode.

A mouse-click switches modes

Switching between true-differential and virtual-differential (that is, mathematical superposition) measurement modes requires no more than a mouse-click. After you set up two measurement channels, you can even measure the same DUT in both modes at the same time. A comparison of the true and virtual differential modes appears in Figure 2, which shows the transmission of a SAW filter, a representative passive linear device. As you might expect, there is no noticeable difference in measurement results between modes.

As an additional measurement example, Figure 3 shows the gain of a differential low-noise amplifier (LNA) for WCDMA applications in a power sweep. At small source-signal levels, hardly any difference exists between the two modes. With increasing source power, however, the amplifier reaches 1-dB compression at an input power of about -10.5 dBm compared with about -6.5 dBm in the virtual mode. For other differential devices, you can also observe the opposite behavior—that is, earlier compression in virtual mode.

In Figure 3, the stimulus axis of the true-differential trace has been shifted by -3 dB with respect to the axis of the virtual mode. This shift is necessary for a comparison of the two modes because the differential-stimulus amplitudes must be the same. In virtual differential mode, the R&S®ZVA power setting refers to a single-ended source signal, whereas in TruDi mode, the setting relates to a differential-source signal. Because half of the power of the single-ended source signal is contained in its unwanted common-mode component, the power must be increased by 3 dB.

The new R&S®ZVA TruDi option provides system designers with a valuable tool that allows them to measure – rather than guess at – key characteristics of differential devices. Above all, designers can investigate the large-signal behavior of these devices under real operating conditions. Only now have such measurements become possible.

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Author´s biography:
Jochen Simon received his Dipl.-Ing. and Dr.-Ing. degrees from the Technical University of Munich. Since 1993, he has been involved in hardware and software development of vector network analyzers at Rohde & Schwarz, Munich, Germany.

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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

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THAAD Weapon System Successfully Intercepts Target in Second Test

The US Missile Defense Agency and Lockheed Martin conducted another successful flight test of the Terminal High Altitude Area Defense (THAAD) weapon system, intercepting a unitary target in THAAD second flight test at the Pacific Missile Range Facility (PMRF) on Kauai, HI. This hit-to-kill intercept demonstrated THAAD's precision against in-bound threats and its ability to provide increased protection for troops and assets. Preliminary data indicates the flight test met all objectives. This included new goals, which set this test apart from previous flight tests:

- The target was intercepted in the mid endo-atmosphere
- The THAAD Fire Control and Communications unit's data link communicated with a simulated Aegis Ballistic Missile Defense Ship via satellite link with the Navy's Space and Naval Warfare Systems Command, located in San Diego, CA. This successful link highlights the interoperability of the various elements of the United States' Ballistic Missile Defense System (BMDS)
- Proved THAAD's endgame capability
- Examined hit assessments in radar data

Other objectives were met, including demonstrating the integration of the radar, launcher, fire control, communications and interceptor operations; interceptor seeker characterization (target identification); discrimination and intercept of a non-separating liquid-fueled target; and examining launch procedures and equipment. The THAAD program began flight testing in November 2005 at White Sands Missile Range (WSMR), NM. Three successful THAAD tests were conducted at WSMR, including the intercept of a unitary target in July 2006. Earlier this year, the first flight test conducted at PMRF demonstrated THAAD's ability to intercept a threat representative target in the high endo-atmosphere. THAAD is designed to defend US troops, allied forces, population centers and critical infrastructure against short- to intermediate-range ballistic missiles. THAAD comprises a fire control and communications system, interceptors, launchers and a radar. The THAAD interceptor uses hit-to-kill technology to destroy targets and is the only weapon system that engages threat ballistic missiles at both endo- and exo-atmospheric altitudes.

Raytheon Receives Approval for Precision Placement of NPOESS Antennae

Raytheon Co. received approval of its environmental assessment from the National Science Foundation (NSF) for precision placement of two National Polar-orbiting Operational Environment Satellite System (NPOESS) SafetyNet™ data-receipt antennae at the McMurdo Bay research station in Antarctica. This milestone will enable construction to begin on the NPOESS antennae or receptor sites in McMurdo during the 2007-2008 Southern Hemisphere summer. With the harsh weather and remote polar environment, antennae placement is very difficult and adequate planning is vital to complete this work on schedule. NPOESS will monitor global environmental conditions and collect and disseminate data related to weather, atmosphere, oceans, land and near-space environment. SafetyNet, a major feature of the NPOESS ground system, is a unique and innovative network of fifteen data-receipt antennae sites and fiber-optic communications around the world. SafetyNet will provide the time-critical NPOESS data to civil, military and science users in fewer than 30 minutes, compared to current data delivery for US polar-orbiting weather satellite systems, which require more than two hours. The optimum for weather forecasting is to have the most minimal data delivery time possible, increasing the ability to forecast weather in a more timely and accurate manner. "NPOESS data is vital for future weather analysis and forecasting to support military operations, civil applications and scientific research," said Mike Mader, vice president and NPOESS program lead for Raytheon Co. "The NSF approval of this environmental assessment culminates two years of Raytheon and government efforts to secure key worldwide NPOESS receptor sites and is further evidence that collaboration between the NPOESS Integrated Program Office, NSF and the Northrop Grumman-Raytheon team work well." Raytheon Intelligence and Information Systems is part of the Northrop Grumman Corp.-NPOESS team. Northrop Grumman is the prime contractor and has overall responsibility for the program development effort.

Northrop Grumman Wins $256.6 M Marine Corps Contract

The US Marine Corps has awarded Northrop Grumman Corp. a contract valued at $256.6 M to develop its new Ground/Air Task Oriented Radar (G/ATOR), which consolidates the missions of five Marine Corps radars into a multi-role radar system. The contract scope of work during this first program phase includes system development, fabrication and test of the Increment I system, low rate initial production of two G/ATOR systems and full rate production of an additional 15 systems, and logistic support. G/ATOR is a highly mobile system intended to fully support the Marine Corps' expeditionary warfare requirements. The new radar system will provide the Marines with enhanced capabilities to detect, track and provide target quality data to engage hostile aircraft, cruise missiles, unmanned air vehicles, rockets, mortars and artillery. G/ATOR will also provide robust air traffic control capabilities to enhance the safety of Marine Corps air operations. G/ATOR will enable enhanced operational capabilities using Northrop Grumman's proven Active

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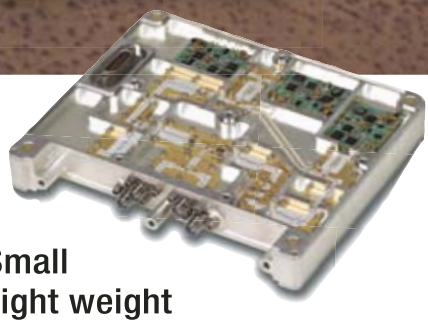

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Electronically Scanned Array (AESA) radar technology. This AESA architecture will allow G/ATOR to provide multi-mission performance and the ability to automatically adapt to dynamic battlefield conditions, at significantly lower operations and maintenance costs, compared to existing radar systems. G/ATOR incorporates a scaleable open system architecture and multi-network connectivity to ensure compatibility with Navy, other US Department of Defense and allied command and control systems. "We look forward to teaming with the Marine Corps and leveraging Northrop Grumman's decades of expertise and experience in designing and building mobile air defense radar systems," said Emmitt E. Gibson, vice president of Ground Based Tactical Radars at Northrop Grumman. "Our company brings extensive capabilities in data fusion, correlation, tracking and network connectivity to the Marine Corps' next generation multi-mission radar system."

Harris Corp. Successfully Completes AEHF Multiband Terminal Testing

Harris Corp. has completed the formal testing of its Advanced Extremely High Frequency (AEHF) Navy Multiband Terminal prototype system two weeks ahead of schedule. The company's completion of the prototype test represents yet another success in a series of milestone achievements for Harris, which is competing for the $1 B plus US Navy communications program. Conducted at the Harris Navy Integration and Test Facility in Palm Bay, FL, the company's testing verified that all aspects of the Harris Navy Multiband Terminal (NMT) terminal and interfaces to the government-furnished antennas exhibited exceptional performance across the required breadth of communications. "Our outstanding prototype test results, combined with our ongoing investments in the follow-on NMT System Development and Demonstration phase, ensures the Navy that Harris offers the lowest-risk NMT solution going forward," said Sheldon Fox, vice president and general manager of Department of Defense programs, Harris Government Communications Systems Division. "The Harris NMT approach utilizes proven, readily available technologies that will deliver a highly reliable and technically capable terminal to the warfighter. The test utilized the common Communications Group and ship Antenna Group terminals developed by Harris, along with US government-furnished antennas for submarine mast, submarine periscope and shore applications. As determined by Harris, it was successful in demonstrating low data rate (LDR) and medium data rate (MDR) communications using an operational MILSTAR satellite. Extended data rate (XDR) and simultaneous LDR-MDR communications were also demonstrated, operating with MIT-Lincoln Laboratory's satellite simulator. Harris teammate Azoic Engineering developed the software required to access the MILSTAR and future AEHF satellites—a critical element of the NMT Phase 1A Program. ■

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Defining Moment for EADS and French MoD

The French armaments directorate (DGA) has selected EADS Defence & Security (DS) to carry out preparatory work for the development of an operational system consisting of army networks for latest-generation telecommunications, entitled Système Opérationnel Composé des Réseaux des Armées pour les TElécommunications Nouvelle Génération (SOCRATE NG). Within the scope of this €2 M contract for its Defence and Communications Systems (DCS) Business Unit, DS is the prime contractor of a consortium that brings together T-Systems France, TDF, Bull, CS, Silicom and EADS Apsys.

The aim is to define the future infrastructure of a mainland telecommunications system for the French Ministry of Defence (MoD) as well as the associated administration/management support organization. Being the first stage of a structuring programme within the MoD, the study is tasked with defining the technical, financial, legal and contractual conditions that will enable an optimized service to be offered that perfectly meets the MoD's strategic and operational goals. The study will end with the submission of a technical and financial proposal relating to the design, realization, deployment and support of such a telecommunications system in early 2008.

This new telecommunications setup, for which the first entries into service are planned for 2010 at the latest, aims at serving the three branches of the armed forces as a minimum stage and ensuring their transition to a combined and lasting system offering a reliable and powerful high speed end-to-end secure service. It will also promote the exchange of information by allowing connection to interlinked networks (inter-ministerial or multinational).

Glasgow University Opens Nanofabrication Centre

The James Watt Nanofabrication Centre at Glasgow University, Scotland, has opened. Centred on the department of electronics and electrical engineering, the new facility will be the focus of interdisciplinary research at the nanometre scale and brings together many different research groups working in engineering and the physical and life sciences. The Centre has comprehensive micro and nanofabrication facilities housed within 750 m^2 of clean room space, including one of the most advanced large area high resolution electron beam lithography tools in the world.

A boost for the Nanofabrication Centre is the announcement of Engineering and Physical Sciences Research Council (EPSRC) funding, worth over £4 M, for a major nanoelectronics research project. It will involve five teams from the university collaborating to develop transistor technologies required for future generations of integrated circuits. It is anticipated that the work will have a major impact in key areas of electronics including microprocessors for computers, but will also be used more widely in numerous communications, medical, safety and imaging applications.

Professor Iain Thayne, who is leading the research, said, "This project between the departments of electronics and electrical engineering and physics and astronomy will deliver key information and understanding which will enable the semiconductor industry to continue to be one of the most successful on the planet in the coming decades."

Thales and DCN Consolidate French Naval Activities

DCN and Thales have finalised with the French government the agreement concerning the consolidation of their activities within the French naval defence sector. This major step is aimed at the constitution of a consolidated European naval defence industry in which DCN and Thales will have a major role to play. Under the terms of the agreement, DCN will acquire the totality of Thales's naval activities in France excluding its equipment activities.

Simultaneously, Thales will acquire a 25 percent stake in DCN alongside the French government, which will retain the remaining 75 percent. Thales becomes 'the industrial shareholding partner' of DCN and the terms of governance will allow Thales to play an active role on the Board of Directors to support the development of DCN. There will also be the possibility for the company to increase its stake in DCN to 35 percent over the next two years.

This collaboration brings about synergies, in particular in the industrial and commercial fields as well as in upstream R&D sectors. It will strengthen the competitiveness of DCN's offer to its customers, including its development on the international market. This phase is operational and a new organization is being implemented by DCN, ensuring the optimal integration of the teams that will join the group.

European Security Organisation Launched

A group of major European players in the security sector has announced their intention to launch the European Organisation for Security— EOS—which is the private sector's response in support of the European Commission initiative: European Security Research and Innovation Forum (ESRIF).

The Organisation has two main aims: to promote the development of a more coherent security market in the European Union and to contribute to the definition of a holistic European civil security policy. To achieve these targets EOS will engage in active co-operation with Euro-

pean and national stakeholders. In order to ensure highest possible buy-in, it is in talks with future partners from a wide range of players involved in these sectors, including users and operators, private and public research intuitions, and large and small commercial companies.

François Gayet, secretary general of the AeroSpace and Defence Industries Association of Europe (ASD), and a representative for the promoting organisations, elaborated, "EOS has the objective to contribute to value creation at the European level for innovative solutions and technologies. A significant element in EOS's charter is to contribute to the creation of a homogenous European market for security solutions."

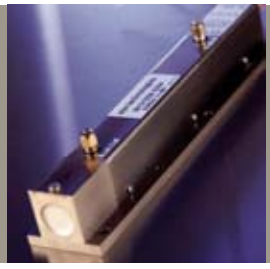
Small Development Helps ESA Think Big

The European Space Agency (ESA) has signed a €100 M framework contract with OHB-System AG of Germany to develop a European Small Geostationary Satellite platform for telecommunication missions. With this initiative, ESA is supporting European industry in broadening the product portfolio range on offer to the commercial telecommunication satellite market, by covering a market segment where no optimised European solutions currently exist.

This contract covers the first part of an initiative aimed at the definition of a general-purpose small geostationary satellite platform, which will enable European players to compete effectively on the commercial telecommunications market for small platforms. To achieve this, ESA has set up a new programme element under the Advanced Research in Telecommunications Systems (ARTES).

The 'ARTES 11' programme, which currently has eight of the Agency's Member States participating, is divided into two parts. It initially involves the development and manufacture of the first flight model of a generic bus. The platform will accommodate a payload mass of up to 300 kg with power consumption of up to 3 kW over a 15-year mission lifetime.

The programme subsequently involves the development, manufacture and launch of a first satellite mission to provide flight heritage and in-orbit demonstration for the platform. The mission payload is due to be selected around end-2007/early 2008 under an open tender process and the satellite selected is scheduled to be launched by the end of 2010. ■



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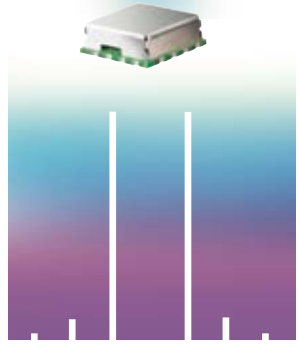

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LAVI-9VH+	820-870	990-1040	120-220	+19	+36	+23	7.2	46	46	15.95
LAVI-10VH+	300-1000	525-1175	60-875	+21	+33	+20	6.3	50	45	22.95
LAVI-17VH+	470-1730	600-1800	70-1000	+21	+32	+20	6.8	52	50	22.95
LAVI-22VH+	425-2200	525-2400	100-700	+21	+31	+20	7.7	50	45	24.95
LAVI-2VH+	2-1100	2-1100	2-1000	+23	+34	+23	7.5	48	47	24.95
LAVI-25VH+	400-2500	650-2800	70-1500	+23	+32	+20	7.5	50	45	24.95

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SBTC-2-25+	1000-2500	50 Ω	3.49
SBTC-2-10-75+	10-1000	75 Ω	3.49
SBTC-2-15-75+	500-1500	75 Ω	3.49
SBTC-2-10-5075+	50-1000	50/75 Ω	3.49
SBTC-2-10-7550+	5-1000	50/75 Ω	3.49

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Bright Outlook for MEMS in Consumer Electronics

Nearly all major categories of MEMS have seen, or may soon see, applications in consumer products, reports In-Stat. As a result, the worldwide MEMS market in consumer electronics will grow from $727 M in 2006 to over $1 B by 2009, the high-tech market research firm says. MEMS will expand to a broad array of consumer applications including game consoles, portable consumer electronics devices (such as digital camcorders) and GPS devices. "In the longer term, MEMS memory, MEMS fuel cells and other types of MEMS devices could also join the list," says Steve Cullen, In-Stat analyst. "However, these technologies are expected to initially find usage in other product areas that are less cost sensitive, with application in consumer electronics products unlikely until after 2010."

Recent research by In-Stat found the following:

- Pressure sensors have the greatest potential in consumer electronics in the short-term, followed by microphones and displays.
- At least two firms are introducing MEMS resonators and oscillators with the intention of taking a piece of the long established crystal market.
- MEMS microphones have been a recent success because of rapid adoption in the mobile handset market, where their small size, ease of handling and competitive price has resulted in double-digit market share.

Solid Growth in Global Semiconductor Market to Continue Through 2008

After five consecutive years of revenue growth that brought worldwide semiconductor revenue to a record $247.7 B in 2006, the cyclic history of the industry would suggest a reversal is overdue, reports In-Stat. But with an extended period of above average worldwide GDP growth ahead, continued semiconductor revenue growth will occur in 2007 and 2008, followed by a mild average selling price-driven downturn in 2009, and a return to growth in 2010 and 2011, the high-tech market research firm says. "Over the long term, we expect that the industry will continue to experience revenue cycles, but that the cycles will become less extreme than they have been in the past and the long-term compound annual growth rate will be slightly below 10 percent," says Jim McGregor, In-Stat analyst.

Recent research by In-Stat found the following:

- Worldwide semiconductor revenue is projected to grow 7.9 percent in 2007 to $267.3 B.
- The industry should surpass $300 B in revenues in 2010.
- Unit demand is expected to remain strong throughout the forecast period.

The research, "Semiconductor Product Market Forecast—Let the Good Times Roll," covers the global semiconductor market. It analyses the underlying demand for semiconductors and how the demand matches with projections for semiconductor capacity, as well as other underlying factors that will affect semiconductor demand and pricing. It provides worldwide and regional GDP forecasts, a semiconductor capital expenditure forecast, worldwide semiconductor unit, ASP and revenue forecasts and semiconductor revenue forecasts by region.

Mobile Broadband-enabled Consumer Electronics Will Reach 50 Million by 2012

No sooner has the market for consumer electronics devices incorporating Wi-Fi begun to gain real traction than another, based on high-speed connections via 3G cellular technologies or mobile WiMAX, is starting to take shape. According to a new study from ABI Research, portable consumer electronics—digital cameras, media players, portable game devices and more—are beginning to offer direct mobile broadband connections to the Internet. By 2012, annual shipments of such devices are expected to approach 50 million. "In the near term, connected portable devices will rely more on 3G cellular connections," says principal analyst Philip Solis. "However, the 3G market is fragmented; different carriers are using different frequencies in different regions of the world. Such fragmentation represents a significant challenge. In addition, such devices must compete against smartphones that increasingly include similar functions." The first few products have already appeared, all from South Korea. Two portable video players—Digital Cube's iStationNetforce and Cowon's Q5—offer 3G connections through add-on HSDPA modules. "A modular approach makes it easier to support multiple carriers," notes Solis, "but the connectivity is not seamlessly integrated." The first true device of this class, offering embedded HSDPA, is Samsung's VLUU i70 digital camera. Not just a 7.2 megapixel camera, the i70 also shoots video, reads e-books, receives T-DMB television, plays MP3s and video, and allows the user to send or download photos and videos. Nonetheless, ABI Research expects portable game devices and media players to dominate the market. Qualcomm's Snapdragon platform and Freescale's MXC (Mobile Extreme Convergence platform) will help enable cellular-based devices and a wide ecosystem of WiMAX semiconductor vendors will enable devices with embedded WiMAX. "In the long term, WiMAX has more potential than cellular-based connections for these devices," says Solis. "Its an IP-based network with simpler architecture and better connection to the Internet. Sprint, with its commitment to WiMAX, will promote such devices heavily, in the process helping US markets keep up with Korea and Japan." The new

study, "Mobile Broadband-enabled Consumer Electronics," explores how the market for mobile broadband-enabled consumer electronics will play out from 2007 to 2012. It examines the strengths and weaknesses of each air-interface and indicates which will dominate at the beginning and the end of the period. It forms part of the Mobile Broadband Research Service.

Regulatory Concerns Encourage Auto Industry Adoption

Following an extensive study into the various high technology advanced driver assistance systems, the Strategy Analytics Automotive Electronics service report, "ADAS: Assessing Opportunities and Challenges," reveals a current, low, one percent penetration rates for ADAS applications in light vehicle production—except for camera and parking assistance systems, which already stand at 20 percent. However, there is significant potential for future growth due to governmental concerns over the high rate of collision injuries, as vendors bring new developments to the market. ADAS will become easier and less costly to install, encouraging automakers to fit systems on more lower segment models, forecast to reach 10 percent penetration by 2013. ADAS systems reviewed include adaptive cruise control, adaptive front-lighting, blind spot monitoring, lane departure warning, parking assistance and pre-crash safety systems. The study also looks into emerging applications such as driver attention, night vision, traffic sign recognition and the latest vehicle-to-roadside communication safety systems. Suppliers and auto manufacturing activities are also covered. While systems prices decline, camera technology will improve to provide a valuable role in object recognition. Cameras will become the basis for a host of new applications, which are mapped in the "ADAS Systems Market Forecast" and the "ADAS Sensors Market Forecast," found in this report. Strategy Analytics predicts the cost-effective development of different applications sharing the same sensor, as well as development of enhanced applications using a variety of different types of sensors, better known as "sensor fusion." "Vehicle makers and suppliers are focusing sharply on ADAS as they collaborate in developing new systems to meet the eSafety challenge of halving road traffic accidents by 2010," says Kevin Mak, industry analyst of the Automotive Electronics Services. "Semiconductors are a vital enabler for cost-effective ADAS development. These applications will provide new revenue opportunities for automotive chip vendors," adds Chris Webber, VP Global Automotive Practice. In addition to this report, Strategy Analytics offers a tactical database which lists car model with ADAS features installed. ■

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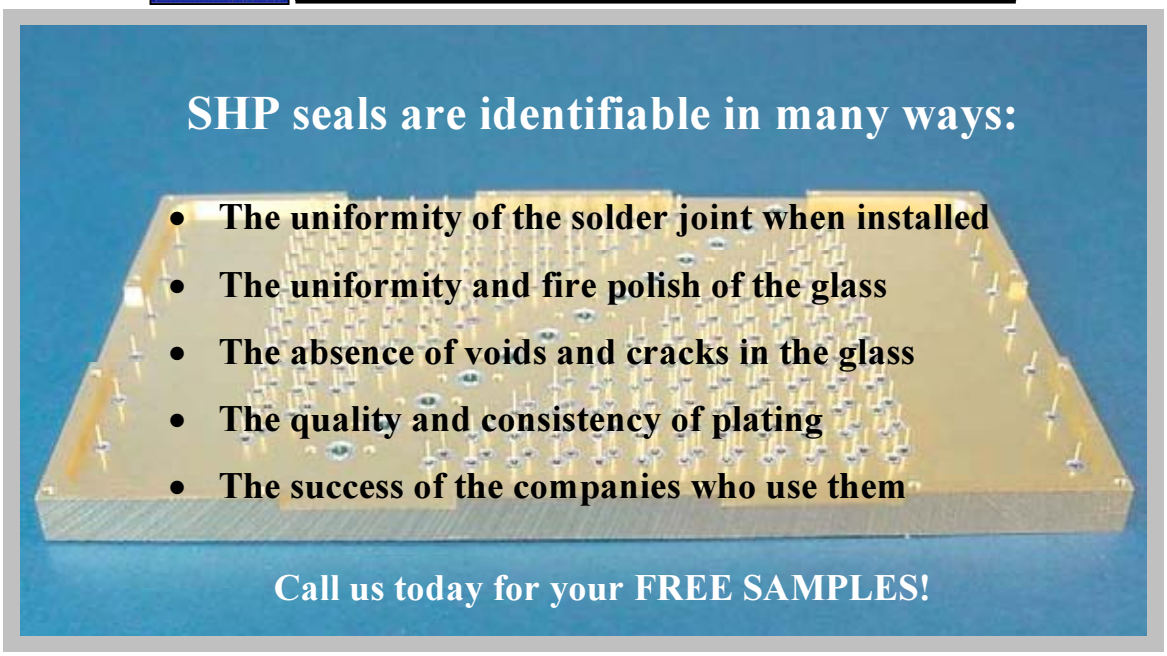

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MODEL	FREQ (GHz)	MIN GAIN (dB)	MAX GAIN VARIATION (+/- dB)	MAX N.F. (dB)	MAX IN / OUT VSWR	MIN POUT @ 1dB COMB (dBm)	DC POWER	
							VOLTS	NOM (mA)
AF01-4151510B	0.1 – 4.0	15	0.5	1.5	2:1	+ 10	+ 12	60
AF01-4281512B	0.1 – 4.0	28	0.6	1.5	2:1	+ 12	+ 12	90
AF01-4401512B	0.1 – 4.0	40	0.75	1.5	2:1	+ 12	+ 12	120
AF01-6132513B	0.1 – 6.0	13	0.5	2.5	2:1	+ 13	+ 12	60
AF01-6252513B	0.1 – 6.0	25	0.6	2.5	2:1	+ 13	+ 12	90
AF01-6362513B	0.1 – 6.0	36	0.8	2.5	2:1	+ 13	+ 12	120
AF1-1814A	1.0 – 18	14	1.0	3.5	2:1	+ 5	+ 3.2	40
AF1-1821A	1.0 – 18	21	1.25	3.5	2:1	+ 5	+ 3.2	60
AF1-1828A	1.0 – 18	28	1.5	3.5	2:1	+ 10	+ 5	100
AF052013A	0.5 – 20	13	1.0	4.0	2.2:1	+ 5	+ 3.2	40
AF052019A	0.5 – 20	19	1.5	4.0	2.2:1	+ 5	+ 3.2	60
AF052025A	0.5 – 20	25	2.0	4.0	2.2:1	+ 8	+ 5	100
AF0120183A	0.1 – 20	18	0.8	2.8	2:1	+ 8	+ 5	60
AF0120253A	0.1 – 20	25	1.2	2.8	2:1	+ 10	+ 5	100
AF0120323A	0.1 – 20	32	1.6	3.0	2:1	+ 10	+ 5	130
AF00118173A	0.01 – 18	17	1.0	3.0	2:1	+ 8	+ 5	60
AF00118253A	0.01 – 18	25	1.4	3.0	2:1	+ 10	+ 5	100
AF0118333A	0.01 – 18	33	1.8	3.0	2:1	+ 12	+ 5	150

HIGH FREQUENCY AND MILLIMETER WAVE AMPLIFIERS UP TO 45 GHz

MODEL	FREQ (GHz)	MIN GAIN (dB)	MAX GAIN VARIATION (+/- dB)	MAX N.F. (dB)	MAX IN / OUT VSWR	MIN POUT @ 1dB COMB (dBm)	NOM DC CURRENT @ + 12V (mA)
A1826153508A	18 – 26	15	1.0	3.5	2:1	+ 8	80
A1826224010A	18 – 26	22	1.25	4.0	2:1	+ 10	160
A1826294010A	18 – 26	29	1.5	4.0	2:1	+ 10	220
A1840157008A	18 – 40	15	2.0	7	2.2:1	+ 8	120
A1840227010A	18 – 40	22	2.5	7	2.2:1	+ 10	180
A1840287010A	18 – 40	28	3.0	7	2.2:1	+ 10	240
A2640125010A	26 – 40	12	2.0	5	2:1	+ 10	120
A2640205010A	26 – 40	20	2.5	5	2:1	+ 10	180
A2640285010A	26 – 40	28	3.0	5	2:1	+ 10	240
A3045155010A	30 – 45	15	2.0	5	2:1	+ 10	120
A3045225010A	30 – 45	22	2.5	5	2:1	+ 10	180
A3045295010A	30 – 45	29	3.0	5	2:1	+ 10	240

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MODEL	FREQ (GHz)	MIN GAIN (dB)	MAX GAIN VARIATION (+/- dB)	MAX N.F. (dB)	MAX IN / OUT VSWR	MIN POUT @ 1dB COMB (dBm)	NOM DC CURRENT @ + 12V (A)
AP231132	1.7 – 2.3	30	1.0	10	2:1	+ 35	3.0
AP231134	1.7 – 2.3	30	1.0	10	2:1	+ 39	5.5
AP231139	1.9 – 2.3	30	1.0	10	2:1	+ 35	3.0
AP271143	2.3 – 2.7	23	0.5	10	2:1	+ 33	1.5
AP421148	3.7 – 4.2	40	0.5	6	2:1	+ 33	2.2
AP153153	14.0 – 15.3	23	0.5	8	2:1	+ 30	1.8
AP175154	15.0 – 17.5	42	1.0	9	2:1	+ 31	3.5

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MODEL	FREQ (GHz)	MAX INSERTION LOSS (dB)	MAX VSWR	TYP LIM THRESHOLD (dBm)	MAX LEAKAGE @ 1W CW INPUT (dBm)
LP0520	0.5 – 2.0	0.5	1.3:1	+ 9	+ 20
LS0520	0.5 – 2.0	0.6	1.4:1	+ 6	+ 14
LP2080	2.0 – 8.0	1.2	1.5:1	+ 9	+ 19
LS2080	2.0 – 8.0	1.3	1.6:1	+ 6	+ 14
LP4080	4.0 – 8.0	1.2	1.5:1	+ 9	+ 19
LS4080	4.0 – 8.0	1.3	1.5:1	+ 6	+ 13
LP8018	8.0 – 18	1.8	2.0:1	+ 9	+ 19
LS8018	8.0 – 18	2.0	2.0:1	+ 6	+ 13
LP05018	0.5 – 18	1.8	2.0:1	+ 9	+ 20
LS05018	0.5 – 18	2.0	2.0:1	+ 6	+ 14

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MODEL	FREQ RANGE	MAX VSWR	MAXIMUM FLATNESS (+/- dB)	CONNECTORS	
				INPUT	OUTPUT
DZR124AA	10 MHz - 12.4 GHz	1.25:1	0.3	SMA (M)	SMA (F)
DZR124AC				SMA (M)	SMC (M)
DZR185AA	10 MHz - 18.5 GHz	1.25:1	0.5	SMA (M)	SMA (F)
DZR185AC				SMA (M)	SMC (M)
DZR265AA	10 MHz - 26.5 GHz	1.30:1 (To 18.5 GHz) 2.02:1 (To 26.5 GHz)	0.1 (To 16.5 GHz) 0.3 (Overall)	SMA (M)	SMA (F)
DZR265AC				SMA (M)	SMC (M)
DZM020BB	100 KHz - 2.0 GHz	1.30:1	0.1 (Per 100 KHz) 0.3 (Overall)	BNC (M)	BNC (F)
DZM040BB	100 KHz - 4.0 GHz			BNC (M)	BNC (F)
DZM124AB	10 MHz - 12.4 GHz	1.20:1 (To 4.5 GHz) 1.30:1 (To 7 GHz) 1.40:1 (To 18.5 GHz)	0.2 (Per Octave) 0.3 (Overall)	SMA (M)	BNC (F)
DZM124NB				TYPE N (M)	BNC (F)
DZM185AB	10 MHz - 18.5 GHz	1.20:1 (To 4 GHz) 1.50:1 (To 18.5 GHz)	0.2 (Per Octave) 0.3 (For 10 MHz to 8 GHz) 0.5 (Overall)	SMA (M)	BNC (F)
DZM185NB		1.20:1 (To 4 GHz) 1.40:1 (To 18.5 GHz)		TYPE N (M)	BNC (F)
DZM1857B				APC-7	BNC (F)
DZ1018	1 GHz - 18 GHz	8.0:1 (Typ)	1.0 (Typ)	SMA (M)	SMA (F)
DZ1026	1 GHz - 26 GHz	8.0:1 (Typ)	1.5 (Typ)	SMA (M)	SMA (F)
DZM265AA	10 MHz - 26.5 GHz	1.8:1 (To 26.5 GHz)	0.2 (Per octave to 8 GHz) 0.3 (To 18 GHz)	SMA (M)	SMA (F)
DZR400KA	10 MHz - 40 GHz	1.8:1 (To 40 GHz)		K (M) 2.9 mm	SMA (F)
DZR50024A	10 MHz - 50 GHz	2 : 1	1.0	2.4 mm (M)	SMA (F)

- UNITS AVAILABLE ARE IN DROP-IN OR PACKAGES WITH CONNECTORS
- ALSO AVAILABLE: HIGH SENSITIVITY & STANDARD BIASED SCHOTTKY DETECTORS
- HIGH SENSITIVITY ZERO-BIASED DETECTORS, MICROSTRIP TUNNEL DETECTORS, PULSE POWER MONITORS

TUNNEL DIODE DETECTORS (SELECTED MODELS)

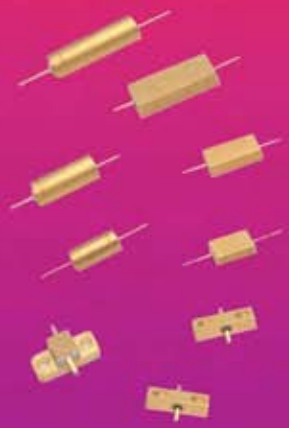
MODEL	FREQ RANGE (GHz)	MIN SENSITIVITY K (mV/mW)	MAX FLATNESS (+/- dB)
DT0105	0.1 - 0.5	1000	0.75
DT0110	0.1 - 1.0	800	0.75
DT0510	0.5 - 1.0	1000	0.5
DT0520	0.5 - 2.0	800	0.7
DT2040	2.0 - 4.0	1000	0.5
DT4080	4.0 - 8.0	800	0.6
DT8016	8.0 - 16.0	800	0.7
DT1018	1.0 - 18.0	700	1.0
DT1826	18.0 - 26.5	400	1.0
DT1026	1.0 - 26.5	400	1.5
DT2640	26.0 - 40.0	300	1.5
DT1-40	1.0 - 40.0	250	2.0
DT2-40	2.0 - 40.0	250	2.0

TUNNEL DETECTORS LIMITER PROTECTED (1 W)

MODEL	FREQ RANGE (GHz)	MIN SENSITIVITY K (mV/mW)	MAX FLATNESS (+/- dB)
DTL0520H	0.5 - 2.0	500	1.0
DTL2018H	2.0 - 18.0	300	1.5
DTL1018H	1.0 - 18.0	300	1.5

TUNNEL DETECTORS / PREAMPLIFIERS

MODEL	FREQ RANGE (GHz)	MIN SENSITIVITY K (mV/mW)	MAX FLATNESS (+/- dB)
DTA182544	1.0 - 18.0	10,000	1.5
DTA182660A	10.0 - 26.0	10,000	1.0 TYP
DTA264060A	26.0 - 40.0	10,000	2.0 TYP
DTA184060A	18.0 - 40.0	10,000	2.5 TYP



HARMONIC (COMB GENERATORS) WITH OR WITHOUT INTEGRAL PREAMPLIFIERS 0.1 – 50 GHz

- HERMETICALLY SEALED PACKAGE
- OPTIONS FOR INPUT DRIVE OF 0 dBm OR +10 dBm
- BROADBAND OUTPUT SPECTRUM
- FIELD REMOVABLE CONNECTORS FOR DROP-IN ASSEMBLY

MODEL	INPUT POWER (dBm)	INPUT FREQ (MHz)	MAX INPUT VSWR	MIN OUPTPUT POWER PER PICKET dBm				
				UP to 4 GHz	4 – 8 GHz	8 – 12.4 GHz	12.4 – 18 GHz	18 – 26 GHz
GCA100A	0	100	2 : 1	-12	-20	-30	-40	--
GCA100B	+10	100	2 : 1	-12	-20	-30	-40	--
GCA200A	0	200	2 : 1	-7	-15	-25	-35	--
GCA200B	+10	200	2 : 1	-7	-15	-25	-35	--
GCA250A	0	250	2 : 1	-2	-10	-20	-30	--
GCA250B	+10	250	2 : 1	-2	-10	-20	-30	--
GCA500A	0	500	2 : 1	+3	-5	-15	-20	--
GCA500B	+10	500	2 : 1	+3	-5	-15	-20	--
GCA1000A	0	1000	2 : 1	+3	0	-10	-15	--
GCA1000B	+10	1000	2 : 1	+3	0	-10	-15	--
GCA0526A	0	500	2 : 1	+3	-5	-15	-20	-40
GCA0526B	+10	500	2 : 1	+3	-5	-15	-20	-40
GCA1026A	0	1000	2 : 1	+3	0	-10	-15	-35
GCA1026B	+10	1000	2 : 1	+3	0	-10	-15	-35
GCA1526A	0	1500	2 : 1	+3	0	-5	-10	-25
GCA1526B	+10	1500	2 : 1	+3	0	-5	-10	-25
GCA2026A	0	2000	2 : 1	+3	0	0	-10	-20
GCA2026B	+10	2000	2 : 1	+3	0	0	-10	-20

HARMONIC COMB GENERATORS WITH COAX MODULE, 0.5 WATT INPUT

MODEL	INPUT FREQ (MHz)	MAX INPUT VSWR	MINIMUM OUPTPUT POWER PER PICKET dBm						
			UP to 4 GHz	4 – 8 GHz	8 – 12.4 GHz	12.4 – 18 GHz	18 – 26 GHz	30 - 40 GHz	40 -50 GHz
GC100**	100	2 : 1	-10	-20	-30	-40	--	--	--
GC200**	200	2 : 1	-5	-15	-25	-35	--	--	--
GC250**	250	2 : 1	0	-10	-20	-30	--	--	--
GC500**	500	2 : 1	+5	-5	-15	-20	--	--	--
GC1000**	1000	2 : 1	+5	0	-10	-15	--	--	--
GC0526**	500	2 : 1	+5	-5	-15	-20	-40	--	--
GC1026**	1000	2 : 1	+5	0	-10	-15	-35	--	--
GC1526**	1500	2 : 1	+5	0	-5	-10	-25	--	--
GC2026**	2000	2 : 1	+5	+5	0	-10	-20	--	--
GC1550A	1500	2 : 1	--	--	--	-10	-25	-40	-50
GC2050A	2000	2 : 1	--	--	--	-5	-15	-30	-40

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1. SUFFIX (**) SPECIFY OPTIONS FOR INTERNAL DC RETURN AND PACKAGE STYLE FIRST POSITION "N" INDICATES NO DC RETURN AND "R" INDICATES INTERNAL DC RETURN SECOND POSITION "C", "L", OR "Y" INDICATES PACKAGE STYLE
2. OTHER INPUT FREQUENCIES FROM 10 MHz TO 4.0 GHz ARE AVAILABLE
3. FOR SECOND HARMONICS UP TO 4.0 GHz, THE FUNDAMENTAL FEEDTHROUGH IS TYPICALLY +15 dBm

INDUSTRY NEWS

▲ David Vye

■ **David Vye** joins the staff at ***Microwave Journal*** as technical editor and business development manager. Vye was formerly a product-marketing manager with Ansoft Corp., responsible for high frequency circuit/system design tools and technical marketing communications. He is a 1984 graduate of the University of Massachusetts at Dartmouth, with a concentration in microwave engineering. He first joined M/A-COM's Advanced Semiconductor Operations, developing automated test and active device characterization methods for power GaAs MESFET technology, as well as MMIC design. In 1987, he joined Raytheon's research division, where he was responsible for IMPATT diode transmitter development for a number of millimeter-wave applications. Between the years 1994 to 1998, he was a member of the design staff at Raytheon's Advance Device Center. His responsibilities included circuit development (MMIC) and device modeling for AlInAs/GaInAsInP PHEMT and GaAs HBT technologies.

■ **Aeroflex Inc.** announced that it has completed the acquisition of privately-held **MicroMetrics Inc.**, Londonderry, NH. MicroMetrics is a design and full service manufacturer of both standard and application specific RF/microwave diodes and semiconductor devices.

■ **Dover Corp.** announced that its Dover Electronics subsidiary has completed the acquisition of **Pole/Zero Corp.** Terms of the transaction were not disclosed. With the acquisition of Pole/Zero, the **Microwave Products Group** (MPG) of Dover Electronics' Components Group will have annualized sales in excess of $100 M.

■ **AML Communications Inc.** announced that it entered into a letter of intent to acquire a controlling position in **Mica-Tech Inc.** in a cash-for-stock transaction. Under the terms of the agreement AML will purchase 51 percent of Mica-Tech's outstanding stock for $800,000. The acquisition is subject to negotiation of a definitive agreement.

■ **RF Monolithics Inc.** (RFMI) announced that its wholly-owned subsidiary, **Aleier Inc.**, has entered into a strategic alliance agreement with **MACTEC Engineering and Consulting Inc.**, a wholly-owned subsidiary of MACTEC Inc., to offer integrated enterprise asset management (EAM) and engineered management systems (EMS) solutions with machine-to-machine (M2M) communications technology to the facilities management market.

■ **Agilent Technologies Inc.** announced plans to expand the company's investment in its Integrated Circuit Characterization and Analysis Program (IC-CAP) device modeling software. The company will establish a new research and development modeling center in Beijing, China, to better serve the industry's leading semiconductor foundries and to respond to advancements in complementary metal-oxide-semiconductor (CMOS) modeling in particular.

■ **ANADIGICS Inc.**, a supplier of wireless and broadband communications solutions, announced that it has entered into an Investment Contract with the Kunshan New and Hi-Tech Industrial Development Zone (KSND), to jointly construct a new state-of-the-art 6" gallium arsenide (GaAs) integrated circuit (IC) wafer fabrication facility (fab) for ANADIGICS Inc. in the city of Kunshan in the Jiangsu Province in China, for the purposes of expanding the company's wafer fabrication capacity beyond its primary wafer fabrication located in Warren, NJ. It is anticipated that ANADIGICS will invest in capital expenditures of approximately $10 to $15 M over a two-year period commencing with the fourth quarter of 2007 through an initial production phase projected in the first quarter of 2009. The total investment by ANADIGICS over the life-term of the facility, which could extend up to 50 years, is estimated at $49.88 M.

■ **Nitronex**, a developer and manufacturer of high performance RF power transistors for the commercial and broadband wireless infrastructure markets, has teamed with **Rockwell Collins** to further develop the GaN on Si manufacturing infrastructure for military applications. Funded by the Air Force Research Lab (AFRL), the manufacturing technology program began in the fourth quarter of 2006 and is expected to continue through 2009.

■ **Barry Industries** announced the company's participation within the **Modelithics** CLR Library. The Modelithics Library is the industry's first and only substrate—and part value—scalable surface-mount model library, that now allows designers to de-embed pad parasitic effects, enabling user-specified pad effects to be applied. Barry featured products include scalable resistors with sizes as low as 0405 to 1206.

CONTRACTS

■ **TRAK Microwave Corp.** announced that it has been selected by **Raytheon Network Centric Systems** to be a key supplier on its multi-function radio frequency system (MFRFS) sensor system development and demonstration program. This program is part of future combat systems. In support of this program, TRAK will supply Raytheon the up/down converters, frequency reference modules and signal generators. The multi-function radio frequency system is a critical FCS sensor on multiple FCS ground vehicles.

■ **Advanced Control Components Inc.** announced that it has received a production order in excess of $3.7 M from the National Radio Astronomy Observatory for a dual-channel downconverter/switch matrix used on the ALMA Program. ALMA (Atacama Large Millimeter Array) is an international collaboration to develop a world-

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- > Lead Free RoHS Compliant
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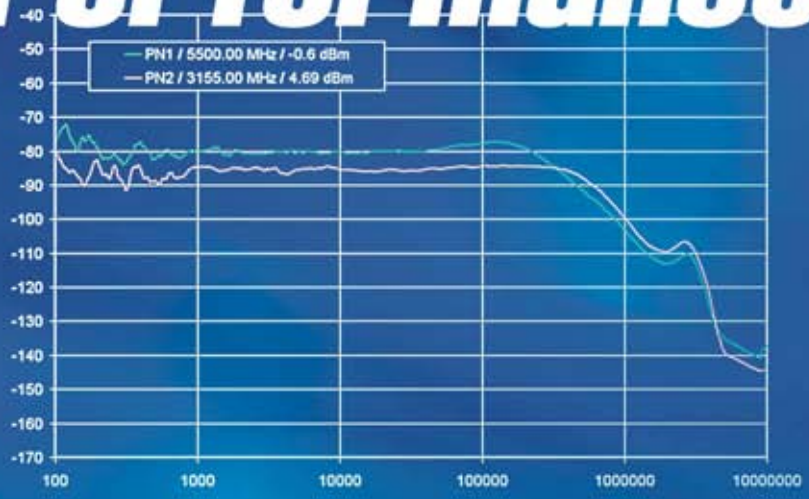
- > Small Size, Surface Mount

Performance



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"They said it couldn't be done. We said give us three months."

Charles Ohiri
Senior RF Engineer
AR Modular RF

I love a challenge. Always have. Just tell me something is impossible and I'll try to prove you wrong. When I was a kid, that used to drive my parents crazy. But today, in my line of work, that attitude really comes in handy.

Like when I was asked to create an RF amplifier for WiMAX. They wanted it no larger than 3" x 5" and the amplified signal had to maintain its linearity. Conventional wisdom said you couldn't build an amp that small with almost perfect linearity. My team said, "give us three months."

The result is our new WiMAX band 802.16-2004 compliant 20-watt module. It's 3" x 5" and its linearity is practically perfect. But we were wrong about one thing. We told them it would take at least three months, but we delivered the module in 45 days.

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class telescope composed of a group of 66 radio-telescope antennas that will work together to study the universe from a site in the foothills of Chile's Andes Mountains. The frequency converter has two inputs and provides four output channels; there is separate attenuation control for each of the output channels. Each of the channels can be independently controlled to switch between upper and lower sideband outputs. The converter incorporates CAN bus architecture for multiple control and monitor functions. Advanced Control Components expects to complete production in early 2009.

■ **RF Micro Devices Inc.** (RFMD) announced it has received its first purchase order from a top-tier military supplier for a new product using RFMD's gallium nitride (GaN) high electron mobility transistor (HEMT) process technology. RFMD's GaN technology can operate over a wide range of microwave frequencies, making it ideal for multiple band and broadband applications. The purchase order is the first received by RFMD for its GaN power amplifiers.

■ **Discera Inc.**, a leader in CMOS MEMS oscillators, resonators, and provider of next-generation timing solutions, announced that **Tyco Electronics' M/A-COM** has qualified Discera's MEMS-based oscillator series, MOS1, for use in its telemetry transmitters. M/A-COM qualified Discera's device after a series of tests as an alternative to quartz crystal in building timing components.

FINANCIAL NEWS

■ **Electro Rent Corp.** reports sales of $30.7 M for the third quarter ended February 28, 2007, compared to $29.3 M for the same period in 2006. Net income for the quarter was $5.2 M ($0.20/per diluted share), compared to a net income of $5.9 M ($0.23/per diluted share) for the third quarter of last year.

■ **Provigent**, a provider of System-on-a-Chip (SoC) solutions for the broadband wireless transmission market, announced that it has closed a fourth round of financing in the amount of $16 M. Globespan Capital Partners contributed funding to this round joining Provigent's existing technology investors: Sequoia Capital, Pitango Venture Capital, Magnum Communications Fund, Ascend Technology Ventures, Delta Ventures and Andrew Viterbi, co-founder of QUALCOMM.

■ **RF Industries Ltd.** reports sales of $3.2 M for the first quarter ended January 31, 2007, compared to $3.4 M for the same period in 2006. Net income for the quarter was $33,000 ($0.01/per share), compared to a net income of $265,000 ($0.07/per diluted share) for the first quarter of last year.

■ **LitePoint Corp.**, a provider of advanced wireless test solutions, announced that it has completed a round of private equity funding from Sequoia Capital.

Network or spectrum analyzer – you choose the mode

The new R&S®ZVL – the instrument with two faces

Many users need both a network analyzer and a spectrum analyzer. But budgets are often tight and space is limited. And sometimes a portable solution may be required. Rohde & Schwarz now has the answer: the new R&S®ZVL. Not only is it the most compact and lightweight network analyzer in its class, it also is a full-fledged spectrum analyzer.

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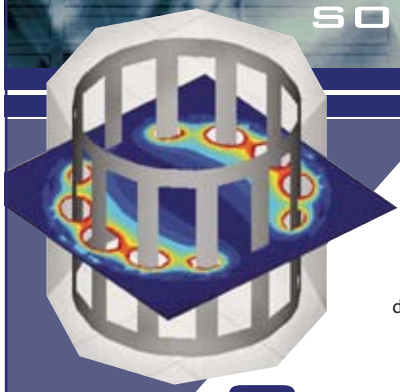

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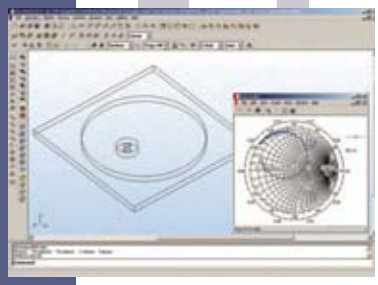

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PERSONNEL

■ California Eastern Laboratories (CEL) announced that **Jaime Tenedorio** has joined the company as vice president of engineering and chief technology officer. His responsibilities will include the development of CEL's new product and new technology roadmaps, as well as directing the engineering services CEL provides its customers and strategic partners. Tenedorio has over 20 years experience in GaAs and silicon semiconductors and consumer product development. He comes to CEL from Flextronics, where he served as vice president of engineering for Flextronics' Components Group.

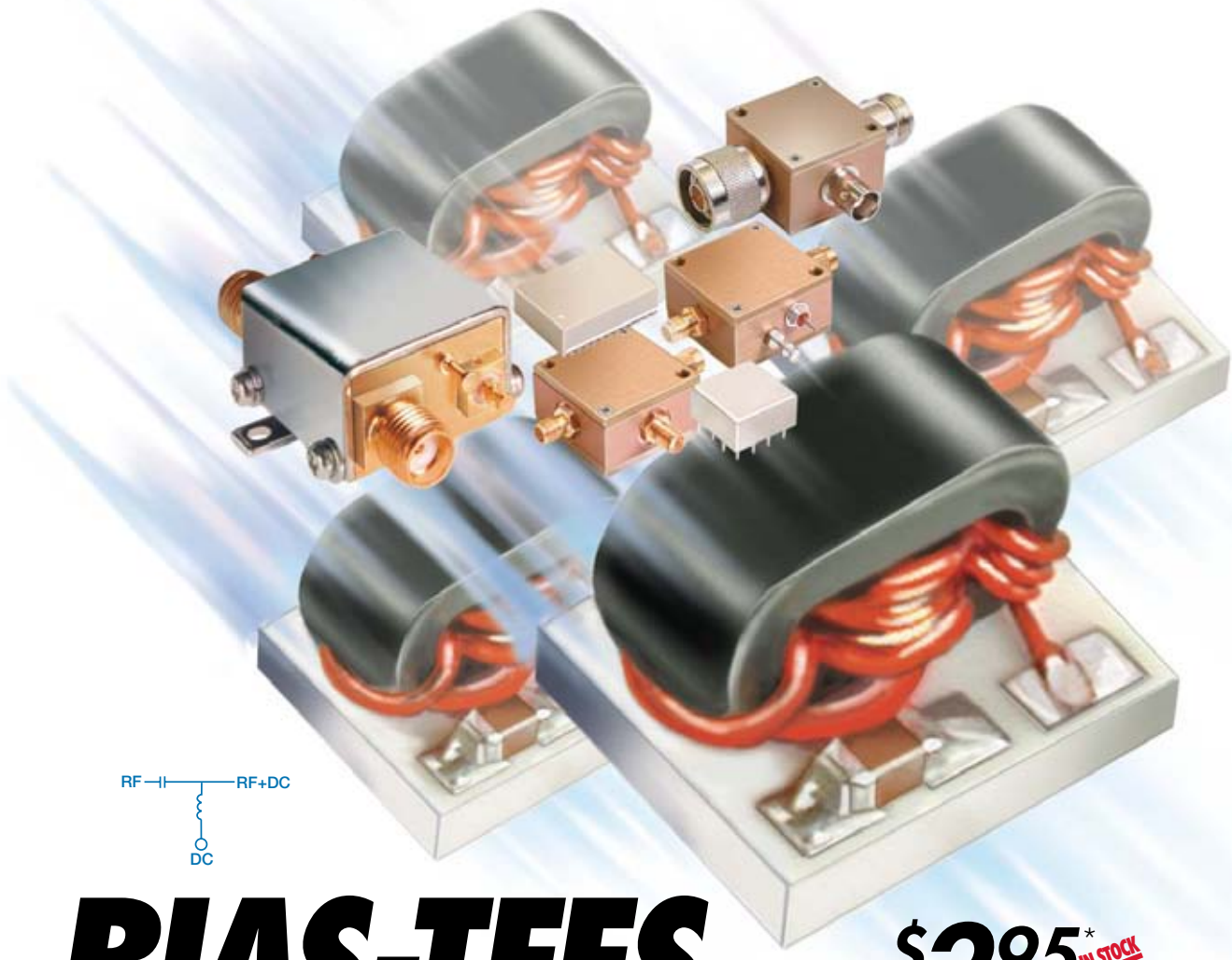
▲ *Michael J. Keating*

■ Precision Connector Inc., a supplier of standard and custom RF/microwave connectors, announced the addition of **Michael J. Keating** as vice president-director of engineering. Keating has over 25 years of design experience in the microwave industry including waveguide components at Airtron Division of Litton, stripline and microstrip design at Merrimac Industries and RF connectors at Astrolab. Most recently Keating served over 10 years as connector engineering manager and RF interconnect technology leader at Micro-Coax Inc. Keating is an active participant in DSCC and EIA committees for RF connector interface standards.

■ Quantum Leap Packaging Inc. (QLP), a provider of high performance semiconductor packaging utilizing Quantech™ proprietary polymers, announced the appointment of **Fritz Johnson** as vice president of business development. Johnson has over 18 years experience in the IC packaging and assembly materials industry, with senior sales and product management positions at Kyocera America Inc., Johnson Matthey Electronics and Sumitomo Bakelite.

■ Inphi® Corp. announced that industry veteran **Norman K. Yeung** has joined the company as vice president, engineering. Yeung will continue to drive Inphi's technology leadership as the company expands its portfolio of high performing integrated circuits with signal integrity for processing high speed data. Prior to joining Inphi, Yeung worked with Sun Microsystems where he led the development of the dual-thread Millennium processor in 90 nm process technology with multiple sites. Before Sun Microsystems, Yeung founded Sandcraft Inc., a fabless semiconductor company which was acquired by Raza Microelectronics.

■ Jacket Micro Devices (JMD), a worldwide supplier of small, high performing RF modules, announced it has hired **John McGuckin** to serve as director of sales. McGuckin brings more than 13 years of technical management experience, including eight years focused in the wireless broadband communications and RF/microwave electronics component industry. Prior to JMD, McGuckin worked for TriQuint Semiconductor, formerly Sawtek Inc., where he served in multiple sales and marketing roles.



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Model	Freq (MHz)	Insertion Loss (dB)	Isolation (dB)	VSWR (:1)	Price $ea. Qty.10
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TCBT-6G	50-6000	0.7	28	1.20	9.95
TCBT: LTCC, Actual Size .15"x.15", U.S. Patent 7,012,486.					Qty.1-9
JEBT-4R2G	10-4200	0.6	40	1.10	39.95
JEBT-4R2GW	0.1-4200	0.6	40	1.10	59.95
PBTC-1G	10-1000	0.3	33	1.10	25.95
PBTC-3G	10-3000	0.3	30	1.13	35.95
PBTC-1GW	0.1-1000	0.3	33	1.10	35.95
PBTC-3GW	0.1-3000	0.3	30	1.13	46.95
ZFBT-4R2G	10-4200	0.6	40	1.13	59.95
ZFBT-6G	10-6000	0.6	40	1.13	79.95
ZFBT-4R2GW	0.1-4200	0.6	40	1.13	79.95
ZFBT-6GW	0.1-6000	0.6	40	1.13	89.95
ZFBT-4R2G-FT	10-4200	0.6	N/A	1.13	59.95
ZFBT-6G-FT	10-6000	0.6	N/A	1.13	79.95
ZFBT-4R2GW-FT	0.1-4200	0.6	N/A	1.13	79.95
ZFBT-6GW-FT	0.1-6000	0.6	N/A	1.13	89.95
ZNBT-60-1W	2.5-6000	0.6	45	1.10	82.95
ZX85-12G+	0.2-12000	0.6	N/A	1.20	99.95
ZX85: U.S. Patent 6,790,049.					

Note: Isolation dB applies to DC to (RF) and DC to (RF+DC) ports.

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AROUND THE CIRCUIT

■ LNX Corp. announced the appointment of **Bill Tufts** as director of sales. Tufts holds a master of science in business management degree from Lesley College. His professional sales background includes 23 years in the commercial and military RF and microwave marketplace while working as a field sales engineer, national sales manager and as a director of business development. He most recently served with Crane Electronics STC Microwave Systems. In related news, LNX announced that **Art Humason** has joined the company as principal technologist. Humason will be responsible for the design and development of advanced microwave subsystems integrating microwave and digital technology for the EW and ECM markets. At LNX, Humason brings over 26 years of experience in the design of Digital Instantaneous Frequency Measurement (DIFM) receivers and microwave subsystems. Before joining LNX, he served as senior principal engineer for several US defense contractors.

▲ Barry Black

■ **Barry Black** has rejoined International Manufacturing Services (IMS) after a two year absence. He will be responsible for overseeing sales in Region Two, which includes northern California, Colorado, Utah, Illinois, and parts of Wisconsin, New Jersey, Long Island and the Dixie states. He will also be responsible for sales in the UK and Ireland. Previously the sales and marketing manager for Centerline Technologies and the North American sales manager for the *Journal of Electronic Defense*, he returns to the IMS sales department and will report to Dan Ziroli, director of sales and marketing.

REP APPOINTMENTS

■ **Phenix Technologies**, a manufacturer of high voltage, high current and high power test systems and components, announced a new exclusive partnership agreement with **TestMart**. The agreement authorizes TestMart to present a full catalog of transformer test equipment, circuit breaker test equipment, battery test equipment, ACDC hipots megohmmeters, AC-DC kilovolmeters, insulation analyzers, AC dielectric test equipment, and heat cycling test sets to government agency and prime contractor buyers.

■ **Micro-Coax** announced the expansion of its sales channel with the appointment of **Youngewirth and Olenick Associates** as its exclusive representative for the Arizona, New Mexico and Nogales, Mexico territories. Youngewirth and Olenick will market and sell Micro-Coax's full line of coaxial cables, connectors, harness assemblies and conductive fibers in the region.

■ **precisionWave Corp.** announced its selection of **Global Instrument Dynamics** (G.I.D.I.Y.) as its exclusive sales representative in Israel. G.I.D.I.Y. specializes in the distribution, technical support and service of measurement, test equipment and systems. G.I.D.I.Y. will promote, sell and support precisionWave's line of low cost, high performance RF test instruments.

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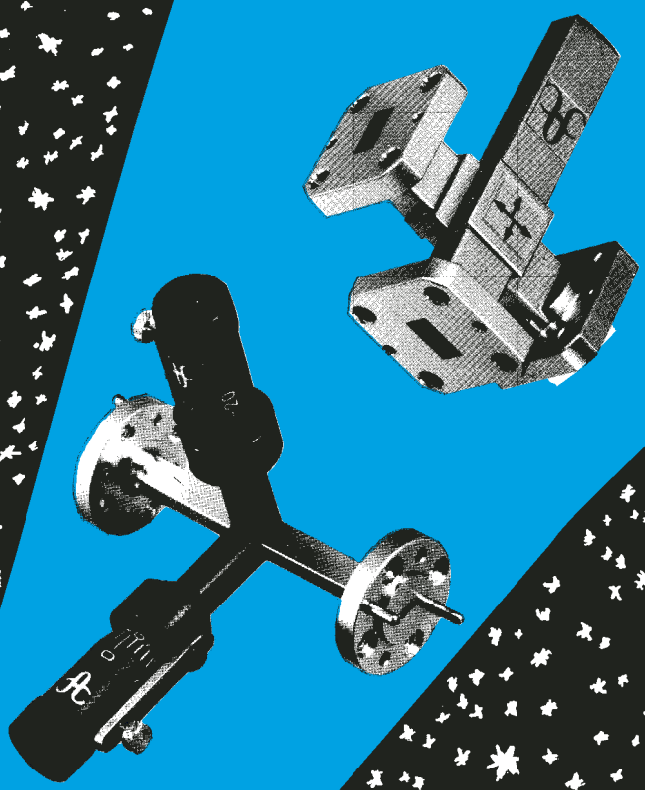

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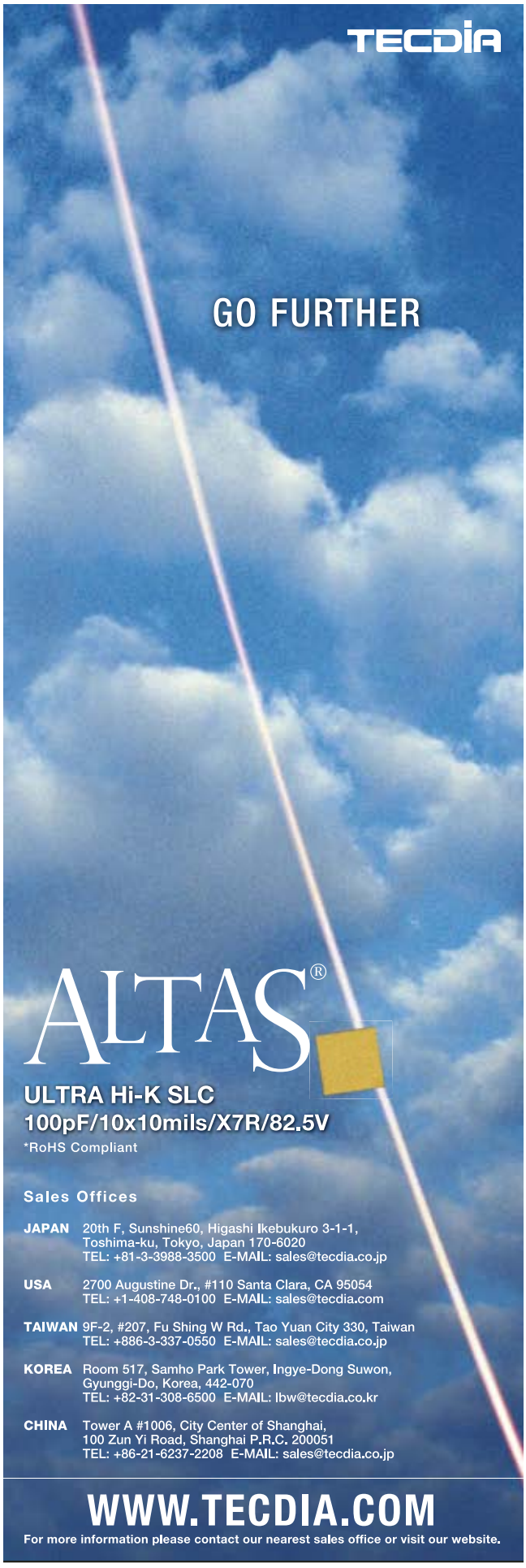

■ **G.T. Microwave Inc.**, Randolph, NJ, announced its appointment of international representative, **SEMIC RF Electronic GmbH**, to cover Germany, Austria and Switzerland. The members of SEMIC RF Electronic GmbH were allotted the task of covering prospective customers in the western region of Europe. SEMIC headquarters is stationed at Postweg 2, 82024 Taufkirchen, Germany, and the web site is www.semic.de.

■ **MITEQ Inc.** announced the appointment of **PhaseCom Inc.** as the company's exclusive sales representative in Texas. PhaseCom Inc. will represent MITEQ's Component division of products, which includes amplifiers, mixers, frequency multipliers, passive power components, switches, attenuators, limiters, phase shifters, IF signal processing components, oscillators, synthesizers, integrated multifunction assemblies and fiber optic products. PhaseCom Inc. can be contacted at (817) 410-5790 or e-mail: mcabrera@phasecom.com.

■ **Digi-Key Corp.** and **Amphenol Commercial Products** announced the signing of a worldwide distribution agreement. Amphenol Commercial Products division (ACP) provides commercial audio/data/storage/telecom interconnect solutions into a wide range of markets and applications, covering traditional connectors through to the latest and next generation technical products. Among ACP products stocked at Digi-Key are D-sub, mini SAS, SFP, Infiniband, USB and RJ45 connectors.

■ **Tampa Microwave** announced the addition of four new rep firms to its US sales network. Each of the new firms will handle all Tampa Microwave products, and their representation is effective immediately. The new members of the Tampa Microwave US sales representative network are: TeraComm: MA, CT, VT, ME, NH, NY, MD, northern NJ, DC, VA and WV (800 Village Walk #296, Guilford, CT (203) 672-5943, www.terracom.com); C-Wave: southern California (1426 Aviation Blvd., Suite 102, Redondo Beach, CA 90278 (310) 931-3521, www.cwaveinc.com); Eastern Instrumentation of Philadelphia: PA, DE and southern NJ (710 E. Main Street, Moorestown, NJ 08057 (856) 231-0668, www.eiphila.com); and Dura Sales: northern California (1925 S. Winchester Blvd., Suite 102, Campbell, CA 95008 (408) 378-0747, www.durasales.com).

WEB SITE

■ **Sivers IMA AB** has relaunched its web site, www.siversima.com, with the focus on 'peak performance' that not only applies to its high end microwave sources such as VCOs, FMCW subsystems, synthesizers, PLLs and custom designed products but also to how it supplies them to its customers worldwide. The web site has improved menu systems to provide easy access to the comprehensive product line and also simplifies financial transactions with customers. The site also includes important contact information and the growing demand for the company's products and services in the US is reflected in the inclusion of its new US sales office and five newly appointed agents.

