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Design Feature
Make Low-Cost Millimeter-Wave Components

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Synthesizers Target Broadband Testing

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MTT-S Preview
Radar & Antennas Issue

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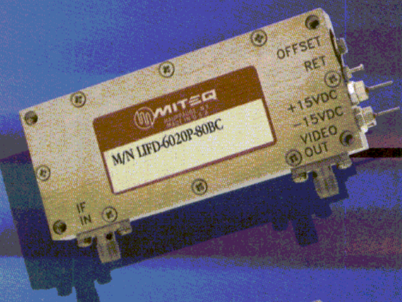
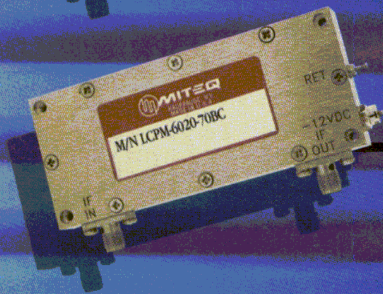
SUCCESSIVE DETECTION LOGARITHMIC AMPLIFIERS



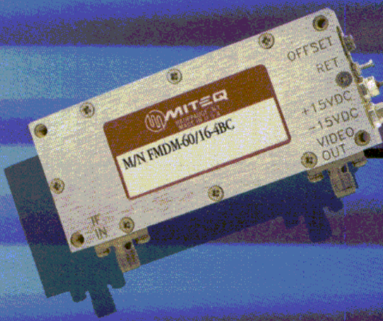
MODEL NUMBER	CENTER FREQUENCY (MHz)	DYNAMIC RANGE (dBm, Min.)	LINEARITY (dB, Max.)	RISE TIME (ns, Max.)	LOGGING SLOPE INTO 93 OHMS (mV/dB, Typ.)
LIFD-3010P-80BC	30	-80 to 0	±0.5	100	25
LIFD-6020P-80BC	60	-80 to 0	±0.5	50	25
LIFD-7030P-80BC	70	-80 to 0	±0.5	30	25
LIFD-16040-80BC	160	-80 to 0	±1.0	30	25
LIFD-300100-70BC	300	-70 to 0	±1.0	20	15

CONSTANT PHASE LIMITING AMPLIFIERS



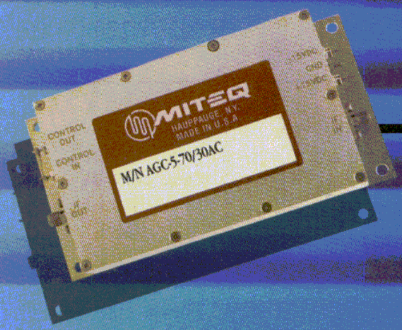
MODEL NUMBER	CENTER FREQUENCY (MHz)	DYNAMIC RANGE (dB, Min.)	OUTPUT POWER (dBm, Min.)	POWER VARIATION (dB, Max.)	PHASE VARIATION (Max.)
LCPM-3010-70BC	30	-70 to 0	10	±0.5	±3°
LCPM-6020-70BC	60	-70 to 0	10	±0.5	±3°
LCPM-7030-70AC	70	