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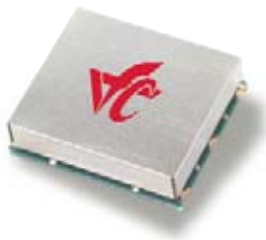

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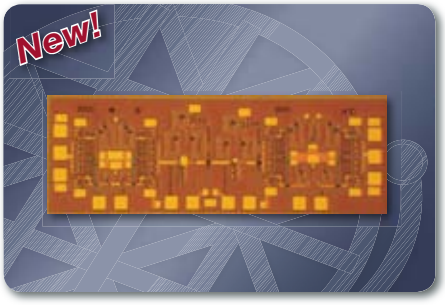

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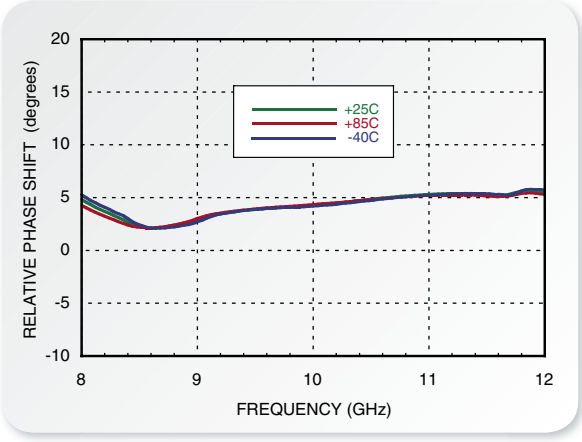

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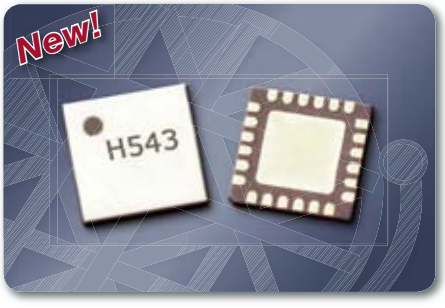

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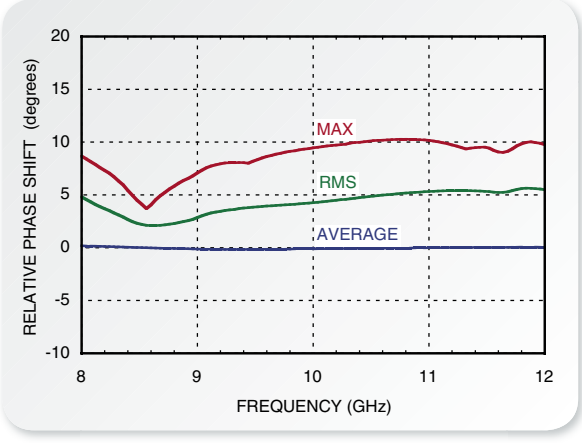

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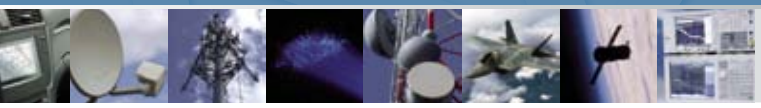

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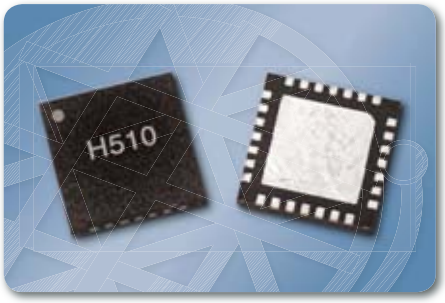

- Fo Low SSB Phase Noise: -116 dBc/Hz @ 100 kHz Typ.
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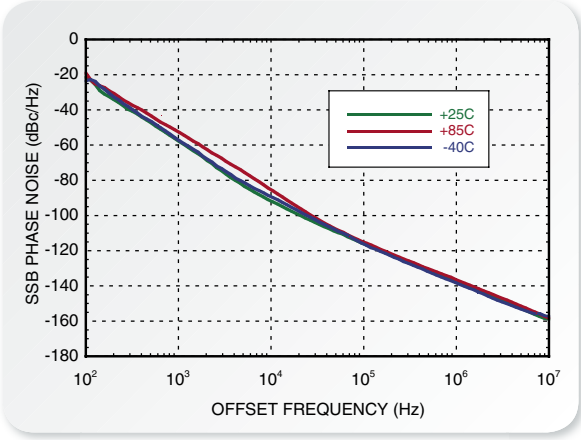

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	10.43 - 11.46	5.215 - 5.73	VCO with Fo/2 & ÷4	7	-110	+3V @ 275mA	LP5	**HMC513LP5 (E)**
NEW!	10.6 - 11.8	5.3 - 5.9	VCO with Fo/2 & ÷4	11	-110	+5V @ 350mA	LP5	**HMC534LP4 (E)**
	11.17 - 12.02	5.585 - 6.01	VCO with Fo/2 & ÷4	7	-110	+3V @ 275mA	LP5	**HMC514LP5 (E)**
	11.5 - 12.5	5.75 - 6.25	VCO with Fo/2 & ÷4	10	-110	+5V @ 200mA	LP5	**HMC515LP5 (E)**
NEW!	11.5 - 12.8	5.75 - 6.4	VCO with Fo/2 & ÷4	11	-110	+5V @ 350mA	LP5	**HMC583LP5 (E)**
	12.4 - 13.4	6.2 - 6.7	VCO with Fo/2 & ÷4	8	-110	+5V @ 260mA	LP5	**HMC529LP5 (E)**
NEW!	12.5 - 13.9	6.25 - 6.95	VCO with Fo/2 & ÷4	10	-110	+5V @ 330mA	LP5	**HMC584LP5 (E)**
	13.6 - 14.9	6.8 - 7.45	VCO with Fo/2 & ÷4	7	-110	+5V @ 260mA	LP5	**HMC531LP5 (E)**

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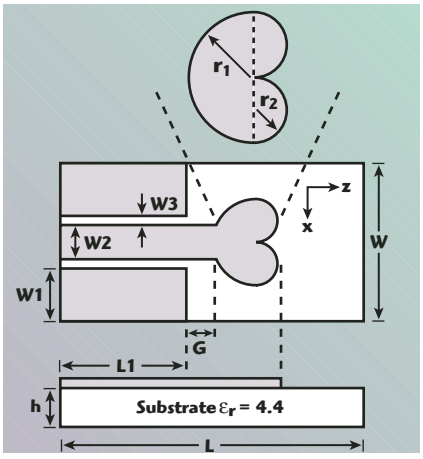
A PRINTED HEART MONOPOLE ANTENNA WITH BAND-REJECTED CHARACTERISTICS FOR IEEE 802.16A AND UWB APPLICATIONS

A novel design of a printed heart-shaped monopole antenna, with a ring-section slot for IEEE 802.16a and ultra-wideband (UWB) applications, is proposed where the 5.150 to 5.825 GHz frequency band has been rejected. The measured bandwidth ranges, for a return loss greater than 10 dB, are 2.30 to 5.02 GHz and 6.08 to 12.37 GHz. The parameters that affect the frequency and efficiency of the proposed antenna have been investigated.

Many various configurations and various substrate materials for ultra-wideband (UWB) applications have been investigated. Many printed broadband monopole configurations,[1–3] such as circular, semi-circular and square shapes, can achieve ultra-wideband characteristics, omni-directional radiation patterns, simple structures, light weight and low cost. The IEEE 802.15.3a standard[4] specifies the 3.1 to 10.6 GHz frequency band for UWB communication systems. However, the 5.15 to 5.825 GHz frequency band has been adopted by IEEE 802.11a[5] for wireless local area networks (WLAN). Interference can occur between UWB and WLAN systems. Two methods can be used to avoid this interference: a band-reject filter, or an antenna with a band-reject slot[6–9] or slit.[6,10] The use of a band-reject filter introduces a circuit complication and extra cost for UWB systems.

Fig. 1 Geometry of a printed heart-shaped monopole antenna.



ANTENNA DESIGN

The geometry of a printed heart-shaped monopole antenna[11] is shown in ***Figure 1***. It consists of a large half-disk and two small half-disks. The large half-disk, with a radius r_1, and two small half-disks, with identical radii r_2, together with a 50 Ω CPW feed line, are printed on an FR4 substrate, with a thickness h = 1.6 mm and a relative permittivity $\varepsilon_r = 4.4$. W and L are the width and length of the substrate, respectively. W_1 and L_1 are the width and length of the coplanar ground planes, respec-

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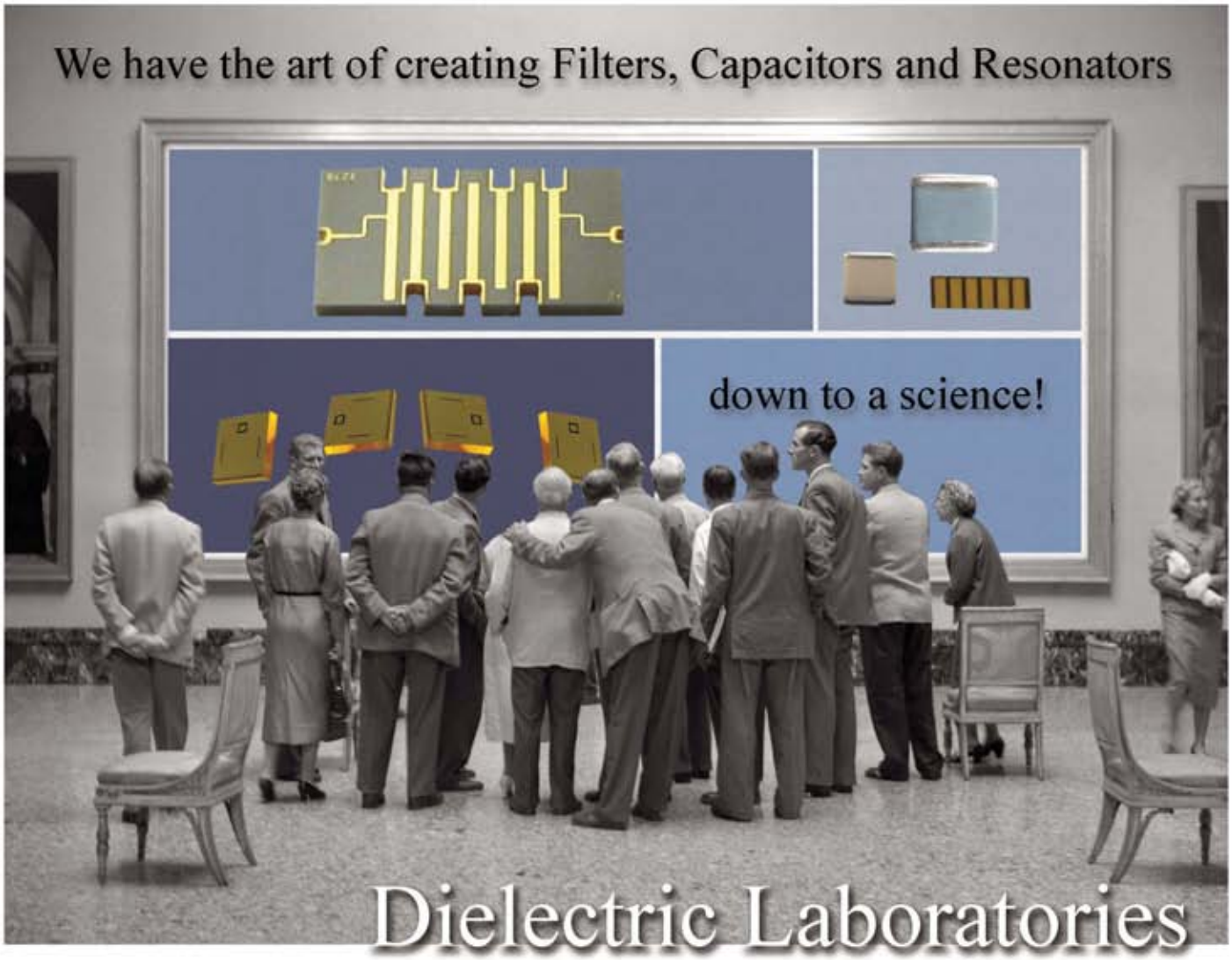

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tively. The width of the center strip of the CPW feed line is W_2 = 6.37 mm. The gap between the center strip of the CPW feed line and the ground plane is W_3 = 0.5 mm. With these dimensions, the impedance of the CPW line is 50 Ω. G is the distance between the heart and the ground plane. The proposed heart-shaped antenna gives a smoother transition than the conventional circular monopole; therefore, it is expected that the printed heart monopole antennas would have a better radiation performance, compared to the convectional printed circular monopole antennas. The broadband and good radiation properties of the printed heart monopole antenna were investigated. In order to add a band-rejection characteristic into the heart-shaped monopole antenna, several approaches have been implemented and studied.

Figure 2 shows the geometry of a printed heart-shaped monopole antenna with a rectangular slot. The width of the rectangular slot is 2 mm. L_2 and h_1 are the length of the rectangular slot and the distance between the top of the big half-disk and the rectangular slot, respectively. When the length of the rectangular slot exceeds the boundaries of the shape of the heart, the rectangular slot will be changed into a ring-section slot. ***Figure 3*** shows the geometry of the printed heart-shaped monopole antenna with a ring-section slot. It consists of a big arc and a small arc. R_3 is the distance between the big arc and the top of the big half-disk and r_4 is the distance between the small arc and the top of a big half-disk. The height of the ring-section slot is h_1. ***Figure 4*** shows the geometry of the printed heart-shaped monopole antenna with a uniform angle ring-section slot. The ring-section slot consists of a big arc and a small arc. R_3 is the distance between the big arc and the top of the big half-disk and r_4 is the distance between the small arc and the top of the big half-disk. The flare angle of the ring-section slot is θ.

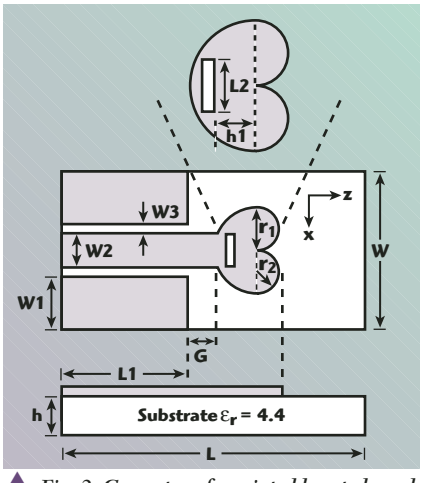

Fig. 2 Geometry of a printed heart-shaped monopole antenna with a rectangular slot.

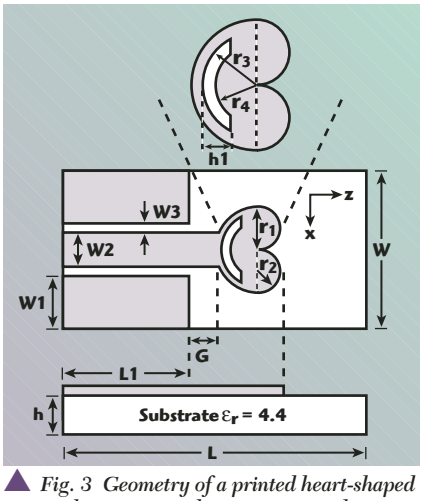

Fig. 3 Geometry of a printed heart-shaped monopole antenna with a ring-section slot.

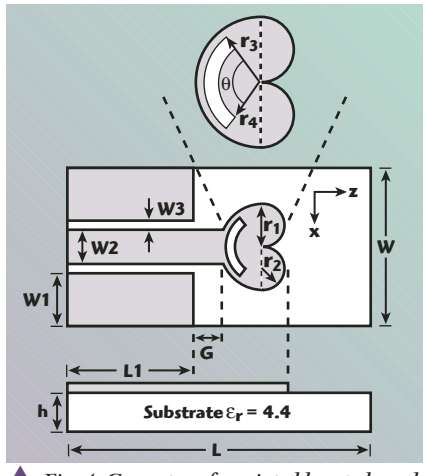

Fig. 4 Geometry of a printed heart-shaped monopole antenna with uniform angle of the ring-section slot.

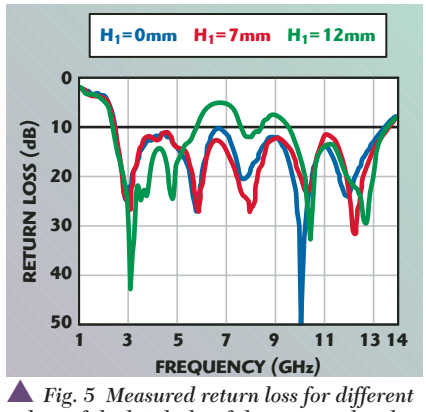

Fig. 5 Measured return loss for different values of the height h_1 of the rectangular slot (L_2 = 6 mm).

The desired lowest operating frequency (f_L) of the printed heart-shaped monopole antenna can easily be determined from the following formulas[12]

$$f_L = \frac{c}{\lambda} = \frac{300 \times 0.24}{1 + r} \qquad (1)$$

where r is the equivalent radius of the proposed monopole antenna, determined by

$$R = \frac{A}{2\pi 1} \text{ (mm)}$$

$$A = \left(\pi r_1^2\right) + 2\left(\pi \frac{r_2^2}{2}\right) + \left(G \times 6.37\right) \left(\text{mm}^2\right)$$

$$1 = G + r_1 + r_2 \text{ (mm)} \qquad (2)$$

where A is the area and 1 is the total height of the proposed antenna.

The heart-shaped monopole antenna is not a regular planar monopole antenna, so the original parame-

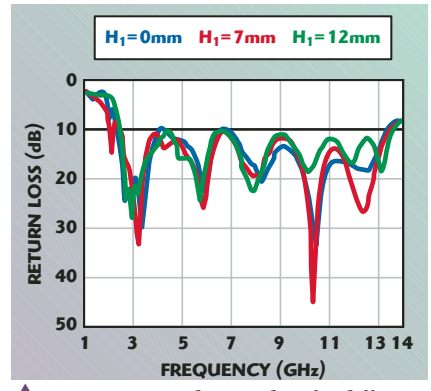

Fig. 6 Measured return loss for different values of the height h_1 of the rectangular slot (L_2 = 12 mm).

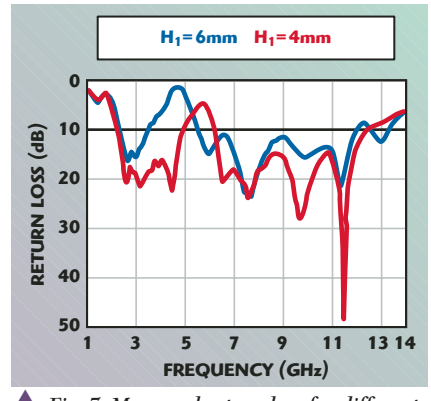

Fig. 7 Measured return loss for different values of the height h_1 of the ring-section slot (r_4 = 10 mm).

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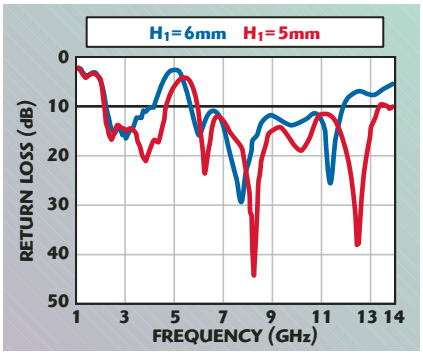

Fig. 8 Measured return loss for different values of the height h_1 of the ring-section slot (r_4 = 11 mm).

ter 0.221 in Equation 1 has been replaced by 0.24. For the proposed design, the center frequency of the rejected band is determined by the longest side of the slot etched into the heart-shaped monopole antenna. The longest side of the slot is approximately a half wavelength at the center frequency of the rejected band.

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EXPERIMENTAL RESULTS AND DISCUSSION

The original printed heart-shaped monopole antenna provided a very wide bandwidth, larger than 10 GHz.[11] The measured bandwidth, for a return loss greater than 10 dB, is from 2.48 to 13.35 GHz. Hence, an impedance bandwidth of approximately 137 percent has been obtained. For the purpose of avoiding interference between UWB and WLAN systems, an antenna with a band-rejected characteristic is proposed. The parameters that affect the performance of the proposed antenna have been investigated. They include the position and the height of the slot. The return losses of the proposed antenna have been measured using a HP8720ES network analyzer from Agilent Technologies Inc. An optimal design, applicable to IEEE 802.16a[13] and IEEE 802.15.3a (UWB)[4] mobile wireless communication products, is proposed.

PRINTED HEART-SHAPED MONOPOLE ANTENNA WITH A RECTANGULAR SLOT

Figures 5 and ***6*** show the return loss for different positions h_1 of the

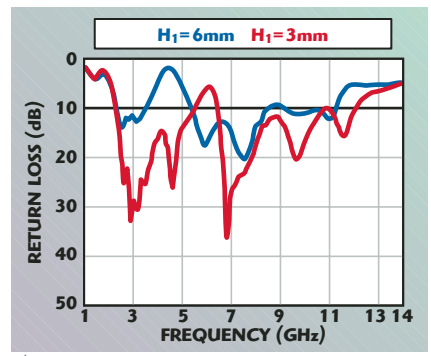

Fig. 9 Measured return loss for different values of the height h_1 of the ring-section slot (r_4 = 12 mm).

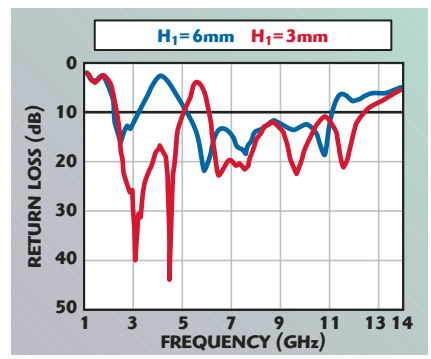

Fig. 10 Measured return loss for different values of the height h_1 of a ring-section slot (r_4 = 13 mm).

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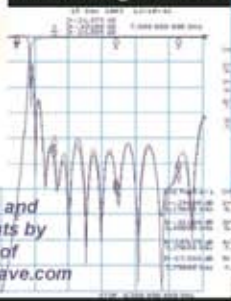

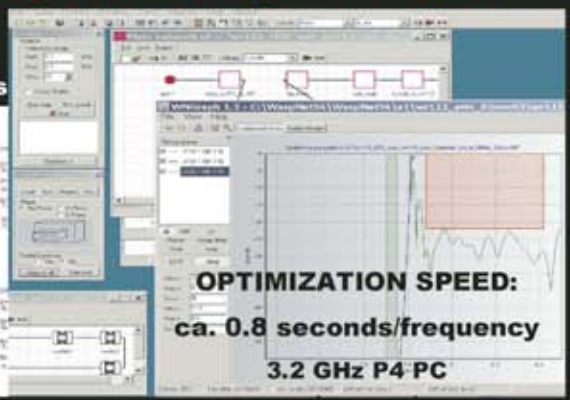

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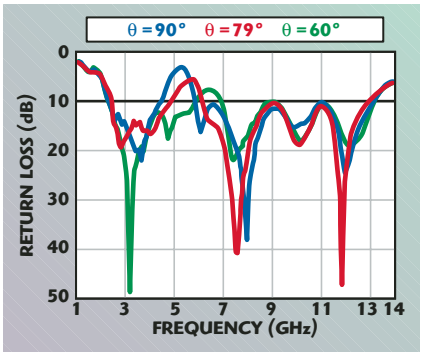

Fig. 11 Measured return loss for different angle θ of a ring-section slot (r_4 = 10 mm).

rectangular slot, with L_2 = 6 and 12 mm, respectively. The other dimensions are W = 35.07 mm, L = 46 mm, W_1 = 13.85 mm, L_1 = 20.67 mm, G = 0.8 mm, r_1 = 16 mm and r_2 = 8 mm. It shows that the bandwidth is sensitive to h_1. For L_2 = 6 mm, when the height of the rectangular slot is h_1 = 12 mm, a band-rejected characteristic is shown.

DIFFERENT HEIGHT H_1 AND DIFFERENT RADIUS R_4 FOR THE PRINTED HEART MONOPOLE ANTENNA WITH A RING-SECTION SLOT

Figures 7 to ***10*** show the return loss for different heights h_1 of the ring-section slot for r_4 = 10, 11, 12 and 13 mm, respectively. All the other dimensions are the same as previously. The distance r_3 between the big arc and the top of the big half-disk is fixed at 14 mm. As the value of

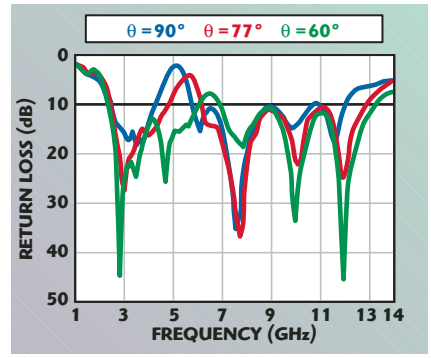

Fig. 12 Measured return loss for different values of the angle θ of a ring-section slot (r_4 = 11 mm).

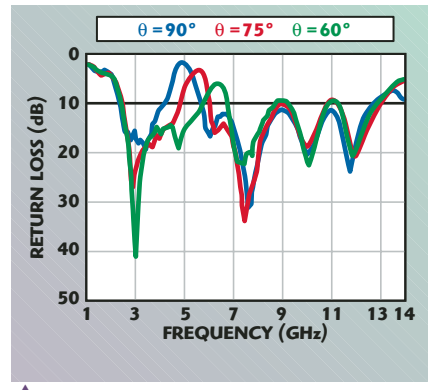

Fig. 13 Measured return loss for different values of the angle θ of a ring-section slot (r_4 = 12 mm).

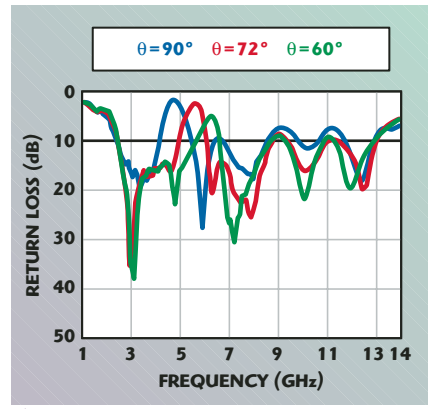

Fig. 14 Measured return loss for different values of the angle θ of a ring-section slot (r_4 = 14 mm).

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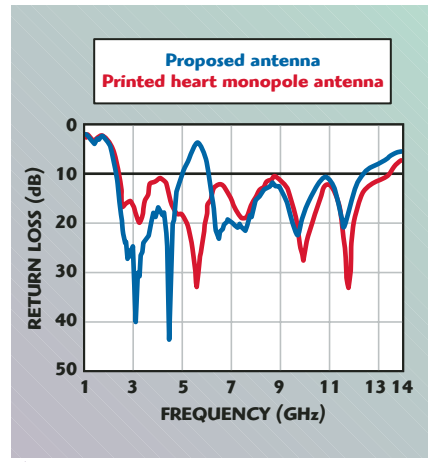
h_1 is changed, a band-rejected characteristic is shown. The rejected band is strongly affected by h_1, because the length of the ring slot is related to h_1.

DIFFERENT ANGLE θ OF THE RING-SECTION SLOT AND DIFFERENT VALUES OF R_4 FOR THE UNIFORM-ANGLE RING-SECTION SLOT

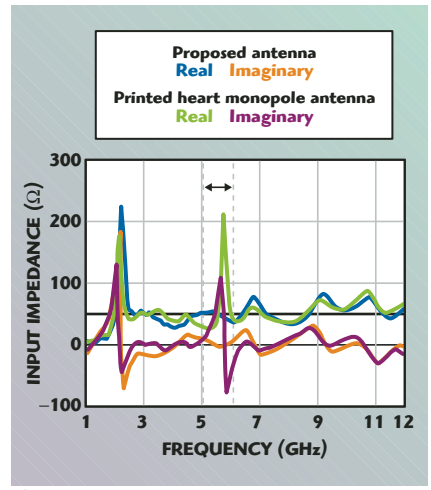
Figures 11 to ***14*** show the return loss with different flare angles of the ring-section slot for r_4 = 10, 11, 12 and 13 mm. In this case, the distance r_3 between the big arc and the top of a big half-disk is still fixed at 14 mm. When the value of the angle of the uniform-angle ring-section slot is changed with r_4 = 10, 11, 12 and 13 mm, a band-rejected characteristic of the printed heart antenna is observed. As the flare angle θ increases, the rejected band shifts to a lower frequency.

OPTIMIZED DESIGN

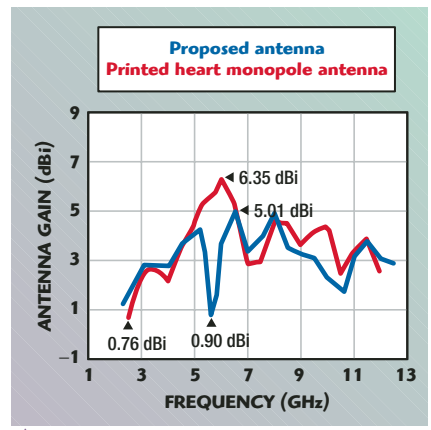
From this investigation and study, an optimized design of the antenna with a ring-section slot can be obtained. The effect of the gain drop of the printed heart monopole antenna



▲ *Fig. 15 Measured return loss for the proposed and the UWB antenna.*



▲ *Fig. 16 Input impedance of the proposed and printed heart-shaped monopole antennas.*



▲ *Fig. 17 Measured peak gain of the proposed and printed heart-shaped monopole antennas.*

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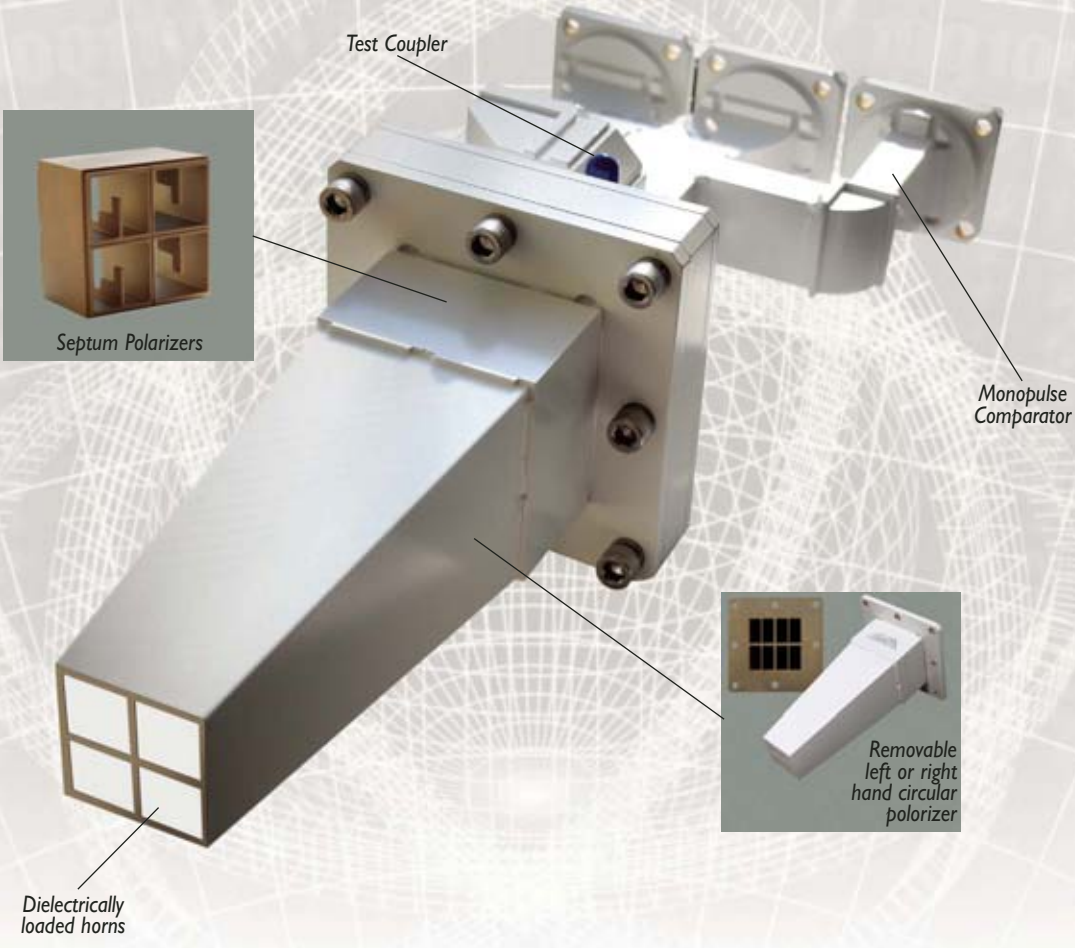

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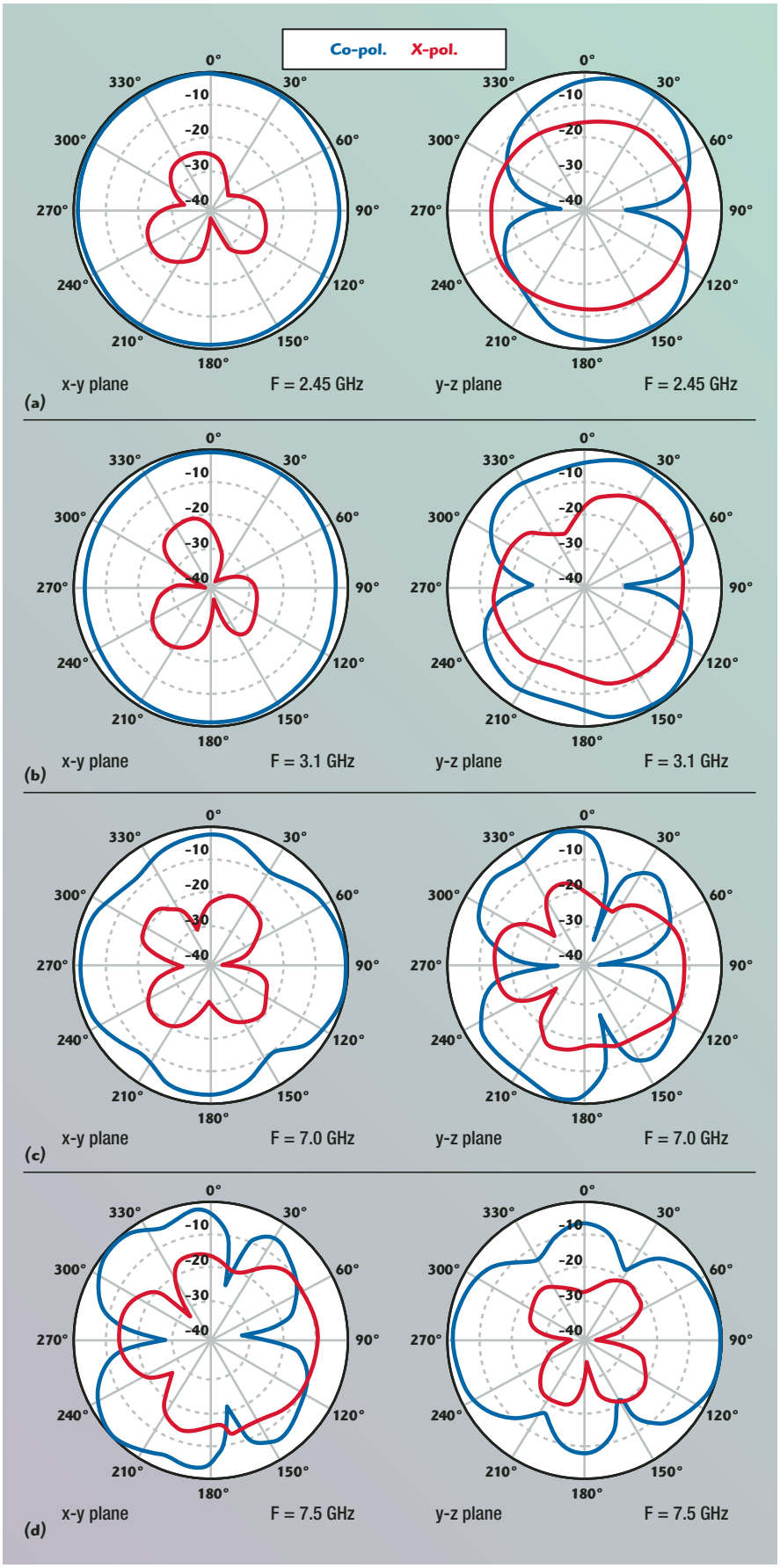

▲ *Fig. 18 Measured radiation patterns of the proposed antenna.*

with a uniform-angle ring-slot section is not significant. Consequently, the geometry adopted is a printed heart-shaped monopole with a ring-section slot. The optimized parameters are ε_r = 4.4, h = 1.6 mm, h_1 = 3 mm, W = 35.07 mm, W_1 = 13.85 mm, W_2 = 6.37 mm, W_3 = 0.5 mm, L = 46 mm, L_1 = 20.67 mm, G = 0.8 mm, r_1 = 16 mm, r_2 = 8 mm, r_3 = 14 mm and r_4 = 13 mm. ***Figure 15*** shows the measured return loss of the printed heart monopole antenna and the proposed antenna. The measured return loss bandwidth ranges are 2.30 to 5.02 GHz and 6.08 to 12.37 GHz, which are satisfactory for IEEE 802.16a and IEEE 802.15.3a (UWB) applications. The input impedance of the proposed and printed heart monopole antennas are shown in ***Figure 16***. The band-reject property of the proposed antenna is shown and proven. ***Figure 17*** shows the measured peak gain of the proposed antenna. The gain drop over the rejected band is obvious. The measured radiation patterns measured at 2.4, 3.1, 7.0 and 7.5 GHz are shown in ***Figure 18***. At these operating frequencies, the radiation patterns of the proposed antenna are suitable to IEEE 802.16a and UWB applications.

CONCLUSION

The design of a printed heart-shaped monopole antenna with a CPW feed line provides a very wide bandwidth, larger than 10 GHz. The measured bandwidth range, for a return loss greater than 10 dB, is from 2.48 to 13.35 GHz. However, the 3.1 to 10.6 GHz frequency bands of the UWB systems overlap the 5.15 to 5.825 GHz frequency bands of the WLAN systems and an interference occurs between the UWB and WLAN systems. A ring-section slot has been added to the printed heart-shaped monopole antenna to reject the 5.15 to 5.825 GHz frequency band. A novel design of a printed heart-shaped monopole antenna, with a ring-section slot, usable for IEEE 802.16a and IEEE 802.15.3a (UWB) applications, has been investigated and proposed. The rejected band of this antenna can be controlled by varying the length of the ring-section slot etched within the printed heart-shaped antenna. ■

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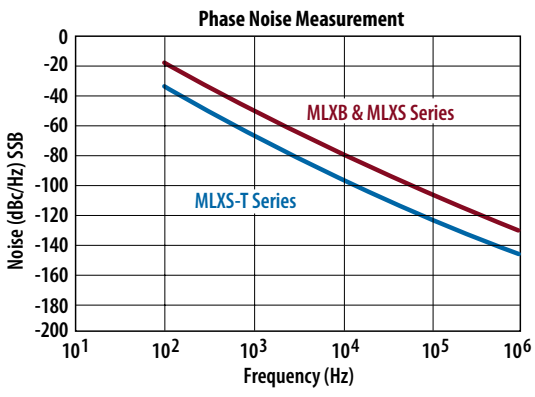

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ACKNOWLEDGMENT

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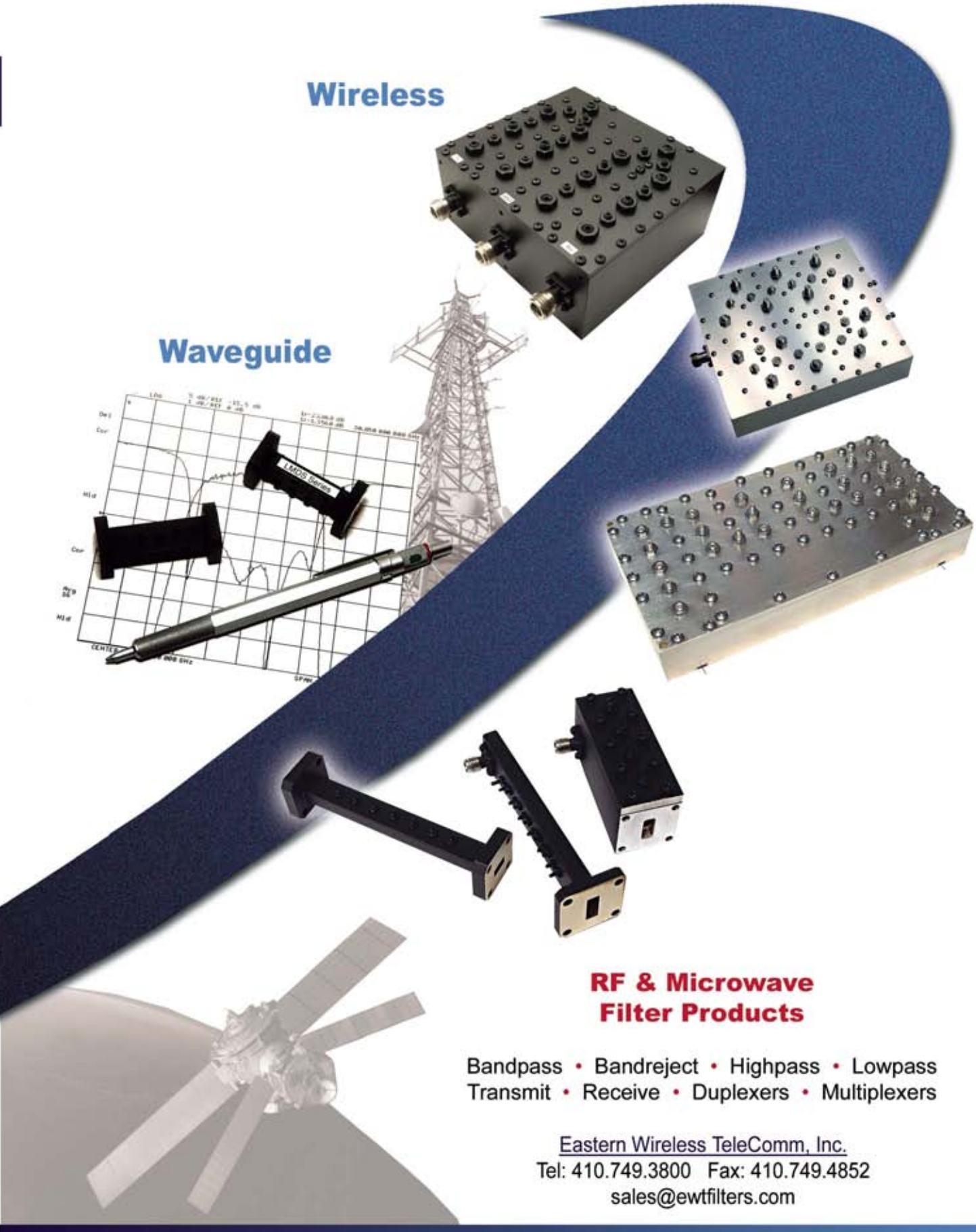

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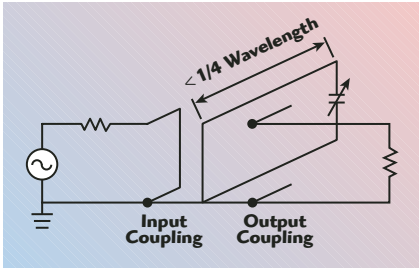

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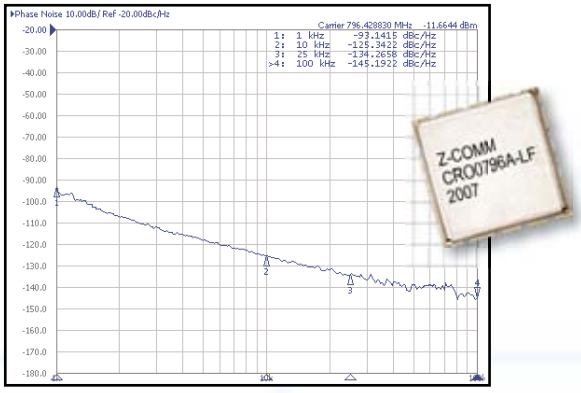

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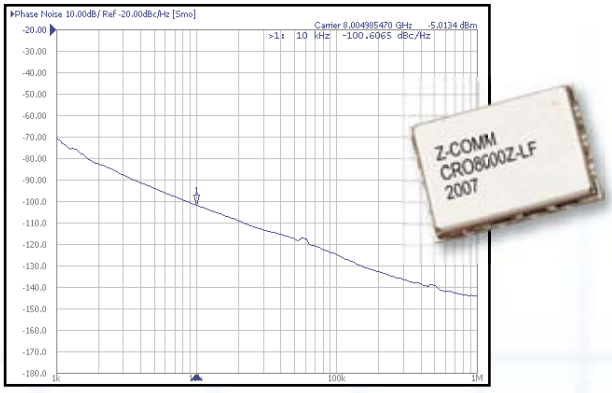

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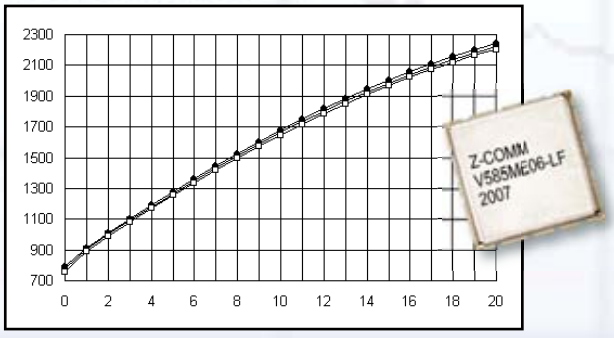

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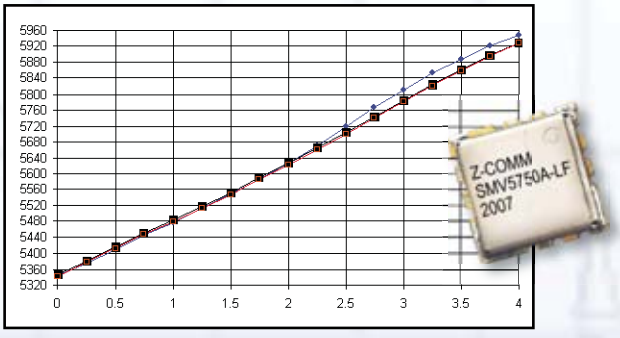

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lel at a certain distance. Bringing the surfaces closer together increases the capacitance, which lowers the center or resonance frequency. Therefore, the resonance frequency of the cavity can be varied according to the amount of distance between the surfaces of the conducting plates, that is the end cap and the top plate. The end cap and the top plate are highly conductive, in order to achieve a very high capacitor Q, which improves the resonator's performance at high power (large current) applications, as well as in high selectivity filter applications. In addition, allowing the ceramic disc to expand and contract with temperature against the expansion and contraction of the holding mechanism results in a corresponding change in distance with temperature that results in maintaining greater frequency stability. The loss of a coaxial transmission line is a function of its length (the longer the length the higher the loss). The loss also increases as the square root of frequency, as a result of the skin effect at RF frequencies. This holds true for coaxial cable, waveguide or a single wire. This loss is dissipated as heat by the current carrying conductors. Loading a coaxial transmission line with a capacitance to form a resonator reduces the loss from the line, but the overall loss of the resonator will increase, unless the loading capacitor Q is of the same order as the Q of the line. However, the harmonic response of the line is extended according to the amount of shortening of the line, independent of Q. High Q loading has

Fig. 2 The loaded cavity.

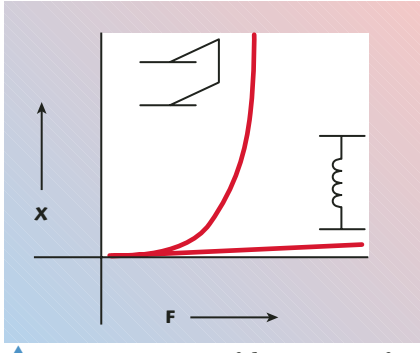

Fig. 3 Comparison of the reactance of a transmission line and a lumped inductance.

Fig. 4 The ceramic disk.

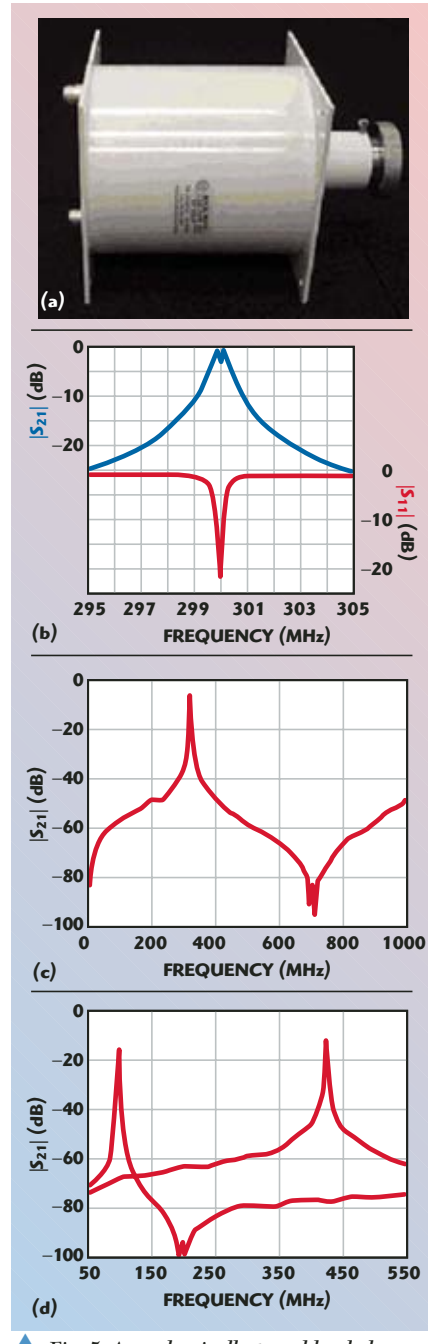

Fig. 5 A mechanically tuned loaded cavity filter and actual test data of its passband performance.

TABLE I

RESULTANT Q OF THE CAVITY FOR A FIXED CAPACITOR Q

Line Wavelength	Line Q	Q of Cap	R_s of Cap	Resultant Q
0.245	4342	4276	0.37208274	4339
0.200	5250	4276	0.03598788	4941
0.100	7475	4276	0.00849559	5553
0.050	8235	4276	0.00379934	5660
0.025	8440	4276	0.00185202	5684

TABLE II

RESULTANT Q OF THE CAVITY FOR A CONSTANT SERIES RESISTANCE OF THE CAPACITOR

Line Wavelength	Line Q	Q for Cap	R_s of Cap	Resultant Q
0.245	4342	883903	0.0018	4515
0.200	5250	85491	0.0018	7076
0.100	7475	20182	0.0018	10549
0.050	8235	9026	0.0018	8606
0.025	8440	4400	0.0018	5792

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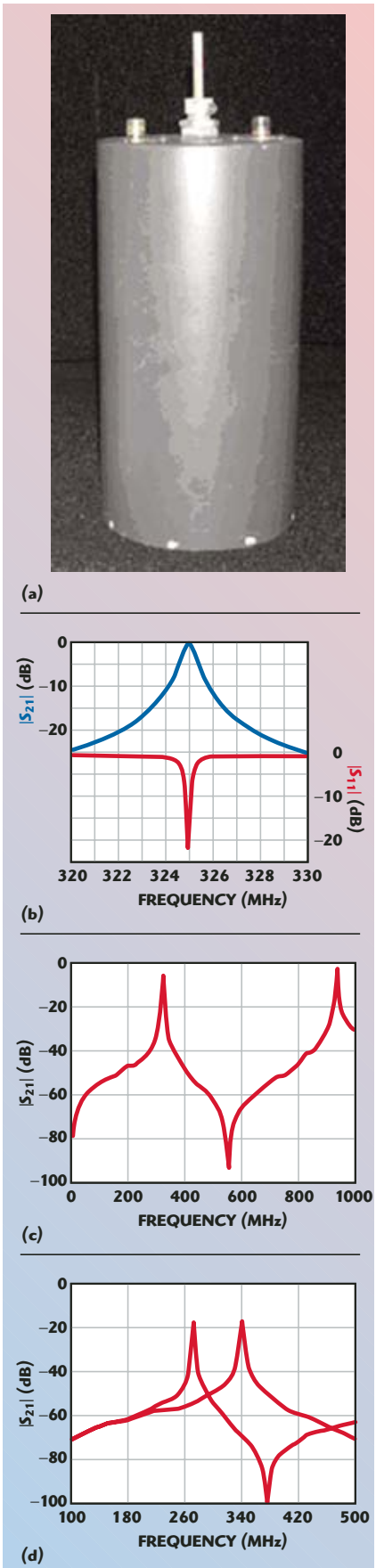


Fig. 6 A mechanically tuned unloaded cavity filter.

been difficult to realize in the past, as a typical air capacitor Q is much lower than the coaxial line Q, due to the very small air gap required to realize the capacitance (the air gap usually being much less than the distance between the inner conductive post and outer cylinder). Additionally, at high power, the small air gap may cause flashover sparking resulting in a breakdown. Accordingly, thin, small diameter ceramic cylinders, which reduce the length of a coaxial post, have been used to increase the flashover voltage handling and to produce extended stop band performance filters at the expense of Q. Additionally, the currents flowing on the plates of the capacitor cause loss, which in turn results in RF induced heating of the plates. In the past, metallization schemes, such as deposited thin films or silver fired conductors, have been applied directly to the plates of the capacitor, substantially increasing these losses. By utilizing highly conductive silver-plated copper material abutting or near the ceramic, those losses are dramatically reduced and the power handling greatly increased.

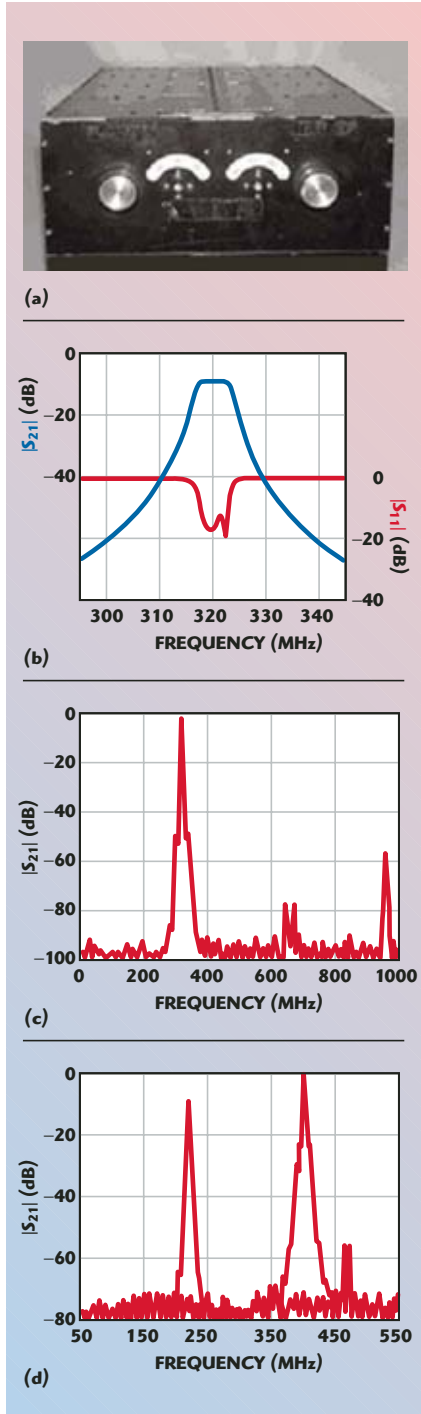


Fig. 7 A mechanically tuned diplexer filter, typical of a non-cavity type and its test data.

DETAILED ANALYSIS OF THE TRANSMISSION LINE Q

The quality factor Q of a resonant electromagnetic system is defined as the product, at resonance, of the angular frequency ω and the ratio of the total energy stored in the system to the power dissipated or otherwise coupled out of the system

$$Q = \omega \bullet \text{energy stored} / \text{average power loss}$$

which can be written as[3]

$$Q = \tfrac{1}{2}\,(\text{sum of reactances} + \omega \bullet \text{sum of } |dX/d\omega|)/\text{sum of resistances} \quad (1)$$

where

Q = quality factor
X = reactance
ω = 2πf
f = frequency

The impedance of the low loss transmission line shorted at one end is

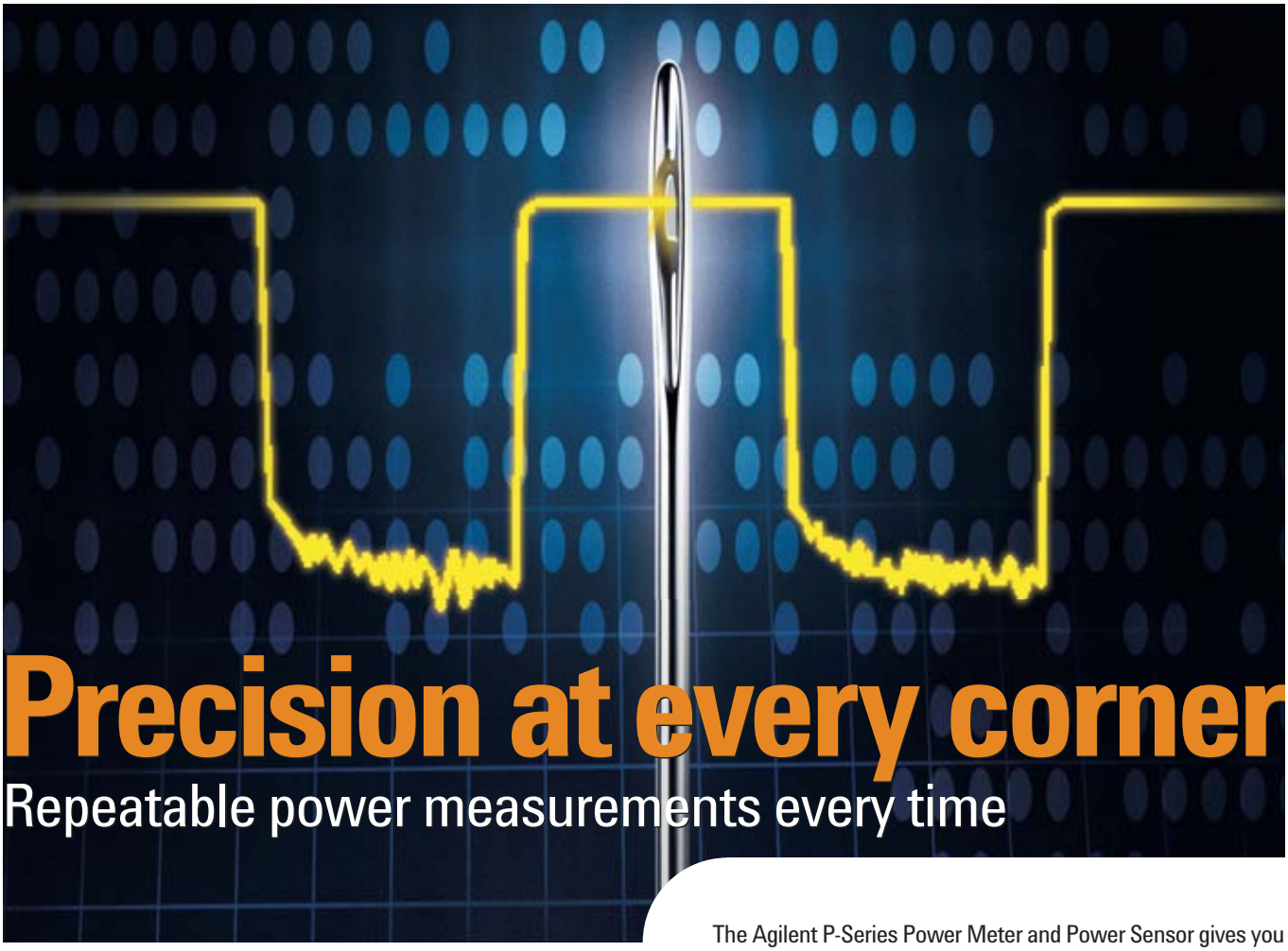
$$Z = Z_o \tanh(al + jBl) = R + jX \quad (2)$$

where

$R = Z_o \sinh(2al)/(\cosh(2al) + \cos(2Bl))$
$R \approx Z_o \sinh(2al)/(1 + \cos(2Bl))$
$X = Z_o \sin(2Bl)/(\cosh(2al) + \cos(2Bl))$
$X \approx Z_o \tan(Bl)$

where

a = line attenuation (Nepers/m), (dB/m/8.686)
B = ω/c
l = line length ($l < \lambda/4$)
c = velocity of light
R = series equivalent resistance
Z_o = impedance of the line



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For the capacitor, $X = 1/(\omega C)$, where C is the capacitance and the Q of a single series capacitor is X/R.

Note that the Q of the line can only be approximated as X/R when $1 << \lambda/4$, due to the reactance slope of the distributed line resonator not being the same as an inductor, as illustrated in ***Figure 3***. At resonance, the reactance of the capacitance and the reactance of the line must be equal.

$$Z_0 \tan(Bl) = 1/(\omega C)$$

Solving for C determines the capacitance required to resonate the shortened transmission line at the frequency f.

$$C = 1/(2\pi f Z_0 (\tan(Bl))$$

From Equation 1, the Q of a shortened length of transmission line is

$$Q = \tfrac{1}{2}(\tan(Bl) + Bl/\cos^2(Bl))/(\sinh(2al)/(1 + \cos(2Bl))) \quad (3)$$

As l approaches $\lambda/4$ in Equation 3, it reduces to the simpler form: $Q = 2.1715\ \pi/(A\lambda/4)$

where

A = line loss (dB/in)
λ = in inches

This is the same as

$$8.686\ \pi/(A\lambda)^4 \text{ or } \pi/(a\lambda) \quad (4)$$

This is the well-known result for the Q at resonance of a $\lambda/4$ line.[1]

From Equation 3 and extrapolating the transmission line length toward a zero limit, the Q of the shorted transmission line approaches twice that of the $\lambda/4$ line. It is also easy to calculate the line Q when the length l is very short or near zero from the lumped circuit equivalence, approximating the line as an inductor. That Q is X/R. R reduces to Z_0 al (from Equation 2). Setting $X = \omega L = Z_0 \tan(Bl)$, then $\omega L = Z_0 Bl$. Thus, $Q = Z_0 Bl/Z_0$ al, or $Q = B/a = 2\pi/(a\lambda)$, which compared to Equation 4, is twice the Q of the $\lambda/4$ line.

Using a shortened length of line in series with a capacitor with a Q value equal to the shortened line, the resonant circuit Q is equal to the shortened line itself. Thus, the Q of the shortened transmission line and capacitor circuit is more than that of the $\lambda/4$ line, as shown in ***Table 1***, which summarizes the case of a transmission line loaded with a resonating capacitor with the capacitor Q fixed and equal to the $\lambda/4$ line Q (4276, in this example). Note the increase in the Q of the transmission line by shortening its length. ***Table 2*** shows the Q of the cavity with a constant series resistance capacitor tuning the line to resonance, since a constant Q capacitor as used in the previous table would require its effective series resistance to change with reactance.

When the line length is near $\lambda/4$, nearly all the energy is in the line and a very small capacitor is required to resonate, so that the effect of its very high Q on the overall cavity Q is minimal. With a constant series resistance, the Q of the capacitor decreases since its capacitance is increasing with increased loading. High capacitive loading causes the electric field energy to be stored mostly in the dielectric disc, which acts as a shield to prevent breakdown from the end cap to the top plate. The ceramic-loaded cavity thus allows using a

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shorter length post along with a high Q capacitor to realize a high power-handling filter.

Q ANALYSIS OF LOADING CAPACITOR

Figure 4 is a photograph of a typical ceramic disk. A key point is that there is no thin film plating or silver firing on the ceramic disc itself, as these materials have low conductivities and would cause high losses, in addition to making the tuning method either fixed or mechanically abrasive, as might be done in rotating the exposed plate areas against unexposed areas of bare ceramic. Within the ceramic disc, the electric field is vertical and the magnetic field is circular, axially symmetric and parallel to the conductive surfaces of the plates. Currents flow on the surface of the end cap and top plate along the path from the inner to the outer diameter, perpendicular to the magnetic field. These fields are analogous to a cylindrical cavity (except there are no side walls), which, in general, has a Q proportional to the volume-to-surface area ratio. Although some fringing capacitance exists from the outside surface of the end cap to the top plate without going through the ceramic disc, it is small relative to the ceramic capacitance. Its net effect is combined with the ceramic capacitance when choosing the temperature coefficient of dielectric constant for the ceramic disc. The dielectric increases the current densities on the surface of the plates where the ceramic disc is the dielectric between the conductor plates. This increased current density causes higher loss because of the presence of the dielectric. As such, the Q of the loading capacitance has to be considered not just by the dielectric Q, but also by the conductivity of the plates in contact with or near it. Even if there was no ceramic disc, or if the dielectric losses were zero, the Q would be affected, because the net capacitor Q equals the product of the dielectric Q and the conductor Q divided by their sum, and conductor losses from this higher current density on the capacitor plates will still act to lessen the overall Q of the capacitor. For a simple waveguide cavity filled with a zero loss dielectric, the Q of the cavity is reduced just by the presence of a dielectric in this same manner.[2] There is also a trade-off in selecting the dielectric constant of the material for the loading capacitor; a high dielectric constant gives increased capacitance at the expense of increased current density and thus loss on the plates. A low dielectric constant does not achieve the benefit of reducing the post length. Since it is desirable to reduce the length of the coaxial inner post as short as possible, a common response would be to reduce the thickness of the ceramic disc to increase the capacitance because it allows for the length of the post to be shortened. However, there are two detrimental effects in doing so, the first being a reduction in the Q of the capacitor (reduced volume) and the second being a reduction in the flashover voltage handling. To have high power handling and high enough Q, a thick ceramic is used, namely at least 3 mm, which allows the device to handle at least 100 W.

COMPARISON OF THE CAVITY PERFORMANCE

Figure 5 shows a photograph of a mechanically tuned loaded cavity filter and the actual test data showing its passband performance. The stop band extends to over 1000 MHz, and the filter has a 100 to 400 MHz tuning range. ***Figure 6*** shows a photograph of a mechanically tuned unloaded cavity filter-similar to ones available from

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several filter manufacturers and the actual test data of its passband, extended stop band and tuning range, which is less than 100 MHz.

Figure 7 shows a photograph and the test data of a mechanically tuned diplexer filter, typical of the non-cavity types. Although tunable over an octave, the bandwidths are wide and generally of the order of 1 to 5 percent of the center frequency. This four-section filter does not even provide 20 dB rejection at 5 MHz from the center frequency, compared to the response of the cavity filters, where for similar insertion loss and only a single cavity, nearly 25 dB rejection is achieved.

CONCLUSION

A ceramic-loaded cavity filter does not produce a second passband for a bandwidth many times the center frequency of the filter. This is of great benefit in avoiding responses to out-of-band interference signals or preventing those out-of-band signals from passing through the filter.

The ceramic-loaded cavity filter length is half that of conventional quarter-wavelength cavities. Wide frequency range tunable cavities are available from 30 to 1000 MHz in multi-octave bands, allowing modern communications equipment to be built with fewer numbers of different filters.

The insertion loss of a capacitive-loaded cavity is comparable to that of high Q conventional cavities. Its bandwidth is an order of magnitude narrower than that of a lower Q octave band tunable filter. This is very beneficial for use in direct conversion receivers. The filter and LO synthesizer are tuned to produce a single constant IF directly from the RF avoiding multiple down conversions. This is not even possible in the wider tuned filters, as the bandwidth of those filters is wide enough to allow passage of multiple channels, in which the LO synthesizer is tuned to select a specific channel to down-convert. The interfering image of the desired channel would also be present at the IF. By tuning the narrow band cavity filter and an LO synthesizer to only one RF channel, the undesired image is rejected, eliminating at least one down-conversion stage within the receiver. A ceramic-loaded cavity filter has an excellent temperature stability and high power handling. By suitable selection of cables and coupling probes, notch filters, duplexers, diplexers, combiners, multiple bandpass and bandpass with notch filters are available with this new device. ■

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AN ADAPTIVE WiMAX ANTENNA FOR INDOOR USE

A four-sector switchable WiMAX antenna, for indoor use in the 2.6 and 3.4 GHz frequency bands, is presented. The prototype antenna was designed to provide the highest possible gain in a defined amount of space. Furthermore, the radiation beam is electronically steerable to provide diversity and avoid requiring any action from the user. Given the amount of space, a four-sector antenna was selected. Each sector includes two circular microstrip patches stacked vertically. The microstrip patches are punched out of a metal sheet and use air as a dielectric. A solid-state microwave switch is used to select one of the four sectors. Such a structure assures 360° horizontal signal coverage, with approximately 10 dBi of gain. The antenna design and its measured characteristics are presented.

The Worldwide Interoperability for Microwave Access (WiMAX) system[1] is becoming quite popular in allowing broadband wireless Internet access for private and business users. WiMAX is based on the IEEE 802.16 family of standards.[2] Currently, the first system implementations, based on the 802.16-2004 specifications intended for fixed wireless access, are already being tested and even used. The standard promises high transmission rates achievable by means of different modulation and coding schemes (up to 64-QAM-3/4) and using high gain antennas in a line-of-sight environment, if possible. The first-phase deployment allows fixed access from home or office, with anticipated usage of indoor or outdoor subscriber antennas with quite high gain to attain the high signal levels necessary for high bit-rate transmission. The best choice should be subscriber antennas with a gain of approximately 20 dBi, mounted outside the building and oriented in the direction of the best signal reception. On the other hand, smaller antennas installed inside a building would be more suitable and sufficient enough in a higher cell-density environment. Furthermore, proper reception direction could vary with time according to small-signal channel changes and thus require antenna orientation changes. For these reasons, as a compromise to relatively high antenna gain, two different antenna prototypes meeting the small size requirements, indoor usage and direction adaptability were designed, built and tested for the two frequency bands planned for WiMAX use: 2.5 to 2.7 GHz and 3.3 to 3.6 GHz. These antennas have four beams covering four sectors in the horizontal plane. Each

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THIN CORE Dk AND Df DATA

Core Thickness	Dk 2, 5 and 10 GHz	Df 2, 5 and 10 GHz
0.0025"	2.83	0.0030
0.0030"	3.07	0.0033
0.0040"	2.90	0.0031
0.0050"	3.37	0.0037
0.0050"	2.83	0.0030
0.0060"	3.49	0.0038
0.0060"	3.07	0.0033
0.0066"	2.95	0.0031
0.0080"	2.90	0.0031
0.0100"	3.37	0.0037
0.0120"	3.49	0.0038
0.0133"	3.31	0.0036
0.0140"	3.26	0.0035
0.0166"	3.52	0.0039
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1080	0.0040"	2.90	0.0031
2113	0.0042"	3.29	0.0036
3070	0.0048"	3.29	0.0035
2116	0.0054"	3.26	0.0035
1652	0.0060"	3.46	0.0038
7628	0.0066"	3.49	0.0038

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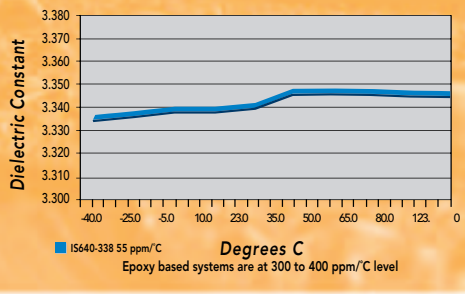

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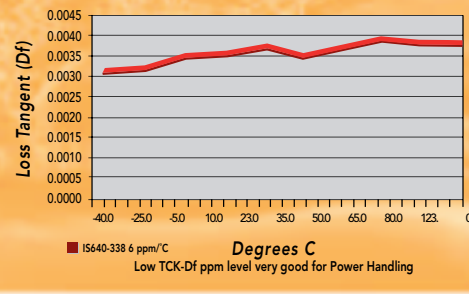

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sector is covered by a vertical broadside array of two circular microstrip patches. The desired sector is selected by a microwave solid-state switch. This solution provides approximately 10 dBi of gain in an arbitrary direction in the horizontal plane and direction diversity at the same time. The vertical polarization of the antenna was selected at all times.

ANTENNA DESIGN

To keep manufacturing costs down, it was decided to keep the antenna design as simple as possible. Microstrip patch antennas allow simple fabrication, impedance matching and polarization selection. A further reduction in manufacturing costs is obtained by punching the required microstrip structures out of a thin metal sheet. Using spacers and air as a dielectric, an improvement of the impedance bandwidth can be obtained at the same time.

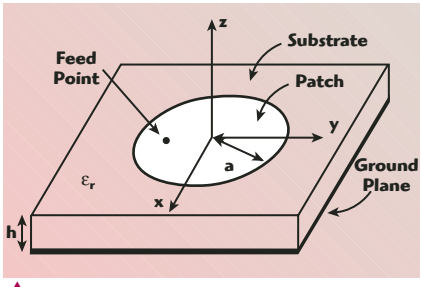

Fig. 1 Circular patch antenna design.

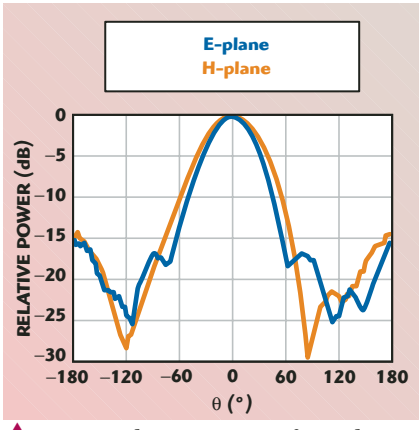

Fig. 2 Radiation patterns of a single circular patch on a square ground plane.

The principles of operation of a circular microstrip patch antenna have been previously published.[3] The basic radiation element consists of a circular metal disk, a so-called patch, spaced from the ground plane by a dielectric, as shown in ***Figure 1***. Such an antenna radiates from the side slot between the patch and ground plane, excited from the z-directed E-field distribution. The feed point is offset from the patch center, determining the antenna impedance. The angular position of the feed point defines the orientation of the field distribution between the patch and ground plane and consequently the orientation of the achieved linear polarization. The antenna resonant frequency depends upon the patch dimensions. For a required resonant frequency f_r of the dominant mode TM_{11}, the patch radius can be approximately expressed as[3]

$$a_e = \frac{1.8412c_0}{2\pi f_r\sqrt{\varepsilon_r}} \quad (1)$$

where a_e is the effective radius, which is slightly larger than the physical radius, a, due to fringing-field effects at the patch edge. The physical radius, a, can be obtained, using iterations from the relation

$$a_e = a\sqrt{1+\frac{2h}{\pi a\varepsilon_r}\left[\ln\left(\frac{\pi a}{2h}\right)+1.7726\right]} \quad (2)$$

Patch antennas are often made, using a microstrip technique, on usually quite thin dielectric substrates of various dielectric constants ($\varepsilon_r > 2$). Higher substrate permittivity results in a narrower impedance bandwidth and lower radiation efficiency.[3] Consequently, the decision was made to design an antenna on an air substrate ($\varepsilon_r \sim 1$) with the patch and ground plane made from a thin brass sheet and separated by a spacer of height h. Standard metal M3 screws were used as spacers in the patch center where the electric field is close to zero. Due to the low dielectric constant of the air, a better radiation efficiency and a wider impedance bandwidth were achieved. The basic design of a single linearly-polarized circular patch on a square ground plane results in quite similar E- and H-plane radiation patterns, as shown in ***Figure 2***, and has a gain of typically 8.5 dBi, which is less than the desired 10 dBi. To achieve a higher gain, the beamwidth was narrowed in the vertical plane (E-plane in the case of vertical polarization). A narrow vertical beamwidth is not critical for the proposed WiMAX network. On the other hand, the horizontal beamwidth should remain the same to cover the desired sector. There are various possibilities to narrow the ra-

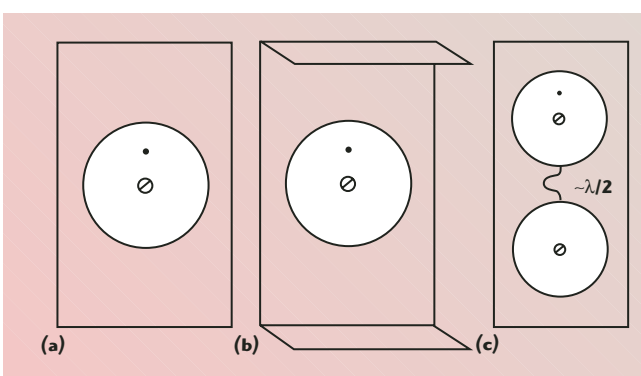

Fig. 3 Various possibilities to narrow the vertical plane radiation pattern.

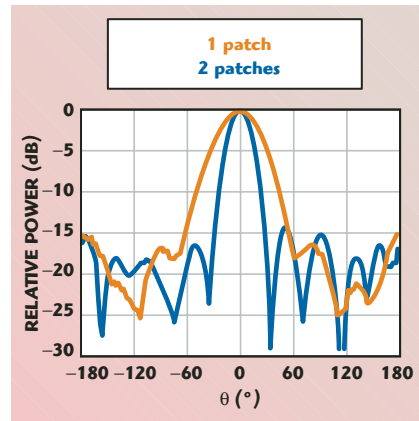

Fig. 4 Comparison of the vertical-plane radiation patterns of a single- and a dual-patch antenna.

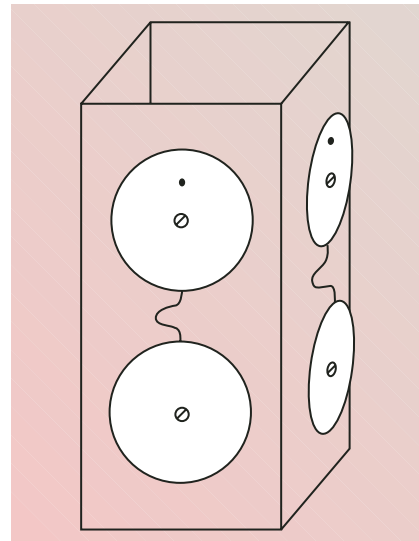

Fig. 5 Design of the four-sector antenna.

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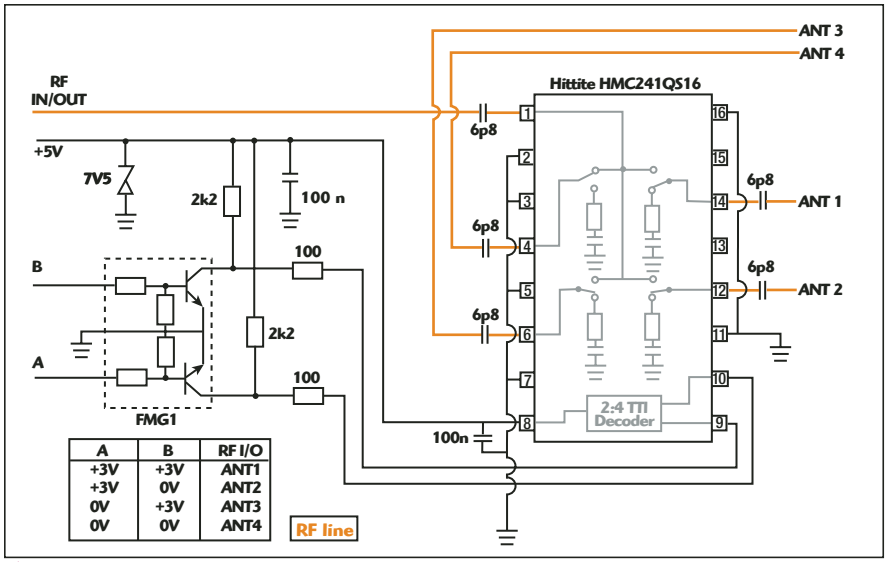

Fig. 6 Electrical circuit diagram of the SP4T switch.

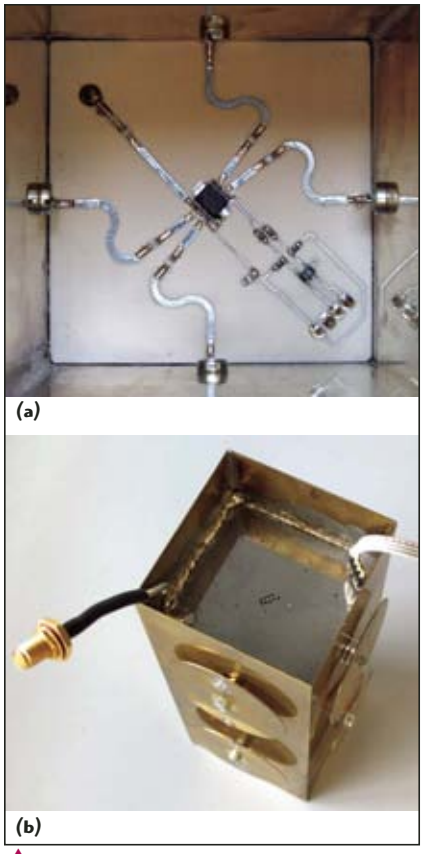

Fig. 7 Microstrip circuit integrated into the antenna; (a) bottom view and (b) top view.

diation pattern in the vertical plane. Three such possibilities are shown in ***Figure 3***: (a) to enlarge the ground plane surface in the vertical direction; (b) to introduce λ/4 flaps on the top and bottom edges of the ground plane; (c) and/or to stack two patches vertically on the same ground plane. The first two solutions did not provide enough gain improvement in the available space. On the other hand, the last solution provides enough gain using a simple series-feed network, connecting the two patches with a λ/2 line. The characteristic impedance of the connecting line is irrelevant due to the λ/2 line-length and does not affect the antenna operation.[4] In the solution adopted, the patches were stacked at a distance of 0.8λ between the patch centers. The vertical-plane radiation pattern of such an array results in a higher antenna gain, up to 12 dBi, as shown in ***Figure 4***. Such an antenna design is convenient for the desired purpose: it has a sufficiently wide radiation pattern in the horizontal plane to cover a wide horizontal range and a moderately high gain on account of the narrower radiation pattern in the vertical plane. The described two-patch array covers one 90° horizontal sector. Four such arrays are used to cover the whole 360° range. The desired sector is selected by a solid-state RF switch. The complete antenna design is shown in ***Figure 5***. Its dimensions were obtained using theoretical calculations first and then final experimental optimization.

SWITCHING CIRCUIT

The described four-sector antenna should allow signal reception and transmission in the most suitable direction without physically turning the antenna. A combining network, including adjustable phase shifters and variable-ratio power splitters, was found to be too complex. A simple and efficient solution is a SP4T switch selecting one of the four two-patch arrays. The same switch also provides direction diversity in the case of a dynamically changing propagation channel. An integrated circuit HMC241QS16 (manufactured by Hittite) was used as a solid-state SP4T switch. The packaged device was installed on a small microstrip board etched on a 19 mil-thick Rogers R4003 laminate. A cheaper version, on FR4 laminate, gave a 0.5 dB higher insertion loss. The microstrip board also carries the DC decoupling capacitors and the logic-level converters for the two control inputs A and B of the solid-state switch. The electrical cir-

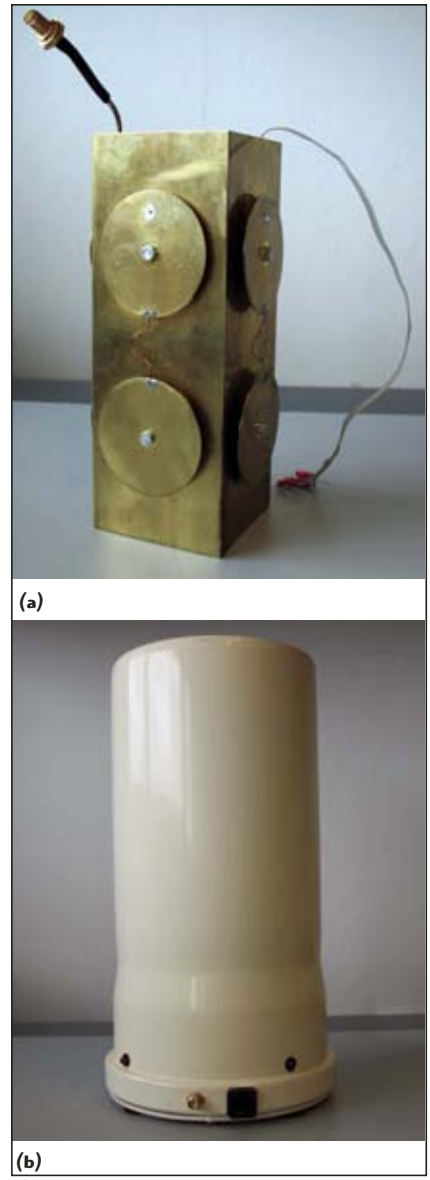

Fig. 8 The final antenna prototype, without (a) and with (b) the radome.

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cuit diagram is shown in ***Figure 6***. The whole board operates from a single supply voltage ranging between +5 and +6 V. The microstrip board fits in the space in the center of the four two-patch arrays so that no additional RF connecting cables are required, as shown in ***Figure 7***. The lengths of the 50 Ω microstrip lines connecting the HMC241QS16 IC to the four two-patch arrays were carefully selected to compensate for both antenna and switch impedance imperfections. Besides the 50 Ω coaxial cable, there are four wires connected to the antenna: the two switch control signals A and B, the switch supply voltage, and ground. The sector-selection logic is not integrated in the antenna; the two control signals A and B are provided by an external circuit. Photographs of the final antenna prototype are shown in ***Figure 8***. As a final product, the antenna is integrated in a plastic housing with an input/output RF connector, a DC connector for the power supply and control voltages and four LEDs, indicating the active antenna sector. The effects of the plastic radome, made from 4 mm thick dielectric with a relative permittivity in the range between 2 and 3, were taken into account in the antenna design.

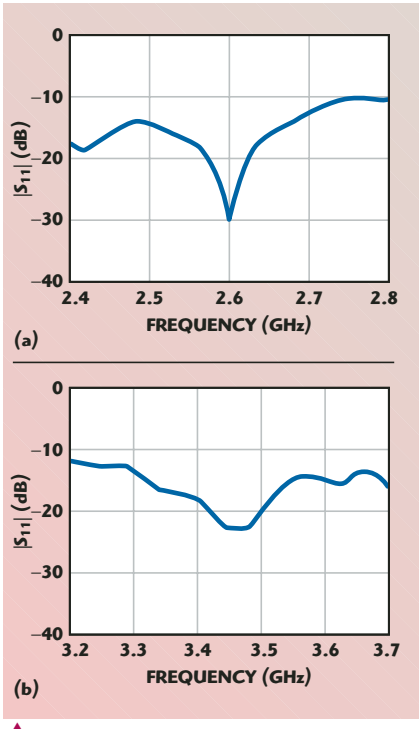

Fig. 9 Typical antenna return loss for 2.6 GHz (a) and 3.45 GHz (b) antennas.

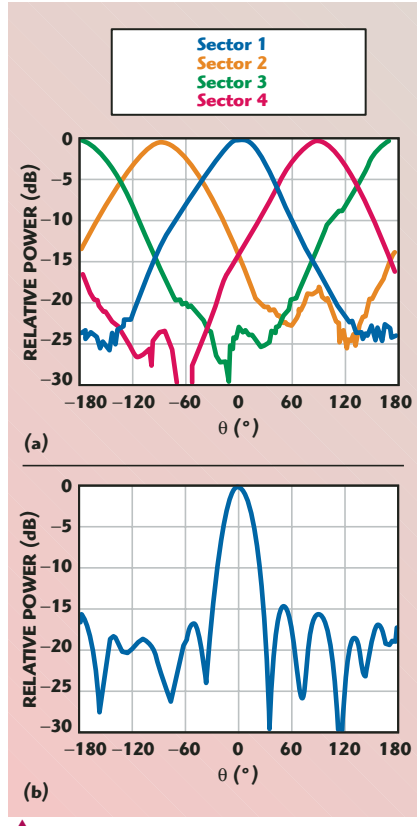

Fig. 10 Radiation patterns at the center frequency in the H- (a) and E-plane (b).

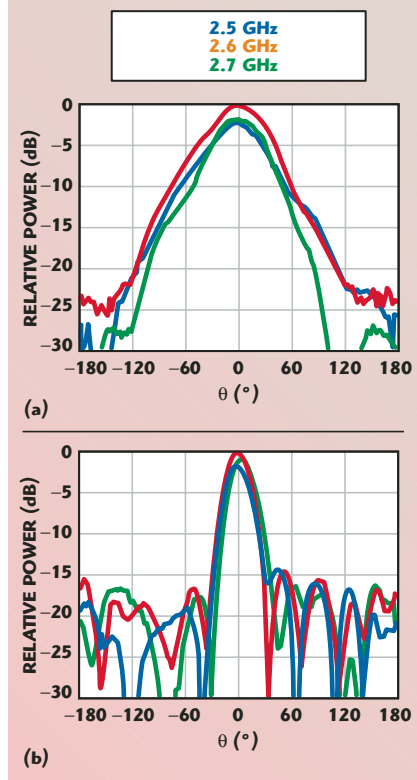

Fig. 11 Radiation patterns at different frequencies in the H- (a) and E-plane (b).

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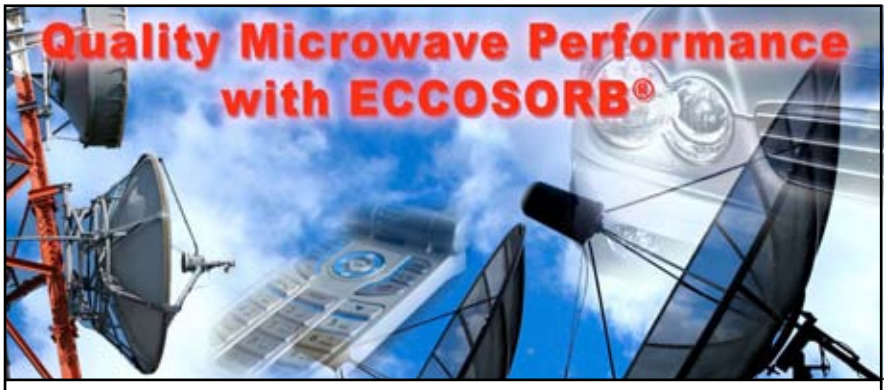
ANTENNA CHARACTERISTICS

The described antenna was fabricated in two different versions, for two different frequency ranges centered at 2.60 and 3.45 GHz. The impedance matching of both fabricated prototypes provided a return loss (S_{11}) better than –12 dB over the entire operating frequency ranges of 2.5 to 2.7 GHz and 3.3 to 3.6 GHz, as shown in ***Figure 9***. The radiation patterns for the 2.6 GHz prototype antenna have been measured. The radiation patterns for all four antenna sectors in the horizontal plane (H-plane) and for a single sector in vertical plane (E-plane), measured at the center frequency, are shown in ***Figure 10***. The 3 dB beamwidth is approximately 30° in the (vertical) E-plane and 65° in the (horizontal) H-plane. At the ±45° sector overlap, the horizontal radiation patterns decrease by approximately 5 dB. The 3.45 GHz prototype patterns are similar and are omitted for brevity. As shown, all two-patch arrays in the group exhibit almost equal radiation patterns, with slight differences due to the manufacturing tolerances. The radiation patterns remain similar over the whole specified frequency range of 2.5 to 2.7 GHz or 3.3 to 3.6 GHz. The frequency dependence of the radiation patterns is shown in ***Figure 11***. The final antenna gains, including radome and switch losses, are 11.5 dBi for the 2.6 GHz version and 9.5 dBi for the 3.45 GHz version, in the direction of maximum radiation. The gain difference, of approximately 2 dB between both versions, can be explained by the higher losses in both the solid-state switch and the microstrip interconnection circuit at the higher frequency.

CONCLUSION

The presented antennas were designed and built as part of the WiMAX subscriber station deployment within the framework of the WiMAX system implementation by the company Telsima. All of the prototypes built met the system requirements: good impedance matching and moderate gain in the 10 dBi range, within the specified dimensions of the radome. The prototypes are also quite inexpensive to fabricate in production volume. Although the design was tested at two frequencies, the antenna can easily be redesigned for other frequency ranges as well. ■



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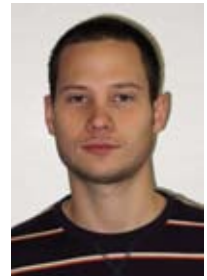

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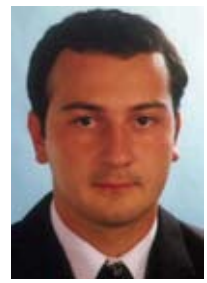

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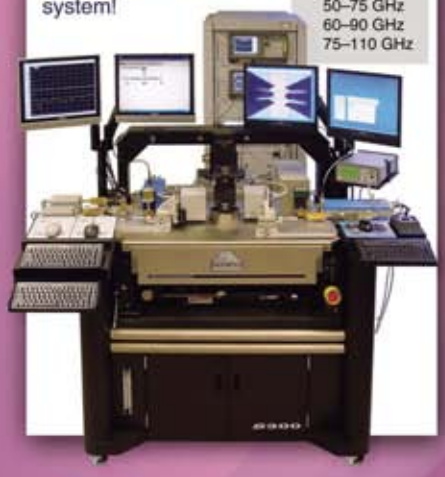

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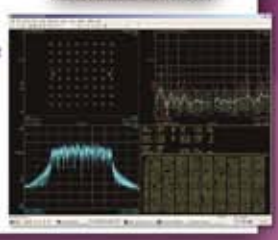

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100 W GaN HEMT MODELING

Recent improvements in GaN HEMT device technology have enabled unprecedented power levels for solid-state amplification. Devices are now capable of exceeding 100 W in a single package.[1] The need for accurate models for these devices has become more apparent as new device technology is being used in many system applications. Unfortunately, device models have not been readily available to circuit designers. In this article, some of the issues uncovered in characterizing and modeling these devices are explored and some guidance is provided for others.

GaN devices now operate at much higher bias conditions than traditional PHEMTs or HBTs, and also dissipate DC power and generate RF power at much higher densities. Due to high RF and DC power levels, it was found that conventional CW device characterization and modeling techniques are no longer adequate. CW S-parameters, for example, are the basis for device model derivation used in empirical models as well as in data-based behavioral models. For empirical model extraction, broadband CW S-parameters are used to extract equivalent circuit models and then to derive bias dependency of intrinsic parameters. For behavioral models, CW S-parameters are stored in a database and used directly for device simulation. However, CW S-parameters are not easily measured for large devices, which cannot be biased safely to regions of RF trajectories under all drive levels and load lines without destroying these devices thermally. In this article, pulsed IV and pulsed S-parameter techniques are used to extract device models at high power levels. It was found that some of the equivalent circuit parameters derived from pulsed S-parameters were very different from those derived from CW S-parameters. This discrepancy between CW and pulsed data was attributed to field-induced traps in the channel, affected by the quiescent bias conditions. For the highest power devices, however, the impedance level made it very difficult to obtain accurate S-parameters. Here, it will be shown that a modified modeling and scaling process can be used where even the improved approach to device model extraction utilizing pulsed IV and pulsed S-parameters[2] is no longer feasible.

An approach is demonstrated to model 100 W GaN HEMT devices, based on measurements of a 30 W device. The four types of devices investigated are commercially available GaN HEMTs from Eudyna Inc. with a total gate periphery of 11.25 (EG3001), 18.0 (EG4501), 27.0 (EG7001) and 36.0 mm (EG9001), respectively. They are capable of nominal output powers of 30, 45, 70 and 90 W, respectively, in the frequency band of DC to 5

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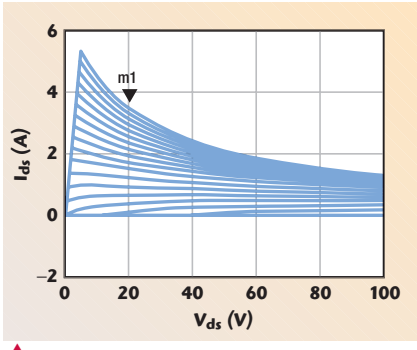
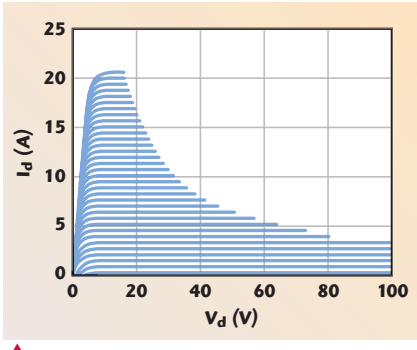
GHz, although much higher saturated powers were obtained from each of them.

The largest device that could be characterized and modeled with acceptable accuracy was tested first. This was an EG3001 (30 W nominal) device. Pulsed IV and S-parameters were used to extract the large-signal model. The extracted model was verified against load-pull data under both single- and two-tone conditions. Using the EG3001 model as the basis, the models for a family of GaN HEMT devices were scaled up, with the largest device (EG9001) demonstrating a saturated power up to 110 W at 2 GHz. The device simulation using these models agreed well with load-pull data under single- and two-tone drives.



▲ *Fig. 1 Modeled IV curves with self-heating effects.*



▲ *Fig. 2 Pulsed IV curves for an EG9001 device (100 W class).*

MESFET MODEL FOR HIGH VOLTAGE DEVICES

A new model has been developed to accommodate the characteristics of high voltage GaN HEMT devices. Improvements were made to adequately represent the transition near the pinch-off region at high drain voltages. Excellent agreement is now shown with pulsed IV data up to 100 V. The model can also be applied to lower voltage devices such as standard PHEMTs or enhancement mode devices with equally good results. The model is compliant with the charge conservation rule at gate and drain terminals.[3] These improvements eliminated "non-physical currents," resulting in much more accurate simulation of the device performance. When the device is scaled to a larger periphery device, the channel temperature may not be the same as the original device. Thermal resistance for the scaled device may not share the same scaling factor due to the spreading of the heat flow. This may result in a higher channel temperature for the larger devices. Self-heating equations were implemented in the model, to enable adjustments to the change in the channel temperature. ***Figure 1*** shows simulated IV characteristics with self-heating effects.

CHARACTERIZATION FOR MODEL EXTRACTION

A family of four types of GaN HEMTs from Eudyna was characterized and modeled. The total gate periphery of these devices was 11.25 (EG3001), 18 (EG4501), 27 (EG7001) and 36 mm (EG9001), respectively. Each tested device was mounted on a chip carrier, which was then mounted in a test fixture. The key data needed for model extraction include pulsed IV, S-parameters and load pull. There are challenges and limitations to this data acquisition due to high power conditions.

Pulsed IV

Pulsed IV data was taken to the limits of device thermal capability with a quiescent drain voltage of 50 V. With the largest device (EG9001), pulsed peak voltage of up to 100 V and current of up to 22 A have been tested. ***Figure 2*** shows pulsed IV data of an EG9001 device, measured with Auriga's AU4100 series pulsed

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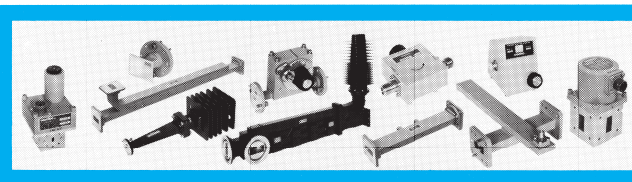

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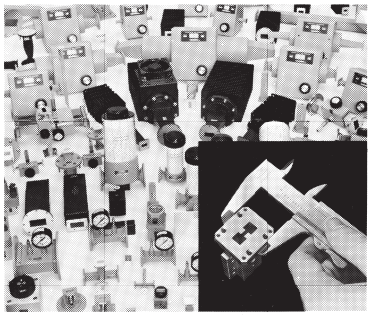

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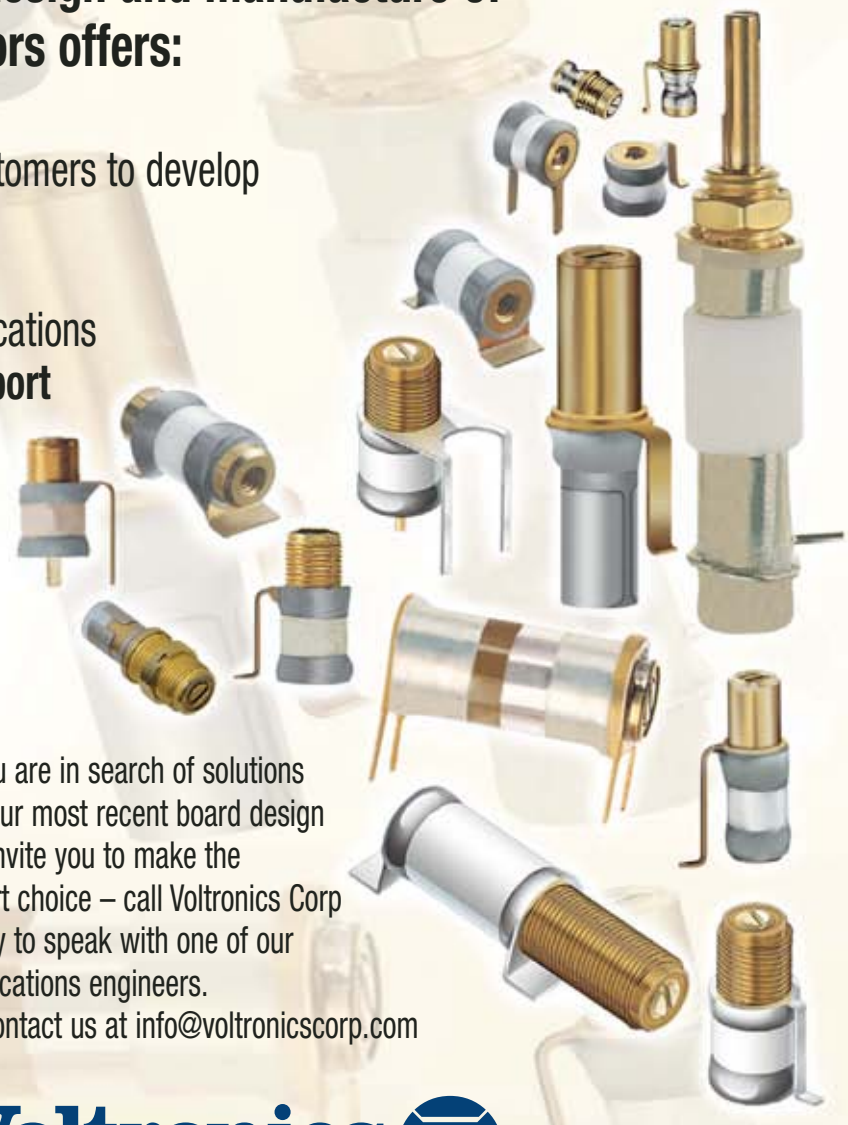

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IV system.[4] The pulsed IV conditions were a pulse width of 2 µs and a duty cycle of 0.3 percent. The quiescent bias point was 50 V and 200 mA. V_g was varied between –15 and +2 V, in steps of 0.1 V.

S-parameters

Due to high power dissipation, these devices can only be safely DC biased at conditions near either the pinch-off or in the low drain bias voltage region. To extract parameters throughout the IV plane as covered by the RF trajectory under all power and load impedance conditions, pulsed bias becomes necessary to limit the instantaneous power consumption and minimize the temperature rise during the measurement. In the pulsed S-parameter measurement system (see ***Figure 3***), an Agilent pulsed network analyzer (PNA) was connected to the device to measure S-parameters while the device was pulse-biased using an Auriga pulsed IV system through a set of bias tees. A complete set of S-parameters at 150 peak bias conditions for an EG3001 was measured and the equivalent circuit parameters were derived for all bias points.

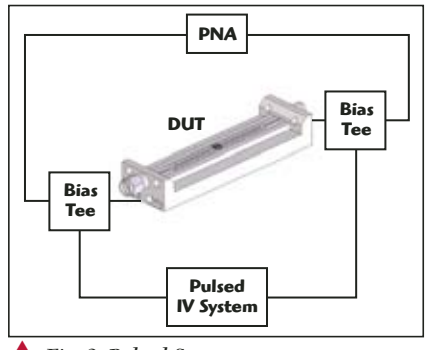

Fig. 3 Pulsed S-parameter measurement system.

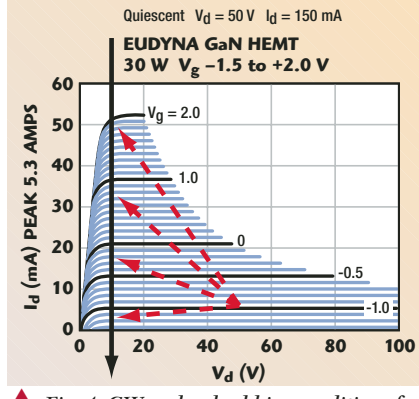

Fig. 4 CW and pulsed bias conditions for S-parameter measurement.

S-parameter Dependency on Quiescent Bias Condition

The bias condition has a strong influence on the performance of GaN HEMT devices, not only due to the thermal effect but also due to the traps populated in the channel. The electrical stress brought about by the bias voltages changes the channel and modulates the performance. This was observed in the pulsed IV data, when

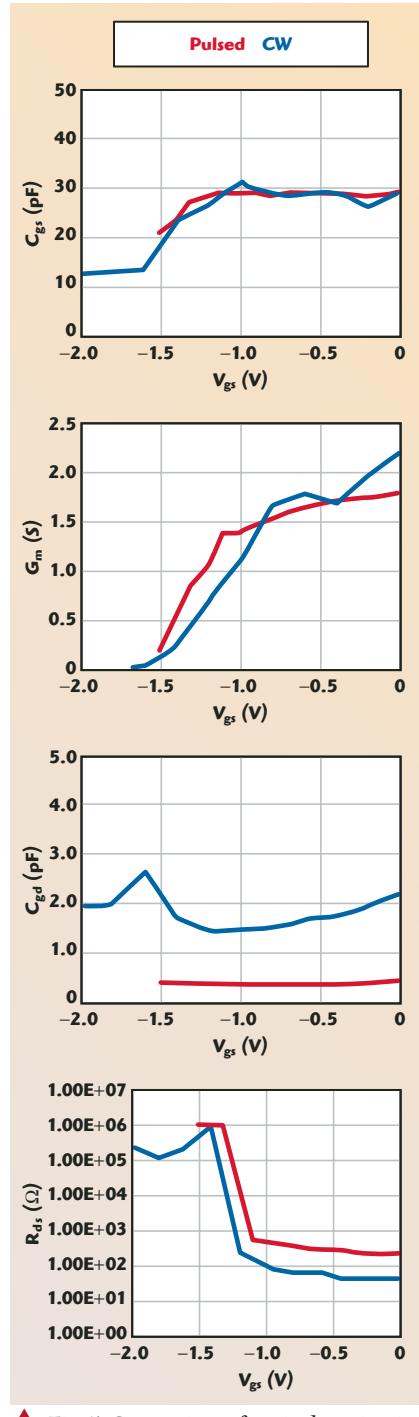

Fig. 5 Comparison of equivalent circuit parameters under CW bias and pulsed bias.

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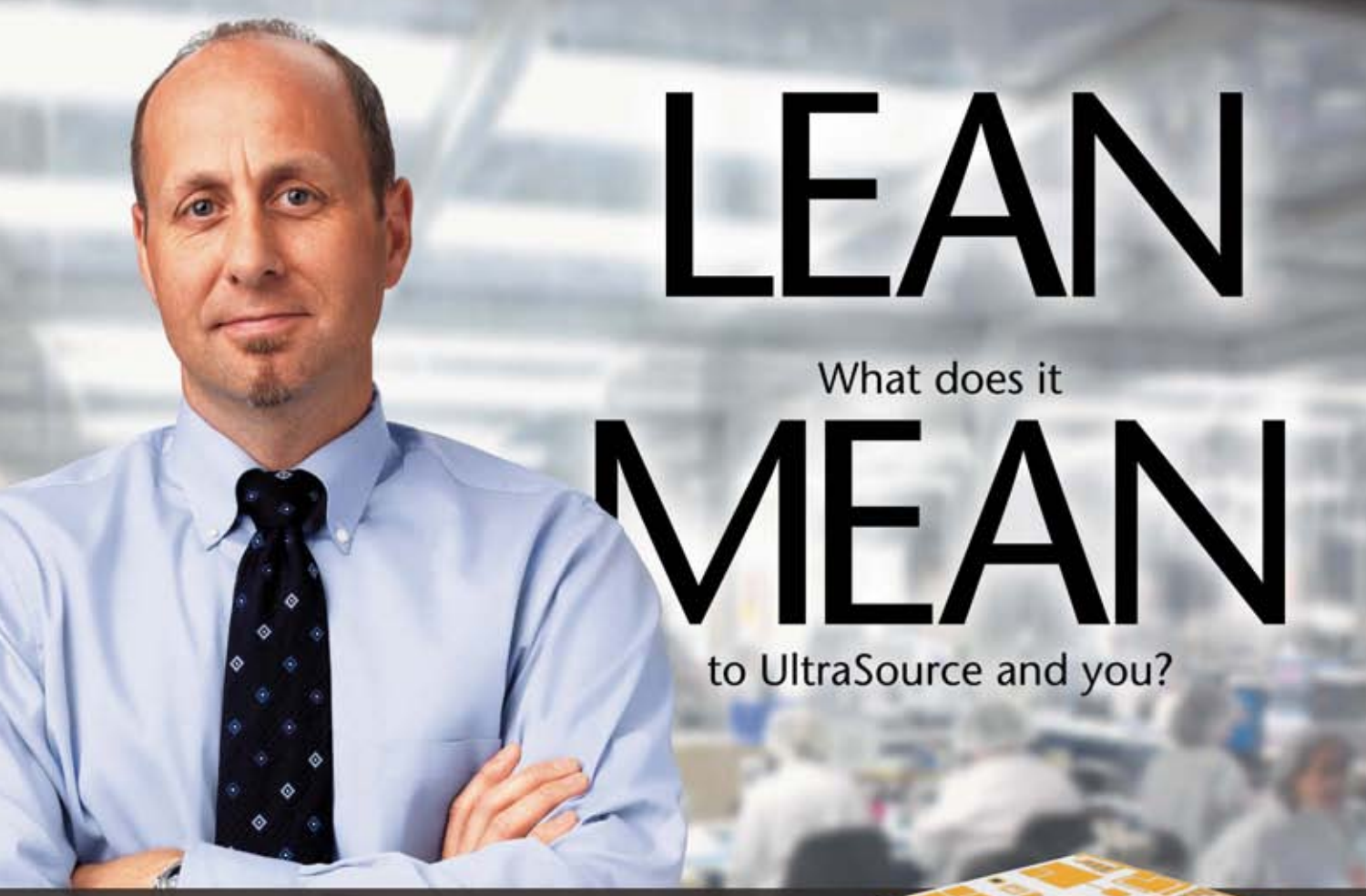

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the quiescent bias point was varied. To test the bias dependency of S-parameters, two sets of S-parameters are measured, CW and pulse, as shown in ***Figure 4***. The CW set was chosen such that the device would be capable of thermally surviving the test. The CW set of S-parameters was taken with a 10 V DC bias on the drain and varying the gate voltage from pinch-off to V_{gs} = 0 V, shown by the black line in the figure. The pulsed set was measured at the same instantaneous bias points as those in the CW test but with a quiescent bias condition fixed at 50 V_{ds}, as shown by red arrows. Therefore, both data sets had the S-parameters taken at the same instantaneous bias point, with the only difference being that the pulsed data was quiescently biased at 50 V and the CW data was quiescently biased at the measured point (10 V). From the measured S-parameters, equivalent circuit models were derived and some intrinsic component values are compared in ***Figure 5***. Parameters such as C_{gs}, G_m and C_{ds} were found to be similar in both CW and pulsed conditions. However, C_{gd} and R_{ds} were found to be very different. This is because the difference in the quiescent bias conditions in these measurements (50 V in the pulsed measurement and 10 V in the CW measurement) is affecting the charge distribution in the channel. This charge distribution, induced by the traps populated in the channel, has a slow time constant and is only affected by the quiescent bias condition. This shows the importance of pulsed S-parameter measurement and the limitation of CW S-parameters.

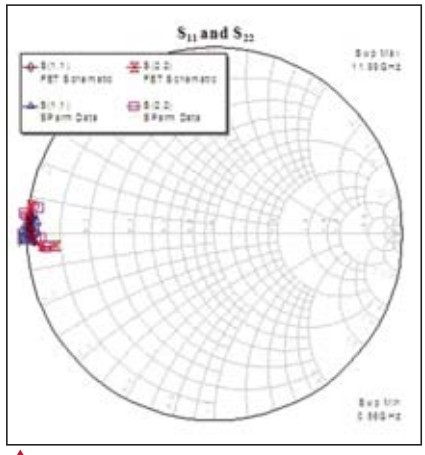

Fig. 6 Pulsed S-parameters of EG9001 device (100 W class).

Limitation of S-parameter Measurements

For model extraction, low frequency data is used to determine the output conductance, transconductance and other parameters. As the size of the device increases, the conductance and capacitance also grow, resulting in very low device impedance. The narrow frequency band of high current bias tees used to pulse-bias the device also makes it very difficult to measure low impedance levels at low frequencies. ***Figure 6*** shows an example of pulsed S-parameters of an EG9001 (the largest in the family) GaN HEMT, the low end of the frequency band being limited at 0.5 GHz by the high current bias tee. As can be seen, the impedance is too low and the data does not have sufficient resolution to derive an accurate equivalent circuit.

Load Pull

The extracted large-signal model was verified against load-pull data. However, load-pull measurement of low impedance devices is as difficult as measuring S-parameters. The advantage of load pull compared to S-parameters is that load pull is usually performed at discrete frequency points while S-parameters are over a wide band from the lowest frequency point possible. For load-pull measurements, therefore, pre-matching circuits can be built for the frequency of interest directly at the input and output ports of the device, eliminating losses from long line effects or tuners. The pre-matched load-pull fixture used for EG9001 model extraction is shown in ***Figure 7***. A quarter-wave impedance transformer is built on a low loss Duroid board at 2 GHz. The pre-match circuits are characterized and their S-parameter blocks are derived for use in the simulation circuits.

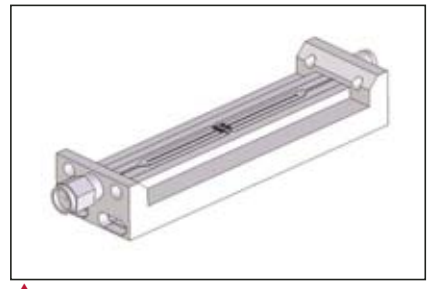

Fig. 7 Pre-matching fixture for load-pull measurements.

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MODELING OF EG3001

An EG3001 (the smallest in the family with total gate periphery of 11.25 mm) was modeled based on pulsed IV and pulsed S-parameter data that was taken over a 0 to 100 V_{ds} pulsed bias with a quiescent bias point at 50 V_{ds}. The voltage dependency of these parameters is implemented in the Auriga MESFET large-signal model for high voltage devices discussed previously. The pulsed IV data is also modeled and implemented. The completed model is used to simulate small-signal and load-pull data. ***Figure 8*** shows the simulated S-parameters at the operating bias point (50 V, 150 mA), compared to the pulsed S-parameter data. The comparison was made at a few other bias points, all resulting in good agreement. ***Figure 9*** shows the single-tone and ***Figure 10*** the two-tone intermodulation comparisons between the data and simulated results. Note that the device delivered a saturated power of 50 W, which was in good agreement with the simulated results. Agreements for gain, efficiency as well as for IM3 and IM5 were excellent.

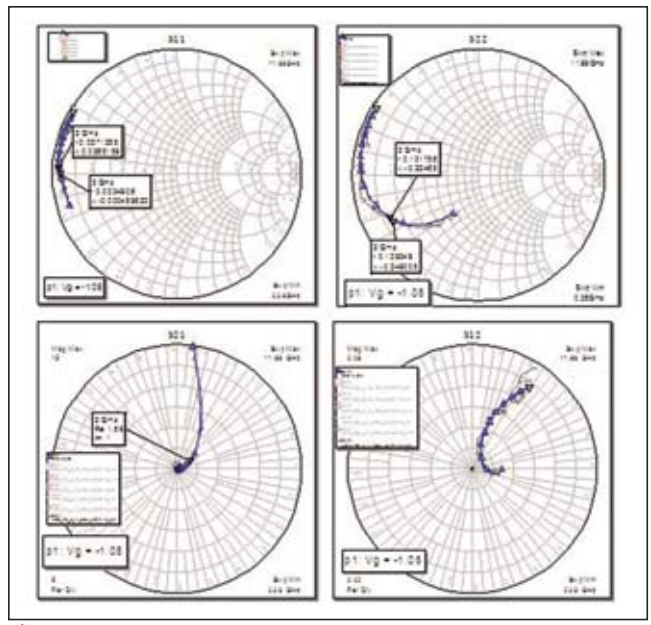

Fig. 8 EG3001 model 60 V 256 mA –1.11 V_g(D)/–1.05 V_g(M).

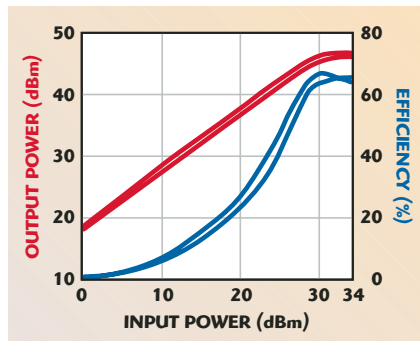

Fig. 9 EG3001 load-pull single-tone results compared with simulation (2 GHz, V_g = –1.08).

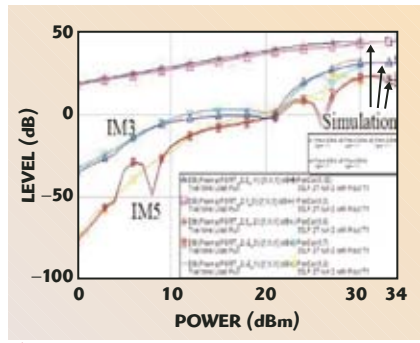

Fig. 10 EG3001 two-tone intermodulation results compared with simulation.

MODELING OF EG4501, EG7001 AND EG9001

The devices EG4501, 7001 and 9001 are from the same family of devices as EG3001 with added cells to increase the output power, EG9001 being the largest with total gate periphery of 36 mm. As previously discussed, the model extraction from S-parameter data was not practical for these devices due to the resolution limitation of measured S-parameters. Large-signal models for all of these devices were derived from scaling the EG3001 model by the gate periphery ratio, 1.6, 2.4 and 3.6, respectively. All device parameters were scaled, except for the gate and drain inductances L_g and L_d, which were derived from matching the high frequency behavior of S-parameters. ***Figures 11*** and ***12*** show an example of scaling applied to the largest device, EG9001. Single-tone and two-tone intermodulation data and simulated results are compared. Note that the device delivered a saturated power of 110 W, which was in good agreement

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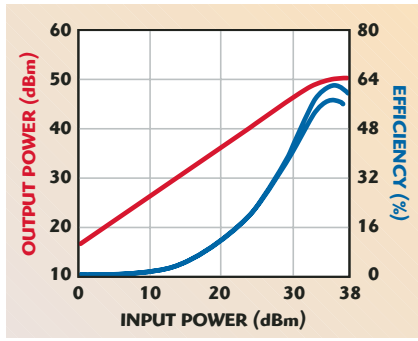
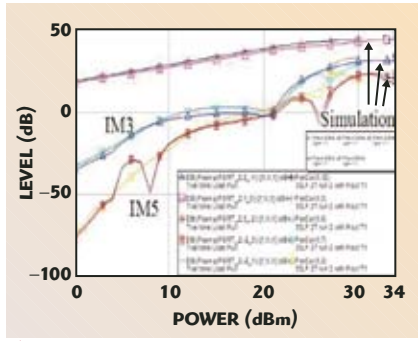


▲ *Fig. 11 Single-tone 100 W device performance compared to simulated results.*



▲ *Fig. 12 Two-tone intermodulation performance of a 100 W device compared to simulated results.*

with the simulated results. Agreement on its gain and efficiency, as well as IM3 and IM5 was also good over wide input power levels. The measured and simulated power (110 W) of EG9001 was less than the scaled power level expected from EG3001, which delivered 50 W. When the pre-matching fixture elements were replaced by ideal lossless tuners in the simulation, the output power from the device increased by 1.5 dB, which agreed with the expected output power from a scaled device. This implies that the losses in the fixture contributed a loss of 1.5 dB in output power. The fixture loss becomes more critical for a device that presents very low impedance to the circuit.

CONCLUSION

The family of GaN HEMT devices, with output powers ranging from 50 to 110 W, was modeled successfully. The 50 W device (EG3001) model was extracted using pulsed IV and pulsed S-parameter data. Equivalent circuit parameters extracted from pulsed S-parameters revealed a strong bias dependency of these parameters, and demonstrated the importance of pulsed S-parameter measurement for model development. The EG3001 model was scaled in order to derive device models of larger devices up to EG9001 with power levels of 110 W. The model validity was verified by single- and two-tone load-pull measurements at 2 GHz. The scaling capability provides a successful approach to deriving models for 100 W level devices. This combined modeling and scaling approach provides the designer with a powerful and efficient tool. ■

ACKNOWLEDGMENT

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Yusuke Tajima *received his BS and PhD degrees in electronics engineering from Tokyo University in 1970 and 1980, respectively. He continued his research and development work at Toshiba Central Laboratories in Japan and then at Raytheon Research Division, which he joined in 1979. In 2000, he became the general manager of ACCO USA, responsible for the US operation of ACCO France. Since 2004, he has been the director of modeling and design for Auriga Measurement Systems LLC.*

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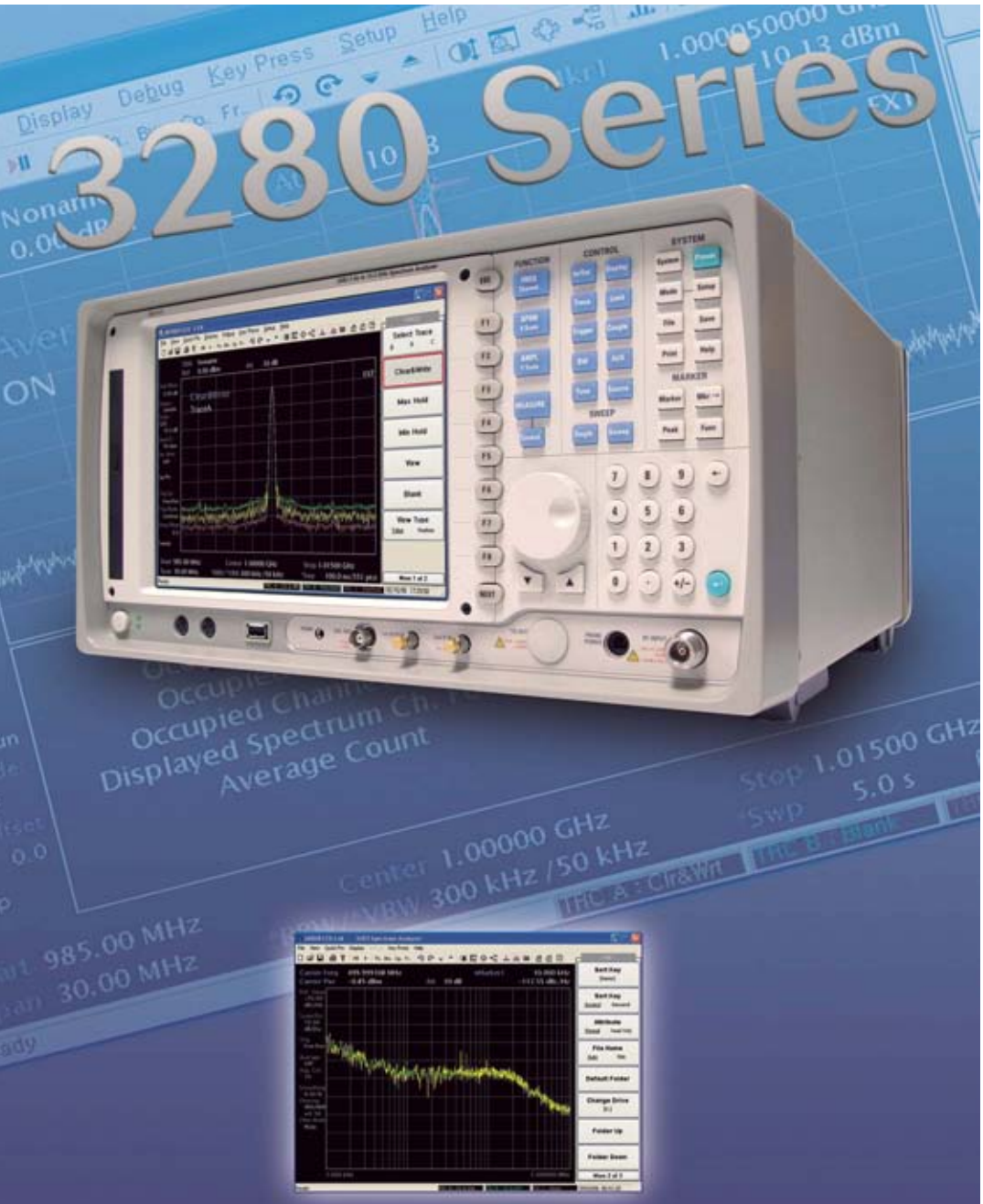

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AN ADAPTIVE BASEBAND DIGITAL PREDISTORTION SYSTEM FOR AN RF POWER AMPLIFIER

In this article, a baseband digital predistortion (DPD) radio frequency (RF) power amplifier (PA), based on the complex gain compensation and adaptive algorithm, is investigated. First, the nonlinear characters of the power amplifier are described. Next, based on the nonlinear model of the power amplifier, the mechanism and algorithm of the digital baseband predistortion are presented. A complete DPD system, including a digital board for implementing the DPD algorithm and an RF board with a sample PA, is then developed. Finally, the performance of the DPD system is tested and experimental results are obtained. Significant improvement of linearity can be observed when different kinds of signals are applied to the system.

With the rapid growth of modern wireless communication technologies and markets, higher spectrum efficiency is required for higher data rates and larger capacity. As a result, high order digital modulations with high peak-to-average ratio are usually adopted to meet these requirements. Therefore, the dynamic range and linearity of the high power RF amplifier are of great importance. To meet these requirements, many linearization techniques have been developed, among which the baseband digital predistortion is the newest and most promising.[1–3] This article focuses on the algorithm and the implementation of the DPD system.

CHARACTERISTICS OF THE POWER AMPLIFIER

Generally, the nonlinearity of a power amplifier can be characterized by the AM-AM and the AM-PM distortions. The AM-AM distortion occurs as the gain varies when the input power level changes, while the AM-PM occurs when the phase shifts with a change in the input power level.[4,5] The AM-AM and AM-PM distortions are illustrated in

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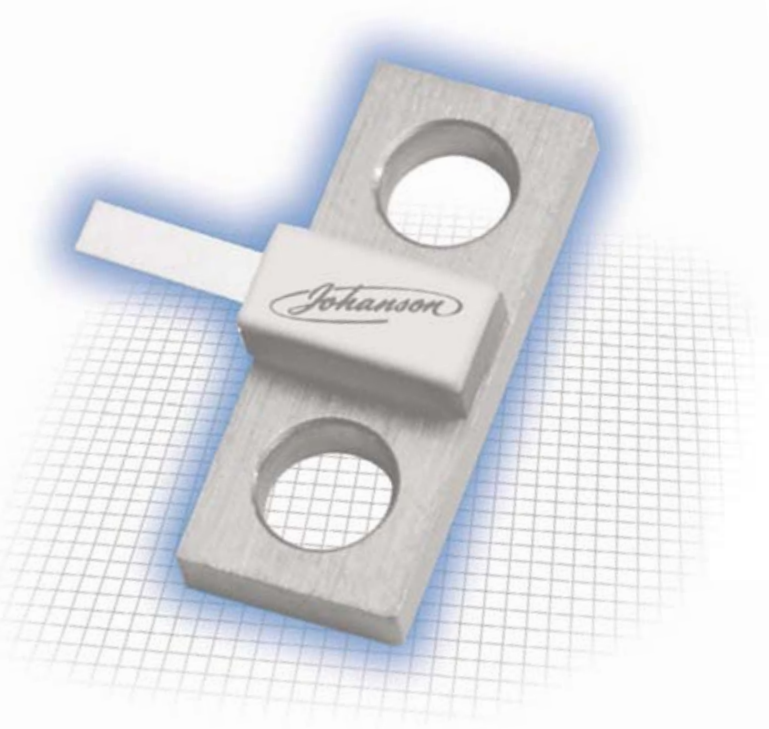

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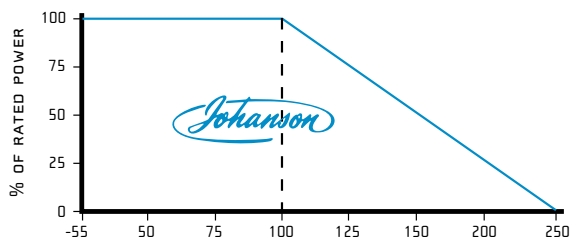

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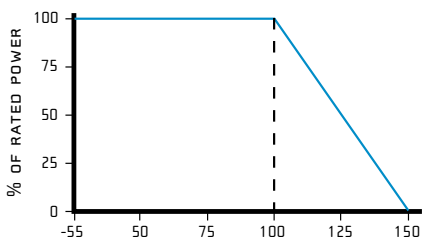

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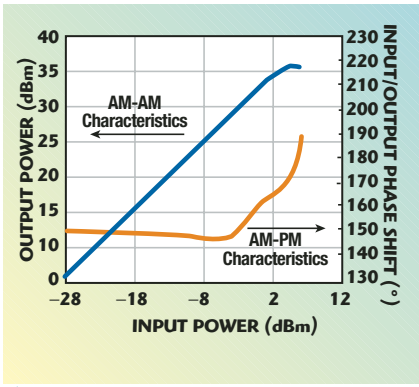
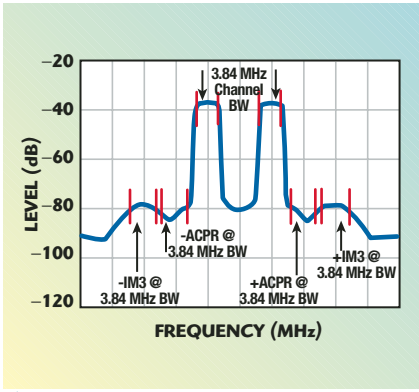
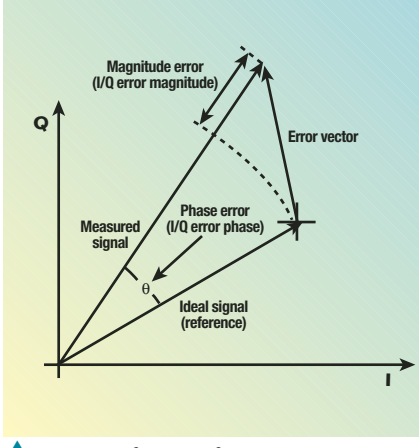


▲ *Fig. 1 Examples of AM-AM and AM-PM distortions.*



▲ *Fig. 2 Two-carrier WCDMA ACPR.*



▲ *Fig. 3 Definition of error vector magnitude.*

Figure 1. In modern communication systems, the adjacent channel power ratio (ACPR) is commonly used to characterize the performance of power amplifiers. ***Figure 2*** shows an example of ACPR. Another important RF power amplifier specification is the error vector magnitude (EVM), which is a common modulation quality metric and is widely used in digital communication systems, as shown in ***Figure 3***.

BASEBAND DIGITAL PREDISTORTION SYSTEM

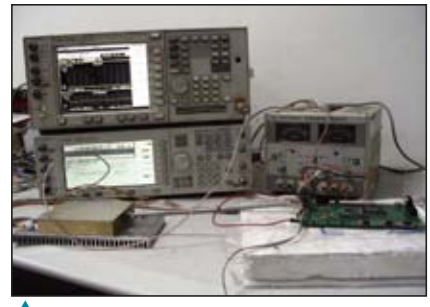
The nonlinear distortion of the RF power amplifier can be reduced or corrected through linearization techniques, such as the feedback method, the feedforward method, the RF predistortion method, the baseband digital predistortion method, etc. Each linearization method has its advantages and limitations. Among these methods, the baseband digital predistortion (DPD) technique, with the support of modern digital techniques, can be applied for many kinds of power amplifiers and different kinds of modulated signals. The DPD follows the trend of digitalization and thus will have great potential in the future. The basic idea of baseband predistortion is to adjust the baseband signal before the modulator and the power amplifier, so that the linearity of the entire system is improved. A simplified block diagram of the entire system, including the PA, ADCs, DACs, modulator and the demodulator, is shown in ***Figure 4***, where F ($|V_i|$) is the complex predistortion function of the DPD, while G ($|V_p|$) is the complex gain of the PA and the modulator. When the input signal, V_i, is applied to the DPD, the predistorted signal Vp is obtained. The predistorted signal V_p is then sent to the modulator and the PA, and the PA output signal is V_{out}. A portion of V_{out} is coupled out and demodulated to the feedback baseband signal V_f. The relationship between V_i and V_{out} is

$$V_{out} = V_P G(|V_P|) = V_i F(|V_i|) G[|V_i F(|Vi|)|] \quad (1)$$

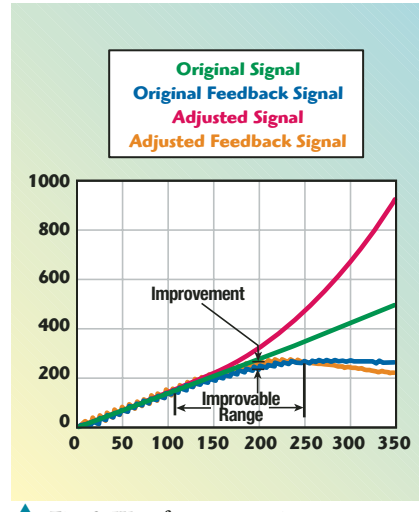
Since only a very small amount of output power is coupled to the downconverter and the demodulator, it can be assumed that the feedback baseband signal V_f is linearly proportional to the PA output V_{out}

$$V_f \propto V_{out} \quad (2)$$

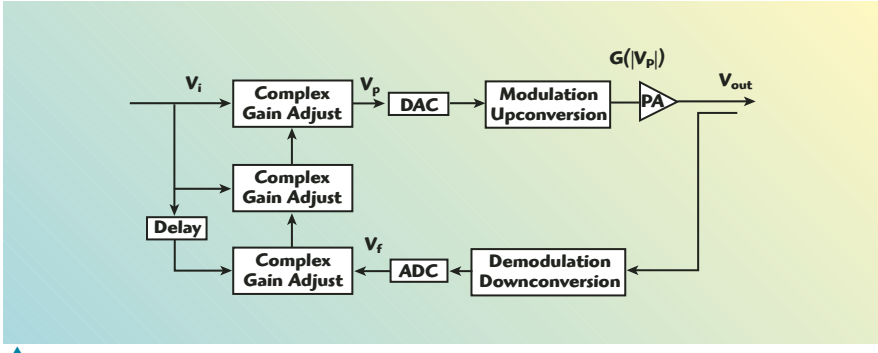
If the predistortion function F is properly chosen, the product of F and G will be a constant k. Thus, the cascade of the DPD, the modulator and the PA will be an ideal linear transmitting system. The complex predistortion function F is indexed according to the magnitude of the input complex signal. When a baseband signal is applied to the input of the system, an address is generated, with which the corresponding complex coefficient is obtained. This look-up table (LUT) method is a useful digital



▲ *Fig. 5 The DPD system.*



▲ *Fig. 6 Waveform comparison.*



▲ *Fig. 4 Baseband digital predistortion system.*

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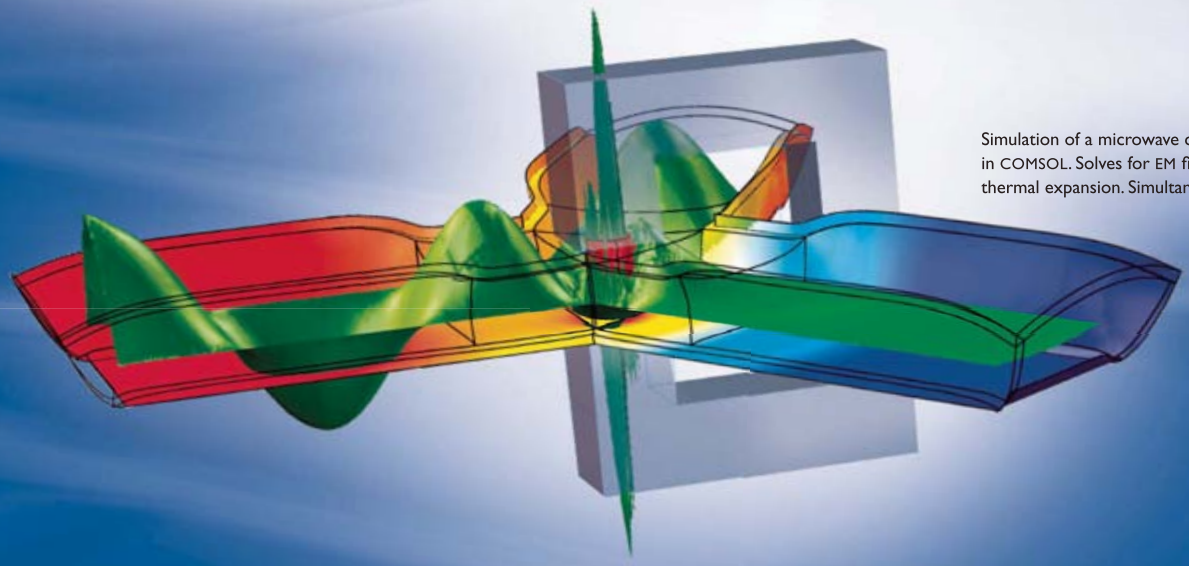

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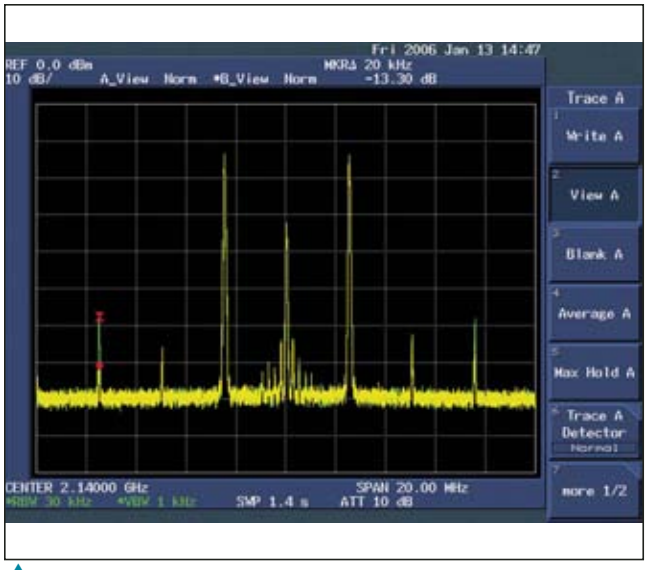

Fig. 7 Two-tone signal spectrum.

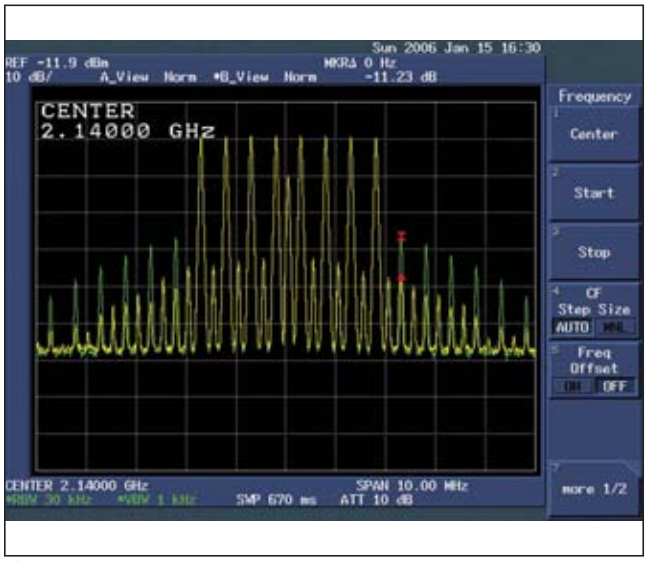

Fig. 8 Eight-tone signal spectrum.

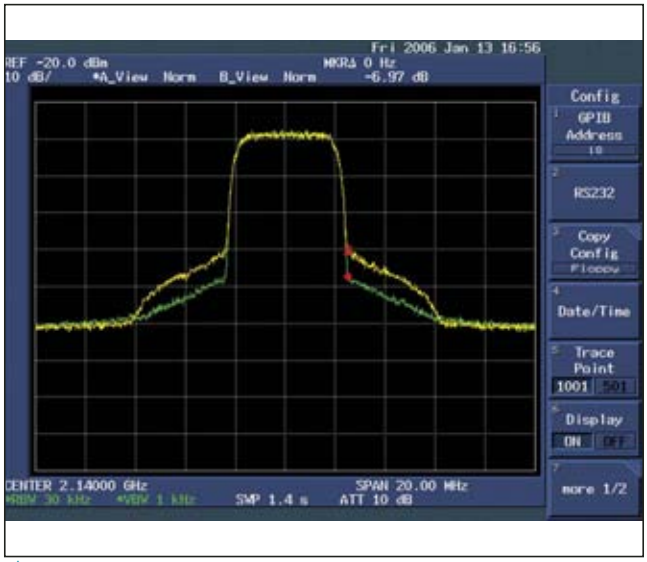

Fig. 9 WCDMA signal spectrum.

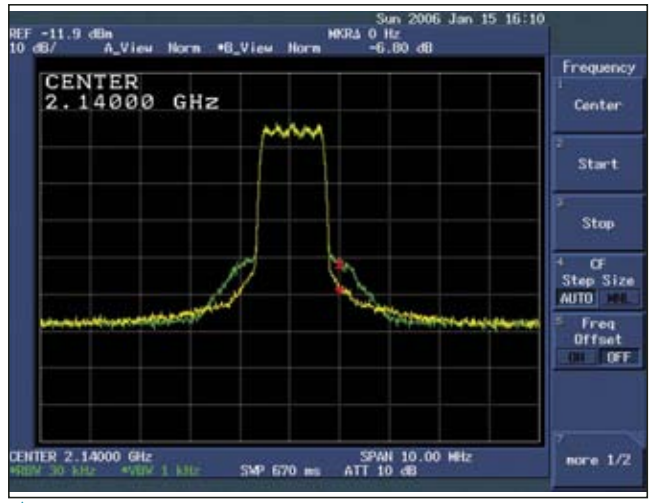

Fig. 10 cdma2000 signal spectrum.

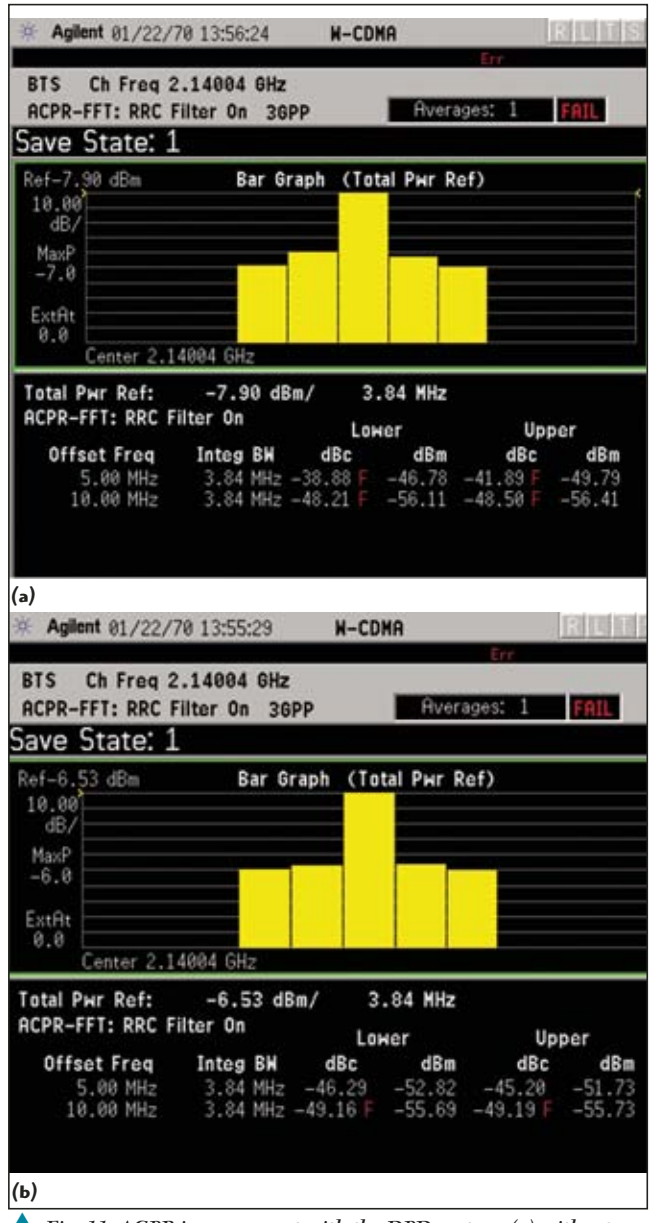

Fig. 11 ACPR improvement with the DPD system; (a) without and (b) with DPD.

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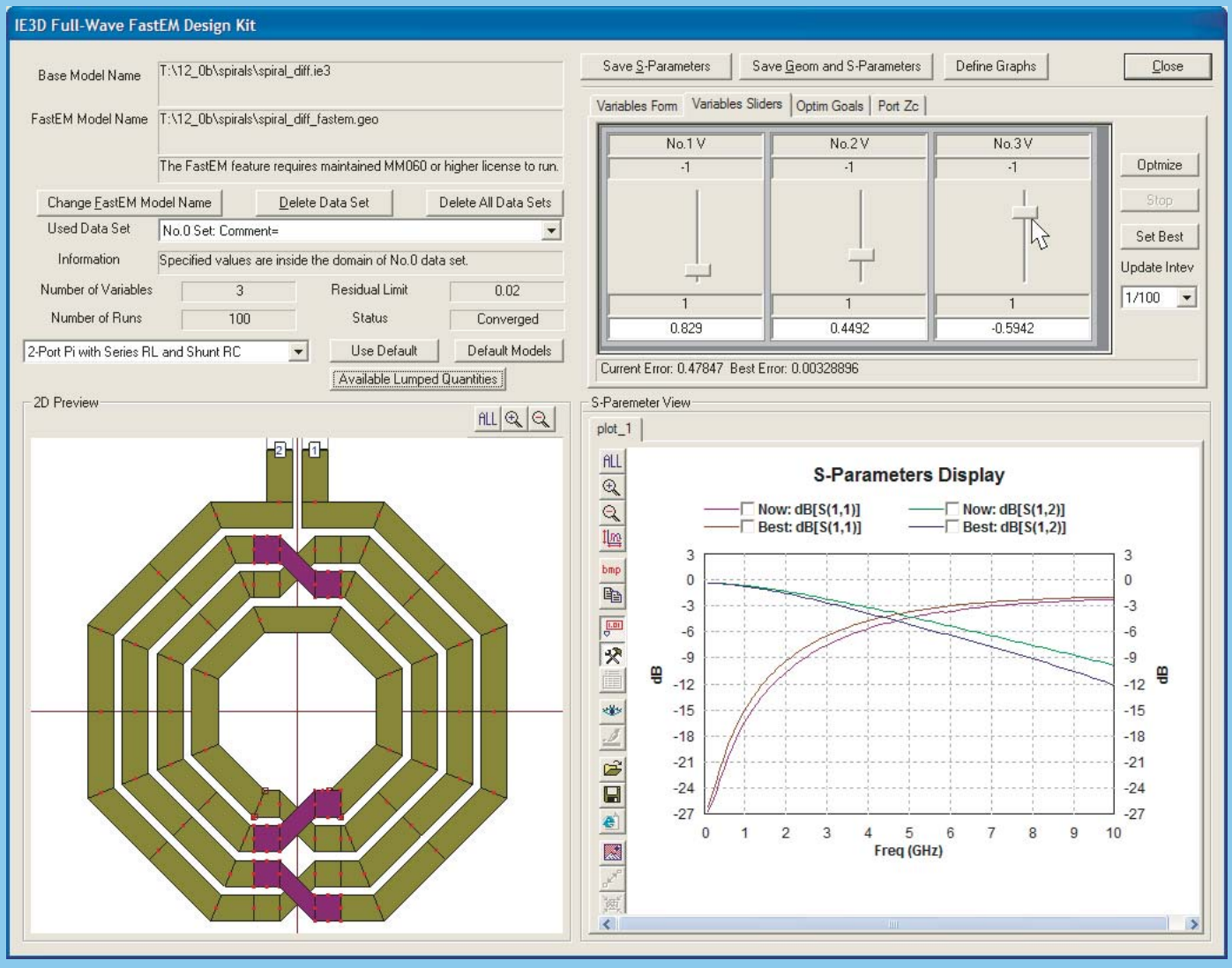

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predistortion method. The complex coefficients are generated according to the nonlinear model of the power amplifier. The nonlinear model can be abstracted with an adaptive algorithm and the iteration procedure. First, a known training signal is sent to the complex gain adjustment module, and is then modulated and upconverted to an RF signal. The digital complex feedback signal is obtained after the power amplifier, down-converter, demodulator and DACs. Second, the digital feedback signal is synchronized with the input training signal by calculating the correlation between the input signal and the feedback signal. Finally, using the adaptive algorithm and the interpolation polynomial method, the complex gain coefficients are obtained.

Several iterations are generally needed to obtain the optimal coefficients, so that the relationship between the initial training signal and the final feedback signal satisfies

$$V_f = CV_i \quad (3)$$

where

C = complex constant

Since the transmitter input signal is known, any type of signal can be regarded as the training signal, and because the algorithm described above is independent of the type of input signal, the complex coefficients can be updated adaptively.

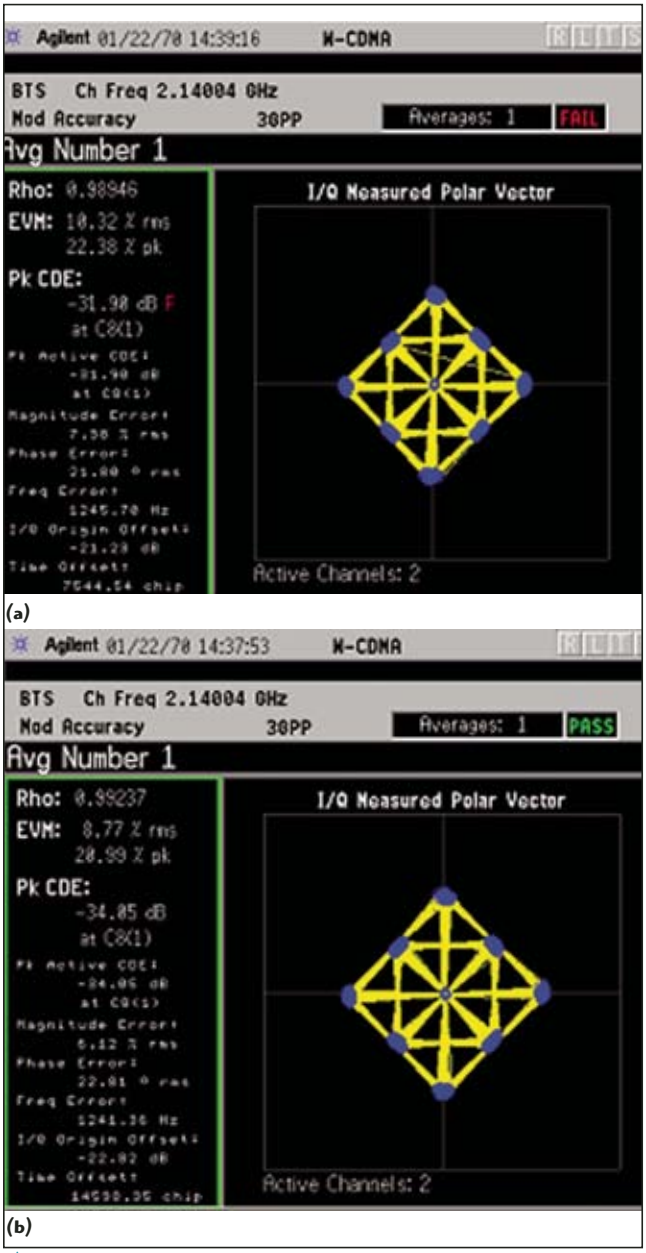
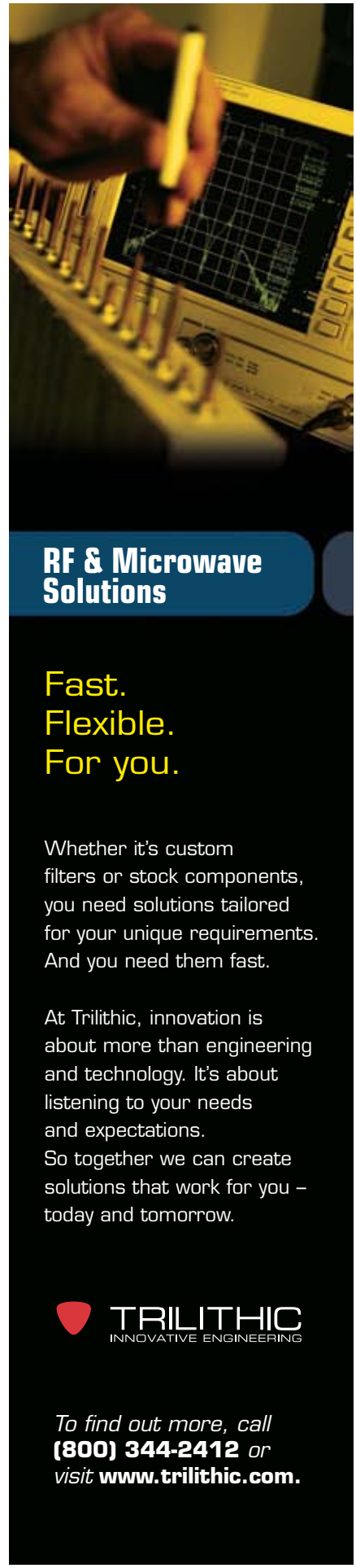


Fig. 12 EVM improvement with the DPD system; (a) without and (b) with DPD.

HARDWARE AND SOFTWARE REALIZATION

According to the method previously described, an adaptive DPD system based on the complex LUT was developed. The system is composed of two parts: the baseband digital board and the RF board. The baseband board includes a field-programmable gate array (FPGA) for algorithm implementation, a micro control unit, the ADC for obtaining the digital feedback signal, and the DAC for obtaining the analog distorted baseband signal. The RF board includes an RF modulator, an RF demodulator, an RF synthesizer and a PA. The RF modulator and the PA form a complete RF transmitter. The RF demodulator is used for



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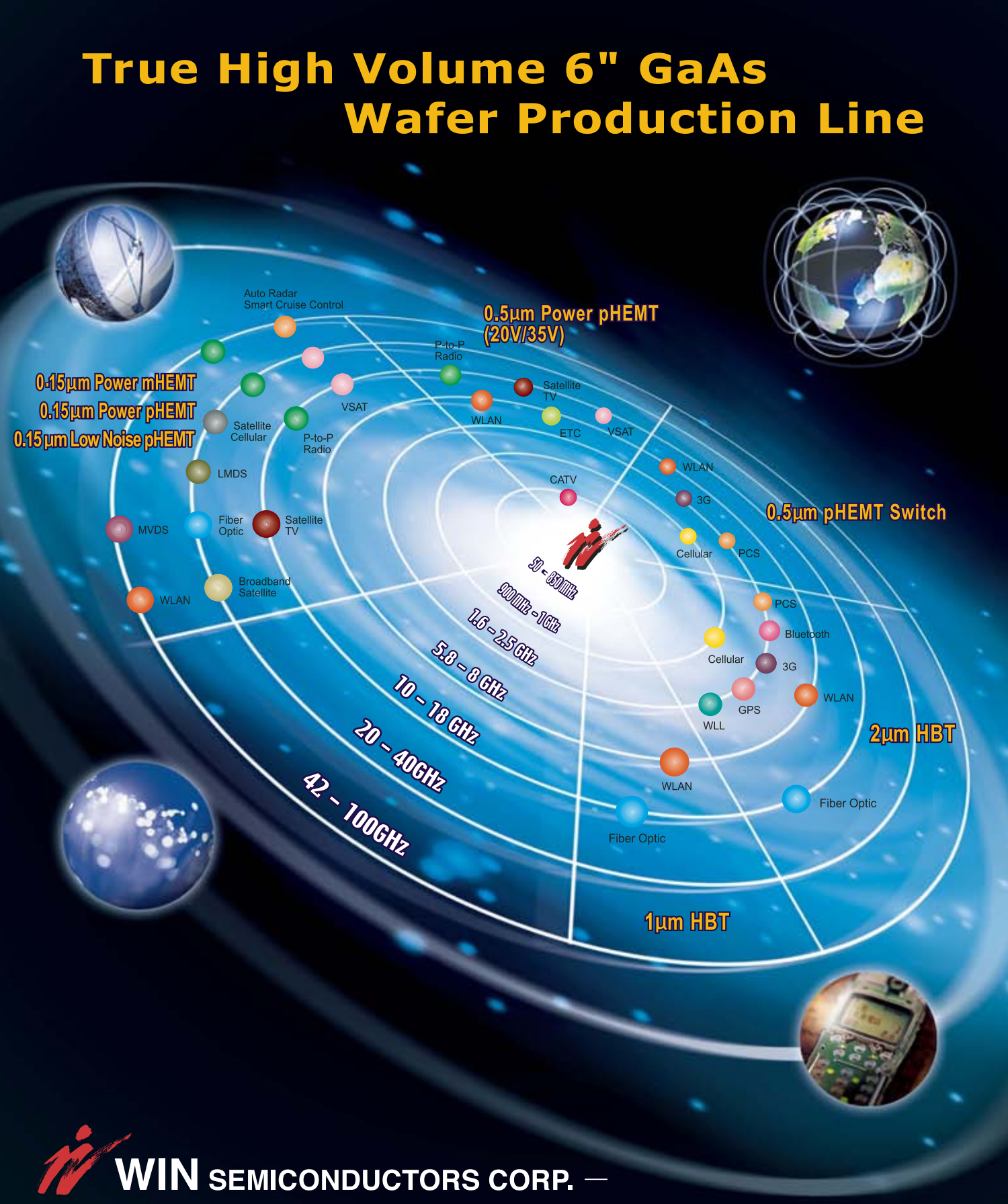

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the adaptive algorithm. ***Figure 5*** shows a photograph of the DPD system.

EXPERIMENTAL TESTS

Experimental tests were carried out to verify the adaptive DPD system. For simplicity and clarity, a ramp signal was used as the training signal to estimate the nonlinear model of the transmitter. After several iterations, optimal LUT coefficients were obtained. ***Figure 6*** shows the comparison among the original training signal, and the feedback signal before and after the DPD. The original signal (the green line) is a ramp signal. Ideally, the feedback signal should also be a ramp signal. Due to the nonlinearity of the power amplifier, the original feedback signal (the blue line) is compressed. According to the original feedback signal, the output of the DPD is adjusted to the pink line. After adjustment, the improved feedback signal (the yellow line) is obtained. Clearly, the adjusted feedback signal is closer to the ideal feedback signal.

The improvement of the DPD system can be observed both in the spectral domain and in the time domain. With the DPD system, the IMD products can be reduced significantly, as shown in ***Figures 7*** and ***8***. The IMD improvement for a two-tone signal is approximately 13 dB, and for an eight-tone signal is approximately 11 dB. For digital modulation signals, the spectral regrowth can be improved greatly, as shown in ***Figures 9*** and ***10***. The reduction is 6.9 and 6.8 dB for a WCDMA signal and a cdma2000 signal, respectively. The ACPR performance is therefore improved significantly, as shown in ***Figure 11***. The improvement in ACPR is more than 6 dB.

It is important to notice that this DPD system has a wideband performance and can reduce the power level on both the adjacent and the alternate channels. The DPD system does adjust both the magnitude and phase of the baseband signal in the time domain, so that the modulation accuracy or the EVM performance can also be improved, as shown in ***Figure 12***. The EVM of a WCDMA signal is reduced from 10.32 to 8.77 percent and the peak code domain error (Pk CDE) is reduced from –31.9 to –34.05 dB.

CONCLUSION

A baseband digital predistortion system has been developed with a complex LUT, which is updated by the adaptive algorithm based on the nonlinear PA model. According to the experimental results, with the DPD system, obvious improvements are achieved both in the spectral domain and in the time domain for several kinds of input signals. ■

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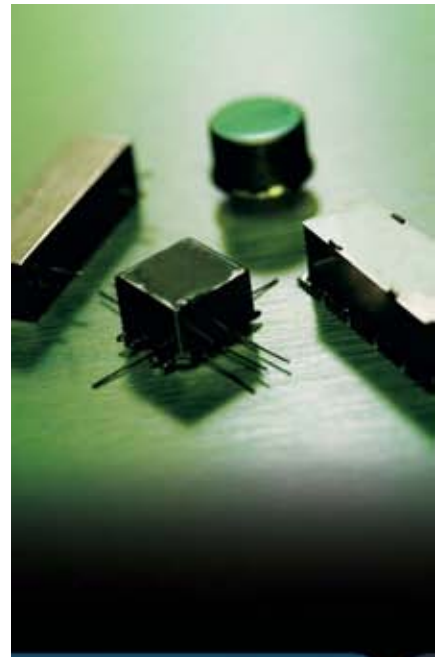

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EFFICIENCY COMPARISON OF A DIGITALLY PREDISTORTED AND A FEED-FORWARD LINEARIZED DOHERTY AMPLIFIER WITH CREST FACTOR REDUCTION

This article provides a direct performance comparison between a Doherty digital predistorted (DPD) amplifier and a Doherty feed-forward linearized power amplifier (DFFLPA) under various crest factor reduction levels. Based on experimental results at an ACLR of –45 dBc, the DPD amplifier achieved a power efficiency of 24.5, 27 and 29 percent, compared to the DFFLPA's 17, 19.5 and 21 percent for peak-to-average power ratios of 9.8, 6.5 and 5.5 dB, respectively.

The increasing importance of spectral efficiency in mobile communication services, such as wideband code division multiple access (WCDMA) and orthogonal frequency division multiplexing (OFDM), has resulted in a fluctuating signal envelope. The large peak-to-average power ratio (PAPR) of these modulations requires base station power amplifiers to have a high linearity. The conventional feed-forward linear power amplifier (FFLPA) has been widely utilized due to its excellent linearity performance in spite of poor power efficiency. In order to overcome this poor efficiency, digital baseband predistortion (PD) has been successfully demonstrated due to the recent advances in digital signal processors.[1] Moreover, a Doherty power amplifier (DPA), along with a PAPR reduction technique, can be applied to these linearization systems to maximize the power efficiency. It is therefore desirable to compare the

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MSPD1012	2 - 12	50 - 500	E50 / E50SM, H50*
MSPD2018	12 - 22	100 - 500	E50 / E50SM, H50*

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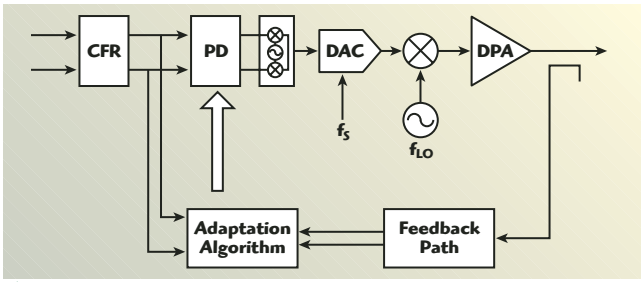

Fig. 1 Block diagram of a Doherty digital predistortion linearization system with CFR.

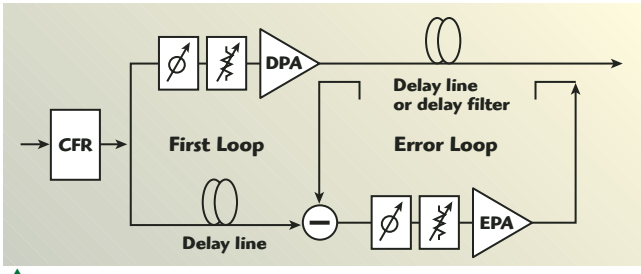

Fig. 2 Block diagram of a Doherty feed-forward linearization system with CFR.

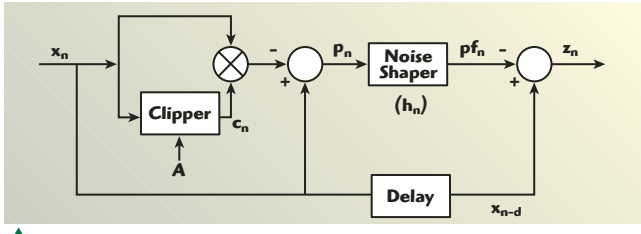

Fig. 3 Block diagram of the CFR.

TABLE I

CFR PERFORMANCE FOR TWO WCDMA CARRIERS

RMS EVM (%)	0	7.01	11.8
Before CFR (dB)	9.8	–	–
After CFR (dB)	–	6.5	5.5

performance of a Doherty PD (DPD) with a Doherty FFLPA (DFFLPA) with respect to efficiency and adjacent channel leakage ratio (ACLR). It is also valuable to show the enhanced power efficiency performance of both systems when using crest factor reduction (CFR).

In this article, the measured efficiencies of power amplifiers, using the DPD technique, DPD with CFR, DFFLPA and DFFLPA with CFR, are presented. Two-carrier WCDMA signals were generated with PAPRs of 5.5, 6.5 and 9.8 dB. The power efficiency is compared at a fixed ACLR on all systems using a 300 W peak-envelope-power (PEP) Doherty amplifier.

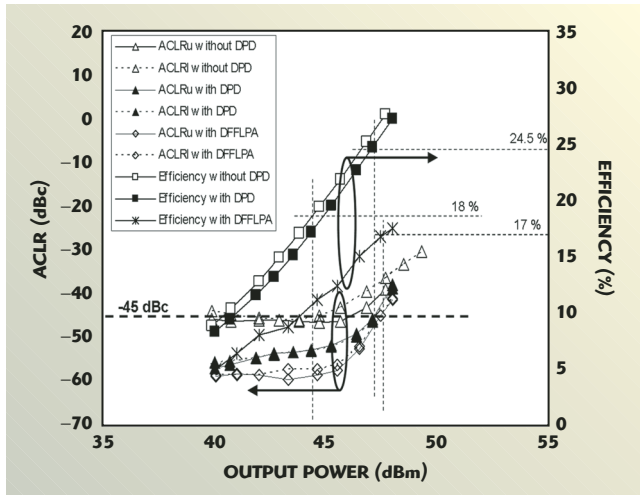

Fig. 4 Experimental results using a 9.8 dB PAPR signal.

OVERVIEW OF THE LINEARIZATION SYSTEMS

The block diagram of the well-known DPD system with an embedded CFR technique is shown in ***Figure 1***. The baseband digital complex input signal is passed through the CFR block so as to reduce the signal's PAPR. This PAPR suppressed signal is digitally predistorted in order to precompensate for nonlinear distortions of the DPA. The feedback path is required to extract the predistortion parameters and adapt these parameters for variations in temperature, aging and voltage changes. ***Figure 2*** illustrates a conventional feed-forward system using the DPA with CFR. The PAPR reduced signal is split into two branches. The upper branch drives the DPA and the lower branch is the reference for extracting distortions, the so-called error signal. This error signal is amplitude-controlled, phase-shifted, amplified by the error power amplifier (EPA) and finally combined with the main DPA signal so as to eliminate any distortions. The CFR block in both figures is based on generating peak cancellation pulses.

CREST FACTOR REDUCTION

The block diagram of the applied PAPR reduction architecture is shown in ***Figure 3***. The clipper output, c_n, can be expressed as $A/|x_n|$ if $|x_n| > A$ or 1 if $|x_n| \le A$, where A is the clipping threshold level and the peak cancellation pulse p_n is defined as

$$p_n = x_n - x_n c_n \quad (1)$$

Therefore, the PAPR suppressed signal z_n is described by

$$Z_n = x_{n-d} - p_n * h_n \quad (2)$$

where x_{n-d}, * and h_n denote the delayed input signal, the convolution operator and the impulse response of the low pass filter (LPF), respectively.

For multi-carrier WCDMA applications, the peak cancellation pulse should be frequency translated to the baseband, filtered, frequency translated back and combined. This is because out-of-band emissions are residing between the different carriers and cannot be filtered out by a single low pass filter (LPF), as opposed to the single carrier application, which employs only one finite impulse response (FIR) filter. In order to reach the targeted PAPR, an iterative method has been proposed that requires several stages.[2] Therefore, a scaling factor, α, is applied after the noise shaper so as to reduce the number of stages required. α can be determined using $\max(|p_n|)/\max(|pf_n|)$.[3]

Table 1 summarizes the compression effects of the CFR technique with respect to various allowable error vector magnitudes (EVM) using two carriers of a WCDMA Test Model 1 (TM1). It should be mentioned that the ACLR was fixed to less than –45 dBc.

EXPERIMENTAL RESULTS

Two carriers of a WCDMA TM1 signal with 64 dedicated physical channels (DPCH) are used in the

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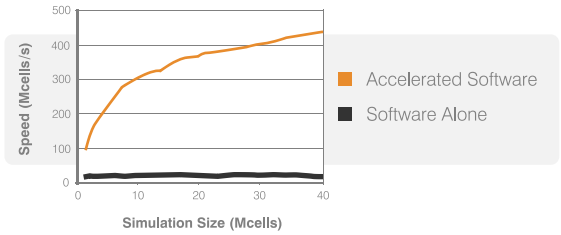

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measurements. The average 30 W DFFLPA has been demonstrated to increase the power efficiency by 2.2 percent compared to the conventional class AB FFLPA.[4] In addition, a linearity optimized DPA has been demonstrated with an improved ACLR.[5] The test bench for the DPD consists of a personal computer for digital signal processing (DSP), an electronic signal generator (Agilent E4438C), a 300 W PEP DPA and a vector signal analyzer (Agilent VSA89641A) for capturing the feedback signals. The predistortion algorithm applied here is based on a memory polynomial architecture (fifth order and three memory terms) using indirect learning.[6] The CFR is processed in the personal computer (MATLAB) in order to generate different PAPRs, namely, 9.8 (no CFR), 6.5 and 5.5 dB. As for the DFFLPA, it has 60 dB of gain at 2140 MHz. ***Figure 4*** shows the measured results of ACLR, output power and efficiency for a 9.8 dB PAPR input signal. At an ACLR of –45 dBc, the efficiency is improved to 24.5 percent using PD. A 10 W power consumption for the DSP-based memory polynomial implementation[7] is included. The DFFLPA achieved an efficiency of 17

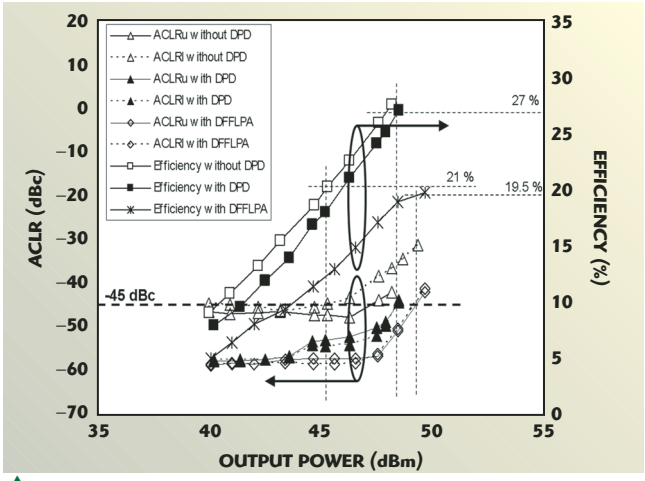

Fig. 5 Experimental results using a 6.5 dB PAPR signal.

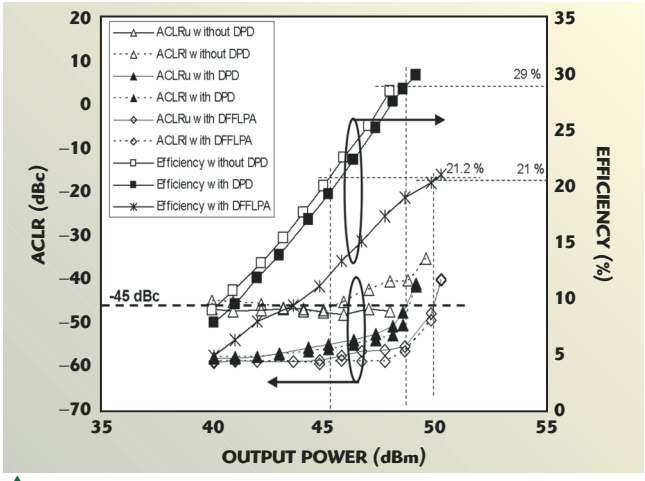

Fig. 6 Experimental results using a 5.5 dB PAPR signal.

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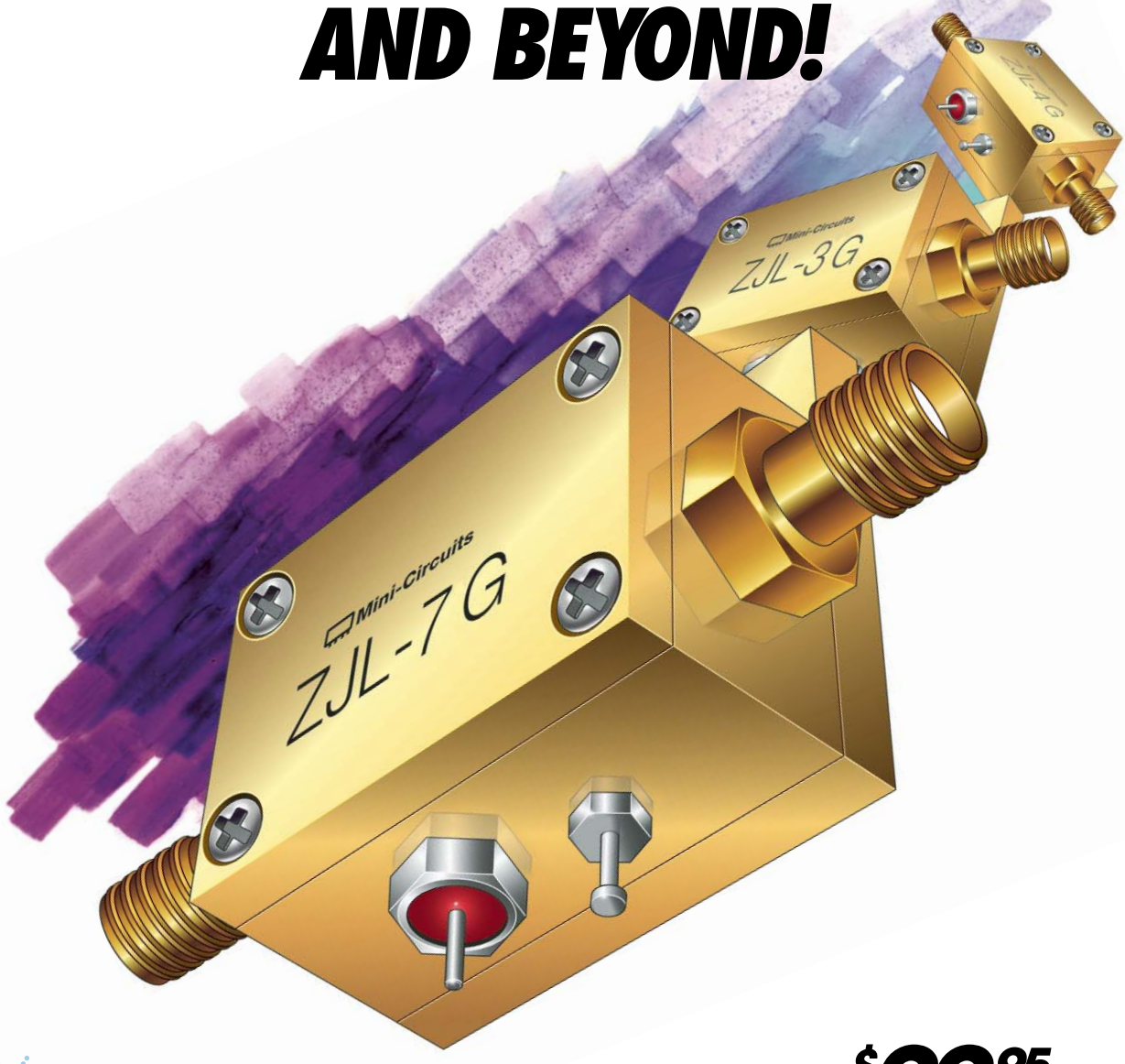

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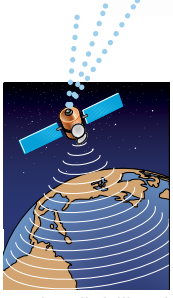

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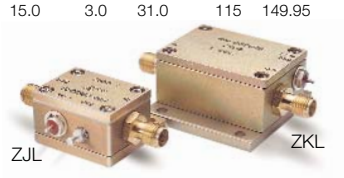
SPECIFICATIONS

Model	Freq (MHz)	Gain (typ) Midband (dB)	Gain (typ) Flat (±dB)	Max. P_{out}1 (dBm)	Dynamic Range (Typ @2 GHz2) NF(dB)	Dynamic Range (Typ @2 GHz2) IP3(dBm)	I(mA)3	Price $ea. (1-9)
ZJL-5G	20-5000	9.0	±0.55	15.0	8.5	32.0	80	129.95
ZJL-7G	20-7000	10.0	±1.0	8.0	5.0	24.0	50	99.95
ZJL-4G	20-4000	12.4	±0.25	13.5	5.5	30.5	75	129.95
ZJL-6G	20-6000	13.0	±1.6	9.0	4.5	24.0	50	114.95
ZJL-4HG	20-4000	17.0	±1.5	15.0	4.5	30.5	75	129.95
ZJL-3G	20-3000	19.0	±2.2	8.0	3.8	22.0	45	114.95
ZKL-2R7	10-2700	24.0	±0.7	13.0	5.0	30.0	120	149.95
ZKL-2R5	10-2500	30.0	±1.5	15.0	5.0	31.0	120	149.95
ZKL-2	10-2000	33.5	±1.0	15.0	4.0	31.0	120	149.95
ZKL-1R5	10-1500	40.0	±1.2	15.0	3.0	31.0	115	149.95

NOTES:
1.Typical at 1 dB compression.
2. ZKL dynamic range specified at 1 GHz.
3. All units at 12V DC.



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percent for the same ACLR value of –45 dBc. If the ACLR specification were set at –55 dBc, then the DPD and DFFLPA would have efficiencies of approximately 15 and 12 percent, respectively. In ***Figure 5***, for an input signal with a 6.5 dB PAPR (7.01 percent of EVM), the DPD and DFFLPA achieved an efficiency of 27 and 19.5 percent, respectively, at an ACLR of –45 dBc. An important result shows that, for an ACLR specification of –55 dBc, the efficiencies are almost identical for the DPD and DFFLPA. As seen in ***Figure 6***, as the PAPR is further reduced to 5.5 dB (11.8 percent of EVM), the DPD's efficiency can approach 29 percent, while the DFFLPA can achieve 21 percent. Once again the efficiencies between the two systems are almost identical for an ACLR specification of –55 dBc. The measured results demonstrate that the DPD required more back-off than the DFFLPA as the PAPR of the input signal decreased. This implies that the DFFLPA with CFR can be used to achieve a higher output power than the DPD with CFR, using the same LDMOS output device. Ultimately, this results in a lower cost for the DFFLPA in comparison to the DPD.

DISCUSSION

The Doherty feed-forward linear power amplifier with CFR (5.5 dB PAPR) has achieved an approximately 20 percent power efficiency with –50 dBc of ACLR at 5 MHz offset, using two WCDMA carriers. This result is over twice that of a conventional feedforward linear power amplifier, which is approximately 8 percent. The measured results demonstrate that the DPD required more back-off than the DFFLPA as the PAPR of the input signal decreased. This also means that the peak power of the main amplifier can be reduced to enhance efficiency with the same performance. In other words, lower peak power LDMOS devices can be used, which implies cost reduction and efficiency enhancement. According to the measurement results, the DPD performance in terms of ACLR showed a performance a little bit worse than for the DFFLPA. There are two possible reasons for this degradation. First, IQ imbalances and DC offsets were not fully optimized for digital predistortion. These impairments could limit the optimum performance for digital predistortion. Second, the test bench for digital predistortion has an approximately 40 MHz bandwidth limitation. This may be the cause of the DPD performance, when two WCDMA carriers with 5 MHz spacing were applied. One additional point is that a 10 W power consumption (CFR and DPD) for baseband processing was included in the DPD, shown in the figures as a solid line with filled square markers. No additional power consumption (CFR) for baseband processing was included in the DFFLPA, as shown by the solid line with asterisk markers. This has a 2 percent effect on the efficiency.

CONCLUSION

This article presents a performance comparison between the DPD and DFFLPA techniques when crest factor

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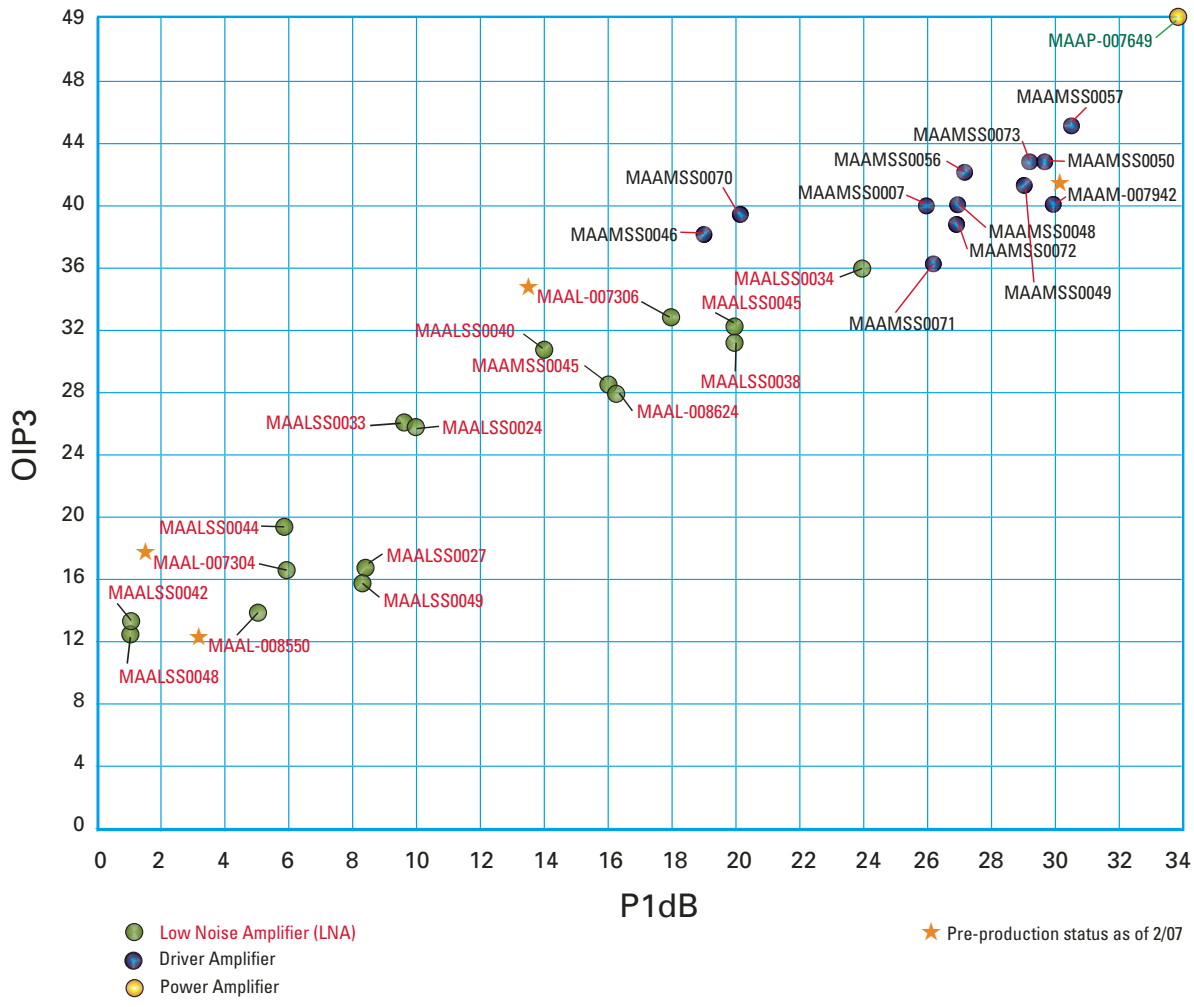

Power Amplifiers (PA)

Frequency (MHz)	Part Number	Bandwidth (MHz)	Center Freq (MHz)	Gain (dB)	OIP3 (dBm)	P1dB (dBm)	Voltage (Volts)	Current (mA)	Package
	Packaged Products								
600 - 4000	MAAP-008170	200	900/2500	16/13	45/45	34.5/34.5	12	100	3 mm PQFN 16 ld
600 - 4000	MAAP-008171	200	900/2500	14/11	46/46	39.5/39.5	12	200	4 mm PQFN 16 ld
800 - 1000	MAAP-007649	200	900	19.5	49	34	7.5	540	4 mm PQFN 16 ld
850 - 960	MAAPSS0095	110	905	37	37	30	3.3	180	3 mm PQFN 16 ld
900 - 2000	MAAM-007217	200	970/1680	15.5/10	17/16	6/4	3	5	SOT-143
2300 - 2800	MAAPSS0103	400	2500	34	42	32	5	250	4 mm PQFN 16ld
2400 - 2500	MAAP-008015	100	2450	31	32	23	3.3	43	3 mm PQFN 12 ld
2400 - 2500	MAAPSS0075	100	2450	29.5	52	26.5	3.3	100	3 mm PQFN 12 ld
2500 - 5000	MAAP-000066-PKG003	2500	3750	28	42	33	8	660	5 mm PQFN 20 ld
3300 - 3800	MAAPSS0104	500	3500	32	42	32	5	250	4 mm PQFN 16 ld
4900 - 6000	MAAPSS0096	1100	5800	20.5	40	29.5	7	360	4 mm PQFN 16 ld
5000 - 8500	MAAP-000021-PKG003	3500	6750	17	40	32	8	600	5 mm PQFN 20 ld
5700 - 5900	MAAP-007899	200	5800	25	38	28	5	350	4 mm PQFN 16 ld
5700 - 8500	MAAP-000067-PKG003	2800	7100	26	41	33	8	640	5 mm PQFN 20 ld
7100 - 11700	MAAP-000069-PKG003	4600	9400	27	40	31.5	8	750	5 mm PQFN 20 ld
10000 - 13250	MAAP-000070-PKG003	3250	11625	29	41	32	8	880	5 mm PQFN 20 ld
12000 - 16000	MAAP-000042-PKG003	4000	14000	20	38	29	8	470	5 mm PQFN 20 ld
12700 - 15400	MAAP-000044-PKG003	2700	14050	17	34	26	8	210	5 mm PQFN 20 ld
13750 - 14500	MAAP-008116	750	14175	30	42	32	8	700	6 mm PQFN 28 ld
13750 - 14500	MAAP-008208	750	14175	28	43	33	8	800	6 mm PQFN 28 ld
13750 - 14500	MAAPSS0111	750	14175	34	39	29	8	400	6 mm PQFN 28 ld
17770 - 19700	MAAP-000072-PKG003	1930	18735	18	40	31	8	500	5 mm PQFN 20 ld

Low Noise Amplifiers (LNA)

Frequency (MHz)	Part Number	Bandwidth (MHz)	Center Freq (MHz)	Gain (dB)	NF (dB)	OIP3 (dBm)	P1dB (dBm)	Voltage (Volts)	Current (mA)	Package
	Packaged Products									
70 - 3000	MAALSS0034	2500	900/1900/2400	14.5/12/9.2	1.55/1.6/1.7	33/36/37	22/23/23	5	88	SOT-89
70 - 3000	MAALSS0038	2500	900/1900/3000	14.5/12/9.6	1.5/1.5/1.5	32/32/32	21/21/21	5	87	SC-70 6 ld
400 - 500	MAAL-008624	100	450	21	0.9	28	16.5	5	60	SOIC-8
500 - 3000	MAAL-007304	200	2400	25	0.7	18	7	3	11.5	SOT-26
500 - 3000	MAAL-007306	200	1800	26	0.75	26	16	3	100	SOT-26
500 - 3000	MAAL-008550	200	900/1900/2400	12	0.6	14	5	3	7	SC-70 6 ld
800 - 1000	MAALSS0040	200	900	16.8	0.95	30	14	5	40	SOT-26
1400 - 2000	MAALSS0048	300	1500/1900	18/17.5	1.6/1.65	13/12	1/0	3	6.5	SOT-26
1400 - 2000	MAAMSS0045	600	1785	14	1.4	29	16	5	45	SOIC-8EP
1500 - 1600	MAALSS0044	100	1500-1600	21	1.6	19	6	5	8	SOIC-8EP
1500 - 1700	MAALSS0049	200	1575	20	1.5	17	8.5	3	9.5	SOT-26
1550 - 1600	MAALSS0042	50	1575	27	1.15	13	1	5	20	SOIC-8EP
1700 - 2400	MAALSS0045	200	2000	19	1.4	32	20	5	80	3 mm PQFN 12 ld
2200 - 2400	MAALSS0033	200	2300	17	0.9	26	10	5	26	SOT-26

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Tunable Broadband Drivers

Frequency (MHz)	Part Number	Bandwidth (MHz)	Center Freq (MHz)	Gain (dB)	OIP3 (dB)	P1dB (dBm)	NF (dB)	Voltage (Volts)	(mA)	Current Package
	Packaged Products									
250 - 4000	MAAMSS0048	200	900/1900/2140	21/16/15.5	40/42/40	27/27/27	4.5/3.3/3.5	5	175	SOT-89
250 - 4000	MAAMSS0049	200	900/1900/2140	19/15.5/15.5	43/43/43	28.5/28.5/28.5	3.5/3.5/3.5	5	288	SOT-89
250 - 4000	MAAMSS0050	200	900/1900/2140	20/14/13	43/43/43	30/30/30	3.4/4/4.5	5	430	SOT-89
250 - 4000	MAAMSS0056	200	900/1900/2140	26.5/22/22	42/42/42	28.5/28/27.5	4/3.5/3.5	5	195	SOIC-8EP
250 - 4000	MAAMSS0057	200	900/1900/2140	24/21/21	32/32/32	30.5/31/31	5/4.5/4.5	5	600	SOIC-8EP
250 - 4000	MAAMSS0072	200	700/1900/3500	32/24/23	39.5/38/5/39	27/28.5/27	5/4/3.7	5	235	4 mm PQFN 16 ld
250 - 4000	MAAMSS0073	200	900/1900/3500	26/24/23	43/43/43	30.5/30/29	5/4.5/3.8	5	590	4 mm PQFN 16 ld
500 - 2500	MAAM-007942	200	900/1900/2140	27/25/24	40/40/40	30/30/30	2.1/2.1/2.1	5	460	4 mm PQFN 16 ld
500 - 2500	MAAMSS0071	200	900/1900/2140	21/17/16	37/38/37	26/26/26	3.2/3.4/3.2	5	115	SOT-89
50 - 2500	MAAMSS0046	200	250/900/1900	18/12.5/10.5	38.5/34/34	19/19/19	4.8/5.1/5.3	5	70	SOT-89
70 - 3000	MAAMSS0070	200	900/1900/2140	13.2/12.7/12	42/41/41	21.5/21/21	3.2/3.2/3.3	5	150	SOT-89

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	Packaged Products									
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MAAPSS0096	4.9-6.0	20.5	28	19	230/5
Power Amplifiers					
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MAAPSS0104	3.5	32	32	26	600/5
MAAP-008170	2.5/3.5	12/10	37/37	27/27	210/12
MAAP-008171	2.5/3.5	10/8	40/40	30/30	420/12

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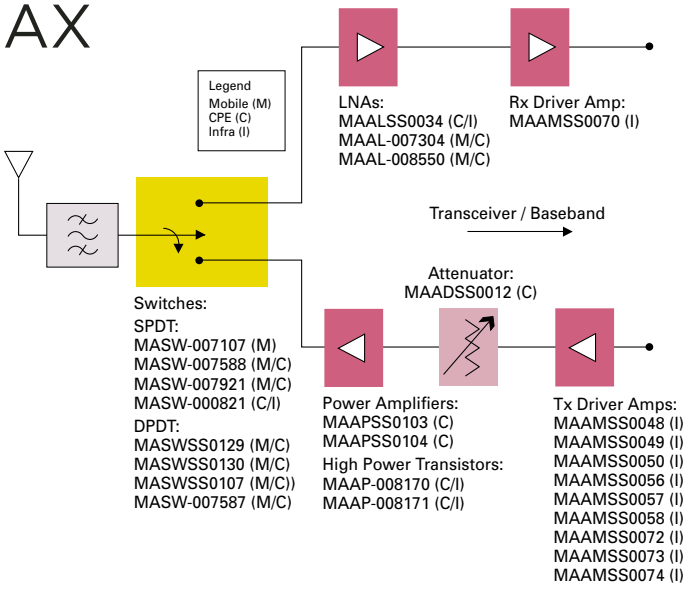

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reduction is used. The results show that, at a lower ACLR specification of –45 dBc, the DPD with CFR can achieve up to 29 percent power efficiency, while the DFFLPA with CFR could obtain 21 percent. However, as the ACLR specification becomes more stringent, the efficiency gap between the two systems decreases. The DFFLPA system was always able to obtain a higher output power than the DPD approach, which ultimately factors into the cost. ■

ACKNOWLEDGMENT

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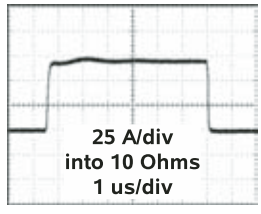

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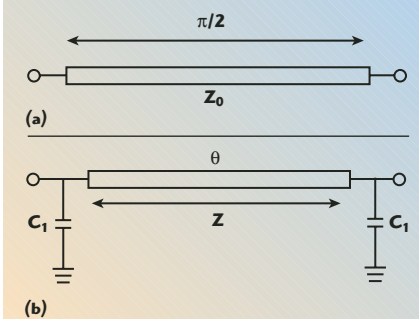
AN EXTREMELY MINIATURIZED MICROSTRIP BANDPASS FILTER

A novel miniaturized UHF bandpass filter, using diagonally end-shorted coupled lines and lumped capacitors, is proposed. The new filter is not only as short as a few degrees in size, but also shows a wider stop band. A two-stage bandpass filter of this type has been designed and fabricated at a mid-band frequency of 300 MHz. Both the theoretical and experimental performances are presented.

High performance bandpass filters, with miniaturized size, narrow bandwidth, wide stop band and low cost, are required in modern wireless communication systems, especially in mobile and portable Internet systems. Planar reduced-size filters, such as λ/2 hairpin resonator[1] and slow-wave resonator[2] filters have already been published. These filters have the advantage of good harmonic suppression, but are still too large to be inserted into commercial transceiver systems. The quarter-wavelength ceramic combline filter, using a high dielectric constant material,[3] is another type of miniaturized bandpass filter. Nevertheless, the electrical length of the transmission line itself is not reduced in this combline filter.

Fig. 1 A λ/4 transmission line (a) and its equivalent shortened line (b).



In this article, an extremely miniaturized filter is introduced, resulting from Hirota's reduced λ/4 transmission line.[4] It shows a wide upper stop band, because the lumped capacitors used in this filter suppress the upper spurious signals. In addition, the electrical length of the proposed bandpass filter can be controlled arbitrarily in theory and reduced to just a few degrees. A filter has been designed and fabricated at 300 MHz to emphasize the effect of the size reduction method, since the lower the resonant frequency, the longer the electrical length.

SIZE REDUCTION METHOD FOR A λ/4 TRANSMISSION LINE

A λ/4 transmission line can be shortened by using a combination of a short tranmission line and shunt lumped capacitors,[4] as shown in ***Figure 1***. The shorted line parameters are

$$Z = Z_0/\sin\theta \quad (1)$$

$$\omega C_1 = (1/Z_0)\cos\theta \quad (2)$$

The characteristic impedance Z of the shortened line increases as the electrical length

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θ of the shortened line gets smaller. If θ is very small, Z will become too high to be realized. Up to now, the limitation of the electrical length of the tramission line is approximately π/8 to π/12. Therefore, it is necessary to overcome the high impedance of the shortened transmission line.

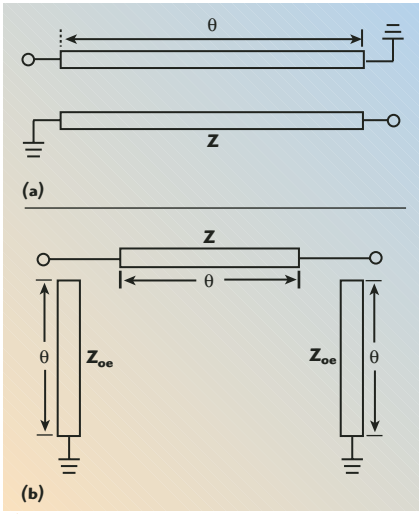

Fig. 2 Diagonally coupled lines (a) and their equivalent circuit (b).

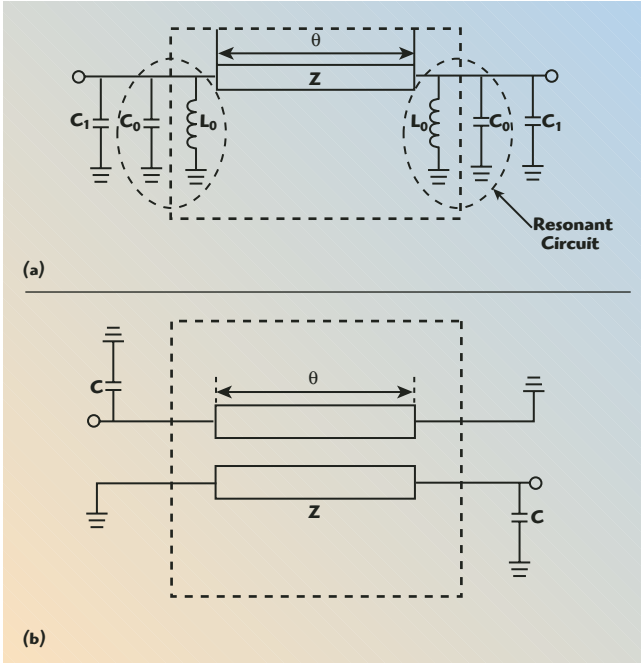

Fig. 3 Equivalent circuit of Hirota's reduced size λ/4 line including artificial resonant circuits (a) and the final equivalent λ/4 transmission line circuit (b).

Figure 2 shows the diagonally shorted coupled lines and their eqivalent circuit.[5] The characteristic impedance of the diagonally shorted coupled lines is given by

$$Z = (2\,Z_{0e}Z_{0o})/(Z_{0e}-Z_{0o}) \qquad (3)$$

From Equation 3, it can be seen that the shorted coupled lines are proper for extremely miniaturized λ/4 transmission lines as the high characteristic impedance can be easily attained by choosing Z_{0e} close to Z_{0o}. As shown in ***Figure 3***, the artificial resonant circuits are inserted in Hirota's lumped distributed λ/4 transmission line, and the high impedance transmission lines with shunt lumped inductors can be replaced by coupled lines. The parts in the two dotted square boxes are equivalent when the following equations are satisfied[6]

$$\omega L_0 = Z_{0e} \tan\theta \qquad (4)$$

$$\omega L_0 = 1/(\omega C_0) \qquad (5)$$

$$C = C_0 + C_1 \qquad (6)$$

Thus, it is feasible to obtain a very high impedance using coupled lines. The peculiar feature of this extremely miniaturized λ/4 transmission line is that the resonant circuits are located at the edge side of the tranmission line. When the miniaturized λ/4 tranmission lines are connected in series, the cascaded circuit becomes a typical bandpass filter, as shown in ***Figure 4***, because the λ/4 section can be used as an admittance inverter. The bandwidth of the filter can be controlled by the coupling coefficient since the bandwidth of a diagonally end-shorted coupled line is closed related to the coupling coefficient.[7]

SIMULATION AND EXPERIMENTAL RESULTS

A two-stage miniaturized bandpass filter, with f_0 = 300 MHz and Z_0 = 50 Ω, was designed with the electrical length of the coupled lines equal to 5.2°. The designed circuit was simulated using HFSS and the results are shown in ***Figure 5***. When the two miniaturized λ/4 transmission lines are connected directly (L = 0 mm), a distorted shape appears. That is because there is an unwanted coupling, which cannot be neglected. It is caused by the 180° phase difference between the edge sides of the cascaded two stages and their distance is too close. Therefore, it is necessary for a very small

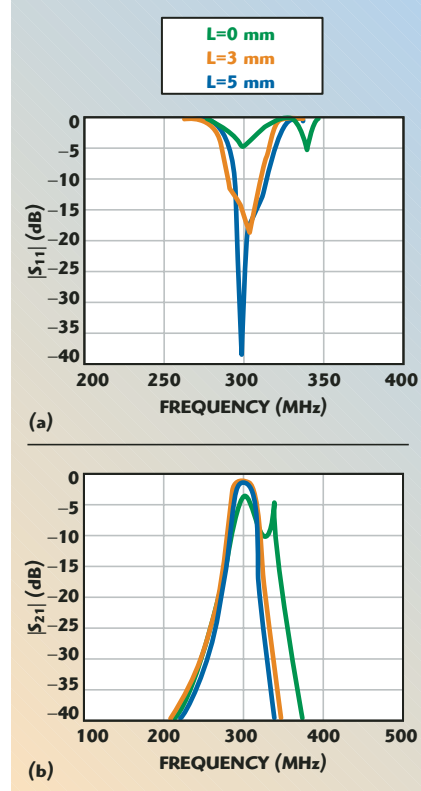

Fig. 5 S_{11} (a) and S_{21} (b) for different lengths of the inter-stage line.

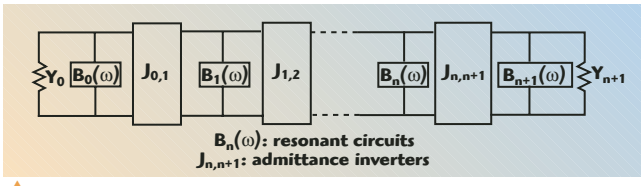

Fig. 4 Generalized bandpass filter structure.

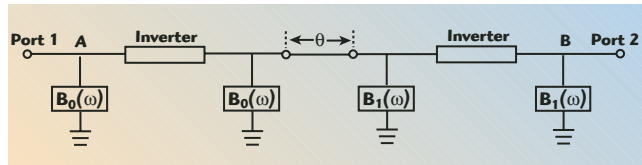

Fig. 6 Schematic of an extremely miniaturized two-stage bandpass filter.

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LFCN-190+	DC-190	400	2.99					
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LFCN-490+	DC-490	800	2.99	•		•		
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LFCN-1400+	DC-1400	2015	2.99				•	
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transmission line of length θ to be inserted between the resonators to block the unwanted coupling, as shown in ***Figure 6***. When the bandpass filter is simulated by HFSS with a small transmission line (L = 3 and L = 5 mm) inserted, it operates normally. To the authors' knowledge, the use of this small transmission line between resonators has not been reported in the literature before. As the size of the filter becomes smaller, this small transmission line section is needed. As shown above, the inter-stage transmission line is indispensable and the filtering characteristics get better as the line length is longer. Considering the size of the circuit, 5 mm is chosen as the length of the inter-stage line. The miniaturized bandpass filter was fabricated on a 1.57 mm thick Teflon substrate with a relative permittivity of 10 and a conductor thickness of 35 µm. The total physical length of the fabricated filter is approximately 1.7 cm. A photograph of the filter is shown in ***Figure 7***. The HFSS simulation and the experimental results have been compared. MIM capacitors are used in the simulation of the filter circuit because the equivalent circuit information for lumped capacitors is not known. The frequency responses of the passband filter over narrow and wide ranges are shown in ***Figure 8***. The center frequency of the actual circuit is 304 MHz and the insertion loss is 4.3 dB. The filter has an extremely wide upper stop band (S_{21} < –45 dB), up to $7f_0$, because the lumped shunt capacitors suppress harmonics. Although the λ/2 hairpin resonators and slow-wave open-loop resonators can also suppress harmonics, they just expand the stop band by shifting the spurious frequencies resulting from the slow-wave effect. The experimental results of the proposed filter show that the harmonics have disappeared, resulting in an ultra-wide band. The measured results of the experimental filter are summarized in ***Table 1***.

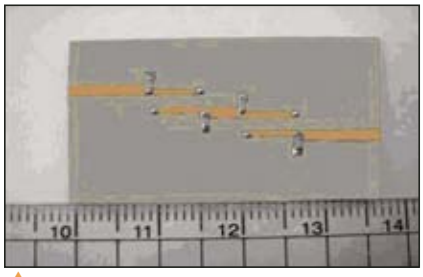

Fig. 7 The fabricated bandpass filter.

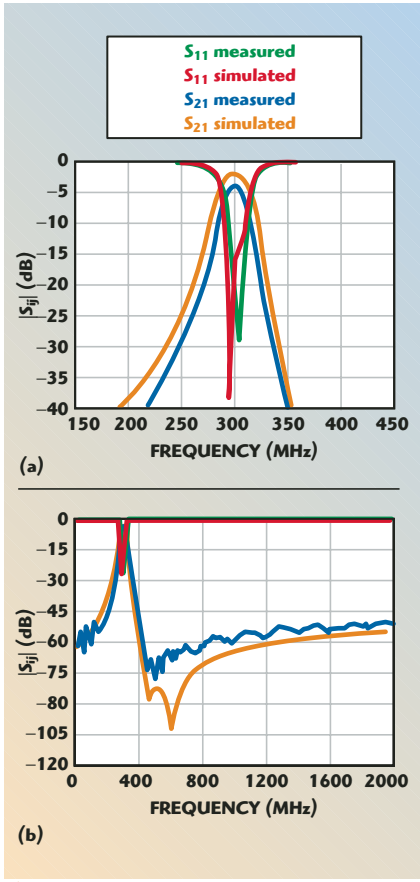

Fig. 8 S-parameters of the filter for a narrow frequency range (a) and a wide frequency range (b).

TABLE I

CHARACTERISTICS OF THE FABRICATED MINIATURIZED BANDPASS FILTER

Frequency range (MHz)	290 to 314
Insertion loss (dB)	–4.3 at f_0
Attenuation (dB)	–64 at $2f_0$ –58 at $3f_0$
Characteristic impedance (Ω)	50

CONCLUSION

An extremely miniaturized bandpass filter, using a combination of diagonally shorted coupled lines and lumped capacitors, is proposed in this article. By using this method, the size of the bandpass filter can be reduced by more than 95 percent, compared with the size of a conventional one and a wider upper stop band is achieved. The measured results agree well with the theoretical ones. This new type of filter can be extended to MMIC technology. ■

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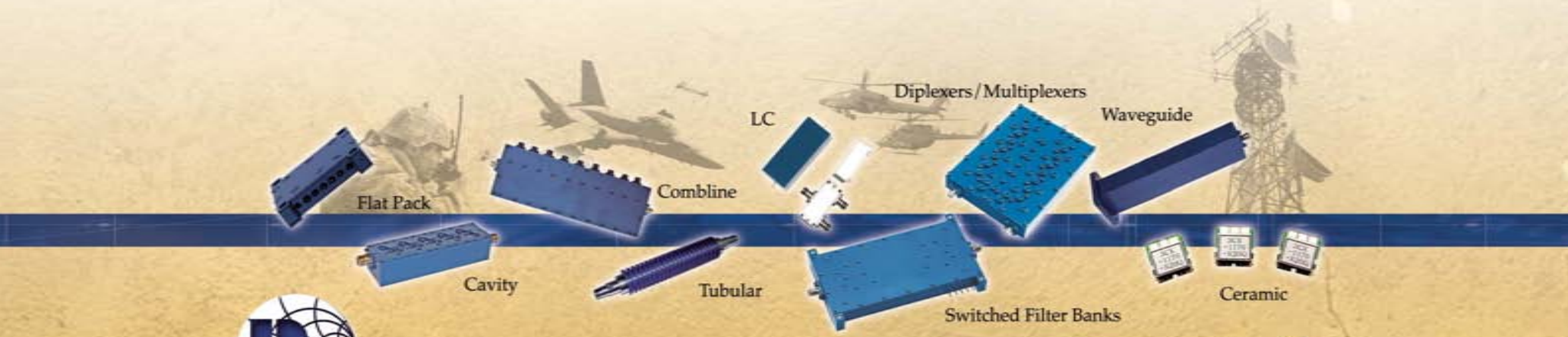

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DESIGN ISSUES FOR A SOLID-STATE POWER AMPLIFIER INTEGRATED WITH A PLANAR ANTENNA

This article presents design and analysis related issues for a solid-state power amplifier (SSPA) integrated with a planar antenna. It discusses the suitability of different planar antenna structures to minimize EM interaction between the radiator and the associated matching circuitry of the solid-state power amplifier. The design and simulation of an SSPA integrated with an antenna is presented, using harmonic balance analysis and an EM simulator simultaneously, to take care of the coupling between antenna and matching circuitry and to address out-of-band instability and nonlinear analysis of the power amplifier.

Efficiency, output power and compactness are the most important parameters of a system for RF/microwave transmitter applications. The power amplifier consumes most of the DC power in a transponder. Thus, much attention is required to maximize the efficiency of the power amplifier. A high efficiency power amplifier allows compact and lightweight power sources, and reduces the cooling requirements. An active antenna, integrated with a power amplifier, addresses all these requirements. The choice of the antenna structure, the class of operation and heat sinking of the power amplifier, the design and simulation tools to simulate the integrated active antenna system and the testing methodology, are all major issues to develop a successful antenna integrated with a power amplifier.

A high efficiency power amplifier allows compact and lightweight power sources, and reduces the cooling requirements.

The choice of planar antenna affects the design topology and system performance, due to the direct integration of the active devices and their associated matching circuits with the antenna. Another important area is the use of simulation tools to analyze an active integrated antenna (AIA) system as an entity.[1] Conventionally, the antenna structure and active circuits are analyzed separately and then integrated together. This procedure results in significant deviation from predicted results when both antenna and active circuits are integrated. Consequently, the analysis and optimiza-

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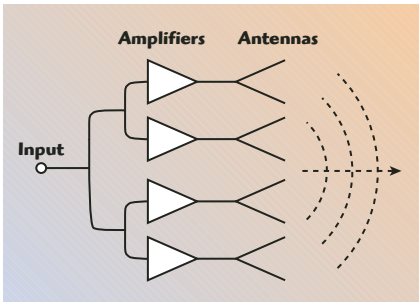

▲ *Fig. 1 Spatial power combining technique.*

tion of the integrated active circuit with the antenna are required at the design level itself. Solid-state systems are more desirable in terms of size, weight, reliability and manufacturability, using mass production technology. The main limitations of solid-state power devices are their limited power output capability along with a downward trend with frequency.[2] To meet the high power requirements of a system, the powers from many individual devices must be combined coherently. Many circuit-based power-combining techniques, using different types of combiner networks, increase the overall output power. However, this technique suffers from efficiency degradation due to the loss in combiner networks. The problem becomes more serious when more and more devices are required to be combined for the same level of output power when the operating frequency is increased.

An AIA technique, with spatial power-combining technology, addresses all these limitations. In a spatial power-combining technique, the energy is combined in the low loss air dielectric medium, as shown in ***Figure 1***. Thus, the combining efficiency will be extremely high. The reduction of combining losses therefore enables one to achieve a high output power with overall high efficiency by combining a large number of solid-state devices, as required in high frequency operation. A lossy feed network is retained at the input of the power amplifiers to ease phase matching. Any losses in the input feed network can be compensated by pre-amplification of the input signal, without seriously degrading the system efficiency.

An active integrated antenna array, with spatial power combining, solves the limitation of the output power handling capability of the solid-state power amplifiers, but it introduces new problems at the same time. There are many design and characterization related issues. The choice of antenna structure, the antenna feed system and the substrate materials used are vital parameters for designing an active integrated antenna system. Different types of antenna feeds, with their merits and demerits, have been discussed in the literature.[3–8] The radiation effects in a compact antenna integrated with an amplifier have been analyzed and discussed.[9,10] To design an AIA system with a power amplifier, the use of a simulation tool to analyze the whole system is also very important, since harmonic balance analysis is required for the power amplifier, whereas electromagnetic analysis is required for the antenna. Characterizing the AIA with a power amplifier is not a conventional procedure since the antenna provides a dynamic load to the amplifier, instead of a fixed 50 Ω load as in the case of a conventional amplifier.

DESIGN RELATED ISSUES

The choice of a planar antenna affects the design topology and system performance due to the direct integration of active devices and their associated biasing and matching circuits with the antenna. The class of operation of the power amplifier and the heat dissipation within the device are also major issues for designing a power amplifier integrated with an antenna. Another important area is the use of simulation tools for analyzing the active integrated antenna system as an entity.

Antenna Structure

With the increase in operating frequency, the size of the antenna is reduced and becomes comparable to the size of the active circuits including the bias and matching networks. Therefore, unwanted radiation from the circuits associated with the active devices will disturb the main and side lobes of the antenna. This effect can be reduced by increasing the spacing between the array elements. Another way is to use a multi-layer substrate with a low dielectric constant substrate for the antenna elements and a high dielectric constant substrate for the associated active circuits. This will reduce the size of the active circuits compared to the antenna elements. To achieve greater bandwidth, a thicker substrate for the microstrip antenna is required. With the increase of substrate thickness, the tendency for surface-wave mode propagation increases, causing unwanted coupling among the antenna elements and with the matching circuit elements of the active circuits. The use of a lower dielectric constant substrate reduces the coupling among the antenna elements without affecting the bandwidth of the antenna. Different architectures of active antennas with amplifiers have been discussed.[11–13] Reactive-type matching networks are mainly used for input and output matching of the amplifier to achieve maximum power transfer to the antenna. Open circuit stubs are popular for matching purposes. These stubs radiate energy due to the generation of standing waves within them. The unwanted radiation from these matching circuits not only distorts the antenna pattern but also increases the cross-polarization level. One way to minimize the unwanted radiation is to use balanced stubs for matching purposes. However, a better way to eliminate the coupling radiation between the matching network and the antenna is the use of an aperture-coupled antenna with active circuits and feeds on the opposite side of the patch. The ground plane, between the patch and matching networks, eliminates the coupling.

Amplifier Operation and Heat Sinking

Different types of architectures for antennas integrated with amplifiers have been discussed.[14–19] Efficiency is one of the main parameters of the power amplifier, which determines the DC power requirement of the transmitter. A high efficiency power amplifier not only reduces the DC power consumption, but also reduces the cooling requirements. Power amplifier operation in a switching mode is a popular technique to achieve high efficiency. Power amplifiers operating in class-D and -E provide a very high efficiency. In both operations, the transistor is operated as a switch, in such a manner that the time domain current and voltage

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waveforms overlap minimally during a period. Thus, the power dissipation within the device will be ideally zero and the amplifier efficiency becomes close to 100 percent. At microwave and higher frequencies, however, it becomes difficult to find transistors capable of switching as fast as required for class-D and -E operation. Moreover, microwave transistors have a finite 'on' resistance with a finite switching time, thus it is not possible to achieve 100 percent efficiency of the microwave amplifiers. The efficiency also decreases with increasing frequency of operation. Among the different classes of power amplifiers, class-F operation has become very popular for its high efficiency and high output power capability at microwave and higher frequency operation. In this class of operation, it is required to control the load impedances at a finite number of harmonics, which is possible for microwave devices.[20,21] In class-F operation, a harmonic resonator in the output-matching network is used to shape the drain waveforms such that the load impedance provides a short at even harmonics and an open at odd harmonics. Most power amplifiers have used transmission line networks to control the impedances at only the second and third harmonics and have achieved a higher efficiency. However, to meet the linearity requirement with moderate efficiency of communication systems, it is generally preferred to operate the power amplifiers in class AB, up to a gain compression of –2 dB. The decrease in DC-to-RF efficiency of the amplifiers with the increase in operating frequency causes the generation of more heat energy within the device. Heat sinking is one of the most critical issues for the design of a power amplifier integrated with an antenna. There are many solutions for heat sinking of the active antenna system. One way is the use of a good thermal conducting substrate, such as aluminum nitride, with a provision of more ground area for the planar microstrip antenna. The active devices, mounted/soldered on the substrate, dissipate heat through the high thermal conduction substrate to the metallic ground plane. Another solution is the mounting/brazing of flip-chip mounted or plated heat sink power devices, directly on the ground plane of the planar antenna structure, providing a heat dissipation path from the ground plane to the metallic package.

Design and Simulation Tool

In conventional amplifier design, the load impedance of the circuit is always 50 Ω (over a wide range of frequencies). However, in an AIA system, the load of the power amplifier is the input impedance of the antenna, with a limited bandwidth and a number of resonant impedances. To ensure the out-of-band stability of the amplifier integrated with an antenna, the antenna should be modeled for its in-band as well as out-of-band response, including its multiple resonance characteristics. Linear circuit analysis is not valid to analyze power amplifiers since power amplifiers are operated in nonlinear conditions to achieve better efficiency and higher output power, instead of maximum gain as in the case of linear amplifiers. Therefore, S-parameter linear analysis cannot be used to design and simulate the power amplifiers. Conventionally, the in-band properties of an antenna are obtained from simple analysis and the effects of their out-of-band properties are ignored during the design phase of the amplifier. The design is then verified experimentally and further modifications are incorporated, based on the measurement results. The main reason for doing so is that the output port of the antenna is located in free space. Thus, proper simulation tools are required to design and simulate the active antenna integrated with the power amplifier, to handle the nonlinearities of the amplifier and the electromagnetic properties of the antenna simultaneously. One method is to extract the broadband frequency response of the antenna as an S-parameter file, and use this file in the linear circuit simulator to analyze the complete circuit. However, this approach is not completely valid for the nonlinear operation of the power amplifier and the electromagnetic coupling among the circuit elements is also not taken into account. Here, an improved technique is proposed to analyze the active antenna integrated with the power amplifier, using a harmonic balance analysis and an EM simulator simultaneously, for nonlinear analysis of the power amplifier and EM simulation of the planar antenna. Agilent's design software ADS2005A has a special feature for EM co-simulation facility. This tool allows simulation of the circuit, partly in an EM environment and partly in a circuit simulation environment. In this case, the planar antenna structure and the matching circuits (excluding lumped elements) can be analyzed by the EM simulator and the over-all response analyzed by the harmonic balance analyzer (HB) to take care of the nonlinear characteristics of the power amplifier.

TESTING RELATED ISSUES

Conventionally, microwave circuits are always tested in a 50 Ω environment, and the measuring instruments are meant for that purpose. As mentioned in the previous sections, the load of the power amplifier, that is the input impedance of the antenna, has a multiple resonance characteris-

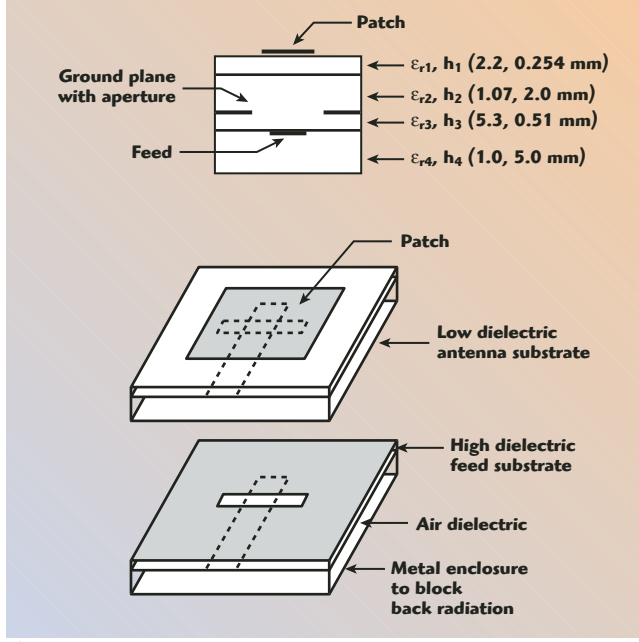

Fig. 2 Patch antenna with an aperture-coupled feed.

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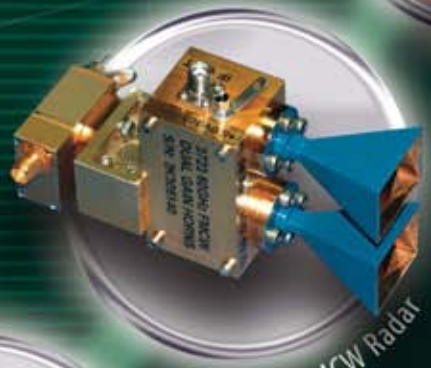

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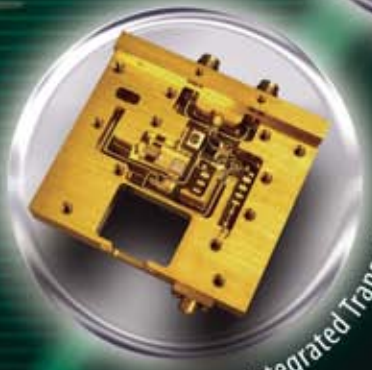

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tic. Such a complex load cannot be modeled and fabricated to replace the antenna physically while characterizing the amplifier separately. Thus, it is difficult to measure the output power delivered to the antenna directly. All the testing and measurements will be similar to the antenna measurement technique and the power amplifier parameter measurement will be an indirect measurement, based on the Friis transmission equation in antenna theory.

DESIGN AND SIMULATION OF AN ACTIVE ANTENNA INTEGRATED WITH A POWER AMPLIFIER

The design and simulation of an active antenna integrated with a power amplifier is presented in this section. An aperture-coupled microstrip patch antenna is selected as the radiator and an MGF2430 MESFET device from Mitsubishi Electric Corp. (MELCO) is used as a power device, to demonstrate the design procedure and obtain simulation results for an active antenna integrated with a power amplifier.

Antenna Design

The structure of an aperture-coupled microstrip radiator is shown in ***Figure 2***. The structure has three substrate layers with different thickness and different dielectric permittivity. The advantages of the structure include:

- A low dielectric-permittivity substrate is used for the radiator element to achieve efficient radiation and at the same time a high dielectric-permittivity substrate is used for a compact feed element.
- The matching circuits with the associated bias network of the power amplifier are placed on the high dielectric-permittivity substrate, making them very compact and reducing the radiation from the circuitry.
- The ground layer between the two substrates provides good EM isolation between the patch radiator and the feed network with the active circuit elements.
- The feed network and active circuits can be enclosed within a metallic package providing a thermal path from the metallic package to the ground for heat sinking the power device and eliminating the unwanted signal pick-up by the circuit from free space.

The aperture-coupled antenna is designed for a center frequency of 4.0 GHz. The design parameters of the patch antenna include:

Patch dimensions: 26.9 × 26.9 mm
Aperture dimensions: 14.0 × 1.6 mm
Feed stub length: 3.90 mm
Feed stub width: 0.80 mm

The structure is designed and simulated by a method of moment analysis using Agilent's Momentum software. The simulated return loss of the designed antenna in a 50 Ω system is shown in ***Figure 3***. The achieved 10 dB return loss bandwidth is nearly 240 MHz, about the center frequency of 4.0 GHz and the gain of the patch is 9.05 dB. The variation of the return loss over frequency means that the impedance of the antenna is varying within the operating frequency range. The simulated broadband impedance characteristics of the antenna show that the impedance is approximately 50 Ω and demonstrate several resonance characteristics out-of-band. The aperture dimensions are selected to minimize the back radiation in the operating frequency range.

Design and Simulation of the Integrated Amplifier with the Antenna

The amplifer is designed by transforming the dynamic input impedance of the antenna to the optimum load impedance of the power device, in order to achieve maximum output power and efficiency. The layout of the matching circuits between the MGF2430 device and the antenna is shown in ***Figure 4***. The nonlinear

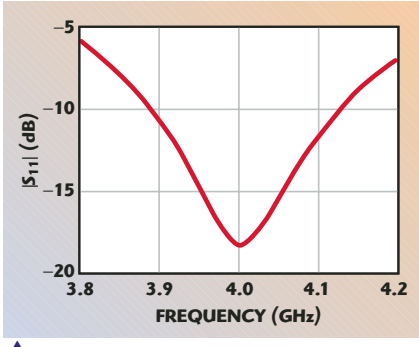

Fig. 3 Return loss of the designed antenna.

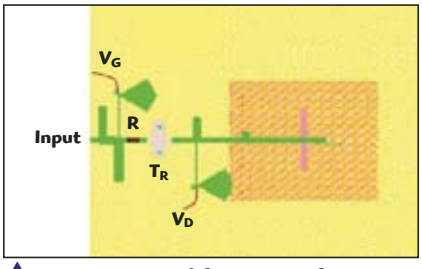

Fig. 4 Layout of the integrated antenna-power amplifier.

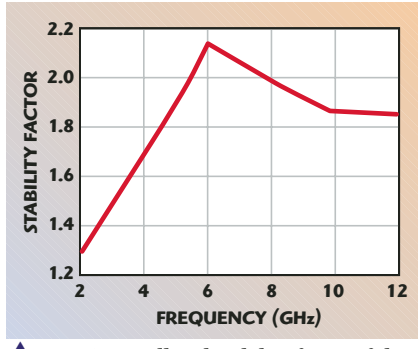

Fig. 5 Broadband stability factor of the amplifier.

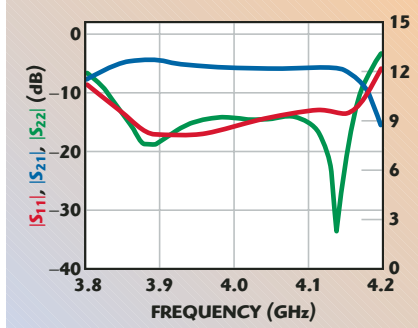

Fig. 6 Amplifier S-parameters with the antenna as a load.

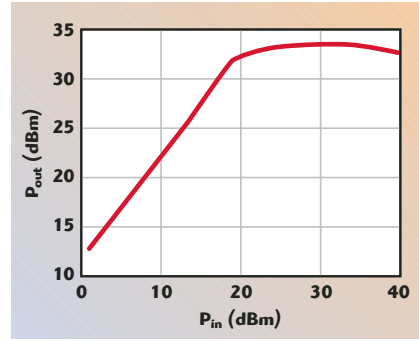

Fig. 7 P_{in} versus P_{out} at 4.0 GHz with the antenna as a load.

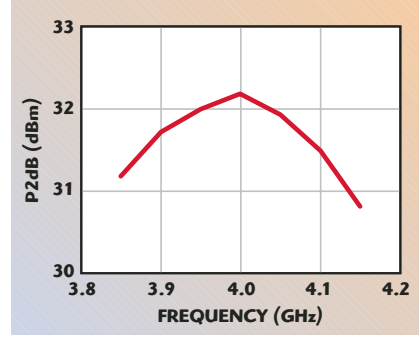

Fig. 8 P2dB response versus frequency.

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• ZHL-20W-13	20-1000	50	+41	+43	3.5	+50	24	2.8	1395.00
• ZHL-50W-52	50-500	50	+46	+48	4.0	+55	24	9.3	1395.00
• ZHL-100W-52	50-500	50	+47	+48.5	6.5	+57	24	9.3	1995.00
▲ ***Without Heat Sink/Fan***									
ZHL-5W-2GX	800-2000	49	+37	+38	8.0	+44	24	2.0	945.00
• ZHL-10W-2GX	800-2000	43	+40	+41	7.0	+50	24	5.0	1220.00
• ZHL-20W-13X	20-1000	50	+41	+43	3.5	+50	24	2.8	1320.00
• ZHL-50W-52X	50-500	50	+46	+48	4.0	+55	24	9.0	1320.00
• ZHL-100W-52X	50-500	50	+47	+48.5	6.5	+57	24	9.0	1920.00

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model of this device is used for harmonic balance analysis of the circuit and to design the matching networks. The matching circuits, with the associated biasing circuitry, are accomodated on the side of the feed network to eliminate electromagnatic coupling between the antenna patch and the matching networks. Double-stub matching is used for both the input and output-matching networks for broadband matching. Resistive loading, using a chip resistor R at the input of the device, is used to make the amplifier unconditionally stable over the broad frequency range. The power amplifier integrated with the antenna is simulated using the co-simulation approach of Agilent's ADS tool. Initially, a DC analysis is conducted to determine the gate bias voltage of the device for a 300 mA drain current at the drain supply voltage of 10 V. Then a stability analysis is done and the value of the input loading resistor is determined to achieve unconditional stability of the amplifier. The stability factor of the amplifier over the broad frequency range of 2 to 12 GHz is shown in ***Figure 5***. The stability factor, greater than one over the broad frequency range of the integrated amplifier, confirms that the amplifier will be stable irrespective of the several resonance impedance characteristics of the antenna.

Initially, a linear analysis is conducted, replacing the power device with its S-parameters, which is a fast method to determine the approximate matching networks of the amplifier to obtain the required gain and return losses of the integrated amplifier. ***Figure 6*** shows the small-signal S-parameters of the amplifier, considering that the antenna impedance is the output load of the amplifier. The simulation shows that the small-signal gain of the amplifier is approximately 12 dB and both return losses are better than 12 dB over a frequency band of 300 MHz, around a center frequency of 4.0 GHz. Finally a harmonic balance analysis is conducted, for the nonlinear analysis of the integrated amplifier using the nonlinear model of the power device. The output-matching network is optimized for proper harmonic termination to achieve maximum output power from the amplifier. The length and position of the stubs are determined for proper harmonic termination. The final output power as a function of input power is shown in ***Figure 7***, at the 4.0 GHz center frequency. The simulated output power, at the -2 dB gain compression point, is 32.2 dBm. It is also clear that the small-signal gain of the amplifier is nearly 12 dB, which agrees with the linear analysis. The output-matching network is determined for maximum output power at the center frequency of 4.0 GHz. The variation of the output power (P2dB) over the frequency range of 300 MHz is nearly 1.6 dB, as shown in ***Figure 8***. The P2dB bandwidth is narrower than the small-signal gain bandwidth.

CONCLUSION

This article presents the design and analysis related issues of a solid-state power amplifier integrated with a planar antenna. It discusses the superiority of the aperture-coupled an-

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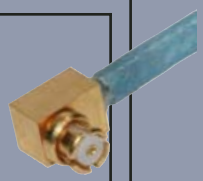

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tenna structure to minimize the EM interaction between the antenna and the associated matching circuitry of the solid-state power amplifier. The design and simulation of an active antenna integrated with a power amplifier, using a type MGF2430 MESFET are presented, using harmonic balance analysis and an EM simulator simultaneously, to take care of the coupling between the antenna and matching circuitry and to address the out-of-band instability and nonlinear analysis of the power amplifier. ■

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20-200	50 ± 1	0.20	1.15:1	500w	C50-108-481/4N
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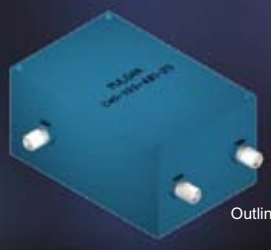
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(With freq. adjustment through voltage control pin)	
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Aging first year	±1 x 10^{-7}
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After warm-up	200 mA (continuous)
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Supply Current:	<800 mA @ 13 V
Bias Voltage Ripple:	100 mV p-p (Max)
RF Output Power:	(w/amp. option) +10 dBm (Min)
When Unlocked:	≤20 dBm
Spurious Suppression:	-65 dBc (Max)
Harmonic Suppression:	
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FREQUENCY SYNTHESIS: CURRENT SOLUTIONS AND NEW TRENDS

This article presents an overview of microwave frequency synthesizer technologies. Various synthesizer architectures along with their main characteristics are analyzed. The new markets' demands, design challenges and possible solutions are considered.

The appeal of a low cost, high performance frequency synthesizer as a key component of virtually any test and measurement (T&M), communication and monitoring system is recognized throughout the microwave industry.[1–5] Although all synthesizers exhibit significant differences as a result of specific applications, they share basic fundamental design objectives as listed below.

BASIC REQUIREMENTS

Frequency Coverage and Resolution

A single tone or relatively narrowband (10 to 20 percent) LO signal can be just enough for many applications. However, modern digital broadband systems require much wider frequency coverage extending to a few octaves. Wide bandwidth and fine frequency resolution (down to 1 Hz and below) are usually "musts" in test and measurement applications such as laboratory synthesizers, network and spectrum analyzers, and synthetic instruments. For synthesizer manufacturers, it may be advantageous to develop a broadband "generic" solution, which can cover a number of applications.

...microsecond tuning speed (together with YIG-based phase noise and spurious characteristics) and low cost... are likely to be the key drivers in the development of the new frequency synthesizers.

Output Power

Required output power levels can range over wide limits, depending on a particular application. A typical scenario assumes the frequency synthesizer as an LO source, driving a frequency mixer in a variety of up- and down-conversion schemes. This normally requires +10 to +17 dBm output signal, although some applications need even more power.

Spurious Content

Spurs are undesired artifact products created by synthesizer components at discrete frequencies. Spur location and level are determined by a particular synthesizer architecture and frequency plan. In microwave communication systems, the spurious products can limit the ability of the receiver to resolve and process a desired signal. Thus, the synthesizer spur level has to be minimized and should not usually exceed –60 dBc relative to the main signal, although many applications require bringing this level down to –80 dBc and below. This requires a specific design effort and

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is usually a tradeoff between other synthesizer parameters, such as phase noise, step size and tuning speed.

Phase Noise and Stability

Phase noise is one of the major parameters that ultimately limits the sensitivity of receiving systems. Synthesizer stability and close-in phase noise strictly depend on the reference signal as well as the particular synthesizer architecture used to derive its output from the reference. Indirect synthesizers also rely on tunable oscillator noise, which can supersede the multiplied reference noise at high frequency offsets. A good example is a YIG-tuned oscillator, typically exhibiting –120 to –130 dBc/Hz at 100 kHz offset from 2 to 10 GHz and above.

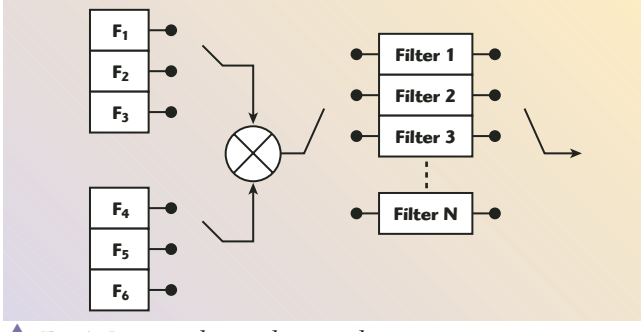

Fig. 1 Direct analog synthesizer schematic.

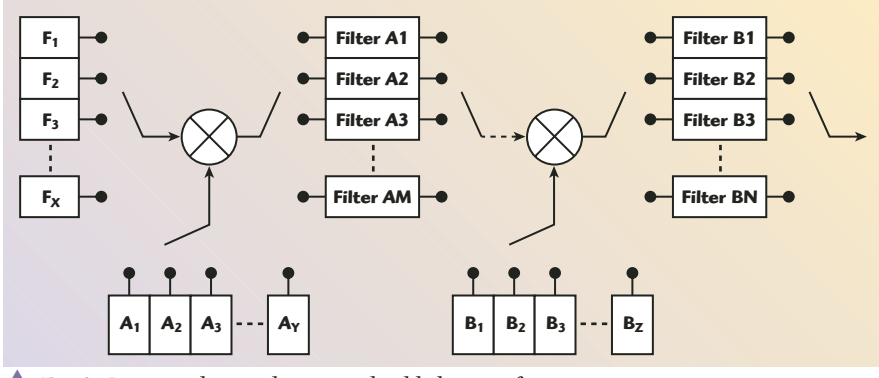

Fig. 2 Direct analog synthesizer with added output frequencies.

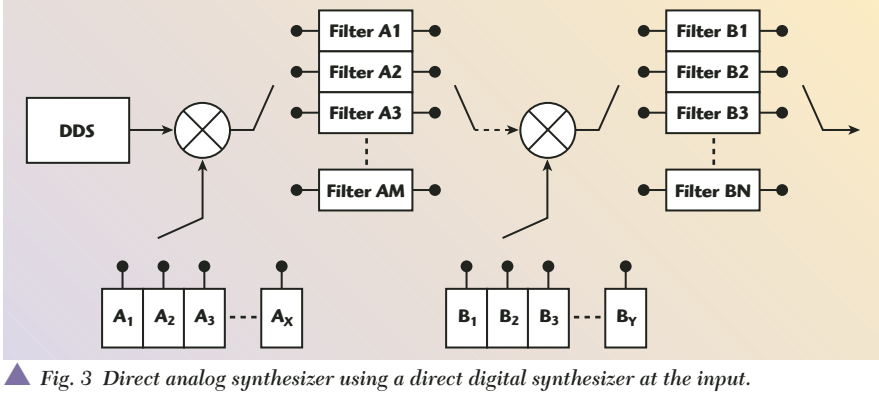

Fig. 3 Direct analog synthesizer using a direct digital synthesizer at the input.

Tuning Speed

Tuning (switching) speed determines how fast the synthesizer jumps from one desired frequency to another. The time spent by the synthesizer jumping between frequencies becomes more and more valuable, since it cannot be used for data processing. New communication systems require higher frequency switching speeds to increase the effective data rate. Even traditionally low speed test and measurement applications would like faster tuning. For example, a new vector network analyzer based on four independent, very fast tuning speed frequency synthesizers has recently been introduced.[6] The synthesizer developers have to consider this trend; target "throughput" numbers (that include all required internal calculations and digital control) should be in the microseconds range.

Power Consumption and Mechanical Constraints

Modern microwave equipment tends to be smaller, lighter, requiring lower voltage and consuming less power. Thus, new synthesizer designs should utilize high integration ICs, avoiding bulky and power hungry components, such as YIG oscillators and filters.

PARTICULAR DEMANDS

The microwave industry feels persistent pressure to deliver higher performance, higher functionality, smaller size, lower power consumption and lower cost synthesizer designs. However, the major technology challenge is in increasing the synthesizer tuning speed as dictated by the ongoing increase of the data rates of modern microwave systems. While many T&M and communication systems still work adequately with millisecond switching speed, new equipment demands microsecond operation together with performance (phase noise, spurious) similar to the low speed designs. Obviously, this presents serious design difficulties and tradeoffs. Another challenge is cost reduction. Although it is considered to be a fairly "standard" requirement, it drastically narrows the designer's choice. These particular requirements—microsecond tuning speed (together with YIG-based phase noise and spurious characteristics) and low cost—are likely to be the key drivers in the development of the new frequency synthesizers.

ARCHITECTURES

While reviewing traditional frequency synthesizer technologies, the current technology trend toward increasing the synthesizer tuning speed is specifically addressed as well as reducing its complexity and cost. Various synthesizer architectures along with their main characteristics are described below.

Direct Analog Synthesizers

The main job of any synthesizer is translating one or more reference signals to a number of output frequencies with a required step size. Direct analog synthesizers are realized by mixing base frequencies followed by switched filters, as depicted in ***Figure 1***. The base frequencies can be extracted from low frequency (crystal, SAW) or high frequency (DRO, sapphire, metal cavity, CRO, etc.) oscillators by frequency multiplication, division, or phase locking.[7]

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The key advantage of a direct analog technique is its extremely fast switching speed, ranging from micro- to nanoseconds. Another distinct advantage is the ability to generate very low phase noise output, due to the use of components (such as mixers) with negligibly low residual noise, compared with the base frequency sources. Thus, the direct analog synthesizer phase noise mainly depends on the noise of the available reference sources and can be fairly low. The main disadvantage of this topology is a limited frequency coverage and step size. In the example shown, only eighteen output frequencies can be generated, even by utilizing both mixer sidebands. The number of output frequencies can be increased by using a higher number of base frequencies or/and mixer stages, as shown in ***Figure 2***. However, this rapidly increases the design complexity and overall component count. An effective solution is the use of a direct digital synthesizer module (DDS) to increase the minimum step size required from the direct analog portion, as shown in ***Figure 3***. Another serious problem is the large amount of undesired mixing products, which have to be carefully planned and filtered out. Special attention should be paid to the switched filter isolation and leakage. Although a large variety of mixing and filtering organization schemes is possible, they tend to be hardware intensive if small frequency steps and wide coverage are required. Therefore, while this approach offers excellent tuning speed and phase noise characteristics, its usage is limited to applications where fairly high cost can be tolerated.

Direct Digital Synthesizers

In contrast to traditional concepts, the direct digital synthesizers (DDS) utilize digital processing to construct an output signal waveform from a base (clock) frequency,[8] as shown in ***Figure 4***. Initially, a digital representation of a desired signal is created and then it is reconstructed with a digital-to-analog converter (DAC) to a sinusoidal or any other desired signal shape. This process is extremely fast, mainly limited by the digital control. This results in very high switching speeds, comparable with direct analog schemes. DDS also provides reasonably low phase noise even showing an improvement (limited by its residual noise floor) over the phase noise of the clock source itself. From this point of view, DDS acts as a frequency divider. However, the most valuable DDS feature is its exceptionally fine frequency resolution, which is determined by the length of the DDS phase accumulator; sub-hertz levels are easily achieved. The main disadvantages are limited usable bandwidth and spurious performance. While a DDS starts working from nearly DC, its highest frequency is limited by the Nyquist criteria to within one half of the clock frequency. Moreover, a practical design requires an output low pass filter for reconstructing the signal waveform, which further decreases the highest operation frequency to approximately 40 percent of the clock signal. Another serious problem is the high spurious content due to quantization and DAC conversion errors. From a spurious point of view, a DDS can be thought of as a mixer. While the spur location can be easily calculated, its amplitude is much less predictable. As a general rule, lower order spurs are the strongest (although fairly high order spurs must be taken into account during DDS frequency planning). The spur amplitude normally increases with a clock frequency increase, which places another limitation on the DDS usable bandwidth. Practical solutions usually range from a few tens to a few hundreds of megahertz output with a broadband spur-free dynamic range (SFDR) level of –50 to –60 dBc. Direct multiplication of the DDS output is obviously prohibited due to further spur degradation. A number of solutions (both hardware and software based) can be used to reduce the DDS spurs.[9] Hardware techniques are usually based on up-conversion of the DDS signal followed by a frequency divider, as shown in ***Figure 5***. It effectively reduces the DDS spurious content at a 20 dB/decade rate, inherent to the frequency division process. Unfortunately, it also reduces the output bandwidth, requiring more LO frequencies and filters, resulting in a higher component count similar to the direct analog schemes, as shown in ***Figure 6***. On the other hand, software techniques involve effective frequency planning and spur separation. These techniques are based on the fact that a DDS spur location is a function of its output and clock frequencies (similar to the frequency mixers). Therefore, for a given output frequency, one can move (and then filter out) an undesired spur by changing the DDS input clock frequency and tuning command. This technique can be effectively combined with PLL architectures, which provide a variable clock source as well as effective PLL-based output filtering. This software technique works fairly well for relatively low order spurious products. The spur density normally increases proportionally to the spur order, which limits the practical usage of this technique to –70 to –80 dBc levels. Due to the mentioned bandwidth and spur limitations, the DDS technique alone is rarely utilized at microwave frequencies. Rather, DDS is used as a fine frequency resolution module in direct analog and indirect architectures.

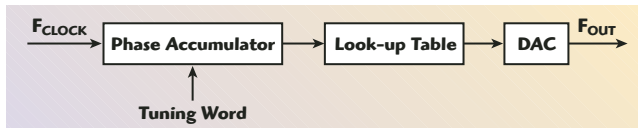

Fig. 4 Direct digital synthesizer block diagram.

Fig. 5 Hardware technique to reduce the spur level of a DDS.

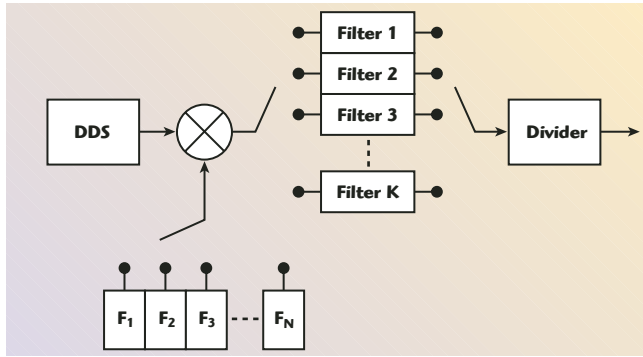

Fig. 6 Scheme to increase a DDS output bandwidth.

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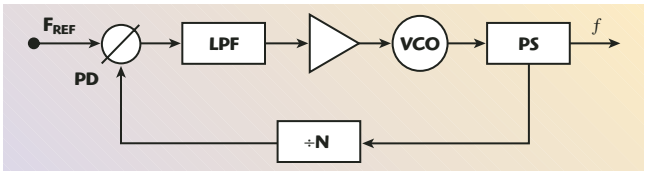

Fig. 7 Indirect frequency synthesizer schematic.

Indirect Frequency Synthesizers

Indirect frequency synthesizers utilize phase locking (PLL) techniques offering smaller size and lower complexity, compared to direct analog schemes.[10–14] A typical single-loop PLL synthesizer includes a tunable voltage-controlled oscillator (VCO), the output of which is fed back to a phase detector (PD) via a power splitter (PS) and a frequency divider with a variable frequency division ratio N, as shown in ***Figure 7***. The other input of the phase detector is a reference signal equal to a desirable frequency resolution. The phase detector compares the signals at both inputs and generates an error voltage which, following filtering and amplification (optionally), slews the frequency of the VCO to the lock frequency given by $f = F_{REF} \times N$, where F_{REF} is the reference frequency at the phase detector input. The major advantages of this scheme are reduced levels of spurious signals, owing to the low pass filter action of the loop, and a much lower level of complexity compared with the direct analog synthesizers. The main disadvantages are longer frequency switching time (which is inversely proportional to the loop bandwidth and consequently step size) and considerably higher phase noise in comparison with direct analog techniques. The single-loop synthesizer phase noise performance within its loop filter bandwidth is given by $\lambda = \lambda_{PD} + 20 \log N$, where λ_{PD} is the cumulative phase noise of the reference signal, phase detector, feedback divider, loop filter and amplifier referred to the phase detector input, as shown in ***Figure 8***. Thus, the phase noise is affected by the large division ratios required to provide a high frequency output with a fine resolution. For example, in order to get 10 GHz output with 1 MHz step size, the feedback divider ratio has to be 10000, which corresponds to an 80 dB phase noise degradation. Moreover, programmable dividers are usually not available at high frequencies, thus an additional fixed divider (prescaler) is required. In this case, the total division ratio will increase by the prescaler division coefficient resulting in further phase noise degradation. Obviously, this simple scheme does not allow utilizing the noise performance of modern low noise reference oscillators. Moreover, the discrete spurs at multiples of the reference frequency tend to be proportional to the loop division ratio N, which also leads to spurious degradation.[10] As a result, the single-loop schemes are only used in moderate performance applications.

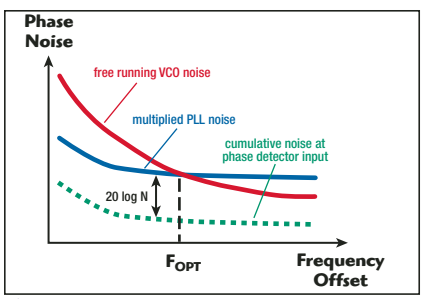

Fig. 8 Single-loop synthesizer phase noise.

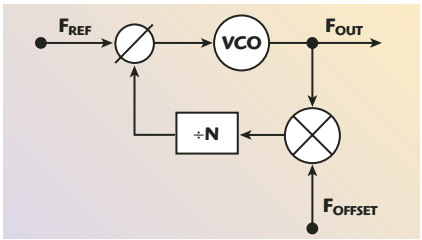

Fig. 9 Single-loop synthesizer with frequency conversion in the feedback path.

The synthesizer's main characteristics can be drastically improved by employing a frequency conversion (mixing) within the synthesizer feedback path, as shown in ***Figure 9***. Here, the VCO output frequency is converted with the aid of an offset frequency source in order to minimize the maximum frequency division ratio and the number of ratios that otherwise would be necessary.[10] The offset signal can be produced from the same reference using additional PLLs (multi-loop schemes) or frequency multipliers. An attractive solution is a sampling (harmonic) mixer that utilizes multiple harmonics created by a built-in step recovery diode. This approach usually leads to a shorter bill of materials in comparison with fundamental mixing schemes. The main drawback of the sampling mixer is its sensitivity to circuit parameters; making one work properly is not trivial. Depending on particular phase noise and step size requirements, a higher number of mixing stages can be needed which leads to a higher level of complexity. Another problem associated with any frequency-mixing scheme is a possible false lock to undesired (that is a wrong sideband) mixing products. This type of failure requires a sufficiently accurate coarse-tuning mechanism. A DAC may be included to coarse-tune the VCO to approximately the correct frequency. This acquisition aid requires linear (and repeatable) VCO tuning characteristics over the operating temperature range as well as precise frequency calibration to compensate the VCO temperature drift. Moreover, DACs are usually too noisy, adversely affecting the synthesizer phase noise performance, if they are not properly removed after the initial frequency acquisition.[10] Another way to reduce the overall loop division ratio is based on the use of a fractional divider. Fractional division coefficients are achieved by dividing the input frequency by N+1 every M cycles and dividing by N the rest of the time.[15] In this case, the average division coefficient will be (N+1)/M, where N and M are integers. For a given step size, fractional-N schemes allow a higher phase detector comparison frequency that potentially results in better phase noise and tuning speed characteristics. The main disadvantage of the fractional-N technique is excessive spurious levels, due

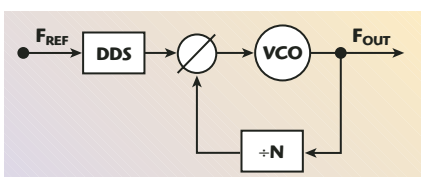

Fig. 10 Fractional-N synthesizer with DDS inserted in the reference path.

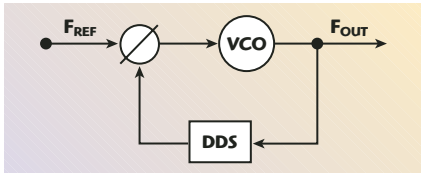

Fig. 11 Fractional-N synthesizer with DDS inserted in the divider path.

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2 – 8	SW1-020080RN1NF	2	80	1.7:1	10/10	20	35	35/70
4 – 12	SW1-040120RN1NF	2.2	80	1.7:1	10/10	20	35	35/70
2 – 18	SW1-020180RN1NF	3	80	2:1	10/10	20	35	35/70
1 – 18	SW1-010180RN1NF	3	70	2:1	10/10	20	35	35/70
SP2T								
0.2 – 2	SW2-002020RN1NF	1.5	70	1.6:1	10/10	20	35	60/60
2 – 8	SW2-020080RN1NF	1.8	80	1.7:1	10/10	20	35	60/60
4 – 12	SW2-040120RN1NF	2.2	80	1.7:1	10/10	20	35	60/60
2 – 18	SW2-020180RN1NF	2.8	80	2:1	10/10	20	35	60/60
1 – 18	SW2-010180RN1NF	3	70	2:1	10/10	20	35	60/60
SP3T								
0.2 – 2	SW3-002020RN1NF	1.6	70	1.6:1	20/20	150	180	85/85
2 – 8	SW3-020080RN1NF	1.9	80	1.7:1	20/20	150	180	85/85
4 – 12	SW3-040120RN1NF	2.4	90	1.7:1	20/20	150	180	85/85
2 – 18	SW3-020180RN1NF	3	80	2:1	20/20	150	180	85/85
1 – 18	SW3-010180RN1NF	3.1	70	2:1	20/20	150	180	85/85

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to phase errors inherent to the fractional division mechanism.

A very effective solution is the use of a DDS module, which is essentially a fractional divider as well. The DDS can be inserted into the reference or divider path, as shown in ***Figures 10*** and ***11***, respectively. Special attention should be paid to the DDS spurious signals, which are degraded by the loop division ratio at the same 20 dB/decade figuration using the DDS in the reference path is more flexible, since it allows minimizing or completely removing the loop division by inserting an additional offset signal as previously discussed. Although no divider is shown when the DDS is inserted in the divider path, this configuration also brings spurious degradation, set by the ratio of the DDS input (clock) and output frequencies. The DDS spurious re-

scribed can be effectively utilized here, enjoying natural, high rejection PLL filtering. Although these solutions complicate the overall design, the complexity can be effectively spread and optimized, which leads to a high performance and reasonably priced design.

VCO Choice

Any indirect synthesizer design strongly depends on the VCO characteristics. Historically, synthesizer developers have relied on YIG-tuned oscillators featuring broadband operation and excellent phase noise performance. The YIG oscillators also offer very linear (and repeatable) tuning characteristics that simplify the synthesizer coarse-tuning algorithm in multi-loop schemes. Beside this, the YIG oscillators feature relatively low and nearly constant tuning sensitivity that also helps to optimize the synthesizer spurious performance. These unique features permitted the YIG-based microwave synthesizers to dominate during the last few decades. However, the high power consumption, large size, high cost and especially low speed inherent to the YIG oscillators have recently contributed to a shift to solid-state VCO architectures. Currently, high frequency (up to 10 GHz and above) VCOs are readily available as low cost, surface-mount IC components. Since the VCO noise is considerably worse compared to its YIG counterpart, the designer should primarily rely on the reference source. Today's commercial crystal oscillators offer noise performance of –160 to –176 dBc/Hz at 20 to 100 kHz offset for a 100 MHz output.[16] These numbers are translated to –120 to –136 dBc/Hz at the same offset and for a 10 GHz output, which corresponds or even supersedes the performance of the best YIG oscillators. Of course, it is assumed that this translation is not affected by the synthesizer system noise floor. Although this assumption calls for very advanced synthesizer solutions, the net effect is evident: the VCO-based designs can potentially achieve much faster tuning speed, together with comparable phase noise and spurious performance without the use of expensive, bulky and power hungry YIG devices.

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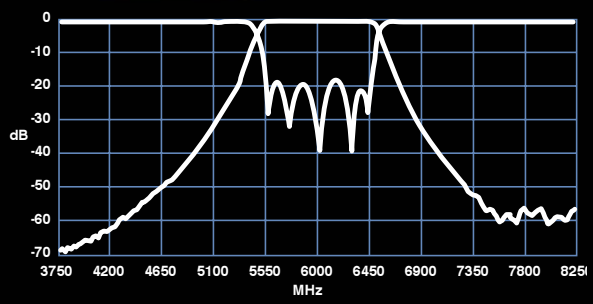

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ing unprecedented speed and phase noise performance. Although its complexity is in conflict with the industry "standard" cost-reduction requirement, it can be an excellent choice for some applications where fairly high cost can be tolerated. Some cost reduction is expected with the development of higher frequency, lower spurious DDS ICs, which can simplify the direct analog synthesizer design. Direct digital synthesizers have a tremendous potential for future growth as a result of exceedingly rapid developments in GaAs, silicon and SiGe devices. The extension of a DDS usable bandwidth (together with its spur content reduction) is the key improvement required by the industry. It will directly impact the performance of direct analog and indirect architectures where a low cost DDS IC becomes a "must have" building block. However, the most exciting near-term developments are likely to be associated with the VCO-based indirect technologies. Much of the progress here will be brought by reduction of the system residual noise floor, in order to extend the PLL bandwidth to much higher frequencies. The most dramatic change will occur when the optimum loop bandwidth extends to a few megahertz, where solid-state VCO noise becomes competitive with the YIG devices. Equipping the synthesizer with a low noise reference gets a "YIG-grade" noise performance, but offers an amazingly faster, microsecond-range tuning speed. These characteristics, accompanied with the low cost inherent to the indirect designs, are likely to secure their domination in the foreseeable future. ■

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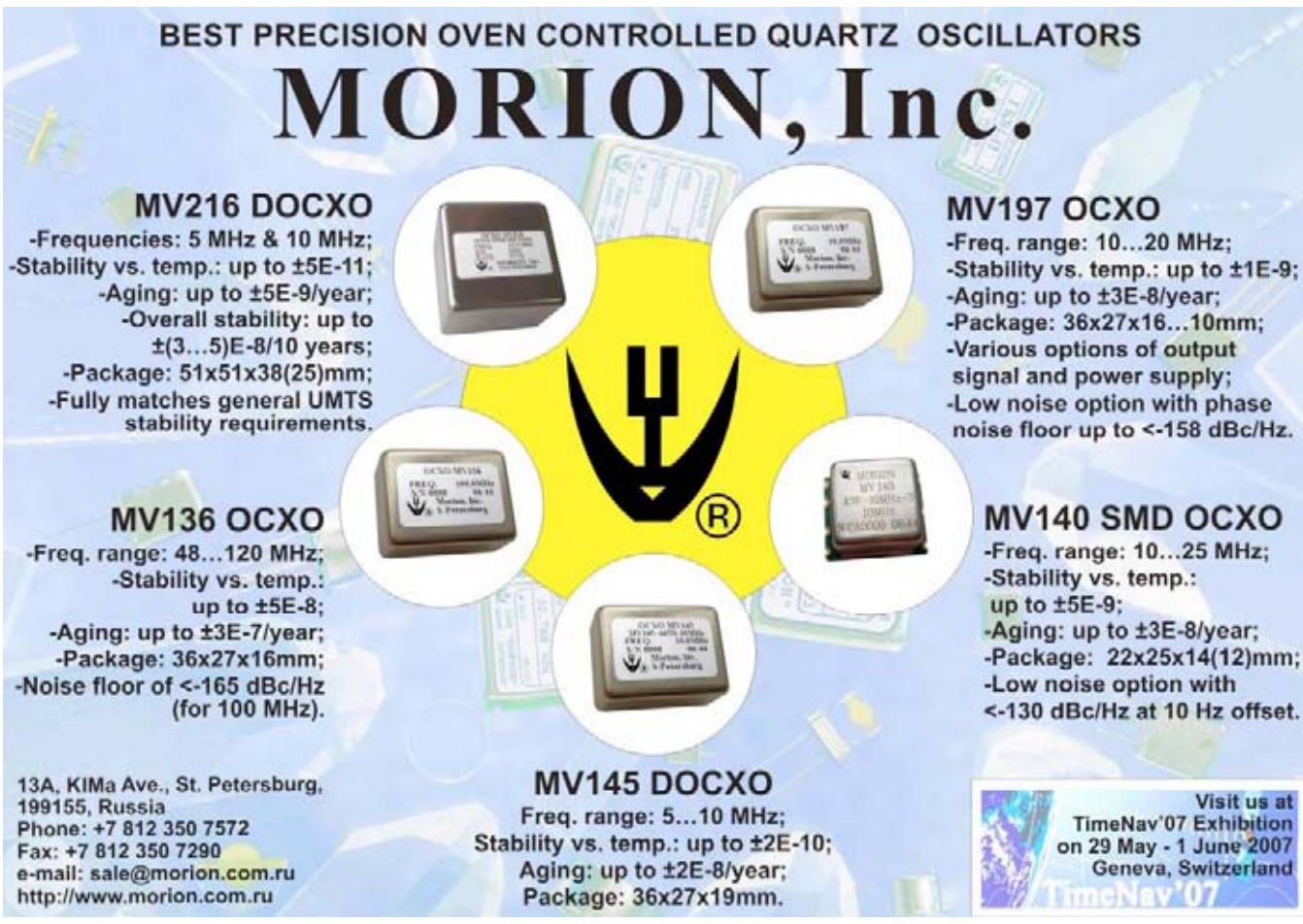

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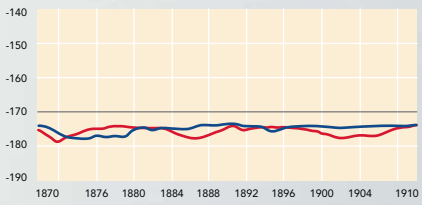

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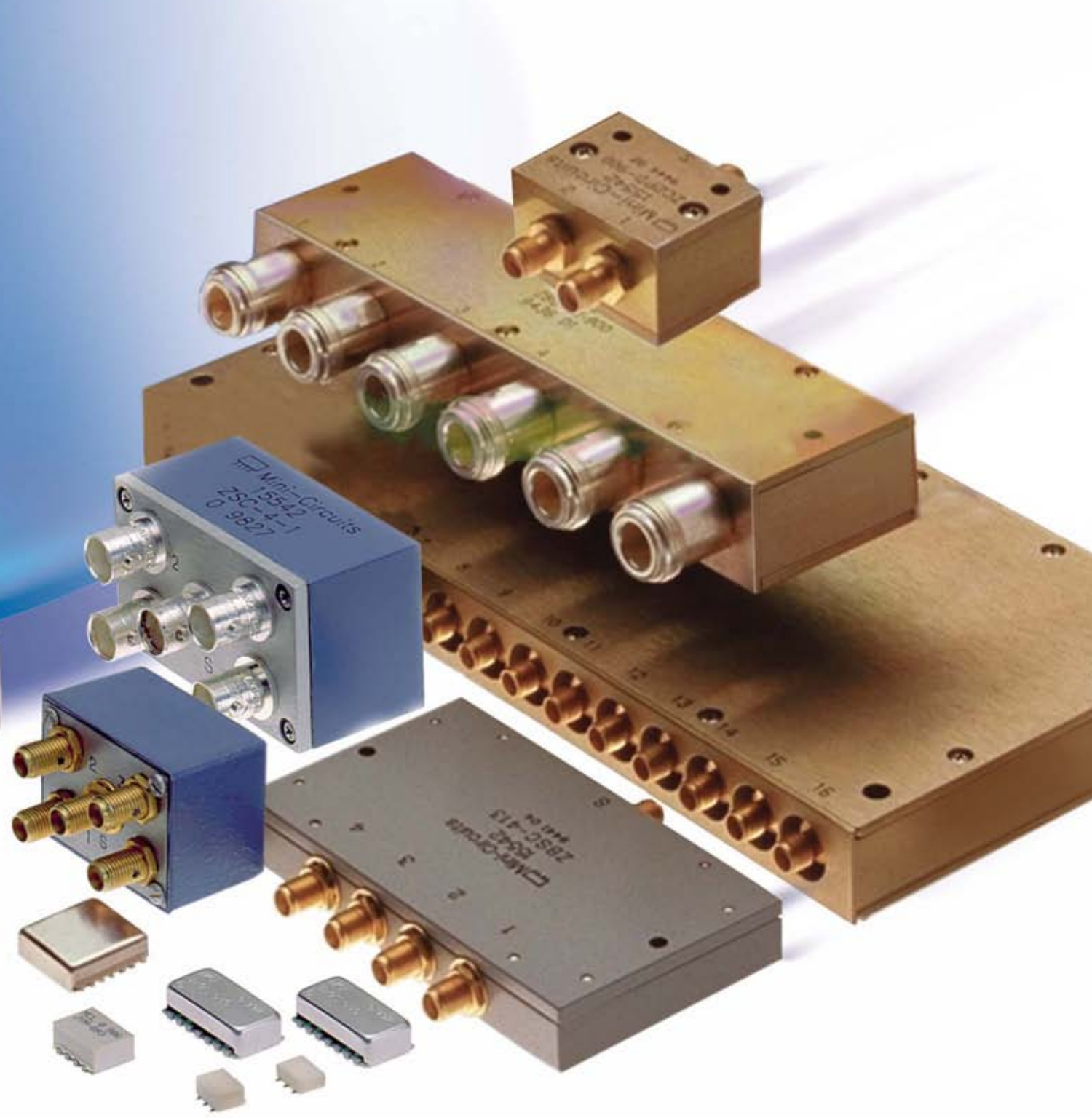

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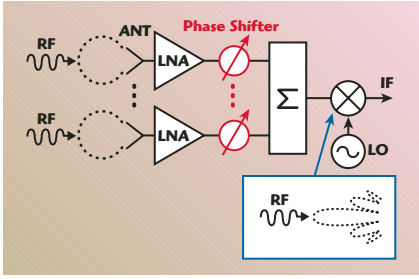
Phased arrays allow the electronic steering of an antenna beam in any direction and with high antenna gain by controlling the phase at each antenna element. This beam steering technique is much more compact and much faster than mechanically steered arrays. Furthermore, phased arrays allow the creation of deep nulls in the radiation pattern to mitigate strong interference signals from several different directions (see ***Figure 1***). They have been in use since the 1950s in defense applications, but have seen limited use in commercial systems due to their relatively high cost. The main reason for the high cost of phased arrays is the complexity of the transmit/receive (T/R) modules which contain low noise and power amplifiers, phase shifters, T/R switches, DC power control, and the necessary address decoders and memory latches for phase and gain setting for each module. Furthermore, T/R modules are hand-assembled using a combination of GaAs chips for microwave amplifiers and phase shifters, and CMOS electronics for digital control. A transmission-line based beamformer is also used to add all of the T/R modules together at the back-end of the array. All of this has basically resulted in very expensive phased arrays suitable only for defense applications.

The cost of phased arrays can be drastically reduced if several RF and digital functions are integrated together on a single chip. For a re-

Fig. 1 A phased array with controllable main beam and nulls.



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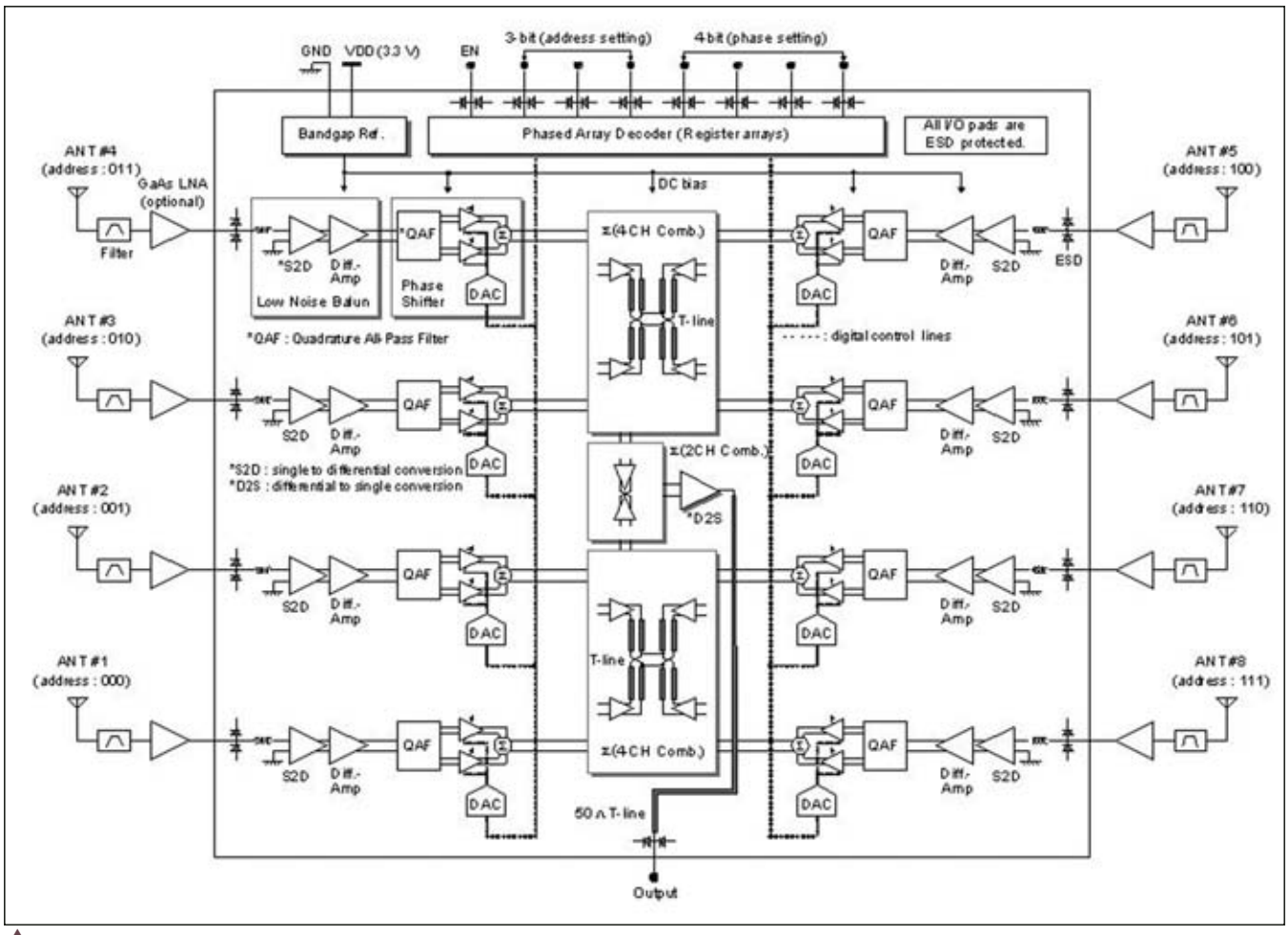

Fig. 2 Block diagram of the eight-element 6 to 18 GHz phased-array receiver.

ceive array suitable for wireless communications, for example, one can integrate the amplifiers, phase shifters, amplitude control and the 8:1 combining network, all on a single chip, using the latest SiGe/CMOS silicon RFICs. In the past few years, tremendous advances have occurred in SiGe and CMOS transistors and their integration technology. It is now possible to get 0.2 µm SiGe transistors with an f_t of 120 to 150 GHz together with 0.18 µm CMOS transistors with an f_t of 50 GHz in a standard BiCMOS process, such as the Jazz SiGe SBC18HX.[1] A six-layer aluminum metal process embedded in an SiO_2 dielectric medium is present above the transistors and allows for very dense RF and DC interconnects. The top metal layer is 3 µm-thick and is ideal for high Q inductors and low loss transmission lines. All of this makes the latest SiGe BiCMOS technology ideal for 2 to 60 GHz applications with excellent gain, noise figure and very high integration density.

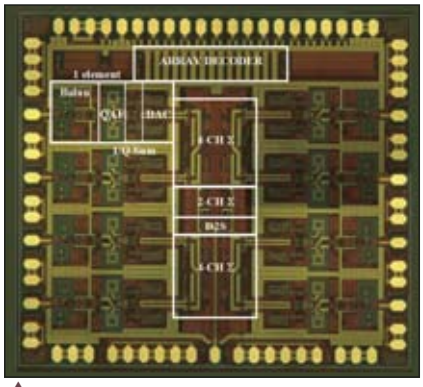

Fig. 3 Photograph of the eight-element 6 to 18 GHz phased-array receiver.

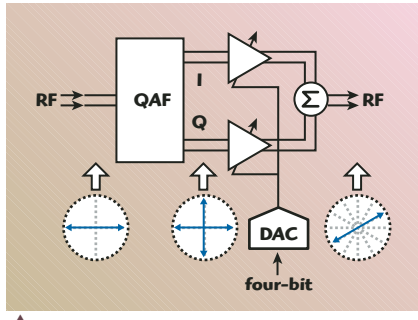

Fig. 4 The miniature 6 to 18 GHz RF phase shifter based on vector addition of RF I and Q signals.

Knowing this, an eight-element 6 to 18 GHz phased-array receiver on a single silicon chip was designed and tested (see ***Figures 2*** and ***3***). The phased-array chip was developed using the Jazz SiGe SBC18HX process. The RFIC chip contains eight RF inputs, followed by eight low noise amplifiers, eight phase shifters with at least four-bits of phase control, and an 8:1 active power combiner with very wide bandwidth (one RF output), together with all the digital functions needed to control the chip such as the address decoders for the individual eight elements, the memory latches for the phase settings, the clock enable functions to load the information on the chip and power regulators. Furthermore, the chip can operate over a narrow bandwidth for communication systems, or over an instantaneous 12 GHz (6 to 18 GHz)

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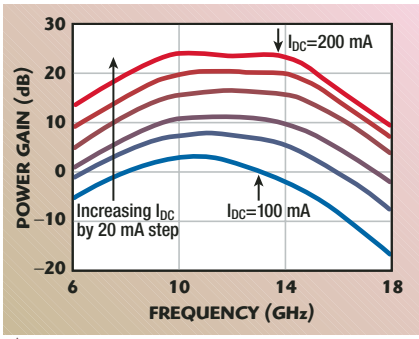

Fig. 5 Measured gain versus bias current for a single channel at 6 to 18 GHz.

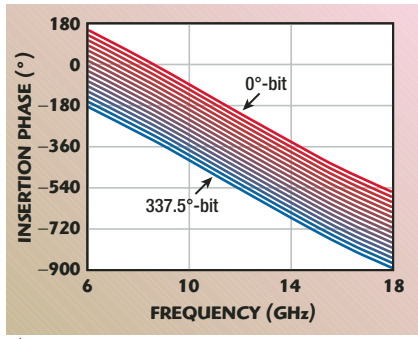

Fig. 6 Measured phase (four-bit phase control) for a single channel at 6 to 18 GHz.

TABLE I

CHIP ELECTRICAL CHARACTERISTICS

Technology	0.18 µm BiCMOS (Jazz SBC18HX)
Frequency (GHz)	6 to 18
Supply voltage (V)	3.3
Current consumption (mA)	100 to 200 (depends on power gain)
Power gain (dB)	2 to 24 (at 12 GHz, controllable)
Phase resolution	four bits (6 to 18 GHz)
Phase error	< $6°_{rms}$ (6 to 18 GHz)
Noise figure (dB)	6.2 (at 12 GHz with 19 dB of gain)
Size (mm)	2.2 × 2.4

bandwidth for EW or radar systems, while keeping its performance unchanged. Thus, solving one of the key barriers to complex phased-array fabrication.

One of the key elements in the design is the miniature 6 to 18 GHz phase shifter (see ***Figure 4***). In this design, the input RF signal is first transformed into a differential signal using an active balun composed entirely of differential transistors, and the differential RF signal is then divided into in-phase (I) and quadrature (Q) signals using a passive I/Q network. The I and Q signals are then added vectorially using a transistor summer circuit. This results in an output phase which can vary from 0° to 360° depending on the gain in the I and Q paths. This gain is set using a four-bit digital-to-analog circuit (DAC), with the input being the digital phase shift and the output being the analog current control for the I and Q paths. This circuit effectively results in a constant phase shift versus frequency and is therefore not a true-time delay circuit. However, for an eight- or even a 16-element array, a constant phase shift is acceptable at the element level, and a TTD circuit is placed at the sub-array level for wideband beam control. ***Figures 5*** and ***6*** show the measured gain and phase of a single element in the array. The measurements for the other seven elements are not shown and have virtually identical results. The chip is only 2.3 × 2.4 mm, consumes 100 to 200 mA of DC current from a 3.3 V power supply with an associated gain from 2 to 24 dB, and the phase response is nearly ideal from 0° (reference) to –337.5° (max. four-bit value). The measured rms phase error, over the entire 6 to 18 GHz range, is less than 6° rms. This is an excellent result and shows a phase accuracy of nearly 6 bits. The measured noise figure is 6.2 ±0.2 dB at 12 GHz (not shown) over the entire 16 phase states. The noise figure can be reduced in future designs to 2 to 3 dB especially for a 6 to 12 GHz operation. However, if a noise figure of 0.8 to 1.6 dB is required for applications such as satellite communications, then the chip must be preceded by GaAs low noise amplifiers. A summary of the chip's electrical characteristics is presented in ***Table 1***. The application areas are in low cost phased arrays for mobile satellite systems, smart-antenna wireless systems for high data-rate communications, and, of course, defense systems such as radars and high bandwidth telecommunication links covering the X- to Ku-band frequency range. The UCSD phased-array receiver is a disruptive element in the design of future phased-array systems and will replace at least eight GaAs chips. Furthermore, one can build 16-element or even 32-element phased arrays on a single silicon chip due to the high yield of BiCMOS technology. A 16-element 30 to 50 GHz phased-array transmitter is currently under development at UCSD. ■

ACKNOWLEDGMENTS

This work was sponsored by the DARPA SMART (Scalable Millimeter-wave Array Technology) program under the direction of Mark Rosker and under a subcontract from Teledyne Scientific Corp., Thousand Oaks, CA. The phased-array chip was developed using the Jazz SiGe SBC18HX process.

Kwangjin Koh *received his BS degree in electronic engineering from Chung-Ang University, Korea, in 1999, and his MS degree in electrical engineering from the Korea Institute of Science and Technology (KAIST), Korea, in 2001. He is currently a PhD student at the University of California at San Diego. From 2001 to 2004, he worked at the Electronics and Telecommunications Research Institute (ETRI), Korea, where he was engaged in the research and development of RF and analog CMOS integrated circuits for wireless digital communications systems, such as WCDMA and WLAN 802.11a/b/g systems.*

Gabriel M. Rebeiz *received his PhD degree from the California Institute of Technology in 1998. He is currently a professor of electrical engineering at the University of California at San Diego. He has contributed to planar mm-wave and terahertz antennas and imaging arrays from 1988 to 1998 and to the development of RF MEMS from 1996 to present.*

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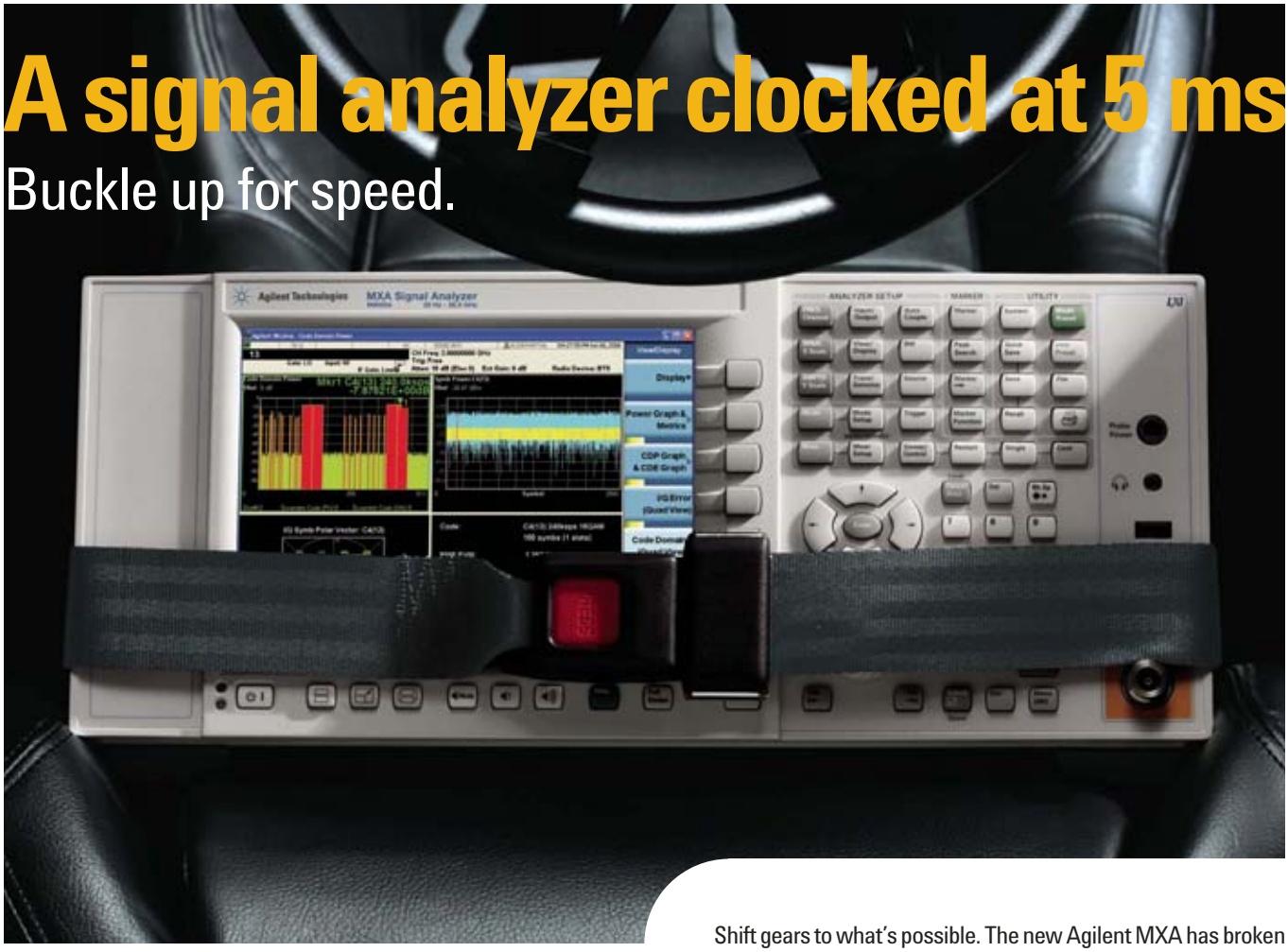

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A DIGITAL INSTANTANEOUS FREQUENCY MEASUREMENT RECEIVER

Most radar warning (RW), electronic countermeasures (ECM) and electronic intelligence (ELINT) systems employ instantaneous frequency measurement (IFM) to identify threats, map the electronic battlefield and eventually implement deceptive countermeasures. In its development of systems in this sector Elisra has made advances with the introduction of its Digital Instantaneous Frequency Measurement (DIFM) receiver, which is shown in ***Figure 1*** as a block diagram. This receiver offers the user large broadband instantaneous frequency coverage of 2 to 18 GHz, high dynamic range, high frequency measurement accuracy and fast throughput time—less than 400 ns.

RF AND IF/VIDEO

To provide an understanding of how these performance figures are achieved one must examine more closely the operation of the new DIFM receiver, starting with the RF and IF/video sections. First, an RF pulse (100 ns minimum) is applied to a limiting RF amplifier where the limited RF power is channelized into M channels and then downconverted to an IF baseband by internal local oscillators. The M IF basebands are processed in the IF/video card to generate the internal signal and to define the band code. The IF baseband channels are then combined into two IF outputs to drive the digital IFM card, which is based on digital processing single bit IF samples and is shown in ***Figure 2***. A functional block diagram of the digital IFM is shown in ***Figure 3***.

The input IF signal is sampled at a high rate to provide the necessary IF bandwidth according to the Nyquist criteria. Sampling is performed with single bit resolution so that the incoming signal is, in fact, limited. As a result the sine wave is transformed into a square wave.

DIFM: PRINCIPLE OF OPERATION

Digital processing is analogous to that of an analog IFM, while enjoying the benefits of digital processors. The basic principle is that the incoming bit stream is subject to a predetermined delay after which it is auto-correlated. The analog mixing and low pass filtering is replaced in the digital domain by auto-correlation (binary XOR) and summation of the resultant bits.

For an incoming bit stream b_k, consisting of N bits, the auto-correlation for a delay of d bits is defined as

$$C_d = \sum_{k=0}^{N-1} b_k b_{k-d} \qquad (1)$$

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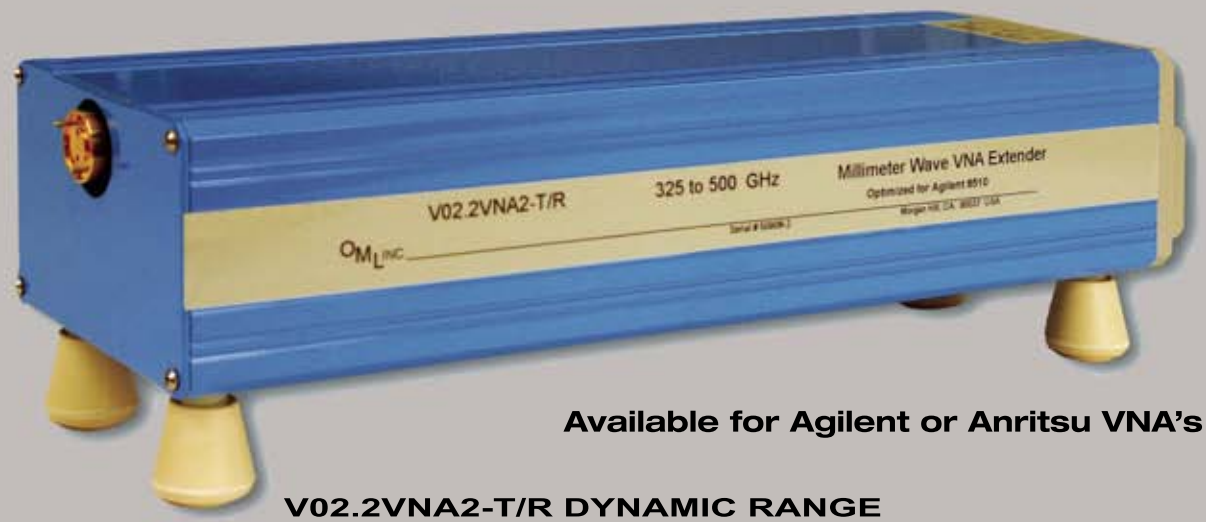

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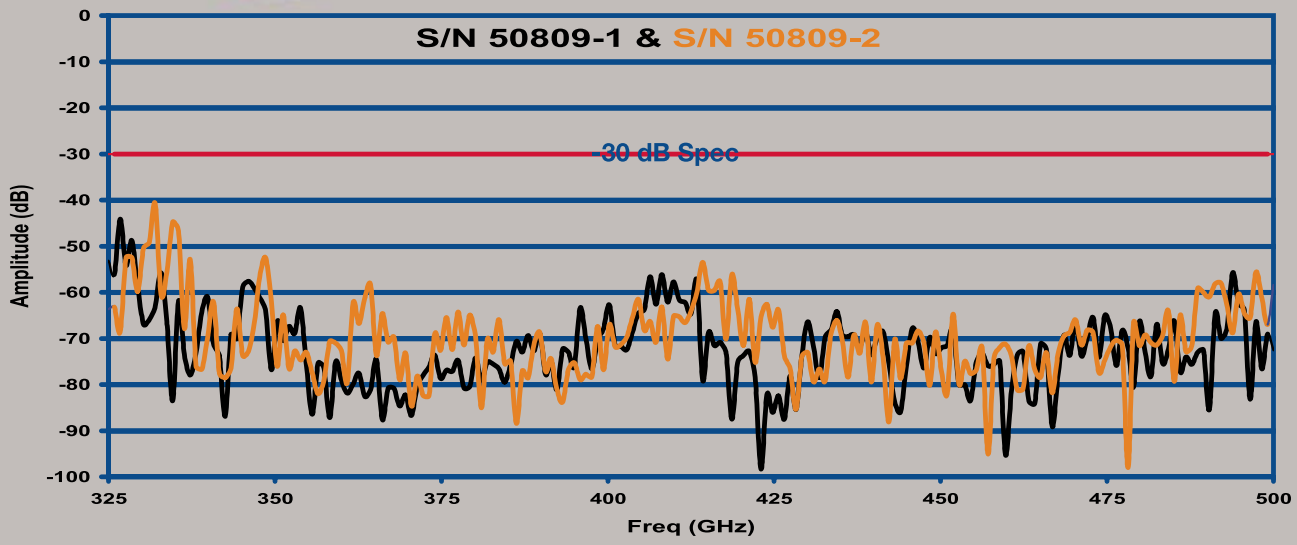

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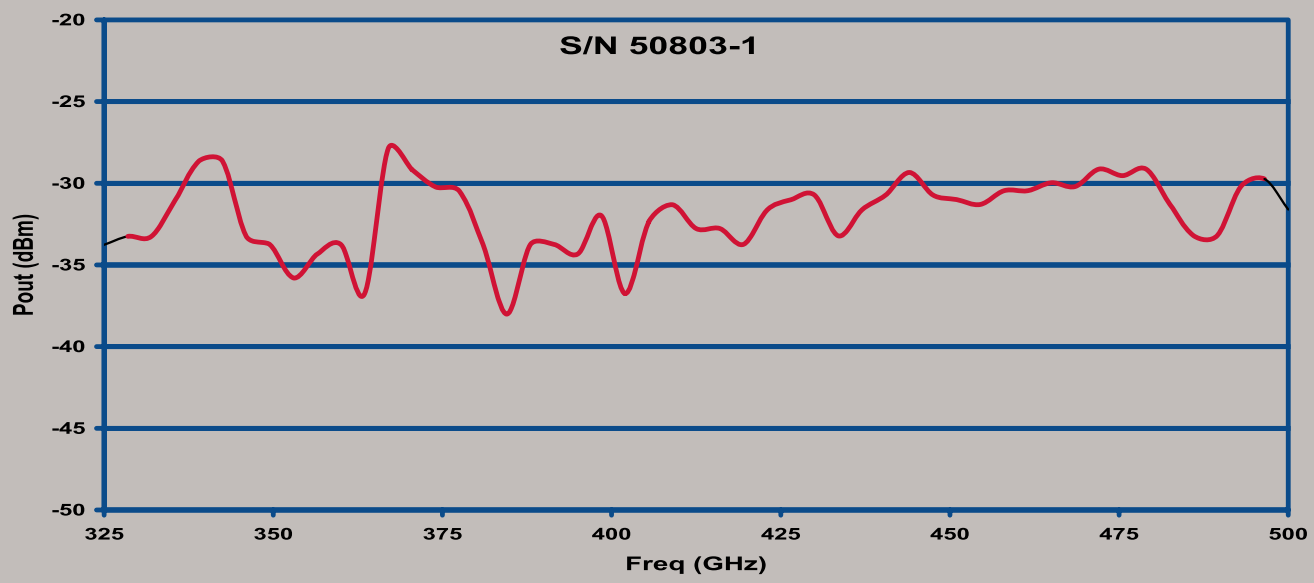

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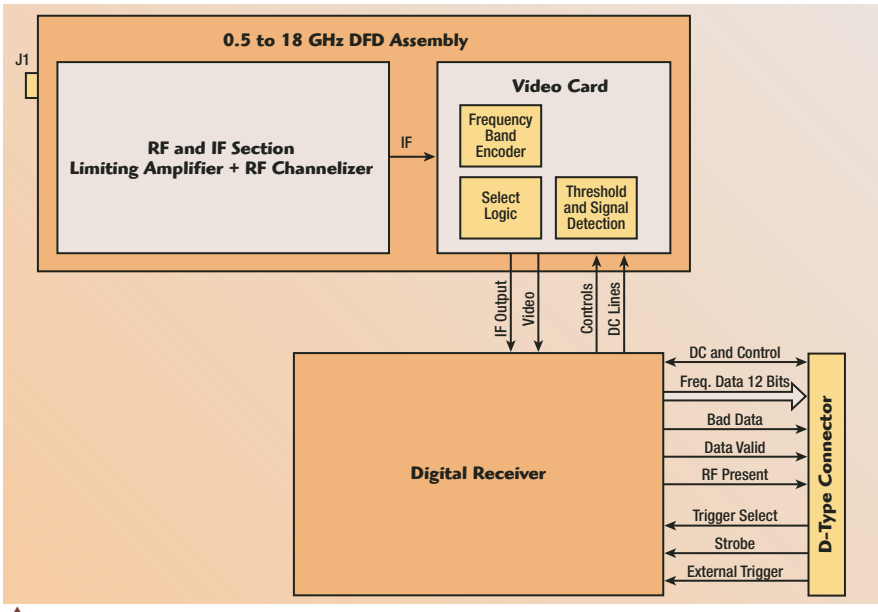

Fig. 1 The DIFM's general block diagram.

It may be helpful to try to visualize the auto-correlation sum as the area enclosed by two overlapping square waves, representing the incoming square wave and its delayed replica (where the two waves are different, the XOR will contribute a '1' bit to the sum).

Fig. 2 The digital IFM card.

Thus, for a delay of 1 bit, each cycle will contribute two '1's to the overall sum. Due to the fact that within a sequence of N bits there are N/T (or Nf) cycles, it is easy to see that $C_1 = 2Nf$, where f is the normalized frequency of the signal with respect to the sample rate f_s. This relationship, depicted in ***Figure 4***, enables a direct calculation of the signal frequency from the value of C_1.

However, this result has only N discrete values and may not provide the desired accuracy and resolution. Increasing the delay d and calculating C_d improves the situation. Following this same reasoning, each cycle now contributes 2d to the value of C_d. The slope is now d times larger, leading to a stronger frequency response—a small change in frequency generates a large change (d times) in the auto-correlation value.

If C_1 reaches the maximum value N at the maximum allowable frequency $f_s/2$, C_d will reach its peak value at $f_s/(2d)$. At this point it will begin to decrease and the result will be a triangular wave with d slants spanning the $0 \ldots f_s/2$ frequency range. ***Figure 5*** demonstrates the relationship between C_k and the frequency. Thus, while C_d is d times more accurate than C_1, it also produces d ambiguous results.

The frequency measurement procedure of the DIFM receiver consists of several successive stages. Each provides a frequency measurement with improved accuracy over the previous stage and is accurate enough to solve the ambiguity of the subsequent stage. The successive stages do not utilize successive delay values, as the accuracy provided by a given step is generally good enough to advance to a delay value somewhat larger than that of the current stage.

As has already been stated, this approach and mathematical foundation is also at the heart of common analog IFM circuits and digital frequency discriminator (DFD) devices. How-

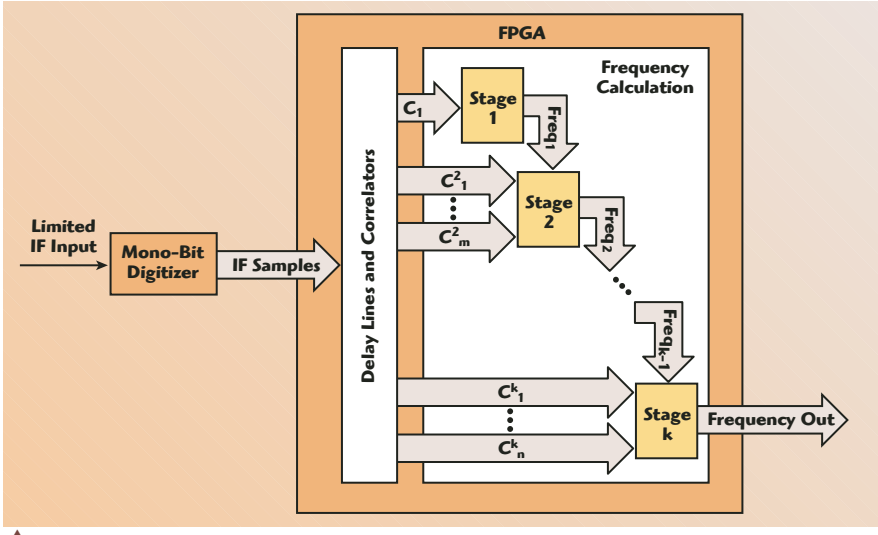

Fig. 3 The DIFM's functional block diagram.

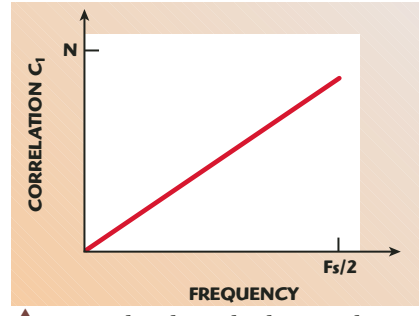

Fig. 4 The relationship between the correlation C_1 and frequency.

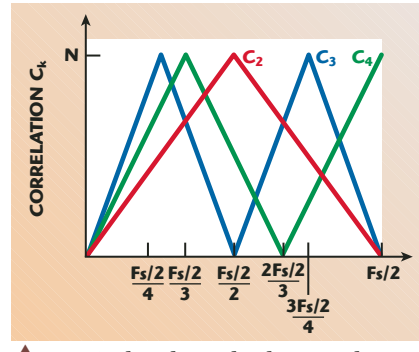

Fig. 5 The relationship between the correlation C_k (k = 2, 3, 4) and frequency.

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TABLE I

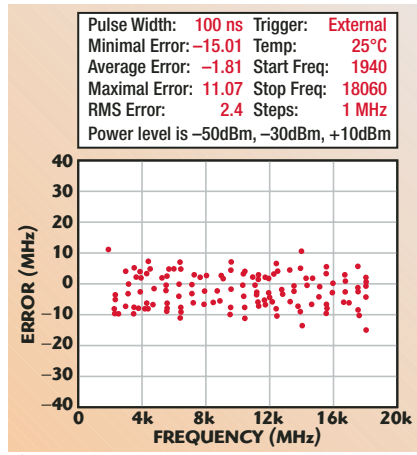
RESULTS FOR 2 TO 18 GHz DIFM

Parameter	Test Results
Frequency resolution (MHz)	0.9
Frequency accuracy (external/internal) (MHz RMS)	2.5
Dynamic range (dB)	60
Throughput time (ns)	380
Signal-to-noise ratio (dB)	3
Threshold level (dBm)	–55
Simultaneous signals	√
Pulse on CW	√
Power consumption (W)	23.5

ever, the digital implementation by field programmable gate array (FPGA) devices facilitates the calculation of many different auto-correlation values, with the advantage of being unrestricted by analog HW considerations relying on physical delay lines. Similarly, the digital delay has absolute accuracy (only limited by sampling clock stability), whereas its analog counterpart suffers from instability due to environmental conditions and requires frequent calibration and maintenance.

IFM devices can suffer from reduced accuracy near frequencies that are related to the delay value. To counter this, within a given stage multiple delays of similar values are employed so that the best of them may be selected. In the analog case this provides an additional burden limiting device performance. The digital IFM, however, accommodates several stages, each supporting several different delay values. Thus, complete accuracy is ensured across the frequency range.

Another key factor is that due to the successive nature of the algorithm, the number of stages implemented may be tailored to various customer needs regarding the trade off between latency and accuracy. With systems supporting the necessary interface, the calculation procedure may be adapted on-line to suit specific system needs.



▲ *Fig. 6 Test results for the Elisra 2 to 18 GHz DIFM receiver.*

Utilization of high speed embedded multipliers in state-of-the-art FPGA devices allows simple implementation of the various stages of frequency calculation and ambiguity resolution. These also account for the short latency within which the desired frequency measurement is provided.

Through the integration of advanced RF design and sophisticated digital methods, the 2 to 18 GHz DIFM receiver is well equipped to deliver high levels of performance and operation. ***Table 1*** illustrates the results when the device was put through its paces using automatic test equipment (ATE). ***Figure 6*** shows the measurements of its RMS frequency accuracy over the 2 to 18 GHz band.

CONCLUSION

The 2 to 18 GHz DIFM receiver offers those requiring radar warning, electronic countermeasures and electronic intelligence systems a digital receiver that incorporates state-of-the-art technology to deliver large broadband frequency coverage, high dynamic range, high frequency measurement accuracy and fast throughput, therefore meeting the demands of modern military/security/countermeasures systems.

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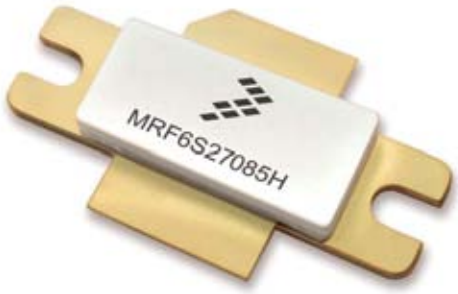

LDMOS FETs FOR 2.7 AND 3.5 GHz WiMAX APPLICATIONS

Each new generation of wireless access technology has presented greater challenges than the previous generation for designers of RF power transistors and power amplifiers. For example, the emergence of digital modulation schemes and multi-carrier amplifiers placed more stringent requirements on linearity. Now, WiMAX is raising the bar even higher, as it employs orthogonal frequency division multiplexing (OFDM), which requires exceptionally high levels of linearity and efficiency, along with high output RF power capabilities. To meet the demands of the WiMAX environment, Freescale Semiconductor has introduced two families of LDMOS FETs that satisfy the demanding operational requirements of WiMAX in both the 2.7 and 3.5 GHz WiMAX bands.

The reason for OFDM's increasing popularity is that it can deliver high data rates with efficient spectrum use by using multiple overlapping carrier signals instead of a single carrier as in current WCDMA and cdma2000 wireless systems. It can accomplish this even in non-line-of-sight (NLOS) links that suffer multipath conditions, which can significantly degrade network performance, without resorting to complex equalization filters that are expensive and difficult to design. It also eliminates crosstalk, and its low symbol rate helps keep time-domain spreading encountered in multipath propagation to a minimum, thanks to a guard interval between symbols.

As a result, in addition to its use in WiMAX, OFDM is rapidly becoming the modulation scheme of choice in coming generations of wireless systems, regardless of the more stringent requirements it places on RF designs and the potential increase in overall

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New! iT2004	2 to 20 GHz	10	1	28
iT2005	30 kHz to 26.5 GHz	16	1	20 to 25
iT2005F	30 kHz to 18 GHz	15	1	19 to 25
iT2008	10 MHz to 26.5 GHz	10	1	24 to 29
iT2009	2 to 26 GHz	20	1	24.5 to 29
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system cost. It is also used in wired broadband applications such as DSL and cable.

OFDM signals have a high peak-to-average power ratio (PAR) because the phase of multiple sub-carriers can combine constructively. Therefore, from a design perspective, it necessitates the use of a high resolution digital-to-analog converter in the transmitter, a high resolution analog-to-digital converter in the receiver and highly linear devices in the transmit section. Levels of nonlinearity that are acceptable in the latest 3G wireless systems result in intermodulation distortion in WiMAX systems that can cause intersymbol interference along with out-of-band spurious signals.

DESIGN CHALLENGES

For designers of RF power devices and amplifiers, the challenge is to deliver a level of linearity that satisfies the difficult requirements of OFDM, while still producing acceptable RF output power with the fewest number of power devices in order to reduce power consumption, system complexity and cost. To achieve this performance, RF power devices are operated in backoff conditions to varying degrees from their rated P1dB gain compression power capability, depending on the chosen amplifier design. The Freescale devices have been designed with various P1dB power levels as high as 160 W CW at 2.7 GHz—believed to be the highest power currently available in an RF power device suitable for WiMAX operation.

Prior to the release of Freescale's LDMOS FETs, the feeling among some was that while LDMOS could deliver the required performance at 2.7 GHz, higher frequencies were beyond its capabilities. However, this is hardly the first time the limits of LDMOS have been proclaimed and then exceeded. The technology has shown repeatedly over the years that its capabilities can be extended to higher frequencies (in this case 3.5 GHz), and that its practical limitations are not likely to be reached anytime soon.

At 3.6 GHz, the MRF7S38075H delivers P1dB output power of 75 W and a WiMAX compliant –49 dBc ACPR at a 12 W average, gain of 14 dB and efficiency of 14 percent. The MRF7S38010H delivers P1dB output power of 10 W and a WiMAX compliant –49 dBc ACPR at a 2 W average, gain of 15 dB and efficiency of 17

TABLE I

WiMAX AMPLIFIER LINEUPS WITH TWO DEVICE SCENARIOS

	MRF6S27015N	MRFG35010N (2 Devices)	MRF6S27085H (2 Devices)	Total
Scenario 1				
Typical gain (dB)	14	10	15.5	39.5
Output power (W)	0.18	1.8	40	40
ACPR (dBc)	–45	–42	–48	–33
Drain efficiency (%)	22	25	23.5	20.8
Current consumption (A)	0.16	0.83 (at 12 VDC)	6.07	7.06
DC power (W)	4.5	18	170	192.5
	MRF6S27015N (2 Devices)	**MRF6S27085H (2 Devices)**	**Total**	
Scenario 2				
Typical gain (dB)	14	15.5	42	
Output power (W)	0.38	40	40	
ACPR (dBc)	–45	–48	–48	
Drain efficiency (%)	22	23.5	21.2	
Current consumption (A)	0.16	6.07	6.73	
DC power (W)	4.5	148	168.5	

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Model Number	Frequency	Watts
SMX100	10KHz-1.0GHz	100
SMX200	10KHz-1.0GHz	200
SMX500	10KHz-1.0GHz	500
SMXE25-S2	10KHz-2.0GHz	25
SMXE25-S3	10KHz-3.0GHz	25
SMXE50-S2	10KHz-2.0GHz	50
SMXE50-S3	10KHz-3.0GHz	50
SMXE100-S2	10KHz-2.0GHz	100
CMX5005	10KHz-1.0GHz	500
CMX100010	10KHz-1.0GHz	1000
CMX200020	10KHz-1.0GHz	2000
ST81-10	1.0GHz-8.0GHz	10
ST81-25	1.0GHz-8.0GHz	25
ST81-50	1.0GHz-8.0GHz	50
ST81-100	1.0GHz-8.0GHz	100
ST181-10	1.0GHz-18.0GHz	10
ST181-25	1.0GHz-18.0GHz	25
ST181-50	1.0GHz-18.0GHz	50
ST101-100-50	1.0GHz-10.0GHz	100/50
TD122-25	2.0GHz-12.0GHz	25
TD122-50	2.0GHz-12.0GHz	50
TD182-25	2.0GHz-18.0GHz	25
TD182-50	2.0GHz-18.0GHz	50

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TABLE II

FREESCALE WiMAX LDMOS FETs

Product	Frequency (MHz)	Pout (average, W)	V_{DD} (VDC)	Gain (dB/MHz)	Efficiency (%)	ThetaJC (°C/W)
2600–2700 MHz, Class AB						
MRF6S27015NR1	2300–2700	3	28	14/2600	22	2.0
MRF6S27050HR3	2500–2700	7	28	16/2500 16/2700	22.5	0.85
MRF6S27085HR3	2600–2700	20	28	15.5/2655	23.5	0.5
MRF6P27160HR6	2600–2700	35	28	14.6/2655	22.6	0.29
3400–3800 MHz, Class AB						
MRF7S38010H	3400–3800	2	30	15/3400 15/3600	17	–
MRF7S38040H	3400–3800	8	30	13/3400 13/3600	18	–
MRF7S38075HR3	3400–3800	12	30	14/3400 14/3600	14	–
DC–5800 MHz, Class AB						
MRFG35003NT1	DC–5800	0.3	12	11.5/3550	25	18.5

percent. Both achieve this performance while meeting linearity and power consumption requirements in spectral form with mask requirements as well as in quadrature form, in terms of error vector magnitude (EVM).

HIGH EFFICIENCY AT 2.7 GHz

At 2.7 GHz, the frequency band used in North America, Freescale has introduced the MRF6P27160H, which delivers 160 W CW at a 35 W average power output level, has a gain of 14.6 dB and efficiency of 22.6 percent with an ACPR of –47.8 dBc. It can deliver its rated power output into a 10:1 VSWR without damage. The device is housed in a low thermal-resistance package, is internally matched, operates at 28 VDC (and up to 32 VDC) and is available on tape and reel.

Freescale has introduced devices with lower power outputs as well, including the MRF6S27085H and MRF6S27015N, which deliver 85 W P1dB CW (20 W average) and 15 W P1dB CW (3 W average) respectively at 28 VDC. The MRF6S27085H delivers a gain of 15.5 dB and efficiency of 23.5 percent, while the MRF6S27015N provides 14 dB of gain with efficiency of 22 percent. The MRF6S27085H is housed in a low thermal-resistance air-cavity package, and the MRF6S27015N in Freescale's cost-effective over-molded plastic packaging. Both are available in tape and reel format.

The performance of the devices lends them well to being cascaded and combined to produce efficient, high gain power amplification solutions under various interstage backoff conditions. Two of these scenarios at 2.7 GHz are shown in ***Table 1***. In the first, a single MRF6S27015N drives two MRFG35010N gain blocks, followed by two MRF6S27085H devices for final amplification. The MRFG35010N is an inexpensive, over-molded plastic-packaged GaAs FET device delivering 10 dB of gain, 1.8 W of RF output and 25 percent efficiency. Total gain for the line-up chain is 38 dB and RF output power is 44 W. In the second scenario, an MRF6S27015N drives two MRF6S27015Ns followed by two MRF6S27085H devices. Total line-up gain is 42 dB and RF output power is 44 W. While these are not the only possible device combinations, they are representative of the performance that can be achieved using the new Freescale devices. Detailed specifications for all of the devices are shown in ***Table 2***.

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Tempe, AZ (800) 521-6274,
www.freescale.com/rf.

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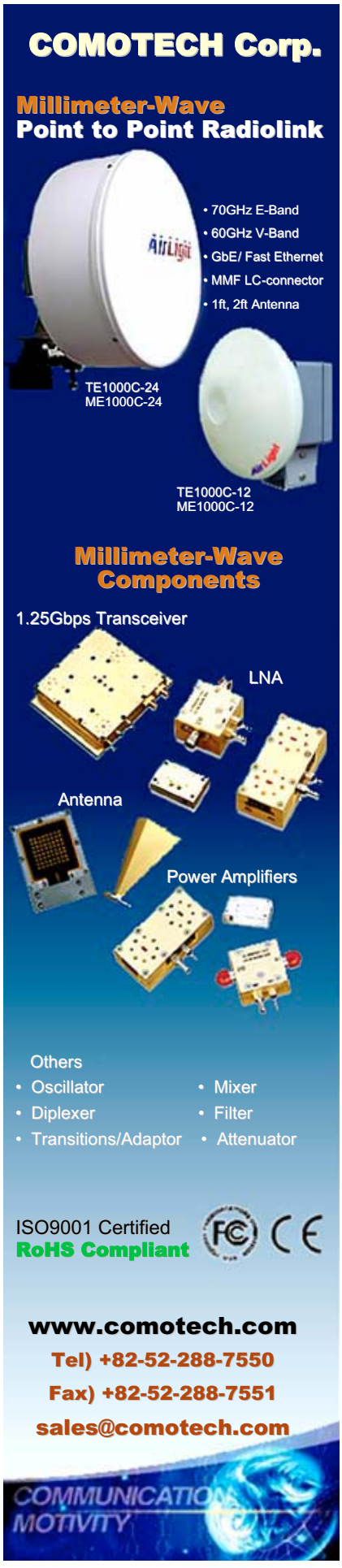

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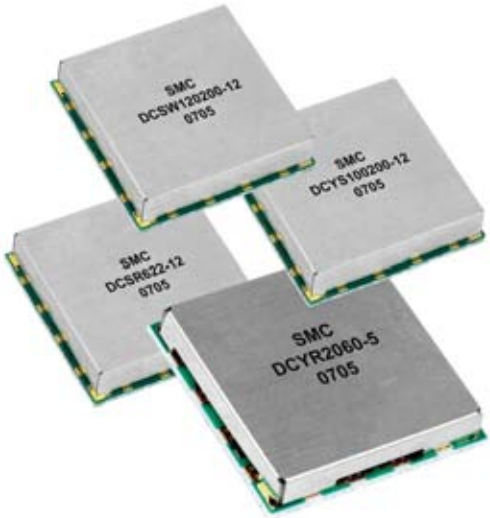

DISTRIBUTED SLOW-WAVE MODE-COUPLED OSCILLATORS FOR PHASE HIT SENSITIVE SIGNAL SOURCES

Because of their direct impact on system efficiency, phase noise and phase hits are major concerns in high performance communication systems. These systems rely on stable, low phase noise sources to increase capacity and reduce bit error rate (BER). Additionally, design cycle time, performance, quality and cost targets remain dominant selection criteria for signal sources. In an effort to lead the market trend, Synergy Microwave Corp. has recently introduced a new family of low noise, compact size (0.5" × 0.5" × 0.16") voltage-controlled oscillators (VCOs).

Numerous oscillators and VCO designs such as the yttrium-iron-garnet (YIG) oscillator have been developed to reduce phase noise and improve system behavior. While YIG sources exhibit good broadband, low noise capabilities, they tend to be power hungry and physically large. Due to the limitations of these devices, many third and later generation systems incorporate multiple narrowband oscillators/VCOs to cover their bandwidth requirement below 2 GHz. Alternatively, the advanced technology team at Synergy has developed a new line of products utilizing oscillator topologies based on a slow-wave mode-coupling mechanism in conjunction with noise feedback and noise cancellation. This new Distributed Coupled Slow-wave (DCSW) approach provides technology well-suited for discrete as well as integrated circuits, resulting in compact size, better power efficiency, lower cost, superb phase noise, wide bandwidth and faster time-to market development.

OVERVIEW OF CURRENT TECHNOLOGIES

In spite of their low phase noise levels, YIG oscillators are sensitive to thermal drift, vibration, lighting, electromagnetic interference (EMI), microphonics, phase hits and frequency modulation, all of which are critical in designing modern communication systems. For instance, in point-to-point and point-to-multipoint radio designs, the microsecond switching speed of a VCO is needed to support the requirements for frequency-agility. Unfortunately, the YIG oscillator's frequency tuning is

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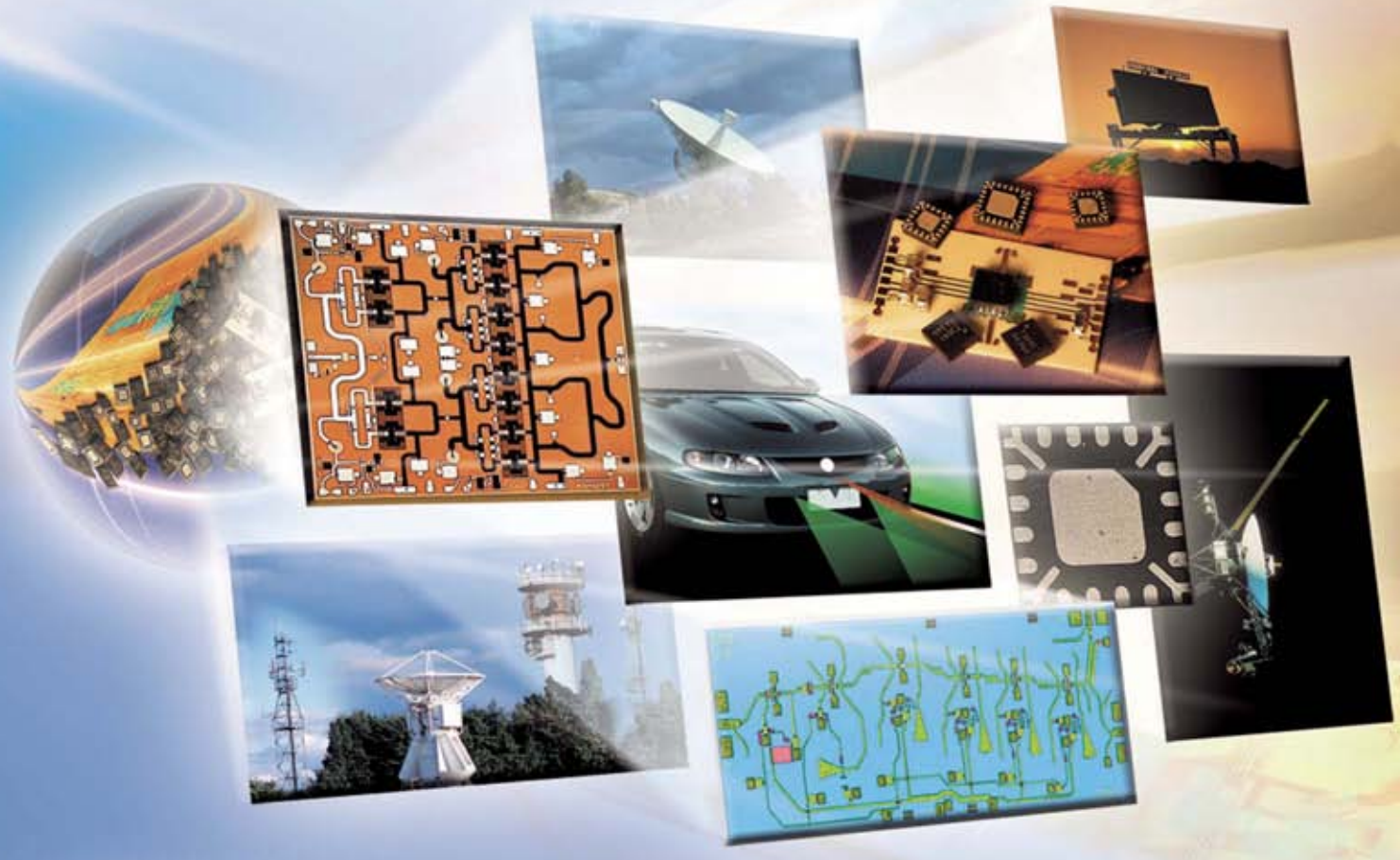

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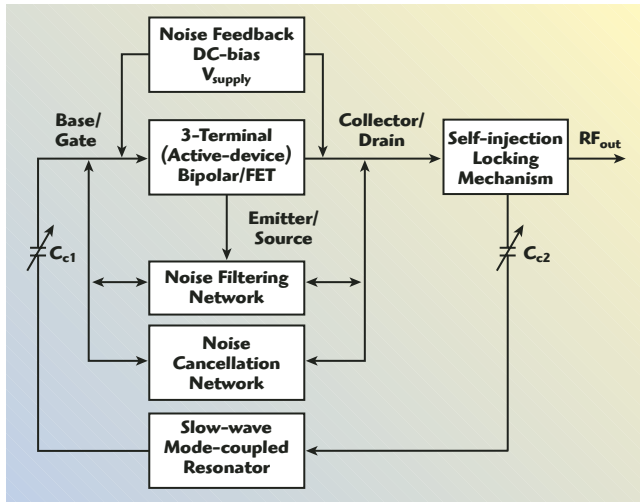

Fig. 1 Block diagram of a DCYS series wideband VCO.

limited by a relatively slow (millisecond) switching speed range. Mechanically, YIG devices are not conducive to integrated-circuit (IC) integration and related benefits such as high volume production and significant size/cost reduction. YIG oscillators are not readily scalable to nonstandard RF packaging or new frequency ranges; custom YIG sources generally require additional non-recurring-engineering (NRE) costs along with long lead-times. In addition, YIG oscillators require a significant amount of power (typically 300 mA at 12 V or more), which in turn makes thermal dissipation a potential concern, especially when protecting the surrounding circuitry of a microwave radio. The operating temperature range of most YIG oscillators is limited to approximately 0° to +60°C, which is unsuitable for many wireless systems.

The new DCYS/DCYR/DCSW series of YIG replacement oscillators overcome these limitations while providing an octave band tuning range, faster tuning speed, low phase noise, low cost, higher power efficiency and small device size. The VCOs using this new-patented technology are currently available for frequencies from 150 to 12000 MHz. The low phase noise performance is exemplified in the DCYR2060-5 device, which measures typical phase noise of –142 dBc/Hz at 100 kHz offset from the carrier for the 200 to 600 MHz frequency band.

Figure 1 shows a block diagram of the DCYS100200 (frequency band: 1000 to 2000 MHz), which is built on a Rogers substrate (dielectric constant of the material is 3.38) and is capable of providing stable performance over a wide range of operating temperatures from –40° to +85°C. The tiny low noise oscillators are housed in surface-mount packages measuring 0.5" × 0.5" × 0.16". These miniature sources are a fraction of the 1.00 to 1.25 in. cube of the smallest YIG oscillators. The slow-wave mode-coupling mechanism enhances the drive level sensitive Q (quality factor), thereby reducing or even eliminating phase hits, diminishing susceptibility to microphonics (to an extremely low level) and minimizing phase noise while maintaining a broadband linear tuning. Phase noise is reduced by dynamically optimizing the group delay and slope of the impedance transfer function across the guided distributed medium of the slow-wave multi-coupled resonator network. This arrangement can be characterized as an active Q-multiplier circuit with evanescent-mode self-injection coupling and locking mechanism that eventually improves the time average loaded Q of the planar resonator. The novel approach supports multi-octave tuning in a small package, and is compatible with IC fabrication processes.

VCO ADVANTAGES

How well does this arrangement perform in terms of phase noise, tuning range and power consumption? As a reference point, the typical phase noise of a commercial YIG-tuned oscillator is –130 dBc/Hz offset 100 kHz from carrier spanning 500 to 2000 MHz, with the combined oscillator circuit and YIG heater current draw that can exceed 500 mA on surges and 100 mA in steady-state operation.

A prime design goal met by the DCSW technology is ultra low phase noise performance and a user-definable frequency band that does not compromise other critical parameters such as bandwidth, figure of merits

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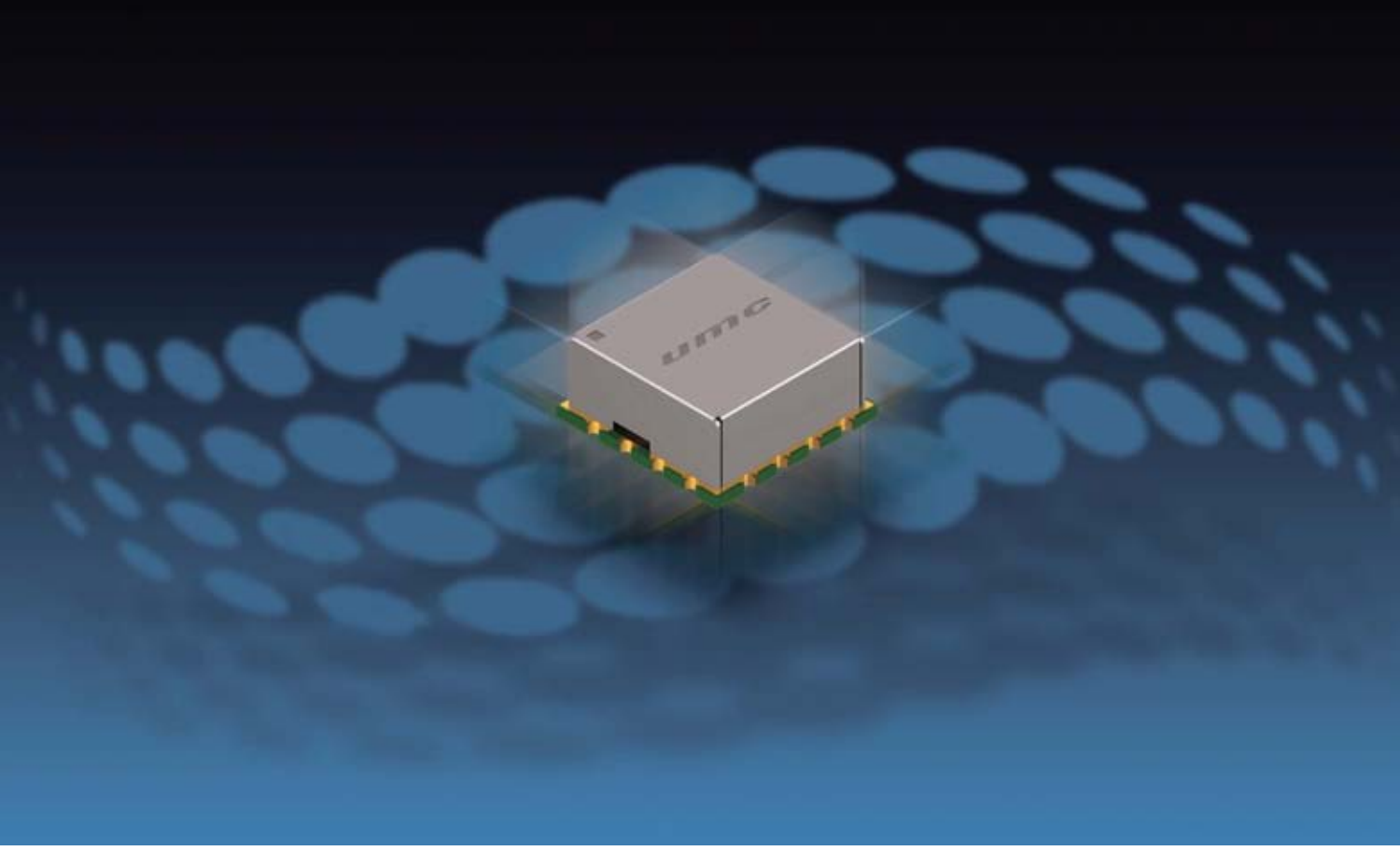

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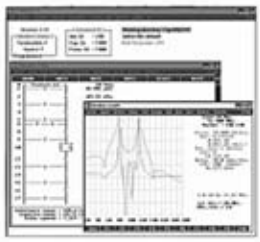
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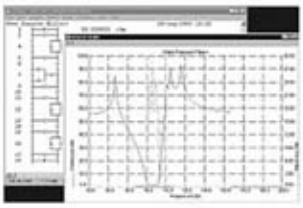
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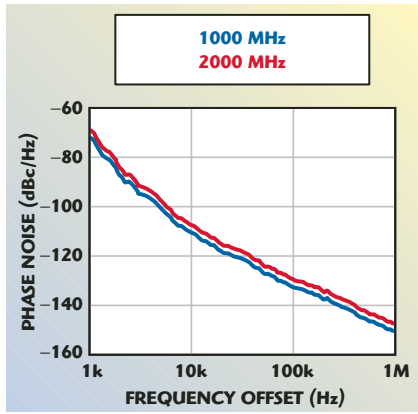

Fig. 2 Measured phase noise of the 1000 to 2000 MHz DCYS1020-12.

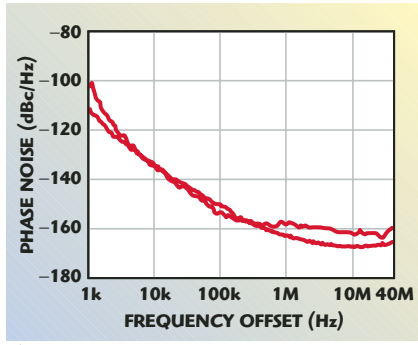

Fig. 3 Measured phase noise of the DCSR622-12 at 622 MHz.

(FOM), temperature stability, size and most importantly high immunity to phase hits. The typical measured phase noise of DCSW120200 (1200 to 2000 MHz) is –132 dBc/Hz at 100 kHz offset from the carrier. At 0.5" × 0.5" × 0.16", the oscillator is smaller than the tiniest commercially available YIG source, and requires less than 40 mA current at +12 VDC. The typical output power is 5 dBm with minimum 10 dB harmonic rejection over the band. ***Figure 2*** shows the phase noise plot of a DCYS100200-12; the typical measured phase noise is –128 dBc/Hz at 100 kHz offset from the carrier with a tuning voltage range of 0 to 28 V. The RF output power is 5 dBm (min) with minimum 10 dB harmonic rejection over the band.

DESIGN GOALS AND PERFORMANCE HIGHLIGHTS

The DCYS and DCSW products are based on fundamental oscillation rather than frequency doubling or multiplication, which can result in increased phase hits and jitter. The DCSW series is easily configurable and can be adapted to other frequency bands offering best-in-class performance, cost-effectiveness and power-efficient signal source solutions. In addition to this, the DCSR series can be used in fixed frequency/narrowband applications providing exceptionally good phase noise performance that rivals the phase noise performance of the commercially available high Q ceramic/SAW resonator-based VCOs for a given class.[1–3] The typical measured phase noise for DCSR622-12 (622.08 MHz), as shown in ***Figure 3***, is –155 dBc/Hz at 100 kHz offset from the carrier and requires less than 40 mA current at +12 VDC, with a tuning voltage range of 0 to 8 V. The typical output power is +4 dBm and 30 dB harmonic rejections for optimized narrowband applications.

Synergy's new series of DCYS/DCYR/DCSW oscillators offer ultra wide bandwidth, and significantly minimize the jitter noise and phase hits. For frequencies as low as 250 MHz and as high as 6000 MHz, the new technology offers a low phase noise alternative to YIGs and other sources, with less susceptibility to vibration and microphonics, less power consumption and smaller size. For applications requiring agile frequency switching speeds, the new oscillators offer the potential of microsecond switching speed for ultra-wideband (UWB) and other emerging wireless applications. The DCSR topology can be extended to other fixed frequencies (200 to 6000 MHz) without expensive NRE or long lead-time of the products. Additional information may be obtained via e-mail at sales@synergymwave.com or from the company's web site at www.synergymwave.com.

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With these requirements in mind, Auriga Measurement Systems has developed its next generation Pulsed IV Measurement System, the AU4550. The AU4550 is designed to meet the ever-changing requirements of the device modeling community. With its modular hardware design and open software architecture, the AU4550 is poised to handle present and future pulsed IV requirements.

TEST CAPABILITIES

This new, high-end Pulsed IV Measurement System is a full-featured characterization platform capable of measuring DC IV curves, pulsed IV curves (see ***Figure 1***), and expandable to pulsed S-parameters and model extraction. With pulse widths as fast as 200 ns and duty cycles as low as 0.01 percent, the AU4550 is ideally suited for isothermal testing of devices subject to the effects of self-heating. Unlike less capable competitive solutions, the AU4550 can deliver up to 200V at 10A, a must for designers working with high power devices.

The AU4550 system has raised the bar for high power pulsed IV performance. Through the use of small external pulser heads, the pulser circuitry has been moved closer to the device under test (DUT), reducing the length of transmission lines from feet to mere inches. With the pulser circuitry moved closer to the DUT, the AU4550 preserves the integrity of the pulsed signal by reducing the effects of the transmission lines on the measurements. The external pulser heads are interchangeable and available in different configurations from 20V - 100mA to 200V - 10A with plans to go to 1200V and beyond.

Because the AU4550 measurement system is capable of capturing current-voltage vs. time, it delivers new ways of exploring the time-dependent effects, such as self-heating and carrier

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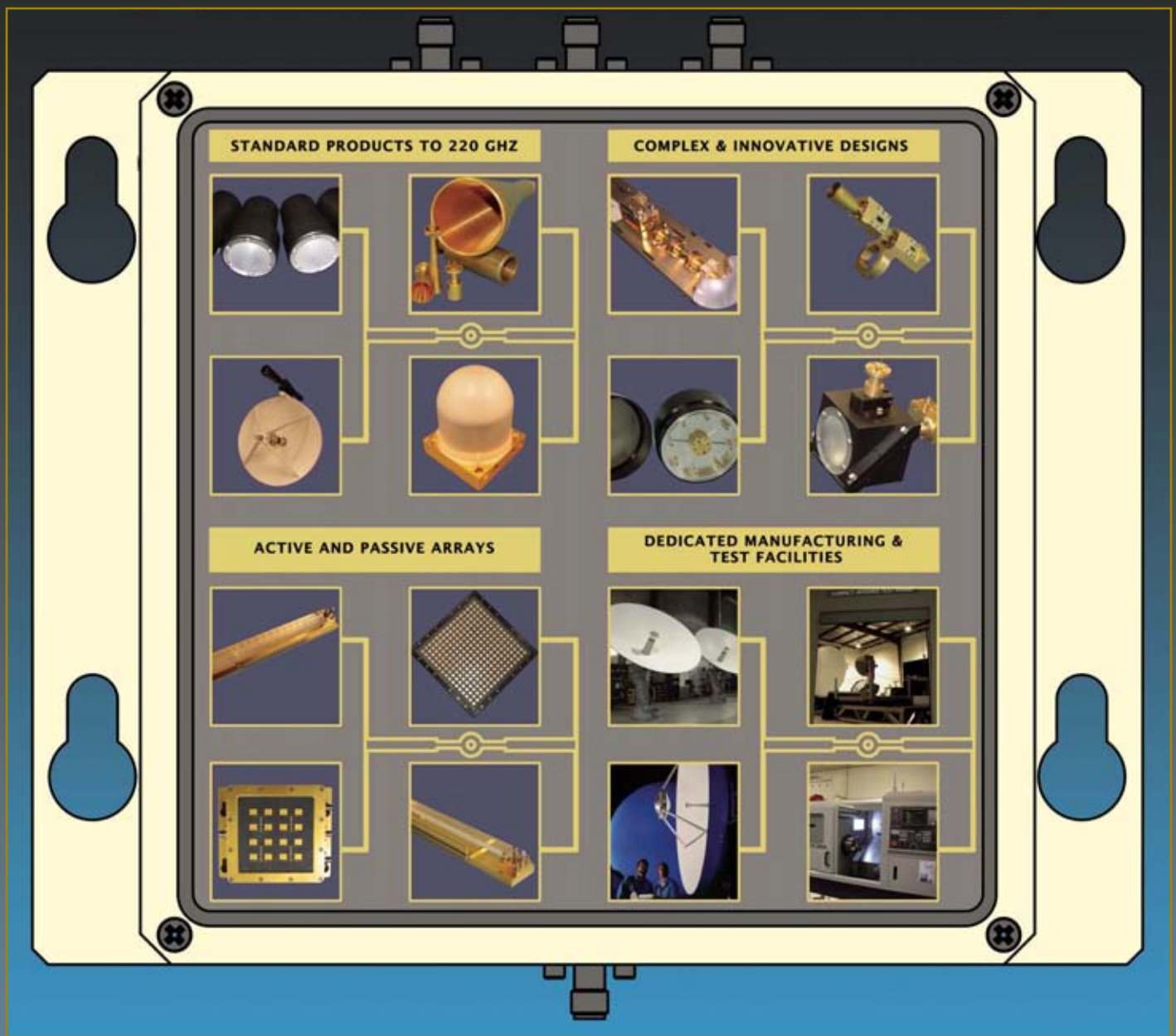

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traps on devices. With the ability to move the measurement aperture across the top of the pulse, designers can see in real time the effects that self-heating and carriers have on the IV curves and better understand the impact they have on their device.

With the addition of the optional S-parameter test set, the AU4550 becomes a full-featured pulsed IV/RF modeling system capable of meeting the most demanding requirements. The AU4550's true wide bandwidth front-end allows it to measure pulsed S-parameters with RF pulse widths as fast as 100 ns with duty cycles as low as 0.01 percent while maintaining a dynamic range of greater than 90 dB.

The AU4550 can also be combined with and control other standalone network analyzers such as Agilent Technologies' PNA-X. With its six-channel triggering subsystem the AU4550 can trigger external instruments to perform measurements synchronous with the DC pulse.

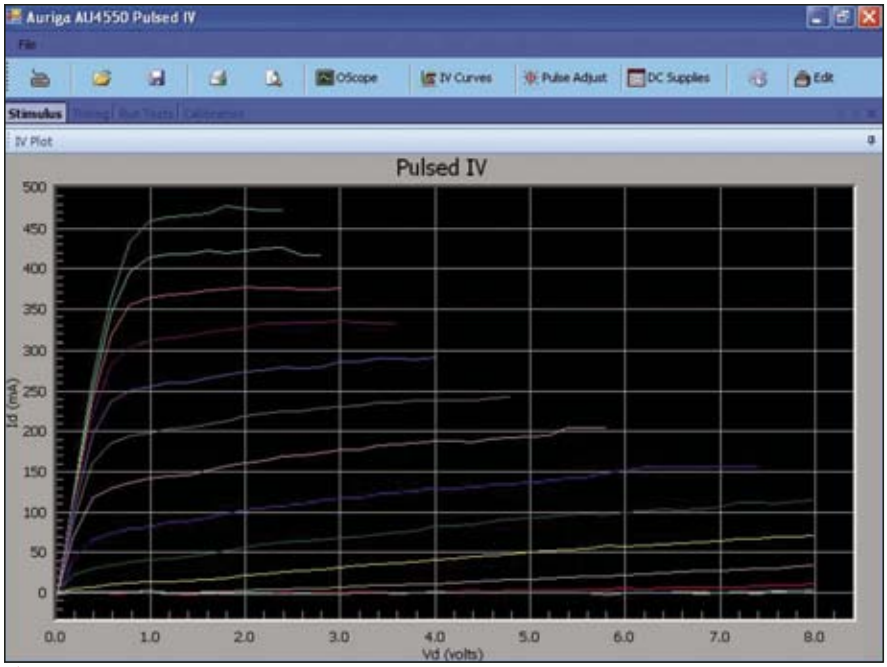

Fig. 1 A typical pulsed IV presentation.

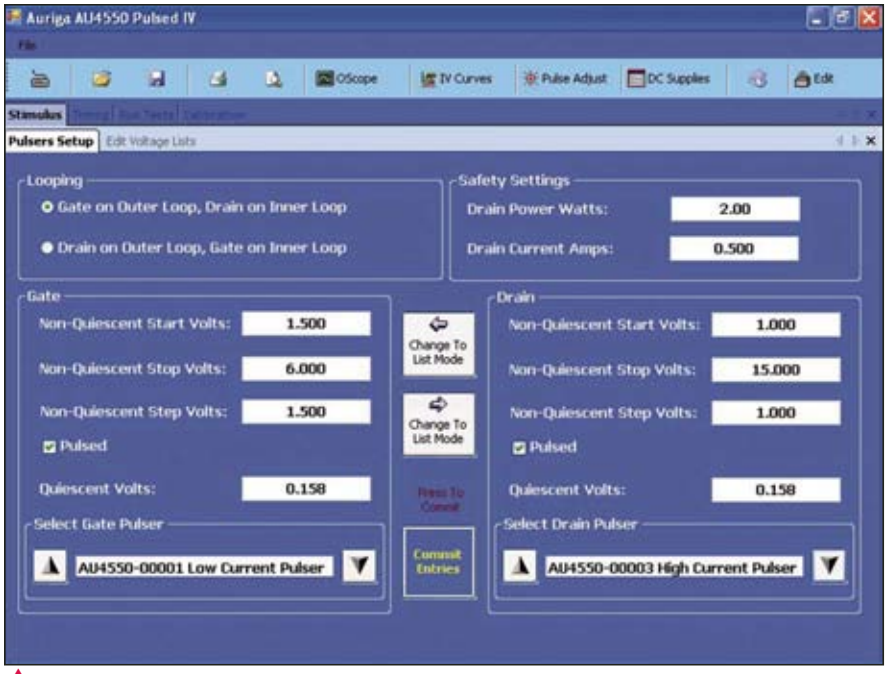

Fig. 2 The user-friendly pulse setup screen.

MODULAR APPROACH

The AU4550 system's modular approach to both hardware and software guaranty a cost-effective upgrade path to address new measurement requirements as they arise. As analog-to-digital converters (ADC) advance, so does the AU4550. Its modular approach to hardware allows the internal ADCs to be upgraded with newer and faster ones as they become available. The external pulser heads allow the user to configure the system as needed—100V - 1A today and 200V - 10A tomorrow. The AU4550 can keep pace with the industry's changing needs, protecting capital investment and improving return on investment.

INTUITIVE USER INTERFACE

The AU4550 offers the most advanced capabilities available in a fully integrated characterization system, including a complete embedded PC with the Windows XP operating system, mass storage and a writable CD. Although it satisfies virtually all requirements with regard to test capabilities and specifications, the intuitive user interface enables even inexperienced users to perform complex measurements quickly and easily. The integrated software and soft front-panel are easy to learn and use. All features are easily accessible on a touch screen and for those who prefer a keyboard, a mini keyboard with an integrated touch pad is provided. ***Figure 2*** shows a typical pulse setup screen.

CONCLUSION

The new AU4550 Pulsed IV Measurement System is giving the modeling community something to be excited about. Users no longer have to fumble with racks of equipment, complicated wiring connections and internally developed software, only to generate questionable results. With its intuitive user interface and superior pulse performance, users are assured of clean accurate data the first time and every time. Additional information may be obtained via e-mail at sales@auriga-ms.com.

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A CONFIGURABLE RF SYSTEM PLATFORM

A new RF system platform has been introduced that is user configurable and easily adapted to meet many of today's military and commercial requirements. The PET-VI features a six-inch color LCD touch-screen display that facilitates easy system control and configuration. The platform consists of three plug-and-play field-replaceable modules comprised of a power supply module, computer module and an RF module.

Examples of applications for this configurable RF system include airborne RF distribution units, broadband switch matrices, and RF attenuation featuring internal computer-controlled linearization and touch-screen attenuation selection. The PET-VI System Platform is also ideal for use as state-of-the-art up- and down-converters with integrated options such as linearized attenuation features and others. In addition, the system can be configured as a high speed frequency synthesizer or a log amplifier with touch-screen log slope selection. With a multitude of RF functions within its capability, the PET-VI RF module can be set up to meet many different RF functions.

The PET-VI system is housed in an airborne ruggedized 19" rack mount chassis, 6U high and 18" deep. It includes a six-inch LCD touch-screen display embedded in the front panel and a compact flash port. All RF input and output connectors are located on the top side of the enclosure. The three individual modules can be extracted from the rear of the assembly.

Cooling fans with speed sensors are mounted on the rear of the RF module and draw cooling air through the module through shielded air filters mounted in two ports on the front face. The RF module features internal temperature monitoring and over-temperature conditions are displayed on the front panel. The cooling fan speeds are also monitored and fan failures are displayed on the front panel as well. In addition, every RF component is current monitored for failure feedback and any failure of an RF component is displayed on the front panel.

The internal computer module is comprised of an ARCOM SBC-GX533 400 MHz single-board computer featuring an AMD Geode GX processor. The computer utilizes a Linux or Windows CE operating system. Compact flash memory contains all of the boot up and operation software and can be easily removed from the system for security

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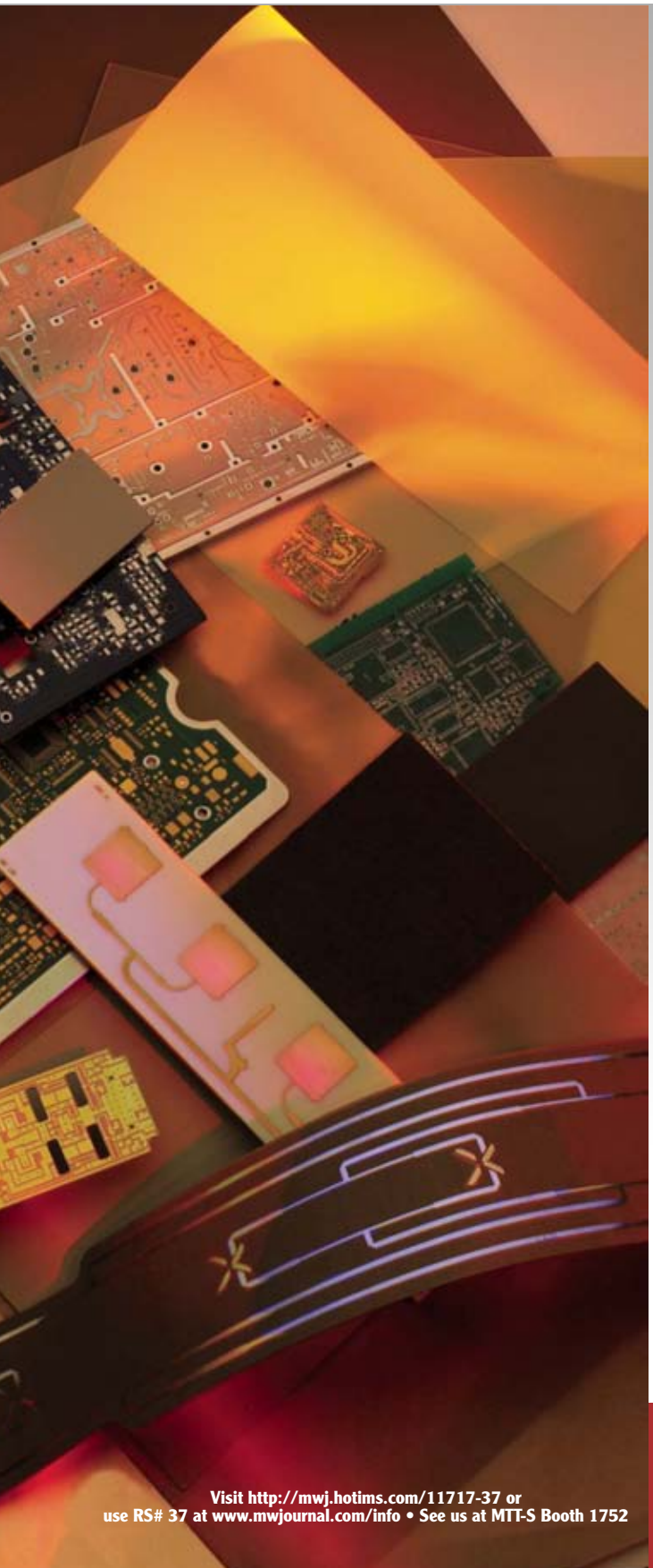

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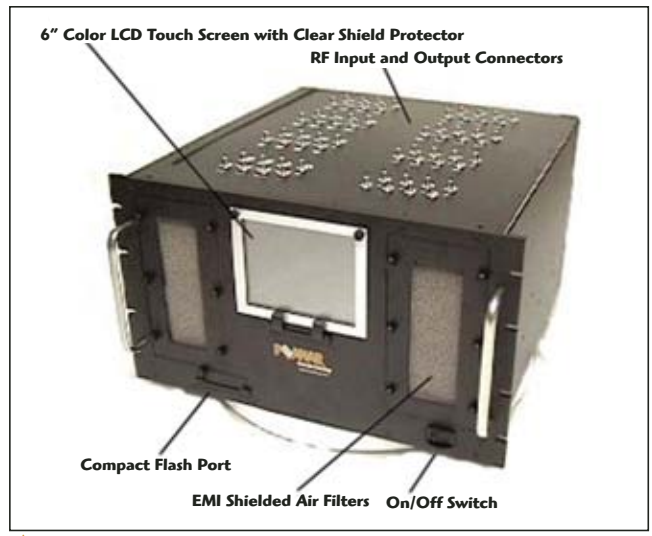

Fig. 1 Front view of the PET-VI System Platform.

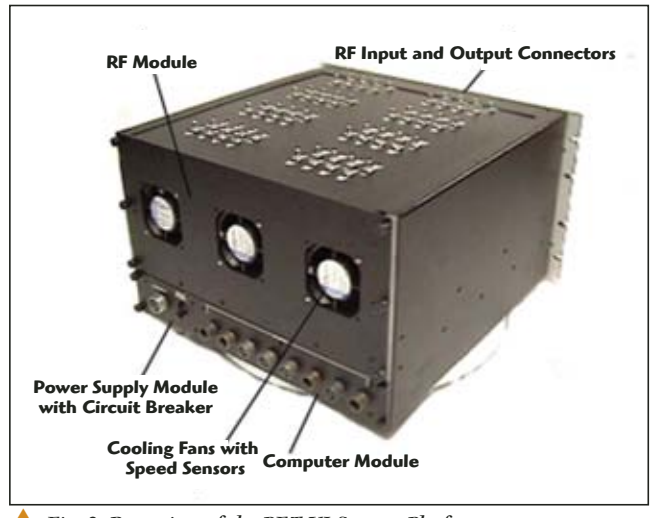

Fig. 2 Rear view of the PET-VI System Platform.

purposes. The unit's software interface is compatible with RS-232-C, RS-422, RS-485, PECL, TTL and Ethernet protocols.

The plug-and-play modular design easily permits in-the-field repairs and flexibility for custom configurations. The power supply module can contain any required power supply, the computer module can be switched in minutes and the RF module can contain any set of RF components required. Up to 320 individual control lines can be accommodated. RF input and output connectors are SMA or QMA connectors, but other connector types can be accommodated. ***Figure 1*** shows the PET-VI System Platform front view and ***Figure 2*** shows its rear view.

The new PET-VI System Platform is a truly versatile RF system capable of providing most any complex RF function, whether it be military airborne or commercial test or control. Additional information may be obtained from the Planar Electronics Technology web site.

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DAT-15R5-S ▲	Serial	50	DC-4000	15.5	0.5	5	3.55
DAT-15575-P ▲	Parallel	75	DC-2000	15.5	0.5	5	3.55
DAT-15575-S ▲	Serial	75	DC-2000	15.5	0.5	5	3.55
DAT-31-P ▲	Parallel	50	DC-2400	31.0	1.0	5	3.55
DAT-31-S ▲	Serial	50	DC-2400	31.0	1.0	5	3.55
DAT-3175-P ▲	Parallel	75	DC-2000	31.0	1.0	5	3.55
DAT-3175-S ▲	Serial	75	DC-2000	31.0	1.0	5	3.55
DAT-31R5-P ▲	Parallel	50	DC-2400	31.5	0.5	6	3.80
DAT-31R5-S ▲	Serial	50	DC-2400	31.5	0.5	6	3.80
DAT-31575-P ▲	Parallel	75	DC-2000	31.5	0.5	6	3.80
DAT-31575-S ▲	Serial	75	DC-2000	31.5	0.5	6	3.80

▲To specify Supply Voltage:
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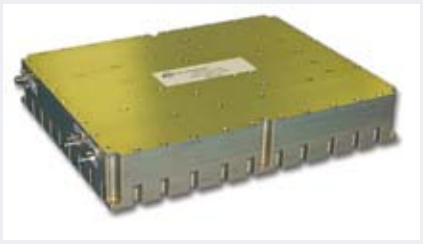

The model SSPA 0.5-3.0-50 is a high power, broadband, Gallium Nitride (GaN) RF amplifier that operates in a frequency range from 0.5 to 3 GHz. This PA is ideal for broadband military platforms as well as commercial applications because it is robust and offers high power over a multi-octave bandwidth. This amplifier was designed for broadband jamming and communication systems platforms. The amplifier operates with a base plate temperature of 85°C with no degradation in the MTBF for the GaN devices inside. The RF line up is comprised of all GaN devices. It is packaged in a modular housing that is approximately 7.0" (width) by 9.0" (long) by 1.5" (height).

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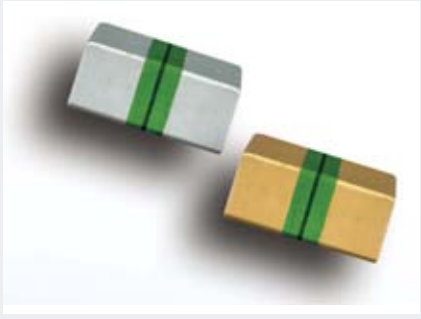

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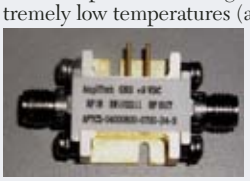

or –257°C) in order to take advantage of the decreased noise figures at those levels. To make it easier to keep these amps cool, the company has designed an extremely efficient amplifier with low DC voltage options (as low as +3 VDC), low current consumption and a lightweight, compact housing. Noise figures as low as 0.07 dB (< 5°K) are possible.

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High Speed Sampler

The AP3501 high speed sampler is an equivalent time sampler for applications in microwave downconverters, network analyzers and sampling oscilloscopes. The highly integrated sampler features a 35 GHz RF bandwidth, with sampling rates up to 800 MS/s and ECL-compatible drive. It is available as a connectorized component, as bare die and in a chip-scale QFN package. The bare die and QFN packaged sampler are attractive for price sensitive commercial applications such as UWB communications and ranging.

AnaPico AG,
Zürich, Switzerland +41-44-440 00 51,
www.anapico.com.
Booth 442 ***RS 225***

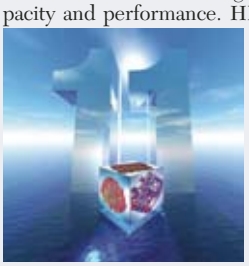
Handheld Spectrum Analyzer

The MS2724B ultra-portable spectrum analyzer features unparalleled performance and continuous frequency coverage from 9 kHz to 20 GHz. Anritsu also introduces the MS2721B and MS2723B handheld spectrum analyzers that offer frequency coverage up to 7.1 and 13 GHz, respectively. The high performance and measurement capability of the MS272xB series make it easier for engineers and field technicians to design, deploy and optimize the performance of wireless devices and networks ranging from commercial to defense and public safety.

Anritsu Co.,
Morgan Hill, CA (408) 778-2000,
www.us.anritsu.com.
Booth 423 ***RS 226***

HFSS v11

HFSS™ v11 offers even greater accuracy, capacity and performance. HFSS is widely used



for designing RF/microwave components, on-chip passives, PCB interconnects, antennas and IC packages. New higher-order, hierarchical basis combined with an iterative solver provides accurate fields, smaller meshes and efficient solutions for large multi-wavelength structures. Complex geometries solve 2 to 5× faster using half the memory with the new v11 fault tolerant, high quality finite element mesher. Continued user interface refinement and data linking enables co-design of complex electronic systems.

Ansoft Corp.,
Pittsburgh, PA (412) 261-3200,
www.ansoft.com.
Booth 701 ***RS 227***

Voltage-controlled Oscillators

This "D" class of voltage-controlled oscillator (VCO) modules incorporates proprietary

YRO™ and coaxial resonator technology. Using internal doublers, these VCOs exhibit typical SSB phase noise of –103 dBc/Hz at 10 kHz across 500 MHz of tuning bandwidth. A variety of package sizes are available incorporating internal amplifiers, bandpass filters and voltage regulators. Additional multipliers can also be incorporated increasing frequency range to 21 GHz.

APA Wireless Technologies,
Fort Lauderdale, FL (954) 563-8833,
www.apawireless.com.
Booth 1256 ***RS 228***

Microwave Office Design Suite

This latest version of Microwave Office design suite offers unprecedented openness and interoperability, enabling ease-of-use and access to best-in-class tools. The latest release continues to deliver key productivity improvements that shorten design cycle time and speed time-to-market for RF/microwave products.

Applied Wave Research Inc.,
El Segundo, CA (310) 726-3000,
www.appwave.com.
Booth 623 ***RS 229***

2.5 to 2.7 GHz WiMAX Amplifier

Amplifier module CMS2010 is a new 2.5 to 2.7 GHz latest generation WiMAX amplifier. With

50 W of P1dB output and a gain of 45 dB it has been specifically designed to meet or exceed the WiMAX (802.16) specifications. The unit has outstanding performance offering better than two percent EVM for 64 QAM symbols at a 10 W output level. It comes with a built-in isolator on the RF output port and is FDD or TDD capable.

AR Modular RF,
Bothell, WA (425) 485-9000,
www.ar-worldwide.com.
Booth 1200 ***RS 230***

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www.EmpowerRF.com

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The BBM3K5KEL (SKU # 1117) is suitable for broadband mobile Jamming and band specific high power linear applications in the P/L/S frequency bands. This compact module utilizes high power advanced GaN devices that provide excellent power density, high efficiency, wide dynamic range, and low distortions. Exceptional performance, long term reliability and high efficiency are achieved by employing advanced broadband RF matching networks and combining techniques, EMI/RFI filters, machined housings and qualified components. Empower RF's ISO9001 Quality Assurance Program assures consistent performance and the highest reliability.

316 West Florence Ave., Inglewood, CA 90301 USA, Phone: (310) 412-8100, Fax: (310) 412-9232

Visit http://mwj.hotims.com/11717-81 or use RS# 81 at www.mwjournal.com/info

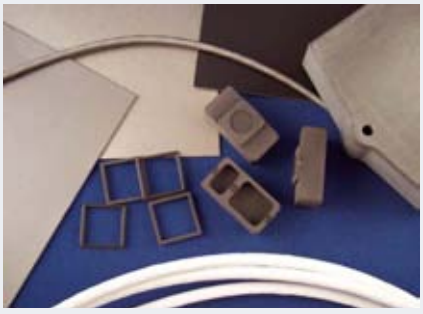
NEW WAVES

10 to 20 GHz Solid-State Amplifier

The model 5S10G20 is the company's first solid-state amplifier that covers the 10 to 20 GHz frequency range. Model 5S10G20, along with the rest of the "S" series amplifiers, is 100 percent VSWR tolerant and has superior linearity, making it ideal for wireless testing.

AR RF/Microwave Instrumentation,
Souderton, PA (215) 723-8181,
www.ar-worldwide.com.
Booth 1200 ***RS 231***

Wave-X EMI Absorbers



ARC Technologies has launched several additions to its Wave-X line of absorbers for control EMI, RFI and SAR. A pioneer in ultra-thin absorber sheets, ARC has added miniaturized chip caps as well as rigid and flexible molded thermoplastic absorbers. The thin, new cable-integrated absorber is extruded over USB and other cables, beneath the insulation, providing significant levels of attenuation and eliminating the need for ferrites and other EMC countermeasures. ARC products are distributed worldwide.

ARC Technologies Inc.,
Amesbury, MA (978) 399-2993,
www.arc-tech.com.
Booth 1207 ***RS 232***

Oscillator Design Insights

New, from one of the most highly regarded authors in the field and available for the first time

at an MTT-S show, *Foundations of Oscillator Circuit Design*, by Guillermo Gonzalez. This unique book provides practical oscillator design guidance through the complete frequency range, from low frequency audio to the more complex used in RF and microwave ranges. Packed with over 1200 equations, the book emphasizes CAD simulation techniques and covers tuned-circuit, crystal, negative-resistance and relaxation oscillators.

Artech House,
Norwood, MA (800) 225-9977,
www.artechhouse.com.
Booth 1510 ***RS 233***

Cable Assembly

The microbend® is a cost effective, true flexible alternative to 0.047" custom semi-rigid cable

assemblies, eliminating the need for predetermined custom lengths and bend configurations. Microbend features include a 40 percent lower loss than 0.047" semi-rigid cable, a minimum bend radius of 0.060", triple shielded construction for high isolation and a frequency range up to 65 GHz. The microbend product has been a design solution utilized in aerospace, military, commercial and hi-rel space applications. Microbend offers reliability and has met performance requirements following life tests of 1000 thermal cycles along with severe vibration and shock profiles in accordance with MIL-STD-202, Methods 107, 204 and 213.

Astrolab Inc.,
Warren, NJ (732) 560-3800,
www.astrolab.com.
Booth 1539 ***RS 234***

Pulsed IV/RF Instrument

The new AU4550 pulsed IV/RF instrument provides unequalled test accuracy, compact design, and inexpensive options and modular hardware that allow easy, inexpensive upgrading. Pulsed heads set closer to the device-under-test and narrow range pulse heads improve accuracy while a synthetic instrument core eliminates hardware redundancies, reducing the footprint by half, even when fully optioned. The AU4550's interchangeable pulser heads and LXI-compliancy allow adaptability to scale pulsed IV to pulsed IV/RF while meeting changing industry standards.

Auriga Measurement Systems LLC,
Lowell, MA (978) 441-1117,
www.auriga-ms.com.
Booth 1642 ***RS 235***

WiMAX Terminations and Resistors

This line of power terminations and resistors are designed for WiMAX applications, specifically for 3.4 to 3.6 GHz. Terminations and resistors are available in a selection of configurations, from chip, to a leaded chip, to a flange mounted device, with power ratings from 20 to 200 W depending on design needs. Barry provides a full line of power and precision thick film resistors, terminations and attenuators on Alumina, BeO, BeO Free™ and Aluminum Nitride for microwave and RF applications. Barry also has an LTCC multilayer foundry, design and production facility for products to 65 GHz.

Barry Industries,
Attleboro, MA (508) 226-3350,
www.barryind.com.
Booth 913 ***RS 236***

Next Generation Amplifiers

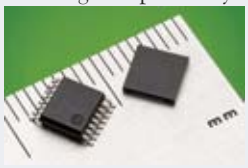
The BZ series of next generation amplifiers features wide bandwidth and low noise figures.

Remarkably, the amplifiers fit into one standard housing (as shown). Within the 30 kHz to 70 GHz range, customized power, gain and noise figure combinations are available. With noise temperature of 10°K at cryogenic temperatures, excellent group delay, military specifications and high dynamic range, these RoHS compliant units may be optimized to achieve up to +30 dBm output power.

B&Z Technologies,
Stony Brook, NY (631) 331-0101,
www.bnztech.com.
Booth 1255 ***RS 237***

Silicon Integrated Circuits

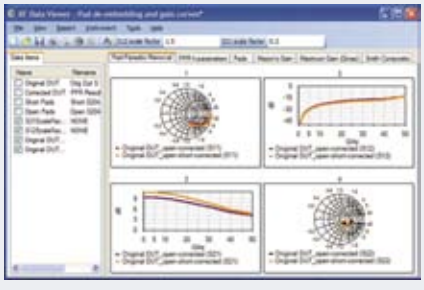
These two NEC silicon integrated circuits (IC) are designed specifically for cable television



set-top boxes. The UPC3220GR is a dual-path AGC amplifier designed to split incoming digital and analog signals. With a noise figure of just 6 dB (typical) it offers good sensitivity, enabling the receiver to provide the television with a robust digital signal. The UPC3228T5S is NEC's newest out-of-band tuner. Housed in a 32-pin QFN package, the UPC3228T5S features 70 dB (typical) of gain control range, enabling it to handle a wide variety of out-of-band signals. Both devices are RoHS compliant and are in stock and available now from CEL.

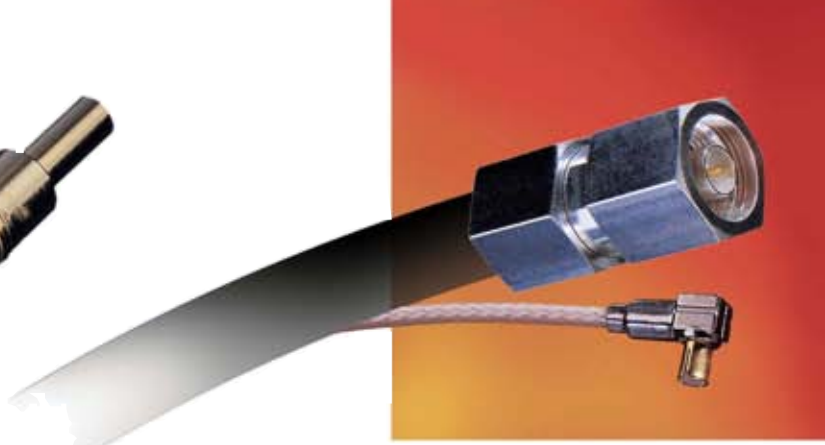
California Eastern Laboratories,
Santa Clara, CA (408) 919-2500,
www.cel.com.
Booth 743 ***RS 238***

RF Measurement Software



WinCal calibration software has been expanded to include key features that will provide

Custom.



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faster and more accurate wafer-level RF measurement. WinCal XE combines advanced calibration with RF accuracy enhancement features. Through powerful new measurement support tools and guidance systems that minimize operator mistakes, WinCal XE enables accurate and reliable RF measurements, a real problem with today's complex semiconductor designs. Key new features of the XE version include: hybrid calibrations for multi-port measurements, local data manipulation for measurement validation and data analysis in the lab and device characterization tools. Price: starts at $4450. Delivery: three weeks.

Cascade Microtech Inc.,
Beaverton, OR (503) 601-1000,
www.cascademicrotech.com.
Booth 1143 ***RS 239***

Low Frequency Amplifiers

These high performance cascadable low frequency amplifiers are designed for connectorized/drop-in applications and operate in a frequency range from 1 MHz to 6 GHz. The amplifiers offer standard and customized gain, output power of up to +30 dBm and noise figure as low as 1.5 dB values to meet special requirements. Models feature low power consumption and high ICP performance. Ciao offers cross-reference models to other major suppliers of similar connectorized low frequency amplifiers. Delivery: one to two weeks ARO.

Ciao Wireless Inc.,
Camarillo, CA (805) 389-3224,
www.ciaowireless.com.
Booth 601 ***RS 240***

Fast Settling Digital Attenuator

This millimeter-wave (MMW) fast settling digital attenuator represents a significant advancement in control device technology. Using fast pin diodes coupled with state-of-the-art digital processing technology, the digital attenuator achieves extremely fast switching times of less than 50 nanoseconds from serial command to RF settling in addition to extremely accurate attenuation settings over the full dynamic range (31.5 dB). Using a serial control interface, the unit is readily adaptable into a complex RF system that has many device interfaces and requires those devices to be controlled from a central processor.

Crane Aerospace and Electronics,
Electronics Group,
Chandler, AZ (480) 961-6225,
www.craneae.com.
Booth 1001 ***RS 241***

Low Noise Amplifiers

These low cost, GaAs PHEMT-based, low noise amplifiers (LNA) operate in a frequency range from 0.5 to 20 GHz, for electronic defense and commercial communication applications. The amplifiers are specifically designed to accommodate numerous and demanding requirements within the homeland security, military and commercial environments for tactical radios, Global Positioning System (GPS) receivers and radar systems. The company's new LNA line-up consists of 30 narrowband and 30 wideband models.

CTT Inc.,
Sunnyvale, CA (408) 541-0596,
www.cttinc.com.
Booth 1113 ***RS 242***

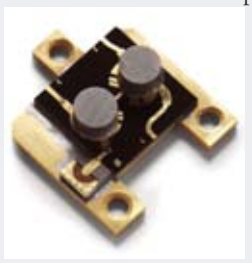
80×5 Switch Matrix

This 80×5 switch matrix operates in a frequency range from 1 to 18 GHz with 0 dB gain and 3 dB fullband flatness. It consists of five pairs of field-replaceable 8×5 nonblocking switch matrix LRUs combined into five outputs each with 100 nsec blanking with a 65 dB on/off ratio and up to 30 dB of gain control. Control is via RS-422, Ethernet or can be user defined.

Custom Microwave Components Inc.,
Fremont, CA (510) 651-3434,
www.customwave.com.
Booth 1355 ***RS 243***

X-band Circulator

The model 4CMD 10-1X circulator is designed for the front-end of active phased-array antennas in X-band. This dual junction microstrip circulator has a 10 percent bandwidth in the 8.5 to 10.5 GHz frequency range. The insertion loss from the antenna to the receiver is 0.9 dB with isolation of 33 dB. Insertion loss between the transmitter and the antenna is 0.5 dB and has 20 dB isolation. The isolation between the transmitter and the receiver is also 20 dB with a maximum VSWR of 1.25 at all ports. These units can handle 10 W of power and operate over the temperature range of –45° to +65°C.



Dorado International Corp.,
Seattle, WA (206) 574-0900,
www.dorado-intl.com.
Booth 712 ***RS 244***

Five-channel Switch Filter Bank

The model SBLP-2-SP-SF/SF-X is a five-channel switch filter bank that provides four filtered channels and one through path for compliance testing. Four-pole Bessel-Thompson filters for OC-1, OC-3 (STM-1), OC-12 (STM-4) and OC-48 (STM-16) provide accurate pulse reproduction and optimized passband group delay characteristics. Unit comes standard with single input/output connectors, TTL control and LED indicators, in a 1.12 × 2.5 × 4.5 package.

Eagle Comtronics Inc.,
Liverpool, NY (315) 622-3402,
www.eaglecomtronics.com.
Booth 1731 ***RS 245***

SMT Frequency Synthesizers

The HFS series frequency synthesizers are available as fixed-frequency or in bandwidths to greater-than-octave at frequencies to 2.5 GHz, and up to 40 percent bandwidths to 5 GHz. Typical phase noise for HFS-2100 (1000 to 2100 MHz) is –100 dBc/Hz at 10 kHz offset, and –112 dBc/Hz at 100 kHz offset. Ideally suited for use as local oscillators in up/down converters for microwave radios in wireless communications systems and as wideband frequency sources for test and measurement instrumentation, HFS series frequency synthesizers are designed to withstand stringent temperature, shock and vibration environments encountered by ground mobile vehicles.

EM Research Inc.,
Reno, NV (775) 345-2411,
www.emresearch.com.
Booth 854 ***RS 246***

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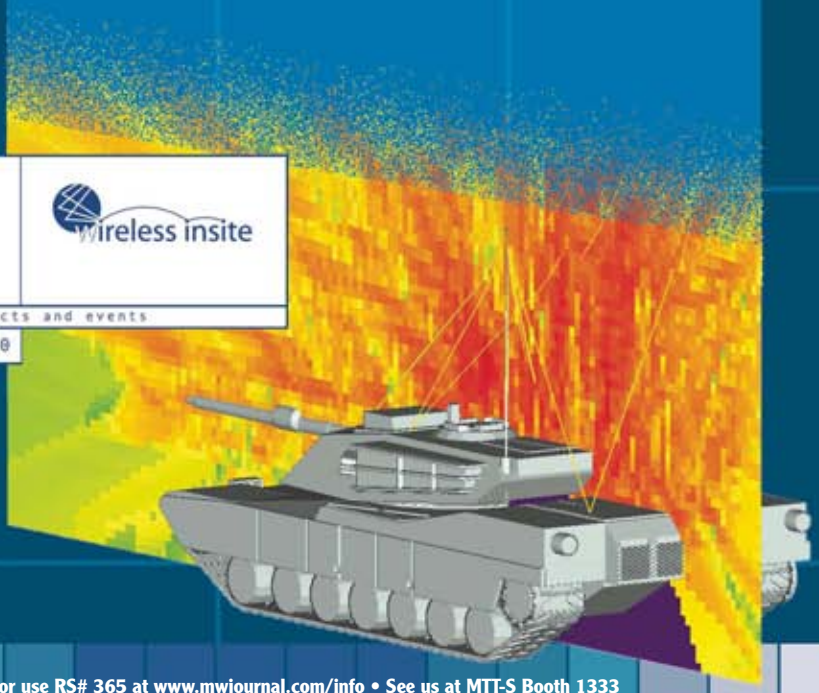

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Frequency Domain THz Spectrometer

The PB7100 frequency domain THz spectrometer produces and detects CW radiation from

100 GHz to well over 2 THz, thus providing the equivalent of a THz scalar network analyzer. Its unique combination of high signal to noise, fine resolution, compact size, room-temperature operation and low cost make the PB7100 an ideal turn-key lab instrument for characterizing a wide range of biological, chemical and explosive substances.

Emcore Corp.,
Alhambra, CA
(626) 293-3400,
www.emcore.com.
Booth 1604 ***RS 258***

Interference Control Solutions

These RF/microwave interference control solutions are designed for opto-electronic appli-

cations in 2.5, 4, 10 and 40 Gbps systems. ECCOSORB® brand absorber products are used to address EMI cross talk and emissions in transceiver and transponder modules, controlling harmonics and spurious signals in modulator-drivers and laser and detector diodes. The company offers a wide range of absorber products under the ECCOSORB brand for insertion loss and cavity resonance applications from 800 MHz to 100 GHz. Custom configurations are available to meet specific requirements.

Emerson & Cuming Microwave Products Inc.,
Randolph, MA (800) 650-5740,
www.eccosorb.com.
Booth 1511 ***RS 247***

RF Coaxial Connectors and Cable Assemblies

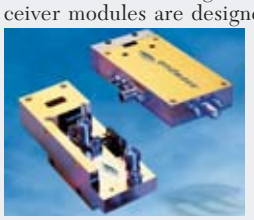
This new line of UMC ultra-miniature RF coaxial connectors provides a quality, snap-on, surface-mount connection

with a maximum mated height of 2.0 to 2.5 mm and DC to 6 GHz electrical performance. All parts are RoHS compliant and mate with U.FL and UFL(V) series connectors. No matter what wireless application you are working in (LAN, MINI-PCI, GSM, CDMA, GPRS, PDA, Bluetooth or microwave radio), the UMC right angle cable plugs, SMT receptacle and between series cable assemblies will provide the package you can count on. All items are available as standard off-the-shelf product sold through a distributor network.

Emerson Network Power Connectivity Solutions, Johnson® division,
Bannockburn, IL (800) 247-8256,
www.emersonnetworkpower.com/connectivity.
Booth 835 ***RS 248***

Millimeter-wave Receivers

These two custom-designed millimeter-wave receiver modules are designed for radiometer



applications. Two down-converter models have been custom-designed to operate at K-band (20 to 40 GHz) and V-band (50 to 75 GHz). Gain calibration is accomplished using an internal K- or V-band noise source, a noise injection coupler and a precision temperature sensor. Using a +2.0 dBm Ku-band local oscillator (LO) input to each module, both units employ a sub-harmonic mixer topology to down-convert from the millimeter-wave input frequency to an IF output under 1 GHz, providing 30 dB of nominal gain to the input signal. The V-band module utilizes an additional diode-based frequency doubler on the LO input, allowing a common local oscillator to drive both modules. Overall, the receiver noise figure is under 4 dB for the K-band model and under 6 dB for the V-band receiver.

Endwave Corp.,
San Jose, CA (408) 522-3100,
www.endwave.com.
Booth 1543 ***RS 249***

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With more than 40-year experience, Seekon Microwave has been a leading supplier of RF&Microwave components, assemblies and subsystems from Asia Pacific, especially for LNAs and Frequency Sources, delivering thousands of products to overseas end users. Now, we can provide products of high performance with competitive price and fast delivery, as well as that of MITEQ and CTT.

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- Custom design available

Amplifiers
- Ultra low noise (NF < 1dB)
- Octave band low noise
- Ultra-broadband
- Multi-octave band
- Medium/High power
- Limiting

ISO 9001:2000

LNAs/Model	Freq. Range (Ghz)	Gain (dB) min.	Gain Flatness (dB)	N.F (dB) max.	P1dB (dBm)	VSWR (IN/OUT)	Delivery Time
XKLA1020N3010	1-2	30	+/-1.0	0.8	+10	2.0:1	2-4 weeks
XKLA2040N3910	2~4	39	+/-1.0	0.7	+10	2.0:1	
XKLA4080N3210	4~8	32	+/-1.0	1.2	+10	2.0:1	
XKLA8012N3010	8~12	30	+/-1.0	1.5	+10	2.0:1	
XKLA1218N2510	12~18	25	+/-1.0	2.0	+10	2.0:1	

Seekon Microwave can easily modify any of its standard models to meet your "exact" requirements.

For additional information, call 86-28-81705322 · Fax 86-28-81700845 · e-mail at sales@seekonrf.com

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Since our beginnings in 1981, Modular Components National has been providing solutions for microwave circuit board technology. Through these years, we've met and exceeded the challenges of your design requirements. As we've developed solutions, we've developed long-lasting partnerships. We're proud of these partnerships and would like to thank you for our years of growth and expansion. At MCN we've invested in equipment to expand capabilities and increase capacity. As we build toward the next 25 years, our commitment remains the same - to anticipate the needs of a fast-growing microwave industry and continue meeting your high performance interconnect requirements from start to finish.

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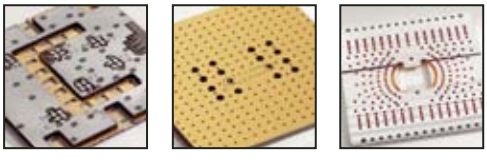

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Eudyna Devices Inc.,
San Jose, CA (408) 232-9500, www.eudyna.com/e/.
Booth 1227 ***RS 250***

Digital Transistors

These two families of 200 mW digital transistors integrate an external resistor bias network into a small form factor package. Tailored for use in switching, inverter, interface and driver circuits, the FJY30xx (NPN) and FJY40xx (PNP) series eliminate the need for an external resistor. This integration reduces part count, which in turn helps designers save board space, lower design costs, simplify circuit designs and maximize system performance. Board space is further optimized by utilizing surface-mount technology (SMT). Size: 1.7 × 0.98 × 0.78 mm SOT523F package. Price: $0.37 (1000). Delivery: six to eight weeks.

Fairchild Semiconductor,
South Portland, ME (972) 910-8000, www.fairchildsemi.com.
Booth 1343 ***RS 259***

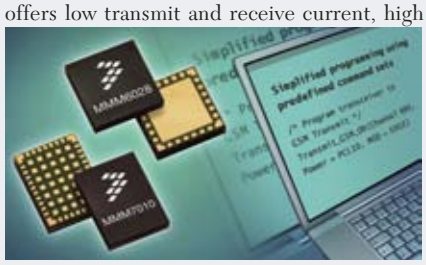
Discrete Field Effect Transistor

The FPD6836 is a mid-size die, 360 µm gate periphery, in a low cost SOT343 package. This gate length (periphery) is roughly 1/2 the size of the FPD750 and twice the size of the FPD200. In applications where simplicity of design is important, the low cost FPD6836SOT343 will work well in a 50 Ω environment and can be used to replace expensive 50 Ω MMICs providing cost-effective gain and power output up to 6 GHz without matching. It is a low power consumption part and will operate at 3 V and 25 to 50 mA.

Filtronic Compound Semiconductors Ltd., Newton Aycliffe, County Durham, UK +44 (0) 1325 301111, www.filtronic.com.
Booth 1002 ***RS 251***

EDGE RF Subsystem

The RFX275-30 is an RF CMOS 90-nanometer transceiver subsystem that offers low transmit and receive current, high receiver sensitivity and compact size. It accelerates phone manufacturers' integration time via simplified programming. Additionally, this subsystem delivers lower total cost of ownership by significantly shortening test time in manufacturing and bill of materials through integration. The highly integrated subsystem delivers: low power consumption for increased standby and talk times, –110 dBm sensitivity for improved call performance, reliable quality for clear reception, low noise and fewer dropped calls, and highly integrated components for ease of assembly.



Freescale Semiconductor Inc.,
Austin, TX (800) 521-6274, www.freescale.com.
Booth 1635 ***RS 260***

RF Subsystem

The new 3G RF subsystem, the RFX300-30, features a single integrated package that supports both multi-mode/multi-band UMTS and EDGE networks. With up to 13 bands supported, the RFX300-30 offers the broadest multi-band support in the smallest form-factor solution for handset manufacturers today. Processed in 90-nanometer CMOS technology, this RF subsystem delivers tremendous benefits for handset manufacturers, including: four band GSM/EDGE support, nine band UMTS support, HSDPA support up to 7.2 Mbps and HSUPA support up to 5.76 Mbps.

Freescale Semiconductor Inc.,
Austin, TX (800) 521-6274, www.freescale.com.
Booth 1635 ***RS 261***

Coaxial Calibration Kits

These 3.5 mm and N type coaxial calibration standards provide highly accurate and repeatable calibration due to RF characterization technologies with competitive price. The precision open, short, load components can be used to calibrate commercial vector network analyzer (VNA) systems up to 9 GHz (model GCS35M-9G, 3.5 mm), 6 GHz (model GCSN-6G, N type) and 4 GHz (model GCSN-4G, N type), respectively.

GigaLane Co. Ltd.,
Gyeonggi-do, Korea +82-31-233-7325, www.gigalane.com.
Booth 444 ***RS 252***

Air Core Coil Inductors

This new family of air core coil inductors is ideal for high frequency circuitry requiring high "Q" in microwave and radar applications. Utilizing typically 47 AWG gold wire, with or without standard or custom

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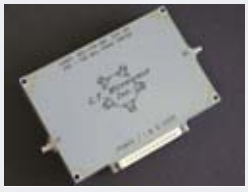
NEW WAVES

chip resistors/capacitors, an infinite variety of configurations is available. Application-specific configurations can also be designed. Shown here: LR/LC series (left, center) and GW series (right). Typical unit price is $2.70 in production quantities.

Gowanda Electronics,
Gowanda, NY (716) 532-2234,
www.gowanda.com.
Booth 514 ***RS 253***

I and Q Vector Modulator

The model M2L-21N-0BT is a narrowband calibrated for True Position PIN diode I and Q vector modulator.



This device simultaneously controls the phase and amplitude of a signal with 360° and 20 dB of dynamic range. True Position calibration sets the phase and amplitude to within ±1° and ±0.25 dB accuracy from any single theoretical command. It is digitally-controlled via two sets (I and Q) of monotonic 12 bit TTL binary logic and switches in 500 nsec. The device control input slope is linear with output voltage.

G.T. Microwave Inc.,
Randolph, NJ (973) 361-5700,
www.gtmicrowave.com.
Booth 604 ***RS 254***

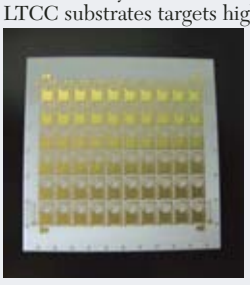
RMS Power Detector

The model HMC610LP4(E) is a 50 Hz to 3.5 GHz, 71 dB true RMS power detector. Ideally suited for the measurement of complex modulated waveforms with large crest factors, the HMC610-LP4(E) is Hittite's first true RMS power detector. Delivering best-in-class dynamic range of 71 dB at 900 MHz and 62 dB at 3 GHz, the HMC610LP4(E) improves upon competitor products by > 5 dB while achieving only 1 dB error over temperature. The SiGe BiCMOS HMC610LP4(E) is packaged in a 4 × 4 mm QFN package and specified for operation over –40° to +85°C.

Hittite Microwave Corp.,
Chelmsford, MA (978) 250-3343,
www.hittite.com.
Booth 934 ***RS 255***

Foundry Service

The foundry service of the multi-layered LTCC substrates targets higher Q, dimensional precision and yield for RF and mm-wave applications. Fine pitch and high Q substrate with thin film metallization, WLAN FEM with the embedded low loss diplexer and RF components sintered by microwave are available. HIRAI ships samples in a week after the design freeze and provides RF design support to your substrate with embedded passive components and test service up to 67 GHz.



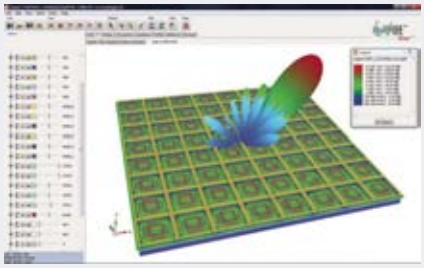
HIRAI SK Corp.,
Tokyo, Japan +81-584892394,
www.hirai.co.jp.
Booth 1824 ***RS 256***

Programmable Microwave Source

The HS1001A USB programmable microwave source is a compact CW frequency source that operates in a frequency range from 9 kHz to 1 GHz. It has a variable output power range of –120 to +15 dBm and the typical phase noise measures –130 dBc/Hz (1 GHz, 10 kHz offset). Holzworth DDS sources utilize frequency multiplication techniques, eliminating phase-locked loops and free running oscillators, resulting in excellent frequency stability and extremely fast tuning.

Holzworth Instrumentation,
Boulder, CO (303) 704-8875,
www.holzworth.com.
Booth 439 ***RS 257***

EM Field Solver



The new Empire XCcel™ 5.1 3D EM field solver is now supporting full 32 bit and 64 bit calculations on Windows XP, Vista and Linux operating systems. A further speed improvement of up to 900 MCell/s has been obtained by smartly exploiting multi-core processor technology. New features include healing of imported 3D data, improved GUI speed for complex structures and even more efficient memory management.

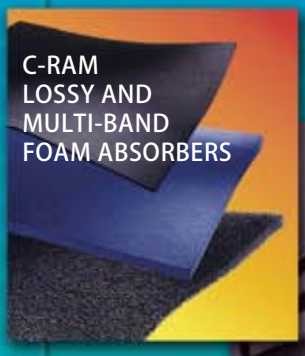
IMST GmbH,
Kamp-Lintfort, Germany +49 2842 981 0,
www.empire.de.
Booth 1154 ***RS 263***

Transimpedance Amplifier/Limiting Amplifier

The 1347TL 11.3 Gbps transimpedance amplifier (TIA)/limiting amplifier (LIA) provides high stressed receiver sensitivity, low cross talk, high gain and low power for 1310-nm/1550-nm 10G-Ethernet and 10G-SONET optical communications. For 10G-Ethernet applications, stressed receiver sensitivity is an important consideration as it assures "plug and play" and full compliance with IEEE 802.3ae standards

High Reliability

Military and Aerospace applications require materials with excellent electrical and physical properties, and above all, a history of proven performance.



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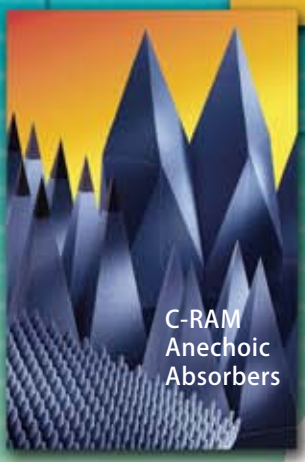

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over all operating conditions. The measured stressed receiver sensitivity of the 1347TL is better than –15 dBm (OMA) for 10GBASE-ER stress conditions exceeding the requirement by nearly 4 dB. This margin directly contributes to higher manufacturing yield and lower cost for manufacturers of receivers.

Inphi Corp.,
Westlake Village, CA (805) 446-5100, www.inphi-corp.com.
Booth 438 ***RS 264***

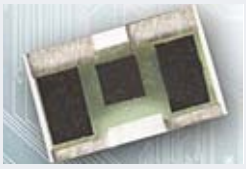
Rack Integrated System

The model RS1802-300 is a complete rack integrated system for various EMC and EW applications. It includes the company's 300 W amplifier for 200 MHz to 1 GHz as well as its 300 W amplifiers for 1 to 18 GHz (1 to 2.5 GHz, 2.5 to 7.5 GHz, 7.5 to 18 GHz). It is a versatile state-of-the-art design that can be tailored to meet customers' specific requirements for frequency range and RF output power levels. These systems can include any combination of pulse, CW or gridded amplifiers in compact solutions.

Instruments For Industry (IFI),
Ronkonkoma, NY (631) 467-8400, www.ifi.com.
Booth 403 ***RS 265***

Attenuator

The model IMA2404 is a surface-mount thick film 0805 attenuator especially suited to RF/microwave applications and communications-oriented circuitry. This thick film attenuator is operational to 15 GHz in a properly matched continuous 50 Ω system. It is available from 1 to 70 dB in 1 dB increments with a tolerance as low as ±0.2 dB. Input power handling is 400 mW (using proper thermal management techniques).



International Manufacturing Services Inc.,
Portsmouth, RI (401) 683-9700, www.ims-resistors.com.
Booth 504 ***RS 266***

Frequency Synthesizer

This line of DDS-based WaveCor™ synthesizers uses proprietary digital techniques to produce an unmatched combination of ultra-fast switching speed, low phase noise and high spurious free dynamic range. Frequency range options are 300 MHz to 2.5 GHz and 300 MHz to 18 GHz as well as dual output versions in these bands. Switching speed on all four models has been reduced to 200 ns when switching to any point in the operating band. This, coupled with typical phase noise at 10 GHz of –125 dBc/Hz at a 10 kHz offset and 1 Hz tuning resolution, represents the industry's best combination of performance and value.

ITT Microwave Systems,
Lowell, MA (978) 441-0200, www.ittmicrowave.com.
Booth 1137 ***RS 267***

Thin Film Networks

These CPW to microstrip thin film networks (TFN) are designed to adapt the benefits of coplanar waveguide wafer probe test methods to the measurement of difficult to test microstrip circuits. These TFNs enhance productivity and precision in product development for semiconductors, interconnect networks and packages by allowing the use of CPW probes to be used for previously difficult to test circuits. Calibration structure substrates are available for all TFN adapter substrate configurations. Products available include 5, 10 and 15 mil thick versions.

J microTechnology Inc.,
Portland, OR (503) 614-9509, www.jmicrotechnology.com.
Booth 544 ***RS 268***

130 nm SiGe BiCMOS Technology

The 130 nm SiGe BiCMOS technology is designed for high speed wireless and optical communications applications. This process combines industry standard 130 nm CMOS with 200 GHz HBT NPN transistors for high performance RF and millimeter-wave integrated circuits. The technology offering includes advanced analog components (inductors, capacitors, resistors) with high density digital circuitry to provide scaling of both the analog and digital blocks in a Systems-on-Chip (SoC) approach. The process is available for prototyping through a Multi-Project Wafer (MPW) Program offering 5×5 mm^2 tiles.

Jazz Semiconductor,
Newport Beach, CA (949) 435-8181, www.jazzsemi.com.
Booth 1706 ***RS 269***

Ka-band Block Converters

Models KABUC and KABDC are Ka-band phase-locked block up and down converters that provide an unparalleled combination of performance and size. These block converters translate L-band signals (1 to 2 GHz) to Ka-band (30 to 31 GHz) and from 20.2 to 21.2 GHz back to L-band. Some of the key features include phase locked to an external 5 MHz/10 MHz or 50 MHz reference, low output phase noise (MIL-STD-188-164A compliant), low output spurious and LO leakage, +15 dBm output power, low noise figure and operating from the single +12 V at 1.2 A maximum for KABUC and 700 mA for KABDC. Weight: < 1 lb.

Jersey Microwave,
Hackettstown, NJ (908) 684-2390, www.jerseymicrowave.com.
Booth 409 ***RS 270***

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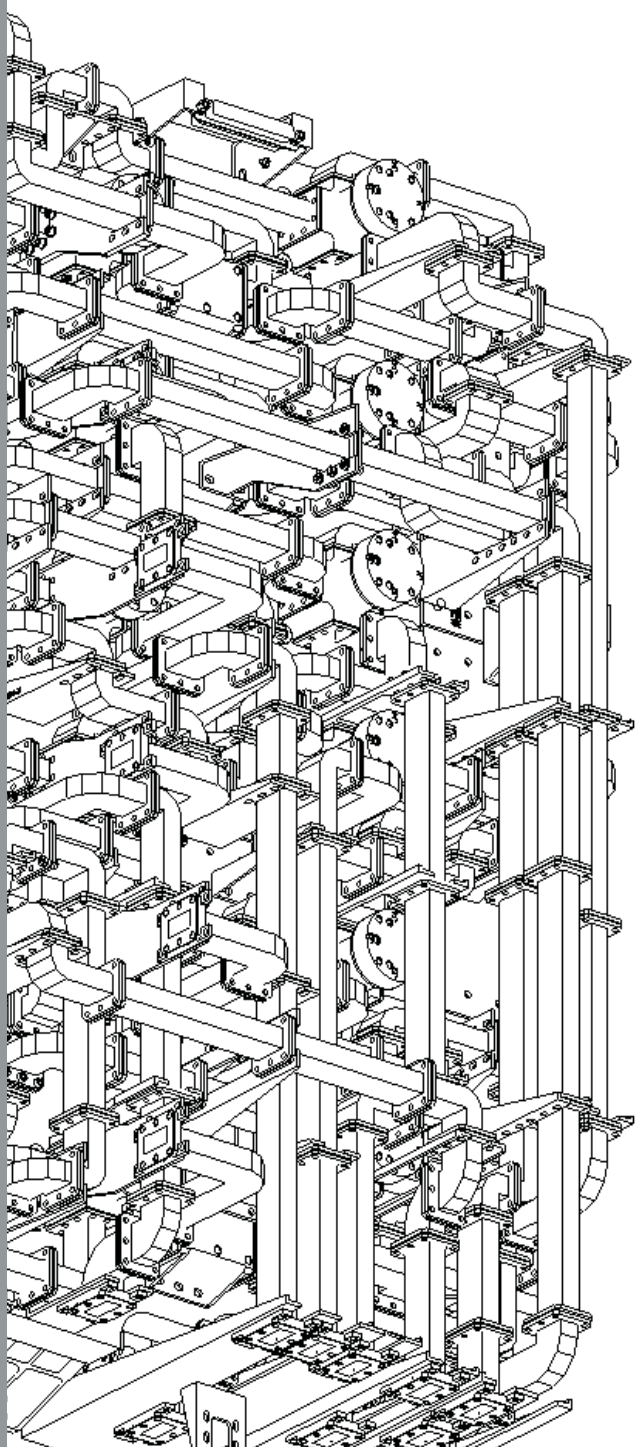

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Mini-type Connectors

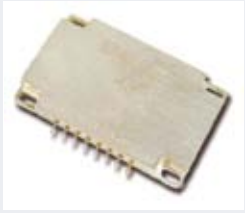
The MC-CARD series of mini-type connectors have an equivalent size to MMCX and offer self-latching coupling, maximum operating frequency of 6 GHz, high reliability and long life. The connectors are widely used in multiple mating occasions, such as wireless network cards, GPS, WLAN, PC MCIA, ISA cards, cable assemblies, telecom, RF testing systems, outside antennas and Bluetooth.

Junper Interconnection Co. Ltd., Ningbo, Zhejiang, China +86-574-87901911, www.junper.com.

Booth 417 ***RS 271***

Low Profile Switched Filter Bank

The model 5SFB-3500/X5500-SMP is a high speed TTL controlled five-channel switched filter bank that covers 3500 to 5500 MHz with channels centered at 3500, 4000, 4500, 5000 and 5500 MHz. Recent enhancements to K&L's switched filter banks make them among the fastest and most reliable on the market today. Switching speeds less than 20 ns improve overall system performance. Additionally, low profile packaging makes these new banks ideal for compact, lightweight applications. Banks are designed using K&L's breadth of experience in filter topologies, assuring high out-of-band attenuation and channel-to-channel isolation.



K&L Microwave, Salisbury, MD (410) 749-2424, www.klmicrowave.com.

Booth 1100 ***RS 363***

Four-way Power Divider/Combiner

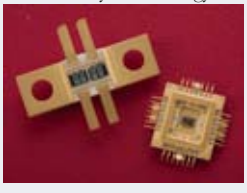
The model 7005265 is a four-way power divider that operates in a frequency range from 0.5 to 26.5 GHz. This model offers input VSWR of 1.8 (maximum), output VSWR of 1.7 (maximum), insertion loss of 4 dB (maximum) and isolation of 16 dB (minimum). This power divider/combiner has amplitude tracking of 1.2 dB, phase tracking of 15°, 3.5 mm female standard connectors and operating temperature of –54° to +85°C. Delivery: stock to 30 days. Unit may be manufactured to meet military specifications.

Krytar, Sunnyvale, CA (408) 734-5999, www.krytar.com.

Booth 545 ***RS 272***

Wirebond Assembly Services

Kyocera America Inc. now offers RF/MW wirebond assembly services in its Assembly Technology Division in the San Diego, CA facility. This allows customers to drop ship RF/MW packages to Kyocera, and then have fully assembled parts shipped directly to them. Kyocera America Inc. is ISO 9001/14001 and ITAR Register, DSCC Certified.



Kyocera America Inc., San Diego, CA (800) 468-2957, www.kyocera.com/packaging.

Booth 614 ***RS 273***

10/15 kW Programmable Power

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Lambda Americas, Neptune, NJ (732) 922-9300, www.lambda-hp.com.

Booth 1352 ***RS 274***

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Model Number	Freq. GHz	Gain dB, min	N.F. dB, max	Pout 1dB Comp	VSWR I/O	Amps @12VDC
MSD-2597601	.02-2.0	33.0	8.0	30.0	2.0:1	.900
MSD-3488601-TTL	.05-3.0	30.0	10.0	30.0	2.0:1	1.00
MSH-2352201-DI	1.0-2.0	20.0	2.7	10.0	2.0:1	.100
MSD-2451501	1.0-2.0	25.0	1.8	23.0	1.5:1	.300
MSD-2654601	1.0-2.0	40.0	5.0	30.0	2.0:1	.800
MSD-3449902	1.9-2.1	30.0	10.0	40.0	2.0:1	7.00

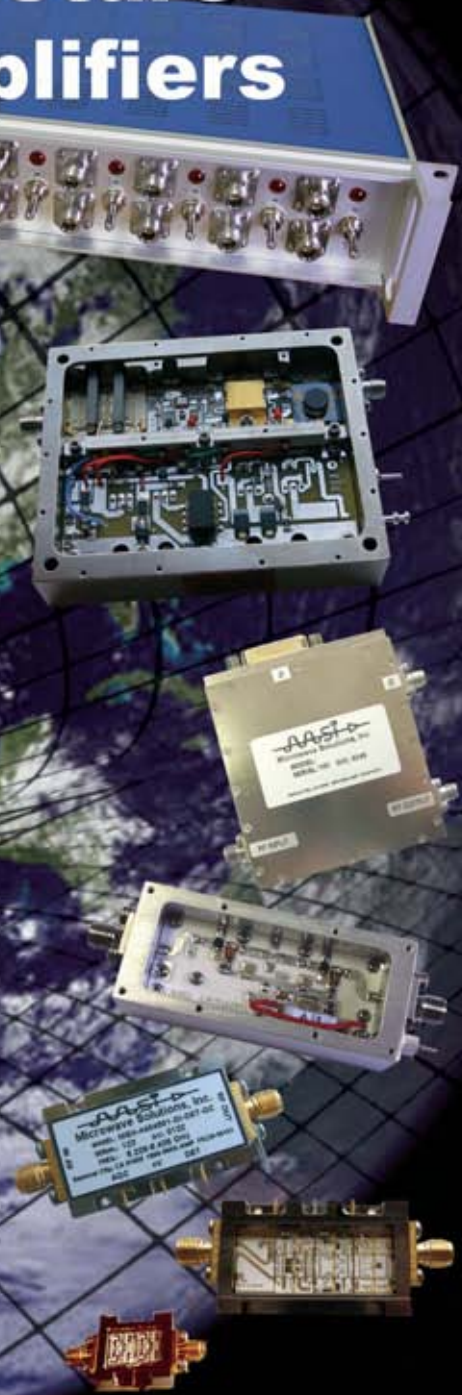
Model Number	Freq. GHz	Gain dB, min	N.F. dB, max	Pout 1dB Comp	VSWR I/O	Amps @12VDC
MSH-4152301-DI	2.0-4.0	12.0	3.0	13.0	2.0:1	.040
MSH-4553307-DI	2.0-4.0	32.0	4.0	15.0	2.0:1	.150
MSH-4752402-DI	2.0-4.0	46.0	2.0	20.0	2.0:1	.260
MSH-4716803-TC	3.4-3.6	48.0	6.5	38.0	1.5:1	3.80
MSH-4222201-DI	3.7-4.2	16.0	2.4	10.0	2.0:1	.065
MSH-4426602	3.7-4.2	25.0	7.0	30.0	2.0:1	1.0
MSH-4627802	3.7-4.2	39.0	8.0	37.0	2.0:1	3.60

Model Number	Freq. GHz	Gain dB, min	N.F. dB, max	Pout 1dB Comp	VSWR I/O	Amps @12VDC
MSH-5452202-DI	4.0-8.0	28.0	3.0	10.0	2.0:1	.150
MSH-5455402-DI	4.0-8.0	26.0	6.0	20.0	2.0:1	.150
MSH-5556603	4.0-8.0	35.0	7.0	30.0	2.0:1	1.00
MSH-4627801	4.4-5.0	39.0	8.0	37.0	2.0:1	3.60
MSH-4427802	5.3-5.9	30.0	8.0	37.0	2.0:1	3.60
MSH-5617801	5.9-6.4	38.0	8.0	37.0	2.0:1	3.60
MSH-5427801	6.4-7.2	29.0	8.0	37.0	2.0:1	3.60
MSH-5417802	7.1-7.7	30.0	8.0	37.0	2.0:1	3.60
MSH-6824701	7.2-8.4	54.0	5.0	33.0	1.5:1	1.80
MSH-6617801	7.7-8.5	39.0	8.0	37.0	2.0:1	3.60

Model Number	Freq. GHz	Gain dB, min	N.F. dB, max	Pout 1dB Comp	VSWR I/O	Amps @12VDC
MSH-6543603	8.0-12.0	34.0	4.0	30.0	2.0:1	1.13
MSH-6142401-DI	8.0-12.0	11.0	3.0	18.0	2.0:1	.090
MSH-6343408-DI	8.0-12.0	23.0	3.5	18.0	2.0:1	.150
MSH-6544402-DI	8.0-12.0	35.0	5.0	20.0	2.0:1	.250
MSH-6417801	9.5-10.5	29.0	8.0	37.0	2.0:1	4.40
MSH-6706805-TC	10.15-10.7	48.0	6.5	38.0	1.5:1	4.20
MSH-7407804	11.7-12.2	30.0	8.0	37.0	2.0:1	4.80

Model Number	Freq. GHz	Gain dB, min	N.F. dB, max	Pout 1dB Comp	VSWR I/O	Amps @12VDC
MSH-7144401-DI	12.0-18.0	8.5	5.0	20.0	2.0:1	.080
MSH-7343403-DI	12.0-18.0	21.0	4.0	20.0	2.0:1	.200
MSH-7645402	12.0-18.0	39.0	6.0	20.0	2.0:1	.370
MSH-7406601	12.7-13.2	30.0	7.0	30.0	2.0:1	1.20
MSH-7407801	12.7-13.2	30.0	8.0	37.0	2.0:1	4.80
MSH-7607801	14.0-14.5	37.0	8.0	37.0	2.0:1	4.80

More Models available



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New Waves

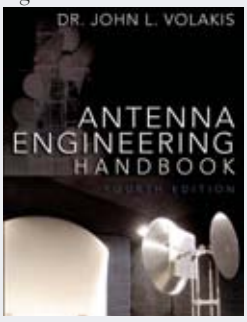
20 GHz Fiber Optic Links

Linear Photonics introduces XiMod 20 GHz fiber optic links. XiMod transmitters feature a small form factor modulator and ultra low noise narrow laser source to provide high dynamic range in a small package. XiMod receivers feature an InGaAs high responsivity PIN photoreceiver for low noise and high linearity in a 2" × 3" housing. XiMod links define the state of the art in performance, size and value for applications including antenna remoting, point-to-point microwave over fiber and specialized communications.

Linear Photonics LLC,
Hamilton, NJ (609) 584-5747, www.linphotonics.com.
Booth 429 ***RS 275***

Antenna Engineering Handbook, 4th Edition

Led by John Volakis, renowned antenna expert, more than 50 of the leading names in the field have completely updated this classic to ensure it remains the most authoritative antenna sourcebook available anywhere. Readers will find all the expertise they need to solve any engineering problem that may arise in the design and application of the very latest types of antenna. 1872 pages, 1500 illustrations. Price: $175, hardcover.



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Diplexers and Triplexers

This series of RoHS compliant diplexer and triplexer modules is designed for Multimedia over Coax Alliance (MoCA) applications including TelcoTV, IPTV, Set-Top-Boxes, Bridge, Gateway devices and wireless interfaces. The frequency range complies with major chipset standards covering 5 to 1525 MHz. A typical triplexer spec consists of 5 to 42 MHz low passband, 54 to 864 MHz middle passband and 975 to 1350 MHz high passband in a 39 × 22.3 × 15.6 mm case size.

MCV Technologies Inc.,
San Diego, CA (858) 552-2008, www.mcvtech.com.
Booth 1636 ***RS 277***

Power Dividers/Combiners

These compact, high performance Wilkinson power dividers/combiners are ideally suited for C-, X- and Ku-band systems applications. Two- and four-way SMA-Female models feature high isolation, low insertion loss, exceptional VSWR and excellent phase/amplitude balance. The dividers/combiners are available in octave bands and also broadband designs including 2 to 18 GHz. Delivery: from stock to four weeks ARO. Made in the USA.

MECA Electronics,
Denville, NJ (973) 625-0661, www.e-meca.com.
Booth 1009 ***RS 278***

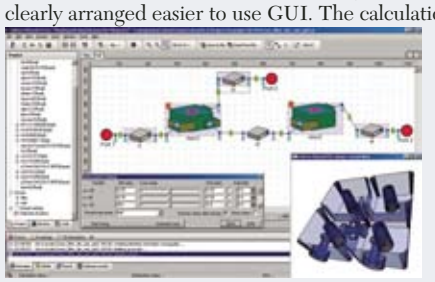
Drop-in Isolators and Circulators

These low cost, lightweight drop-in isolators and circulators are designed to accommodate numerous and demanding requirements within the homeland security, military and commercial environments for tactical radios, SATCOM equipment and radar systems. The DCF series drop-in isolators and circulators operate within frequencies from 450 MHz to 14.5 GHz, offer low intermodulation distortion and surface-mount configuration packages. Over 25 different models are available for a wide range of applications. Package sizing includes 1" × 1" × 0.30" in height, to as small as 0.35" × 0.475" × 0.15" in height.

MICA Corp.,
Manteca, CA (209) 825-3977, www.mica-mw.com.
Booth 1106 ***RS 279***

EM Software Tool

Version 6.5 of the EM-software tool µWave Wizard™ offers a more clearly arranged easier to use GUI. The calculation of losses arising from finite wall conductivity is now available for most mode-matching and 2D FEM structures. Adaptive frequency selection in combination with a rational function interpolation technique yields a significant reduction of simulation times. A series of new, flexible elements including various types of dielectric resonators and full 3D visualization of electromagnetic fields is introduced.



Mician GmbH,
Bremen, Germany +49 (421) 16899351, www.mician.com.
Booth 450 ***RS 280***

7–16 mm and N-type Tappers

These tappers are designed for in-building distributed antenna system applications in both N and 7–16 mm DIN connectors. The tappers are 40 percent lighter than the series they replace yet retain the established reliability and have an expanded bandwidth of 380 to 2700 MHz. The DK-x8 series unequal power splitters unevenly splits high power cellular signals in output split ratios from 30:1 (15 dB) down to 4:1 (6 dB) with minimal reflections or loss over the whole 380 to 2,700 MHz band. The design ensures a good input VSWR and flatness across the band for both main and branch lines.

Microlab/FXR,
Parsippany, NJ (973) 386-9696, www.microlab.fxr.com.
Booth 1117 ***RS 281***

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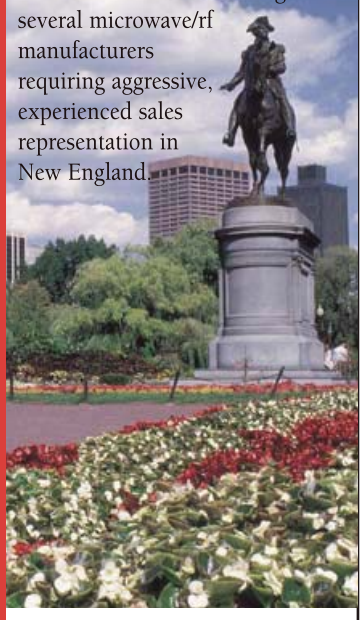

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Manufacturer's Representatives for New England

Contact Mike Crittenden
86 South Cross Road, Bradford, MA 01835
Office: 978.521.1701
Mobile: 978.994.9435
Email: mike_bradfordrfsales@comcast.net

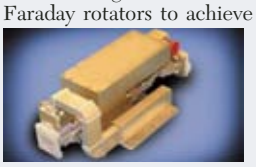
NEW WAVES

High Power PIN Diodes

These non-magnetic metal electrode leadless faced (MELF) packaged PIN diodes feature high power handling and low distortion. The MELF PIN diodes are designed for switching and attenuator applications from HF through UHF frequencies. The product family has a resistance specification at 100 MHz from 0.3 ohms to 1.0 ohms at 100 mA, capacitance specifications at 1 MHz of 0.5 pF to 2.0 pF at 100 V, and lifetime specifications from 1.0 µsec to 8.00 µsec. As a result, this family of PIN devices has lifetime specifications that will allow for lower intermod distortion and have a higher average incident power handling capability.

Aeroflex MicroMetrics,
Londonderry, NH (603) 641-3800,
www.micrometrics.com.
Booth 500 ***RS 282***

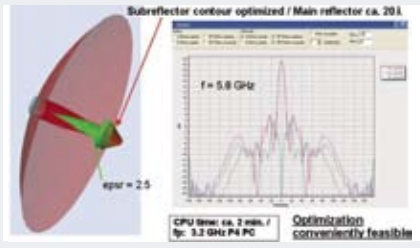
X-band Latching DP2T Switch



This latching DP2T switch utilizes reciprocal Faraday rotators to achieve nonreciprocal action, handling 75 kW peak power and 400 W average power in an X-band configuration. Over a 10 percent frequency bandwidth and 120°C operating temperature the maximum insertion loss is 0.85 dB, and the 35 microseconds switching time and 4 kHz switching rate eliminate concerns over timing. Minimum isolation is 25 dB.

Microwave Applications Group (MAG),
Santa Maria, CA (805) 928-5711,
www.magsmx.com.
Booth 1236 ***RS 283***

Fast CAD and Optimization Tool



WASP-NET's unique hybrid MM/FE/MoM/FD CAD engine combines the high speed and flexibility advantages of four solvers in one single tool, meeting with it the quest of advanced microwave engineers for a new quality in EM CAD and optimization efficiency. The new WASP-NET release, featuring multiprocessor and advanced 64-bit options, offers efficient CAD capabilities also for large sized structures, e.g. slot arrays, reflectors, with typical optimization times of a few minutes on a PC. WASP-NET application examples include: fast optimization of all types of waveguide components and aperture antennas/arrays; full-wave synthesis of waveguide and combline filters; cross-coupled and LTCC filters; dielectric resonator filters; dielectric loaded horns with shaped subreflectors; squarax and stripline elements.

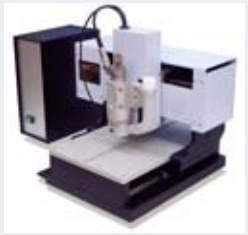
Microwave Innovation Group (MiG) GmbH & Co. KG,
Bremen, Germany +49 421 22 37 96 60,
www.mig-germany.com.
Booth 1048 ***RS 284***

GaAs PHEMT Active Doubler

The 18 to 21 and 36 to 42 GHz GaAs PHEMT active doubler is offered in a 7×7 mm surface-mount QFN package that is RoHS compliant. Identified as the XX1001-QK, this device delivers +25 dBm output power, has excellent fundamental rejection of 50 dBc and offers the added feature of gain control. The device combines an active doubler with an input buffer amplifier and a four-stage power amplifier and provides an ideal solution for a variety of applications, including microwave, point-to-point radio, VSAT, E-band radio, automotive and satellite communications.

Mimix Broadband Inc.,
Houston, TX (281) 988-4600,
www.mimixbroadband.com.
Booth 823 ***RS 285***

PCB Prototyping Machine



The FP-21T Precision is a PCB prototyping machine that enables a user to mill 50 µm lines and spaces. Software for DXF data correction: This is easy-to-handle DXF-output-data correction software that enables a user to correct the incompletely closed loops such as in the microwave circuits designed by a CAD system. This milling machine performs precise milling, drilling and routing. Within a day in a user's laboratory, one can make single-sided and double-sided boards, or RF boards such as for antennas.

MITS Electronics Co. Ltd.,
Tokyo, Japan +81-423-88-1051,
www.mitspcb.com.
Booth 1711 ***RS 287***

System Component Library

Modelithics has introduced a new class of models to The Modelithics Library™ of high accuracy RF and microwave simulation models. The System Component Library (or *SCL Library*™), to be introduced in Q2 2007, will include a collection of accurate linear and nonlinear models for functional system blocks including filters, switches, attenuators, transformers, amplifiers and mixers. The *SCL Library* joins the company's other high accuracy component libraries including the *CLR Library*™ the *NLD Library*™ and the *NLT Library*™ The introductory version of this library will include system block component models from several vendors, such as Barry Industries, Murata, Toko, Skyworks, Mini-Circuits, Maxim, Celeritek, Sirenza and Watkins-Johnson.

Modelithics Inc.,
Tampa, FL (813) 866-6335,
www.modelithics.com.
Booth 657 ***RS 288***

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NEW WAVES

Microwave Passive Components

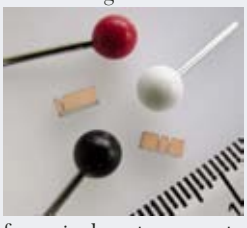
The company specializes in R&D and the manufacture of microwave passive components. Its

extensive product line includes RF coaxial connectors, RF cable assemblies, terminators, attenuators, arrestors, power dividers and isolators. The company offers an unparalleled reputation from well-recognized overseas enterprises in Europe and North America. It holds ISO9001:2001 and ISO14001:2004 and many certificates and patents.

MPDevice Co. Ltd.,
Namdong-gu, Incheon-city, Korea
+82-32-822-3290, www.mpdevice.com.
Booth 1350 ***RS 289***

ANC Chip Antenna

This line of ultra-small ceramic platform antennas is designed for use in portable devices



operating in applications from 1.57 to 2.45 GHz. Platform antennas can reduce design cycle times, inventory management costs and material cost by allowing for a single antenna part number to be used across several different end products. The ANCV1 and ANCG1 series chip antennas are available for on and off ground applications.

Murata Electronics,
Smyrna, GA (770) 436-1300,
www.murata.com.
Booth 1201 ***RS 290***

PXI RF Switches

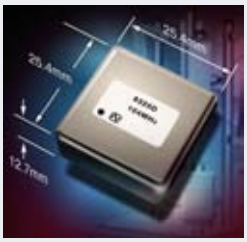
These 11 new RF switches have doubled the company's PXI RF switch offering for 50 and

75 ohm RF applications. The modules include 4×1, terminated 4×1, dual 4×1 and 8×1 multiplexers as well as quad (4) SPDT and dual-terminated SPDT general-purpose configurations. With these new products, engineers have more choices to optimize their RF switch networks around price performance and improved signal integrity. The six 2.5 GHz 75 ohm modules are the company's first switches for high frequency video applications. The five 2.7 GHz 50 ohm modules add to the company's current RF switch offering of 10 modules for routing signals between DC and 26.5 GHz and are ideal for expanding the channel count of RF generators, such as the NI PXI-5671 2.7 GHz vector signal generator, or RF analyzers such as the NI PXI-5661 2.7 GHz vector signal analyzer.

National Instruments,
Austin, TX (800) 258-7022, www.ni.com.
Booth 1617 ***RS 291***

Low Noise OCXOs

These high frequency (80 to 135 MHz) low noise oven-controlled crystal oscillators



(OCXO) improve system performance. The 9325D series of OCXOs is designed for applications requiring a low noise high frequency reference source. The 9325D exhibits tight stability of ±50 ppb over an operating temperature range of –20° to 70°C, while achieving a low phase noise of –160 dBc/Hz at 10 kHz offset.

NDK,
Belvidere, IL (815) 544-7900, www.ndk.com.
Booth 1728 ***RS 292***

Power Combiners

These Radial power combiners range from as few as four ports to as many as 90, operating in bands from 20 MHz through 45 GHz, and up to 50 kW average power. Higher power levels and larger number of inputs are available. Typical combining losses vary from 0.1 dB at low UHF to 0.5 dB at Ka-band, independent of the number of inputs. Series 700 combiners allow hot replacement, and are tolerant of amplifier phase and amplitude mismatches. Applications include: HDTV transmitters, air traffic control, wireless cable, communications, radar and antenna arrays.

ORBIT/FR Inc.,
Horsham, PA (215) 674-5100,
www.orbitfr.com.
Booth 1836 ***RS 364***

N-connector

This glass hermetically sealed N-connector is designed to meet special requirements in ultra-

high vacuum microwave. Applications include: beam position monitors for particle accelerators and ultra high vacuum waveguide components. VSWR of the N-connector shows characteristics that include: less than 1.2 for frequency = DC to 8 GHz and less than 1.4 for frequency = 8 to 18 GHz as standard. The basic design can be modified easily for wide range environments. Custom requirements are available upon request.

Orient Microwave Corp.,
Higashiomi, Shiga, Japan
+81-749-45-8121,
www.orient-microwave.com.
Booth 1702 ***RS 293***

RF Coaxial Cables

YouForm™ high quality, low cost jacketed hand formable cables feature stainless steel

SMA plugs on each end are now available in straight and right angle configurations. 100 percent VSWR tested 1.35 at 18 GHz for SMA straight connectors and 1.35 at 12.4 GHz for SMA right angle. YouForm cables are available in two diameters: 0.085 (0.102 (OD) and 0.141 (0.161 (OD). Lengths from 2" to 18" in stock for $9.95 each for straight SMAs; $13.95 for straight to right angle SMAs and $14.95 for SMA right angle to right angle. Applications include RF and microwave rack-mounted systems, radar, base stations, module-to-module links, communications systems and military COTS.

P1dB Inc.,
San Jose, CA (877) 367-7369,
www.rfmw.com/youform.
Booth 643 ***RS 294***

Oven-controlled Crystal Oscillator

This oven-controlled crystal oscillator (OCXO) addresses the most critical applications where

ultra low noise is required and aims to provide the lowest possible phase noise within a compact package. It features a relatively wide tuning range and a temperature compensation circuit. The OCXO has been developed to address the most critical applications where ultra-low noise is required; for example, as a reference for phase noise measurement or as the master oscillator in radar systems or low noise frequency multipliers/synthesizers. Pascall is now well into the development of a vibration isolated variant.

Pascall Electronics Ltd.,
Ryde, Isle of Wight, UK
+44 (0) 1983 817300, www.pascall.co.uk.
Booth 542 ***RS 362***

RF Power Transistor

The model PDW4020 is a 28 V, single-ended, wideband LDMOS RF power transistor, capa-

ble of generating 150 W P1dB of RF power from 500 to 1500 MHz with over 10 dB of gain at 1500 MHz. This device provides a solution for wideband applications and provides a solution of narrowbands falling between 500 and 1500 MHz.

Peak Devices,
San Jose, CA (720) 406-1221,
www.rfmw.com/peak.
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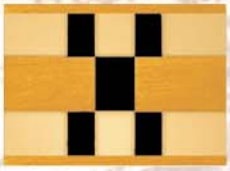

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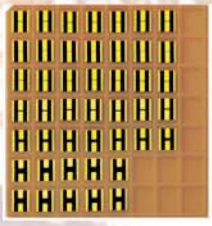

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New Waves

Microwave Counters

The CNT-90XL counters are CW microwave frequency counter/analyzers with an integrated power meter that measure frequency and power to 60 GHz (model dependant). These counters have burst measurement capabilities and offer high resolution and measurement speed that include up to 250,000 frequency samples/sec. The graphic display shows frequency changes over time, directly on-screen, providing measurement and analysis of: FM/AM modulation; power and frequency changes; VCO settling and post-tuning drift. Built-in statistical processing presents an on-screen display of frequency and power distribution; frequency stability; power stability; and modulation; in either numeric, trend-line or histogram formats. CNT-90XL comes in four models, measuring frequencies to 27, 40, 46 and 60 GHz.

Pendulum Instruments Inc.,
Oakland, CA (510) 428-9488,
www.pendulum-instruments.com.
Booth 1610 ***RS 296***

Wideband VCOs

Models VTO-4500-67T, VTO-7500-40M, VTO-10500-29M and VTO-13500-22M are wideband voltage-controlled oscillator (VCO) modules that provide frequency coverage from 3 to 6 GHz, 6 to 9 GHz, 9 to 12 GHz and 12 to 15 GHz respectively, and feature an integrated buffer amplifier for increased output power and load isolation. These VCO modules offer phase noise performance as low as –95 dBc/Hz at 100 kHz. Output power of standard products is typically 10 dBm. These modules are available in an industry standard TO-8 package or a coaxial output package.

Phase Matrix Inc.,
San Jose, CA (408) 428-1000,
www.phasematrix.com.
Booth 954 ***RS 297***

Low Phase Noise Comb Generator

The model 7124 is the latest model in the company's line of ultra-low phase noise (LPN) comb generators. This model has high harmonic output power at high frequencies (~0 dBm at 50 GHz with 27 dBm, 2 GHz input). The model 7124 is designed with non-linear-transmission-line (NLTL) technology so it maintains the same low phase noise characteristics of the company's other LPN models. These models are superior to SRDs not only for their ultra-low phase noise, but an SRD's frequency content rolls off significantly at frequencies > 20 GHz.

Picosecond Pulse Labs Inc.,
Boulder, CO (303) 443-1249,
www.picosecond.com.
Booth 811 ***RS 298***

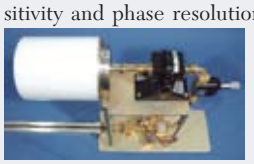
Custom Military-grade Filters

These custom filters and multiplexers are designed for military and high reliability applications. The model QRB1030M2P4-SFS is one of a family of IFF filters designed for military platforms. This filter has more than 60 dBc rejection in a surface-mount package size of approximately 1.1" × 0.6" × 0.2", and delivered in production quantities. The company will tailor any filter design to specific needs and deliver it quickly and on time.

Q Microwave Inc.,
El Cajon, CA (619) 258-7322,
www.qmicrowave.com.
Booth 1357 ***RS 311***

W-band Interferometer

The W-band interferometer features high sensitivity and phase resolution. It operates at a specified frequency in the range of 75 to 110 GHz for the applications of accurate real-time measurement of amplitude and phase characteristics of a medium such as plasma or other dynamically changing dielectric material (confined in a chamber or vessel) under testing. The measurement subsystem works on the principle of coherent signal processing using a phase bridge. The subsystem includes provisions to calibrate the subsystem and/or adjust the transmitter signal for a specific chamber or plasma vessel.



QuinStar Technology Inc.,
Torrance, CA (310) 320-1111,
www.quinstar.com.
Booth 1700 ***RS 312***

Electromagnetic Design Software

As electromagnetic simulations are becoming a "must" for microwave engineers across various segments of industry, simulation speed is viewed as an issue of major significance. To meet the highest expectations in this regard, QWED is bringing to market a variety of solutions that include: a hardware accelerated version of the QW-

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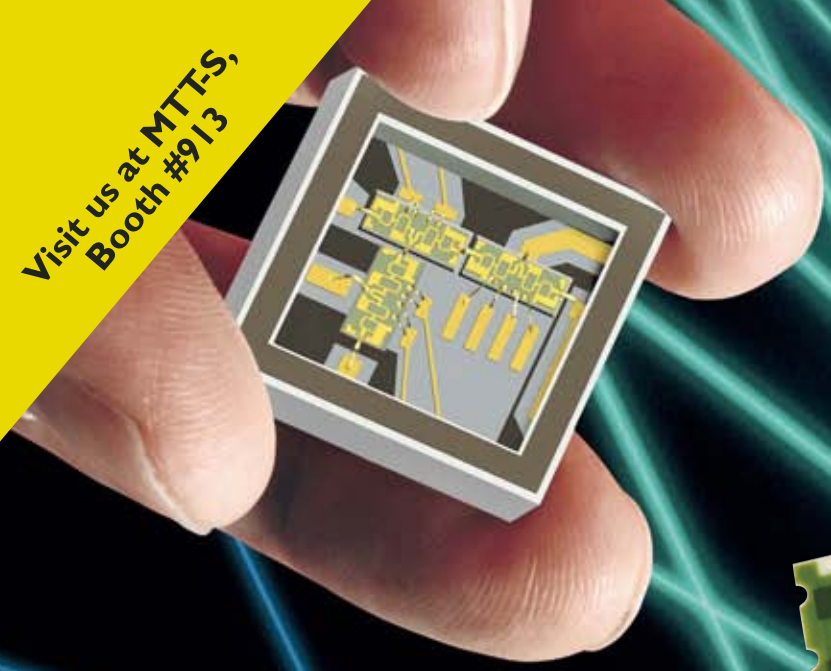

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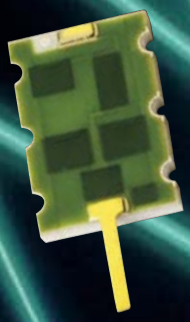

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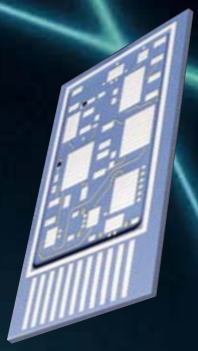
- Life Tested, Proven Reliability
- BeO and Lead Free, Nickel Barrier Available

Flange-Mounted High Power Terminations, Resistors and Attenuators

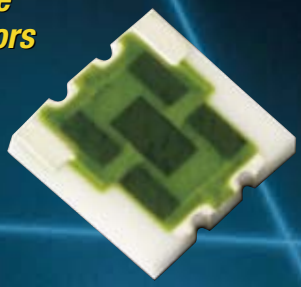
- 1 to 1,000 Watts
- All Brazed Construction
- Low VSWR
- DC - 18 GHz
- All Devices Available with Leads Only

LTCC Multilayer Circuit Capability



- Turnkey Foundry
- Circuits and Transitions Library
- Transceiver Design
- Multi-function Circuit Design
- Integrated Active and Passive Elements
- DC Through 60 GHz Test Capability

High Power Surface Mount Chip Resistors Terminations and Attenuators



- 5 to 50 Watts
- Package Sizes from .080" x .050" to .375" x .250"
- Solderable Devices

Precision Chips

- Resistors, Terminations and Attenuators
- Up to 40 GHz
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QWED,
Warsaw, Poland +48 601 38 64 84, www.qwed.eu.
Booth 1452 ***RS 313***

High Performance Alloys

These high performance air-cooled Fabfin and dual baseplate aluminum and/or copper alloys are manufactured utilizing the company's patented swaging process that eliminates fin to baseplate thermal resistance. Aquasink and Hypercool range of liquid cooled products provide a rugged, flexible solution to cooling compact arrays of high power semiconductors. Using R-Tools, an interactive on-line heatsink simulator, the design engineer is able to design custom heatsinks. R-Theta's extensive experience in thermal management can be fully utilized to optimize the design of its heatsink in a company's applications.

R-Theta Thermal Solutions Inc.,
Mississauga, Ontario, Canada
(905) 795-0077, www.r-theta.com.
Booth 448 ***RS 314***

Notch Filter

Reactel's 6R7-1575.42-X15N11 is a highly selective notch filter. This unit is centered at the GPS frequency of 1575.42 MHz and has a nominal 3 dB bandwidth of 15 MHz. The notch depth is greater than 75 dB at CF ±1 MHz, and exhibits insertion loss measuring less than 1.25 dB. The company has the ability to custom design notch filters to the strictest requirements.

Reactel Inc.,
Gaithersburg, MD (301) 519-3660, www.reactel.com.
Booth 749 ***RS 315***

PC Board Mount Relay

The PC board mount relay is available in a 2P2T transfer configuration. This "PC pin out" device provides greater layout and packaging density measuring 1.30" Sq. × 1.25" high. The relay provides exceptional RF performance and power handling to 8 GHz and is silver-plated for improved grounding and passive IM. Typical applications include 'hot standby,' 'input/output swapping' and using multiples to form switch matrices. It is available in 'failsafe' or 'latching' with optional configured 'circuit insertion' whereby one internal bridging contact is removed to provide a non-shorting circuit path. Available in 12 and 28 VDC.

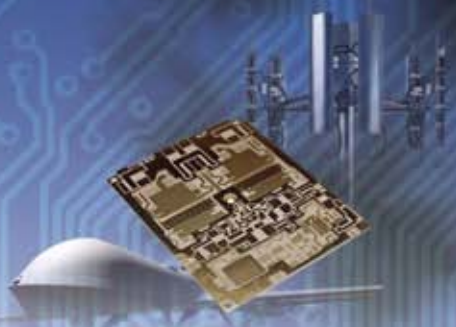
RelComm Technologies Inc.,
Salisbury, MD (410) 749-4488, www.rfrelaystore.com.
Booth 710 ***RS 365***

Coaxial Circulator

This coaxial circulator operates in a frequency range from 225 to 400 MHz and is designed for military communications applications. The lumped element circulator utilizes a patent pending design, which preserves the symmetry between ports while maintaining a broad performance. The unit is lightweight, made with an aluminum housing designed to provide an efficient heat dissipation path. Typical electrical performances from –40° to +85°C are 16 dB isolation, 1 dB IL, 1.40 VSWR, radiation leakage below –100 dBc and 2nd harmonic level less than –60 dBc. Size: 2.05" × 2.58" × 1.14". An isolator is also available with power handling up to 60 W CW.

Renaissance Electronics Corp.,
Harvard, MA (978) 772-7774, www.rec-usa.com.
Booth 612 ***RS 316***

Total Integrated Platform Solutions & Subsystem Assemblies



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Call For Papers

The 2008 IEEE Radio and Wireless Symposium (RWS 2008) incorporating IEEE Wireless and Microwave Technology Conference (WAMICON) will be held in Orlando, FL, on 22 - 24 January 2008 as part of the Radio Wireless Week technical event. In addition to oral presentations and posters, RWS 2008 includes workshops, panels, and an exhibition. Others collocating in the event are the Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems (SiRF) and the IEEE Topical Workshop on Power Amplifiers for Wireless Communications (PA Symposium).

RWS 2008 sessions will highlight applications including (but not limited to):

- 3G/4G Wireless Communication including Emergency/Location Services
- Satellite Network and Wireless LAN Systems
- Software Defined Radio/Cognitive Radio and other Emerging Technologies
- 802.16/LMDS Broadband Fixed Wireless and Last-Mile Access Techniques
- Wireless Mesh and Broadband Local/Personal Area Networks
- Wireless Sensors and Ad Hoc Networks towards Anytime Anywhere Internetworking
- Ultrawideband (UWB) Technologies
- High-Power and Efficient RF Transmitters
- Low-Power/Low Noise RF/Analog IC and System-On-Chip Solutions
- Propagation, Channel Characterization and Fading Countermeasures
- Heterogeneous Mobile Networks and Mobile Network Convergence
- Wireless Security and RFID Technologies
- Seamless Mobility and All-IP Mobile Networks
- Multicasting and Broadcasting

Sessions will cover systems and enabling technologies in the areas of:

- Wireless System Architecture, Integration, and Convergence Issues
- Digital/Analog Adaptive/Collaborative Signal Processing
- System Level Design, Modeling, and Simulation
- MIMO/Space-Time Processing, Relaying Technology, and Smart Antennas
- Signal Generation/Power Amplification, Linearization, and Active Components
- Front-end Passive and Active Sub-systems
- Cross-Layer Design
- Radio on Fiber and optical techniques for UWB communications
- Electrically Small Antennas and handset Packaging

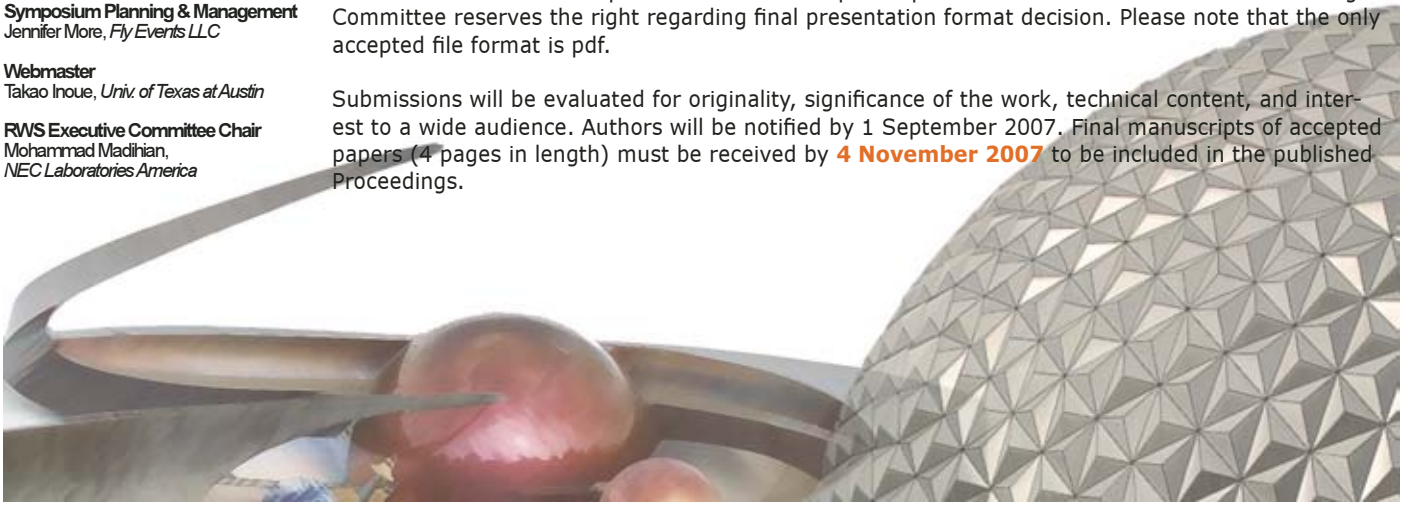
Workshop Proposals

Proposals for workshop topics are solicited, and must be received by 28 June 2007. Details on the process and requirements can be found at www.radiowireless.org.

Paper Submission Instructions

Authors must submit a summary (not more than 4 pages including figures) electronically using the www.radiowireless.org web page by **13 July 2007**; this is a firm date and will be strictly enforced! Authors can indicate their preference for oral or poster presentation format but the Technical Program Committee reserves the right regarding final presentation format decision. Please note that the only accepted file format is pdf.

Submissions will be evaluated for originality, significance of the work, technical content, and interest to a wide audience. Authors will be notified by 1 September 2007. Final manuscripts of accepted papers (4 pages in length) must be received by **4 November 2007** to be included in the published Proceedings.



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Welcome to EuMW2007

EuMW2007 is being held at the ICM (Munich International Congress Centre) in Germany. This is the premier European conference and exhibition for microwave, wireless communications, microwave integrated circuit and radar professionals working in industry, academia and commerce. The conference week provides a platform for revealing state-of-the-art research in these areas by focusing the sessions into four conferences.

Four Conferences:

- European Microwave Conference (EuMC) – 8-12 October 2007
- European Conference on Wireless Technology (ECWT) – 8-10 October 2007
- European Microwave Integrated Circuits Conference (EuMIC) – 8-10 October 2007
- European Radar Conference (EuRAD) – 10-12 October 2007

A range of workshops and short courses complement the regular sessions and start on Monday 8th October. We have had a record year for paper submissions and whilst we are maintaining the same number of sessions, delegates are encouraged to attend more than one conference as the number of parallel sessions have been reduced and spread out to make it easier to benefit from this unique event. This year we expect over 1700 conference delegate registrations and over 5000 visitors to the 250 plus exhibitors, at this exciting venue.

Munich benefits from excellent hotels, restaurants and facilities close to ICM, and easy access from its international airport, rail and road networks. A range of exciting social events are being organised to complement the technical side of the conference and provide a chance for colleagues and friends to exchange ideas.

To register as a conference delegate, visit us online at:

www.eumweek.com

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NEW WAVES

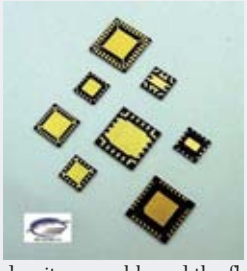
GaAs PHEMT Low Noise Amplifiers

Ideal for the wireless infrastructure and WiMAX markets, this new family of GaAs PHEMT low noise amplifiers (LNA) offers broadband performance (700 to 3800 MHz). Provided in a variety of configurations (single-stage, dual-stage and dual channel), the RF386X series of LNAs provides high gain, low noise and excellent IP3 performance. These self-biased amplifiers operate with a single supply voltage, which range from 3 to 6 V. With impedances near 50 ohms, designers will need to implement minimal external matching to take full advantage of the extended frequency range of these versatile amplifiers. Assembled in a reliable and low cost QFN package, RFMD provides both superior performance and competitive prices.

RFMD,
Greensboro, NC
(336) 664-1233,
www.rfmd.com.
Booth 801 ***RS 317***

LCP QFN Packaging

RJR Polymers Inc. offers a comprehensive line of air cavity plastic quad flat no-lead (QFN) packages. These easily customizable liquid crystal polymer (LCP) packages have a low tooling cost and support epoxy die attach. The multi-up leadframe format provides high density assembly and the flat lid sealing surface improves assembly yields. These high performance packages are capable of handling power levels of > 10 W and frequencies into the millimeter-wave band.



RJR Polymers Inc.,
Oakland, CA
(510) 638-5901,
www.rjrpolymers.com.
Booth 853 ***RS 318***

High Frequency Laminate Solutions

Rogers Corp., a global technology leader in the development of high performance printed circuit materials for use in high frequency circuit applications, features its renown RO4000,® RO3000,® RT/duroid,® RO2800® and ULTRALAM® series high frequency laminate materials along with new product extensions. Rogers' laminates serve a wide range of markets including communications infrastructure, advanced packaging, antenna, aerospace and defense, and digital applications.

Rogers Corp.,
Advanced Circuit Materials Division,
Chandler, AZ
(480) 961-1382,
www.rogerscorporation.com.
Booth 843 ***RS 319***

Modular Test System

The new Cassini modular test system provides for the ultimate in tester re-reconfigurability by implementing a Resource-Per-Module design that allows the end user to configure the test system to specific application requirements. Whether for one site or multiple sites, the tester resources can be quickly aligned to meet the test requirements of the devices.

Roos Instruments Inc.,
Santa Clara, CA
(408) 748-8589,
www.roos.com.
Booth 914 ***RS 320***

High Frequency Ceramic Filters/Duplexers

These monoblock filters are designed to support WiMAX applications. These filters cover frequencies from 2.3 to 6 GHz with a wide variety of center frequencies and bandwidths. Monoblock filters provide improved electrical performance compared to LTCC alternatives and better reliability and size than coupled resonator designs. The low insertion loss and high rejection make these filters an ideal solution for advanced modulation schemes used in both WiMAX and proprietary mesh networks. Custom designs are also available. An example of one of the many part numbers available is: MBP33R3550S100A, which is 3550 MHz with 100 MHz bandwidth.

Sangshin Elecom,
Hershey, PA
(877) 367-7369,
www.rfmw.com/sangshin.
Booth 643 ***RS 321***

High Performance SMA Connector

This high performance SMA connector is designed to address the problem of signal transmission and fragility of solder joints in hand-formable cable assemblies. The eSMA™ connector features a new extended ferrule and enhanced performance from an innovative internal design. This connector also features: failure-proof coupling nuts; EZ style, solder free, captivated center contacts; and a solder damming positive cable stop. Cable assemblies are delivered with these eSMAs professionally installed on Times Microwave Systems TFlex™ cable. These connectors provide a typical VSWR of 1.14 at 14 GHz and can be bent firmly and simply even up close to the connector, where many solder joints in hand-formable assemblies often break.

Santron Inc.,
Ipswich, MA
(978) 356-1585,
www.santron.com.
Booth 1737 ***RS 322***

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New Waves

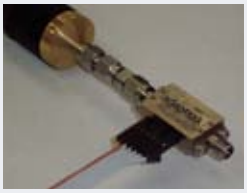
Temp/Humidity Chambers

The Sigma Humidity Solution line of temp/humidity chambers utilizes Sigma's patent pending "Humidity Generator" system. These chambers allow for humidity testing with minimal condensation or DUT contamination. The Humidity Generator humidifies air from the chamber with treated water and returns the precisely controlled humidified air, at temperature, to the chamber. This completely avoids the excessive temperature fluctuations and condensation (up to 40 percent of the water vapor) caused by the more typically used super heated steam injection and water spray systems from other manufacturers.

Sigma Systems,
El Cajon, CA (619) 258-3700,
www.sigmasystems.com.
Booth 829 ***RS 324***

In-line Error Correction

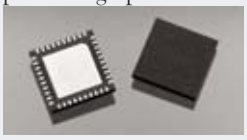
AdapTrak is the new addition to the e-trak family of in-line error correction test and measurement products. AdapTrak is an ideal solution for test applications. It attaches directly to the UUT I/O ports and allows errors, due to cable and system drift, to be corrected from the test rack all the way to the UUT interface.



SenarioTek LLC,
Santa Rosa, CA (707) 544-2770,
www.senariotek.com.
Booth 1213 ***RS 323***

High Linearity Amplifiers

The SZM series of high linearity amplifiers provide high power and linearity for WiMAX CPE solutions (part numbers: SZM-2166Z/SZM-3166Z). Higher output power means higher data throughput and longer range. The company delivers high power for WiMAX CPE solutions with up to +27 dBm of linear power at 2.5 percent EVM. The SZM series cover the 2.3 to 2.7 GHz and 3.3 to 3.8 GHz bands in a pin for pin compatible footprint to simplify board layout.



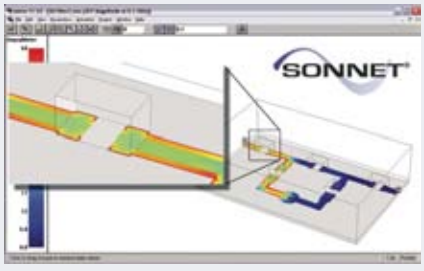
Sirenza Microdevices,
Broomfield, CO (303) 327-3030,
www.sirenza.com.
Booth 637 ***RS 325***

SPDT 7 W Switch

The model SKY13299-321LF is a GaAs single-pole double-throw (SPDT) 7 W switch that operates in a frequency range from 100 MHz to 4 GHz. The SKY13299-321LF is a PHEMT GaAs FET IC high power switch packaged in a 12-lead exposed pad plastic package for low cost commercial applications. This switch is an ideal choice for WiMAX and WLAN applications where low loss, high isolation and excellent linearity are key requirements. Skyworks offers lead (Pb)-free, RoHS compliant packaging. This model offers positive voltage control (0/3 to 0/5 V), low insertion loss of 0.5 dB typical at 3.5 GHz and high isolation of > 35 dB at 3.5 GHz.

Skyworks Solutions Inc.,
Woburn, MA (781) 376-3000,
www.skyworksinc.com.
Booth 643 ***RS 326***

High Frequency EM Simulation Software



The newly released Sonnet® Suites Release 11 offers perfectly calibrated internal ports that can be used for highly accurate attachment points for active or passive components. These Co-calibrated™ Ports enable full co-simulation within the EM analysis environment. Release 11 also includes a totally redesigned Agilent ADS Interface with a new GUI interface and a new 64-bit EM analysis engine.

Sonnet Software,
North Syracuse, NY (315) 453-3096,
www.sonnetsoftware.com.
Booth 1131 ***RS 327***

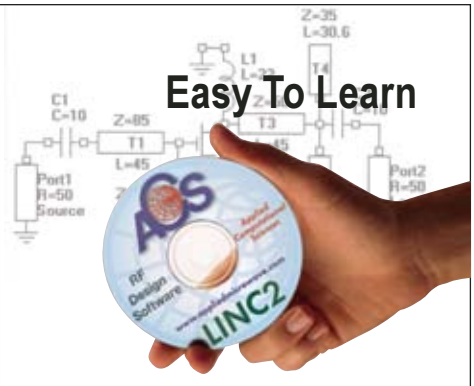
Micro-miniature Threaded Connectors

The micro-miniature threaded connectors (MMTC) are small screw lock RF connectors. Mounting footprints are identical with the MMCX connector to allow for ease in upgrading to the more reliable threaded connection. The MMTC family of products is a 6 GHz, 50 Ω interconnect system with a full range of connectors available including edge card, surface-mount and cable connectors. Patent applied for.

Sources East,
Campbell, CA (408) 374-1031,
www.sourceseast.com.
Booth 1505 ***RS 328***

Hard To Teach

Easy To Learn



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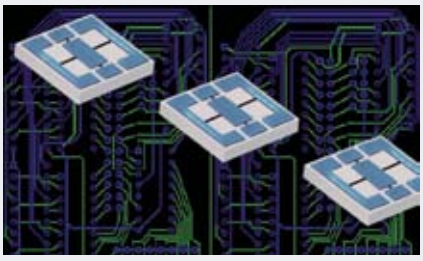
New Waves

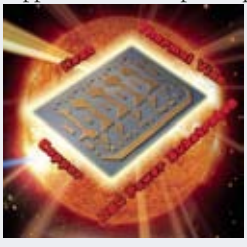
Coplanar Attenuators



These wire bondable or solderable "0303" (0.030" × 0.030" × 0.010") coplaner balanced T attenuators are available on alumina or aluminum nitride (high power) substrates. Constructed using a high stability thin film resistor element, these devices are available with attenuation values from 1 to 20 dB and are suitable for high frequency applications up to 20 GHz. Attenuation tolerance is less than ±0.5 dB to 12 GHz and ±1 dB to 20 GHz. VSWR is less than 1.4 up to 20 GHz. Performance data is available on chip and mounted on Rogers 4350 boards. Price: < $1.90. Delivery: stock to 10 weeks ARO.
State of the Art Inc.,
State College, PA (800) 458-3401,
www.resistor.com.
Booth 1601 ***RS 329***

Thermal Management Solutions

These two new processes include: direct bond copper (DBC) and plate-up copper (PUC) on



aluminum nitride ceramics. Custom copper-on-ceramic solutions can improve thermal and electrical performance in RF, microwave and photonic applications. Thermal Management can now be addressed using the company's 'patent-pending' processes. Processes are also available on BeO and alumina.
Stellar Industries Corp.,
Millbury, MA (877) 840-1884,
www.stellarind.com.
Booth 1251 ***RS 330***

Expanded Flexible Cable Line

The extra-durable Storm Flex™ miniature cable line has been expanded to include a larger,

0.160" diameter cable. Storm Flex 141 assemblies feature connector retentions of 40 lbs straight-pull and 15 lbs right-angle-pull, shielding effectiveness greater than 100 dB through 18 GHz, cable attenuation of 0.61 dB/ft at 18 GHz, and minimal VSWR/insertion loss shift during handling and installation. Available off-the-shelf in popular lengths terminated with 18 GHz SMA male connectors or custom configured to meet unique requirements.
Storm Products–Microwave,
Woodridge, IL (630) 754-3300,
www.stormproducts.com.
Booth 1011 ***RS 331***

Semiconductor Packages

This Power Package series of semiconductor packages is designed for use in high power applications. The

new line of packages is designed to maximize the electrical properties of silicon, gallium arsenide, silicon carbide, gallium nitride and other power semiconductor integrated circuits. Thermally conductive beryllium oxide (BeO) ceramic, used in the construction of StratEdge's power packages, provides the packages with excellent heat dissipation characteristics.
StratEdge Corp.,
San Diego, CA (858) 569-5000,
www.stratedge.com.
Booth 543 ***RS 332***

Test and Data Management Software

Spartan S-parameter Test and Data Management software is a hardware independent solution for the test and analysis of RF and microwave components. Spartan increases test efficiency and data quality while also reducing test costs. Spartan's data mining tools create opportunity to improve: product quality, manufacturing processes and financial performance. Spartan provides the first and best opportunity to realize a powerful, comprehensive automated test and data management system at a fraction of the cost of developing and maintaining your own solution.
Summitek Instruments,
Englewood, CO (303) 768-8080,
www.summitekinstruments.com.
Booth 927 ***RS 333***

In-building Coverage Combining Solutions

This complete portfolio of in-building combining products is designed for all public or pri-

vate communication systems including GSM, CDMA, DCS, WCDMA, FM radio and Tetra. Products range from standard two-, three- and four-way combiners for average in-building systems to highly integrated POI combiners customized to specific requirements such as for subways, tunnels, sports stadiums and exhibition centers.
Sunwave Communications Co. Ltd.,
Hangzhou, China +86 571 88866999,
www.sunwave.com.cn.
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microwave@stormproducts.com

www.stormproducts.com/def5

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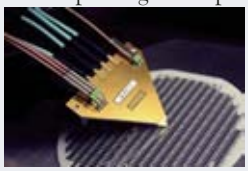
NEW WAVES

RF Wafer Probe

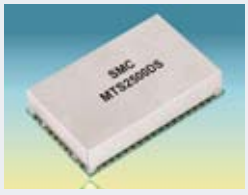
The Multi |Z| Probe® is an RF wafer probe that offers up to eight independent RF transmission lines for testing RF signals up to 15 GHz and digital signals up to 25 GHz. The probe can be individually configured with DC contacts for mixed-mode testing of RF and DC components and has a guaranteed lifetime of over 1,000,000 touchdowns. For production testing, up to four Multi |Z| Probes can be integrated into the unique |Z| Probe Card.



SUSS MicroTec Inc.,
Waterbury Center, VT (802) 244-5181,
www.suss.com.
Booth 1217 ***RS 335***

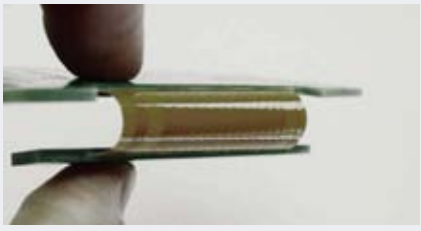
Miniature Synthesizers

The MTS2500DS miniature synthesizers feature a resolution of 1 Hz and outstanding phase noise and spurious suppression. The first model introduced, the MTS2500-110250 covers the frequency range from 1100 to 2500 MHz. It is available in four versions: version one and two have 5 V and 3.3 V supply only and use an external reference of 10 MHz or 1.6 GHz, respectively; the other two versions require 28, 5 and 3.3 V supply voltage and use either 10 MHz or 1.6 GHz references. Housed in a small 1.95" × 1.25" surface- mount Rel-Pro® package their features and performance match the one of much larger size synthesizers.



Synergy Microwave Corp.,
Paterson, NJ (973) 881-8800,
www.synergymwave.com.
Booth 901 ***RS 336***

Multilayer Capability



These products offer low loss and high reliability for conventional and multilayer RF and high speed digital board fabrication. TacPreg prepregs, constructed with BT epoxy/woven fiberglass/PTFE components, offer reduced electrical loss and ease of fabrication for high speed digital and RF commercial and military applications. These dimensionally stable laminates, available with a Dk of 3.00 to 3.5, enable production of 20+ layer boards at FR-4 laminating temperatures and pressures. HyRelex thin flexible interconnect materials offer exceptional thermal, mechanical, electrical and moisture resistant properties for multilayer, double sided and rigid flex circuits. Low dissipation factor, excellent peel strength and smooth surface profile make HyRelex ideal for applications involving high frequencies, high temperatures and harsh environments.

Taconic Advanced Dielectric Division,
Petersburgh, NY (518) 658-3202,
www.taconic-add.com.
Booth 1632 ***RS 337***

RF Power Meter

The model 1830A RF power meter achieves the lowest uncertainty RF power measurement available. This model is designed to replace the HP432A and the external voltmeter for a complete high accuracy average RF power measurement with LXI-C and USB interfaces. It is also compatible with the 478A and 8478A RF power sensors as well as virtually all existing thermistor-based RF power sensors.

TEGAM Inc.,
Geneva, OH (440) 466-6100,
www.tegam.com.
Booth 510 ***RS 338***

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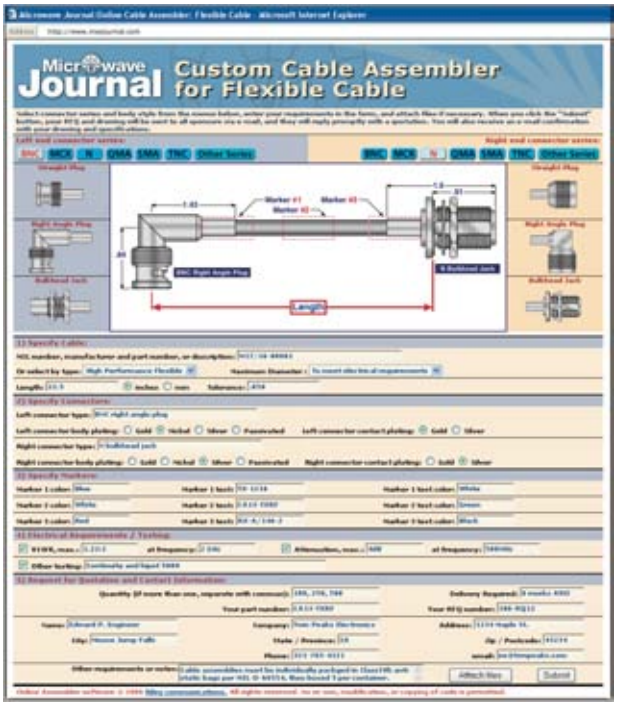

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NEW WAVES

Ultra-miniature Relays

The ultra-miniature SGRF300 and SGRF303 relays are formed-lead versions of the GRF300 and GRF303 relays. These relays are designed to be easily removed with hand tools. The SGRF relays feature the same excellent contact-to-contact isolation, pole-to-pole isolation and repeatability as the GRF relays. The unique ground shield of the SGRF300 and SGRF303 extend performance advantages over similar RF devices that simply offer formed leads for surface mounting.

Teledyne Relays,
Hawthorne, CA (800) 284-7007,
www.teledynerelays.com.
Booth 523 ***RS 339***

Mobile Thermal System

MobileTemp™ System is a mobile thermal (–65° to +200°C) system for testing devices (standard to high frequency), assemblies and PCBs in a compact chamber at the tester site. Modular MobileTemp includes the ThermoStream® temperature source combined with one of the portable ThermoChambers™ (available in CLAMSHELL, FRONT LOAD and HOOD styles). Features include direct device temperature control to ±0.1°C, fast temperature transitions, integral cable ports, interchangeable chambers to meet various applications and mobility—for "Temperature on the Spot.®"

Temptronic Corp.,
Sharon, MA (781) 688-2300,
www.temptronic.com.
Booth 1509 ***RS 340***

Flexible Coaxial Cable

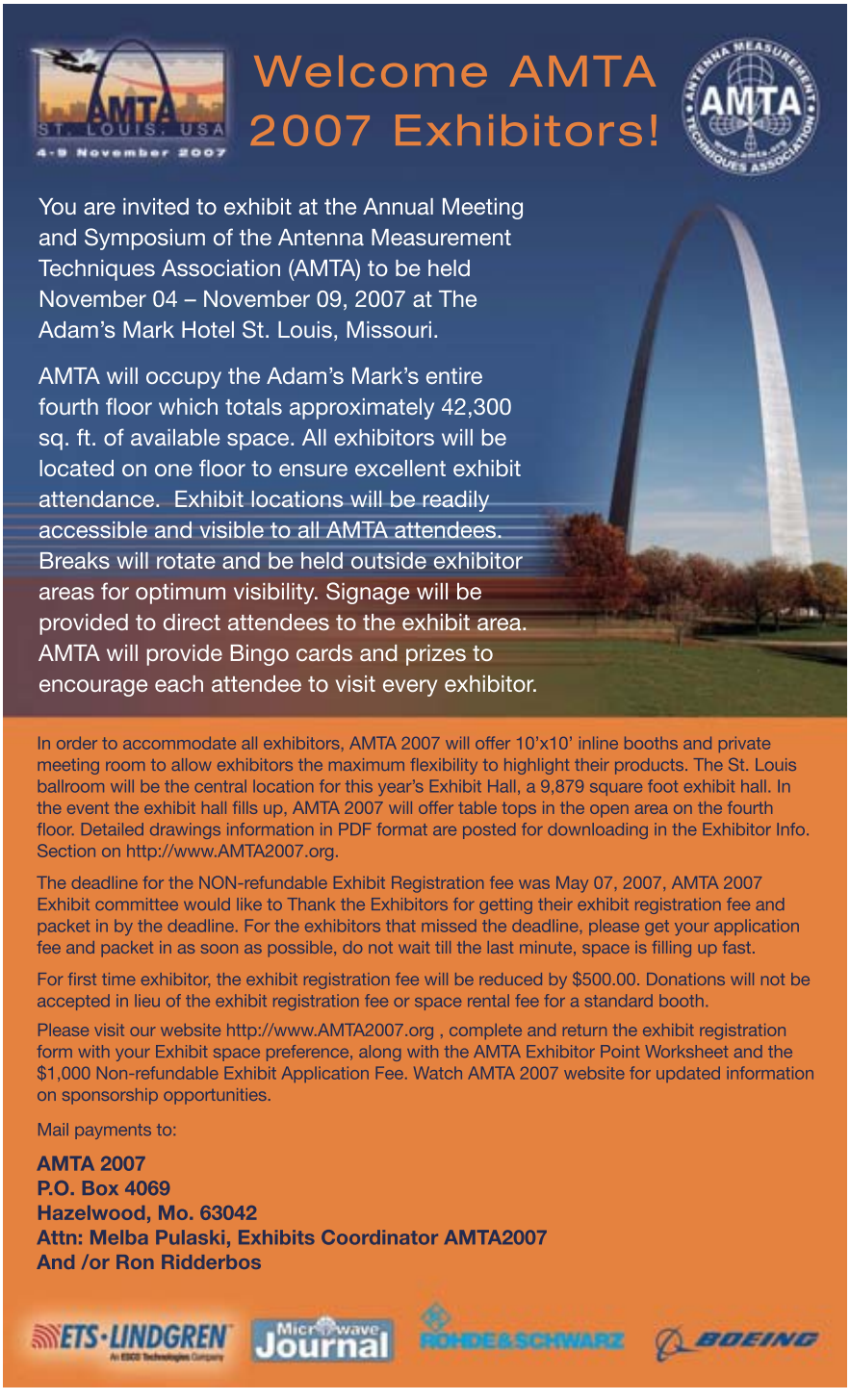
This line of low loss phase stable flexible coaxial cable is designed to operate up to 40 GHz. HFF-1111 and HFF-1130 were designed and engineered to terminate with Tensolite's high performance RF connectors for optimum performance. Furthermore, this new solution was designed to meet the needs of any application where performance and stability at the higher frequency range is critical. The HFF-1111 and HFF-1130 product families will be ideal for multiple application requirements that include military/aerospace and test & measurement.

Tensolite Co.,
St. Augustine, FL (800) 458-9960,
www.tensolite.com.
Booth 1019 ***RS 341***

Millimeter-wave Subsystems

Terabeam/HXI offers design and manufacturing services that include the development of millimeter-wave subsystems for radar, sensor and communications applications. Hardware trade-off studies for these systems are first performed in cooperation with the customer to achieve optimum performance levels. Fast prototyping of new systems can then be performed using standard catalog Terabeam/HXI components. A transition to production can then take place using advanced integration techniques to reduce the size and cost of the hardware.

Terabeam/HXI,
a Division of Terabeam Corp.,
Haverhill, MA (978) 521-7300,
www.terabeam-hxi.com.
Booth 1209 ***RS 342***



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NEW WAVES

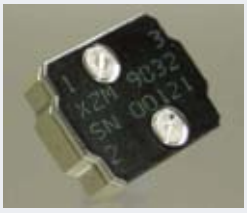
SPDT MEMS Switch

The model TT1244 is a 26.5 GHz SPDT MEMS switch. By leveraging the baseline process and design technology of the production released DC to 7 GHz switch, the TT1244 offers a step improvement in bandwidth and linearity over competing switch solutions, while occupying significantly less area and consuming less power. The TT1244 delivers ultra low insertion loss and outstanding linearity (IP3) for improved system performance—all in a standard surface-mount micro BGA chip scale package. Applications for the TT1244 switch include automated test equipment (ATE), instrumentation, radar (automotive and military) and communications infrastructure.

TeraVicta Technologies Inc.,
Austin, TX (512) 684-8700, www.teravicta.com.
Booth 752 ***RS 343***

Drop-in Isolators and Circulators

These S-, C- and X-band surface-mount packaged drop-in isolators and circulators combine small size and low mass with high power handling capabilities and low loss (0.2 dB per junction). These isolators and circulators are designed for surface mounting using RoHS-compliant SAC solder following the J-STD-020C soldering profile. Single and double junction designs are available for both defense and telecom applications.



Thales MESL Ltd.,
Newbridge, Edinburgh, Scotland, UK
0131 333 2000, www.thales-mesl.com.
Booth 1008 ***RS 344***

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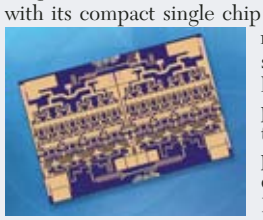
Ku-band GaAs FET

The model TM1414-30L is a Ku-band GaAs FET engineered for SATCOM solid-state power amplifiers. This transistor for final-stage amplifiers provides broadband RF performance to support 14 to 14.5 GHz frequency applications and features high power of P1dB = 45 dBm, high gain of G1dB = 5.5 dB (typical) and low intermodulation distortion, IM3 = –25 dBc (minimum) at Po of 38 dBm. This high performance device is offered in a hermetically-sealed package.

Toshiba America Electronic Components Inc.,
Irvine, CA (949) 623-2900, www.chips.toshiba.com.
Booth 1107 ***RS 345***

High Power Amplifier

TriQuint Semiconductor introduces the TGA4916, which leads the industry with its compact single chip design. The TGA4916 is a Ka-band, fully monolithic 7 W high power amplifier ideally suited for VSAT ground terminal usage. It delivers 38.5 dBm (7 W) of saturated output power and 21 dB of small-signal gain across the 28 to 31 GHz band. Both input and output return losses are typically better than 12 dB due to its balanced design configuration. Bias voltage is 6 V and quiescent drain current 3.2 A (Idq). This product is also available in a 'half-chip' version, designated TGA4906, which delivers 36 dBm (4 W) saturated output power and 22 dB of gain over the same frequency band. Packaged versions of these MMIC devices will be available in the second half of 2007.



TriQuint Semiconductor,
Hillsboro, OR (503) 615-9000, www.triquint.com.
Booth 533 ***RS 346***

RFID Antenna and Reader Stands

Tyco Electronics has expanded its RFID solutions to include integrated UHF RFID antenna and reader stands featuring fully-tested turnkey RFID systems. The M/A-COM MAAN-000176-AT0000 and MAAN-000177-AT0000 RFID stands are designed for standard and customized solutions for use in a variety of applications, including supply-chain management and asset visibility. Additionally, the stands can be integrated with peripheral offerings for additional functionality and are available in floor and wall mount versions.

Tyco Electronics M/A-COM,
Lowell, MA (800) 366-2266,
www.macom.com.
Booth 723 ***RS 347***

Waveguide Power Combiners/Dividers

This series of waveguide power combiners/dividers operates in a frequency range from 2.6 to 40 GHz. These power combiners/dividers offer peak power handling capacity (without additional pressure) ranges from 18 kW in WR28 to 2.5 mW in WR284. All models may be modified mechanically or electrically to meet a customer's special requirements.

Xi'an HengDa Microwave
Technology Development Co.,
Xi'an, Shaanxi Province, P.R. China,
+86-29-85224787, www.hdmicrowave.com.
Booth 411 ***RS 348***

"Underbridge" Technique

Unlike an air bridge, in which the interconnect layer is applied after the thin film conductor layer is complete, UltraBridge is a process in which the interconnect conductor layer is applied and patterned directly on the substrate surface as an "under" bridge. Then silicon nitride (Si3N4) is applied over the interconnect layer to encapsulate it and insulate it from the next metal layer. The silicon nitride features are then patterned and etched and the thin film conductor and resistor layers are applied. The result is a simple, cost-effective method for fabricating high frequency interconnects for Lange couplers, integrated capacitors and integrated spiral inductors.

UltraSource Inc.,
Hollis, NH (603) 881-7799, www.ultrasource.com.
Booth 1743 ***RS 349***

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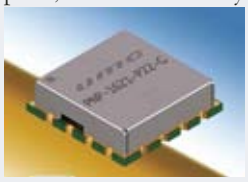
NEW WAVES

CRO-based Synthesizer

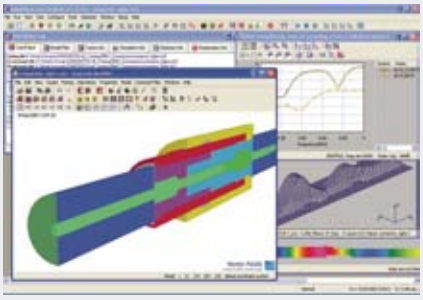
The model PNP-1621-P22-G is a RoHS compliant, CRO-based PNP synthesizer that operates in a frequency range from 2000 to 2100 MHz. This synthesizer features low phase noise performance of –107 dBc/Hz at 10 kHz offset from the carrier over the 100 MHz bandwidth. Operating with a 12 VDC supply while drawing 50 mA (typical) over the temperature range of –40° to 85°C, the PNP-1621-P22-G is suited for applications requiring signal stability, tuning linearity and low phase noise performance across a wide frequency range. Suitable for automated surface-mount assembly and solder reflow. Packaging: 0.6" × 0.6" × 0.135".



Universal Microwave Corp., Brooksville, FL
(480) 756-6070, www.vco1.com.

Booth 508 ***RS 350***

Coaxial Connector Design Software



This new electromagnetic design tool is designed for coaxial devices such as connectors. By providing two-dimensional electromagnetic simulation only, which is ideal for radially-symmetric components, the tool eliminates fundamental barriers that have held back the adoption of CAE in this sector: the high cost of conventional 3D electromagnetic software, and the long simulation times involved. Called Concerto AS, the new software will simulate a coaxial RF connector in a few seconds, and costs around $5000/seat.

Vector Fields Inc., Aurora, IL (630) 851-1734, www.vectorfields.com.

Booth 1454 ***RS 351***

Surface-mount VCXO

This highly-reliable, surface-mount 5116 VCXO is designed for mission-critical space applications. Now radiation tolerant to 100 kRads(Si) total dose, the 5116 VCXO expands the capabilities of industry-standard MIL-PRF-55310/27 clock oscillators into the space market, offering customers proven reliability and performance for demanding space applications, including manned and unmanned military and commercial satellites. The 5116 VCXO is designed in a 9 × 14 mm enclosure to help customers reduce deployment costs by miniaturizing their satellite payloads without sacrificing performance or quality. Key features include: four-point crystal-mount and swept quartz (standard architecture for flight models), choice of class S or class B screening IAW MIL-PRF-55310 and wide (1 to 85 MHz) nominal frequency range.

Vectron International, Hudson, NH
(888) 328-7661, www.vectron.com.

Booth 1101 ***RS 352***

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New Waves

Silicon RF Capacitor

The model HPC0603A is a silicon-based, surface-mount RF capacitor that offers SRF values up to 13 GHz, parasitic inductance of 0.046 nH and operation over a broad frequency range from 1 MHz to several GHz. Voltage options include 6, 10, 16, 25, 50 and 100 V. The capacitor is also available in 0201 and 0402 sizes. Applications include wireless communications, GPS, VCO, filter and matching networks, RF power amplifiers, base stations, RF modules, DC blocks and substrate-embedded circuits.

Vishay Intertechnology Inc., Vishay, Malvern, PA
(402) 563-6866,
www.vishay.com.
Booth 1210 ***RS 353***

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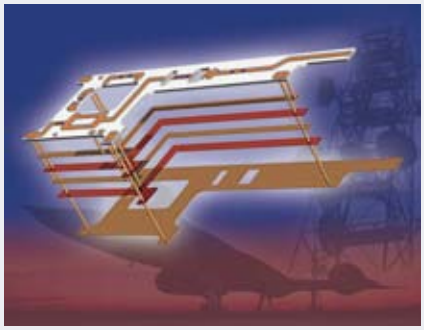


These electro-films patterned thin film substrates are manufactured with 100 percent quality standards. They are visually inspected to MIL-STD-883 Method 2032, level H or K, or to the required internal standard industrial specification. All the substrates go through extensive statistical process controls, combined with inspection by product assurance teams, and are tested for value and tolerance. Vishay can tailor its quality assurance processes to meet specific requirements.

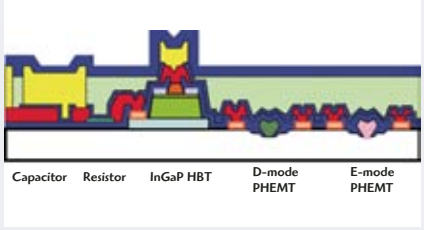
Vishay Intertechnology Inc.,
Vishay Electro-Films,
Warwick, RI (401) 738-9150,
www.vishay.com.
Booth 1210 ***RS 354***

High Power Combiner

Werlatone's patent pending "Collapsed Cohn" Design is a drastic departure from the conventional multi-section Wilkinson approach. The company's low loss unit requires only one or two high power resistors, provides excellent isolation, full input power protection and eliminates high frequency performance roll-off. The two-way combiner, model D7885, is rated at 200 W CW and measures 7.7" × 1.6" × 1.1". Electrical specifications include insertion loss of 0.65 dB maximum, VSWR of 1.4 maximum and port-to-port isolation of 15 dB minimum.

Werlatone Inc.,
Brewster, NY (845) 279-6187,
www.werlatone.com.
Booth 1248 ***RS 355***

H2W Technology



H2W is WIN's integration of GaAs HBT technology with enhancement and depletion mode PHEMT technology onto a single wafer. The process uses low K interlayer dielectrics, through wafer vias, 75 µm final substrate thickness, and up to 900 pF/mm2 of stacked capacitor density, all enabling chip size reduction and high electrical and thermal performance. The

EuMA

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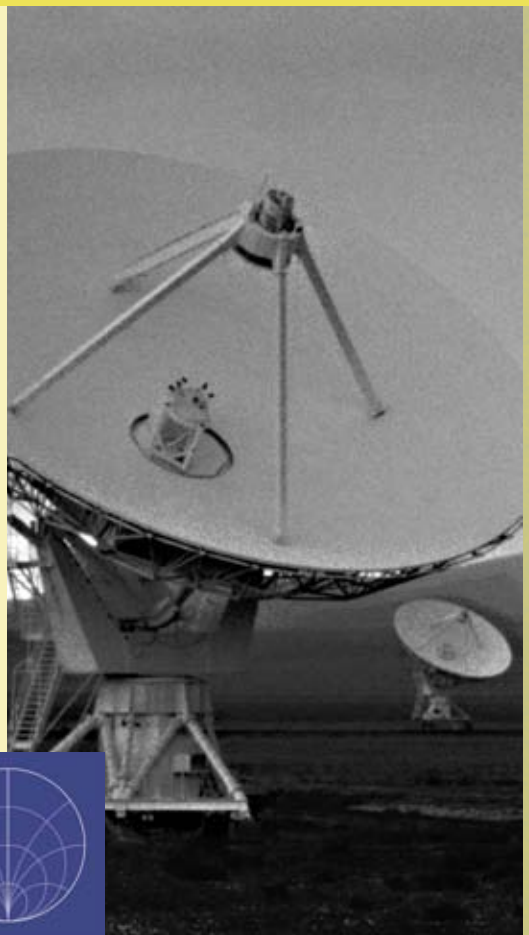
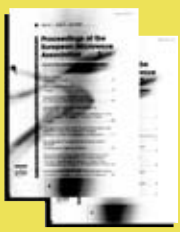


European Microwave Conference Proceedings Archival DVD

This DVD contains all proceedings of the European Microwave Conferences from 1969 until 2003. It's fully indexed and all papers are electronic files or images. The DVD is updated every four years. **For further details and costs, please contact: jmorris@artechhouse.co.uk**

The journal *Proceedings of the European Microwave Association*

This journal is an archival, peer-reviewed publication appearing 4 times per year. Its mission is to enhance the communication among microwave engineers and researchers in Europe, neighbouring areas, as well as world-wide. **For further details and subscription costs, please contact proceedings@eumwa.org**



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WIN Semiconductors Corp.,
Tao Yuan Shien, Taiwan +886-3-397-5999,
www.winfoundry.com.
Booth 613 ***RS 356***

Cable Assemblies

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W.L. Gore & Associates Inc.,
Elkton, MD (302) 292-5100,
www.gore.com.
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Bias Circuit

This patented bias circuit can be designed with a high power MOSFET into one GaAs chip re-

ducing power loss and allowing it to be easily integrated with low cost and to be applied in RF power amplifiers and oscillators. It is capable of keeping the static drain current of the high power FET constant as the temperature varies and thus decreasing the changing of the gain and the linear characteristics of the FET. It can reduce the difference of the static drain current of each FET in the whole wafer or batches of wafers.

Yantel Corp.,
Shenzhen, China +86-755-83551878,
www.yantel-corp.com.
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RF Components

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Yixin Microwave Electronics Co. Ltd.,
Quanzhou, Fujian, China
+86-595-28071010, www.yixinec.com.
Booth 1155 ***RS 359***

Power Amplifier

This high linearity power amplifier (5 W average) is designed for emerging 802.16 WiMAX base station applications. The first in the series of power amplifier products for WiMAX, model ZPA3436-5W, operates over the 3.4 to 3.6 GHz band with typical gain of 46 dB and 37 dBm OFDM output power for 64 QAM, 3/4 coding, 3.5 MHz channel bandwidth, 256 carriers. The superior design incorporating the latest in high power device tech-

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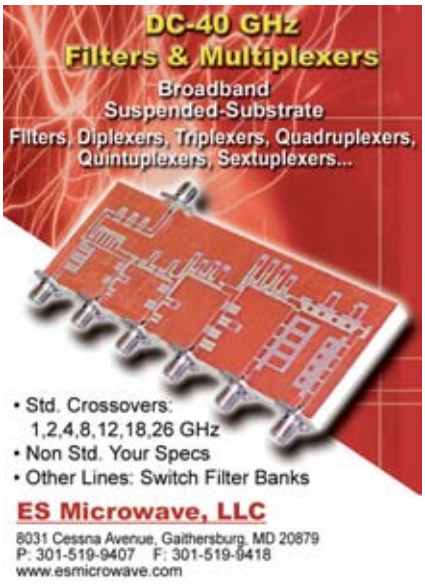

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NEW WAVES

nology, achieves error vector magnitude (EVM) performance of 2 percent at 37 dBm linear output power. The power amplifier is biased at 28 V and draws about 3.5A DC current. The design is lead free and the SMA connectorized package measures only 9" × 4" × 1.5" typical without external heat sink.

Z-Communications Inc.,
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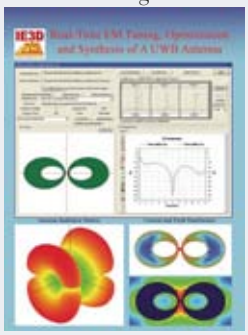
www.zcomm.com.
Booth 1612 ***RS 360***

EM Simulation and Optimization Package

The release of IE3D EM Simulation and Optimization Package V12 features a FastEM Design Kit for real-time full-wave EM design. IE3D Release 12 also implements multi-CPU support, Boolean-enabled equation-based schematic-layout editor, and robust network distributed simulation and optimization.



Zeland Software Inc.,
Fremont, CA (510) 623-7162,
www.zeland.com.
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RS 6

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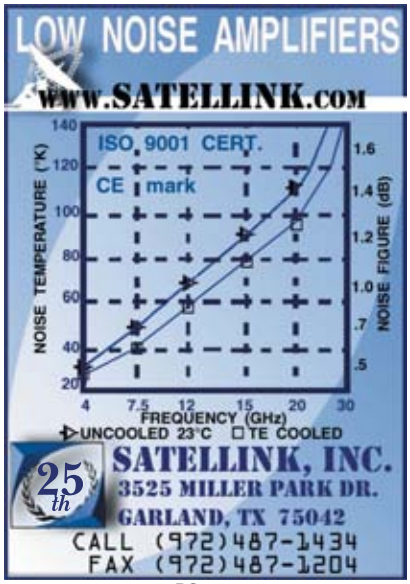

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APPLICATION NOTE

The Evolving Wireless Standards poster and application note are based on IEEE 802.16e mobile WiMAX. As a quick reference guide, the wireless poster highlights a range of information on the latest cellular and wireless connectivity technologies and applications. The "IEEE 802.16e WiMAX OFDMA Signal Measurements and Troubleshooting" application note provides engineers with a guide for measuring and troubleshooting mobile WiMAX signals, components and systems.
Agilent Technologies Inc.,
Santa Clara, CA (800) 829-4444,
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MICROWAVE MODULES AND SUBSYSTEMS CATALOG

This catalog features full specifications on 42 microwave components and synthesizers that are ideal for test and measurement, telecom, military and space applications. The new microwave specialty catalog features a wide variety of connectorized components based on the company's high performance MMICs. These products are ideal for use in laboratory, industrial and automatic test equipment applications, as well as in custom military, space and commercial equipment.
Hittite Microwave Corp.,
Chelmsford, MA (978) 250-3343,
www.hittite.com.

RS No. 201

SHORT FORM BROCHURE

This short form brochure features the company's complete product offering including chip resistors, chip terminations, chip attenuators, planar dividers and planar filters. The brochure highlights key product features, specifications and parameters as well as IMS's custom capabilities.
International Manufacturing Services Inc. (IMS),
Portsmouth, RI (401) 683-9700,
www.ims-resistors.com.

RS No. 202

FIBER OPTIC LINK LITERATURE

This literature highlights the company's 18 GHz SCM Fiber Optic Link. The 18 GHz version is an addition to MITEQ's successful SCM Fiber Optic Link product line. The SCM links are "Plug and Play," requiring no external circuits. Typical applications include antenna remoting, LO remoting, Inter-Facility RF links, EMC test setups and scientific applications.
MITEQ Inc.,
Hauppauge, NY (631) 436-7400,
www.miteq.com.

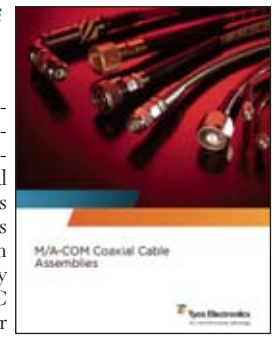
RS No. 203

PRODUCT DATA SHEET

This data sheet provides complete detail on the RF311 and RF331 broadband relays. The two versions, offered with 5, 12 and 26 VDC coils, are packaged in the familiar hermetically sealed TO5 can. Both relays have SPDT contacts with a bandwidth of DC to 8 GHz, with additional features of high resistance to electrostatic discharge (ESD), a metal enclosure for EMI shielding and a ground pin option to improve case grounding.
Teledyne Relays,
Hawthorne, CA (800) 284-7007,
www.teledynerelays.com.

RS No. 204

COAXIAL CABLE ASSEMBLIES CATALOG



The Tyco Electronics M/A-COM high performance coaxial cable assemblies catalog covers products with broad frequency ranges from DC to 50 GHz for ground-based, shipboard, airborne and space applications. This catalog contains an easy to use selection guide sorted by cable diameter (from 0.05 to 1.4 inches), product listings by market segment, application notes and ordering information.
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DCMO1027	100 - 270	0 - 24	+5 to 12 @ 35 mA	+2.5	-112
DCMO1129	110 - 290	0.5 - 24	+5 to +12 @ 35 mA	+2.5	-105
DCMO1545	150 - 450	0.5 - 24	+5 to 12 @ 35 mA	+4	-108
DCMO1857	180 - 570	0.5 - 24	+5 to 12 @ 30 mA	+3	-108
DCMO2260-5	220 - 600	0.5 - 24	+5 @ 35 mA	+2	-108
DCMO2476	240 - 760	0.5 - 24	+5 to 12 @ 35 mA	+4	-108
DCMO3288-5	320 - 880	0.5 - 24	+5 @ 35 mA	+3	-109
DCFO35105-5	350 - 1050	0 - 25	+5 @ 40 mA	+7	-112
DCMO40110-5	400 - 1100	0.5 - 24	+5 @ 42 mA	+5	-103
DCMO40110-8	400 - 1100	0.5 - 24	+8 @ 45 mA	+5	-104
DCMO50120-5	500 - 1200	0.5 - 24	+5 @ 40 mA	+6	-118
DCMO50120-12	500 - 1200	0.5 - 24	+12 @ 35 mA	+6	-103
DCMO60170-5	600 - 1700	0 - 25	+5 @ 35 mA	+3	-99
DCMO80210-5	800 - 2100	0.5 - 24	+5 @ 35 mA	+5	-96
DCMO80210-10	800 - 2100	0.5 - 24	+10 @ 35 mA	+6	-100
DCMO90220-5	900 - 2200	0.5 - 24	+5 @ 35 mA	+4	-98
DCMO90220-12	900 - 2200	0.5 - 25	+12 @ 35 mA	+6	-99
DCMO100230-12	1000 - 2300	0.5 - 24	+12 @ 35 mA	+3	-101
DCMO100230-5	1000 - 2300	0.5 - 24	+5 @ 35 mA	+3	-98
DCMO110250-5	1100 - 2500	0.5 - 28	+5 @ 35 mA	+6	-100
DCMO135270-8	1350 - 2700	0.5 - 20	+8 @ 35 mA	+4	-93
DCMO150318-5	1500 - 3200	0.5 - 20	+5 @ 30 mA	+7	-93
DCMO150320-5	1500 - 3200	0.5 - 18	+5 @ 60 mA	0	-92
DCMO172332-5	1720 - 3320	0.5 - 24	+5 @ 30 mA	+4	-94
DCMO190410-5	1900 - 4100	0.5 - 16	+5 @ 50 mA	+2	-90
DCMO250512-5	2500 - 5125	0.5 - 24	+5 @ 50 mA	-2	-78

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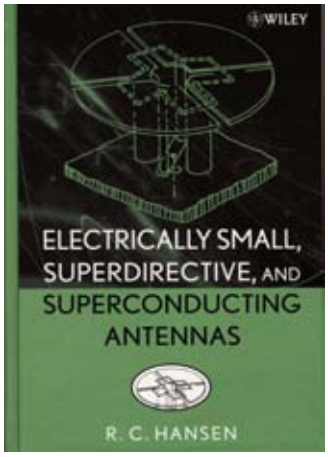

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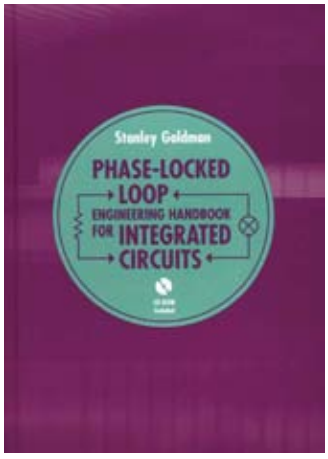
The field of electrically small antennas has long been important for frequencies below roughly 1 GHz. These antennas have characteristics in common that limit performance: low radiation resistance, high reactance, low efficiency, narrow bandwidth and increasing loss in the matching network. Most of these limitations are shared by two other classes of antennas: superdirective and superconductive antennas. This book, aimed at being a primer on all that has been investigated and what works, is divided into three interrelated chapters: Chapter 1 on electrically small antennas, Chapter 2 on superdirective antennas and Chapter 3 on superconductive antennas. Antenna engineers have done what is possible by rearranging the wires; future significant advances will come through use of new low loss magnetic materials and through the use of circuits to compensate for impedance deficiencies. Both areas are addressed. Many engineers interested in these topics have not had the benefit of early papers on these three subject areas. Over the years, many ideas on improving electrically small antennas have appeared. These are discussed under three categories: designs that work, clever physics but bad numbers and pathological antennas. In retrospect, the simplest antennas are the best: dipoles with or without flatness or loading and patches with appropriate substrates. There are no wideband electrically small antennas, unless efficiency is sacrificed for bandwidth. The relatively new field of Non-Foster circuits may change this situation. These circuits produce negative resistance, negative inductance or positive capacitance. They are also called negative impedance converters. Each chapter includes extensive references and an author list. An overall subject index is provided at the end of the book.

Phase-locked Loop Engineering Handbook for Integrated Circuits



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This book is intended to guide readers on phase-locked loop (PLL) theory and show practical applications, designs, simulations and testing techniques. The book emphasizes monolithic PLLs because of the growth in this area; however, the techniques also apply to other PLLs. The book has nine chapters and two appendixes. Chapters 1 though 5 discuss the basic tools that are required to do PLL analysis and specify PLL requirements. Chapters 6 to 9 extend the basics to practical simulation, application and testing problems. Chapter 1 gives an overview of PLLs, presents background information to understand how a loop operates and gives reference material for further study of loops. Chapter 2 covers system analysis of PLLs. Control-system theory and analysis of PLLs is covered in this chapter. Chapter 3 discusses system requirements for a PLL. Chapter 4 discusses the design of the individual components in a PLL. In Chapter 5, phase detectors are studied because understanding how phase detectors work is one of the major keys to understanding how PLLs work. Chapter 6 presents loop-compensation synthesis. The synthesis of loop-compensation components in the loop are application dependent. Chapter 7 discusses test measurements of PLLs. Measurements of PLLs are critical in verifying the performance of the PLL. Chapter 8 covers simulation techniques for PLLs. The types of PLL simulators vary from equation solutions to behavioral-model solutions and to SPICE transistor-level solutions. Chapter 9 presents PLL applications and extensions. PLLs are used to generate frequencies, to do clock recovery of a signal and to resynchronize signals.

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S5W2	S5W5	N5W5	5	±0.40
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S8W2	S8W5	N8W5	8	±0.60
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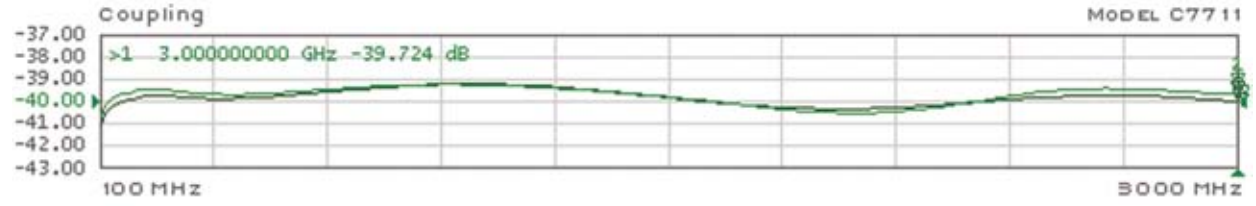

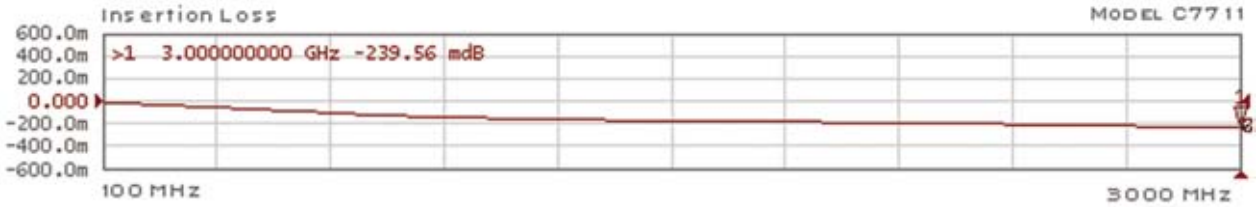

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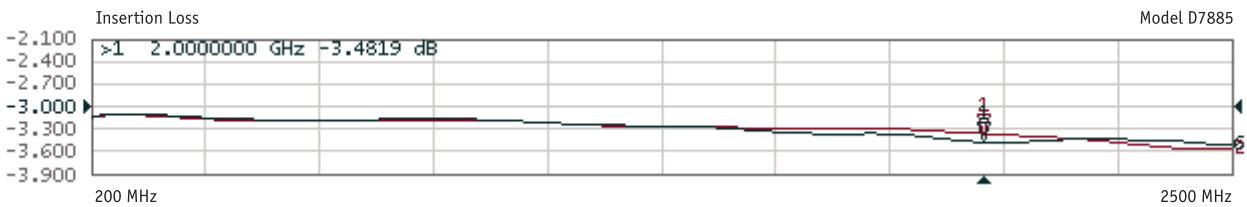

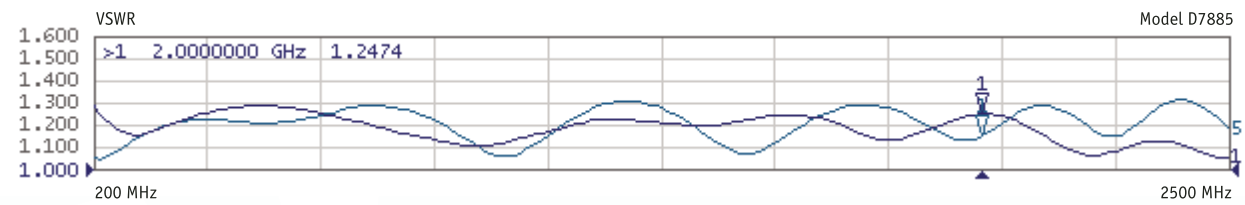

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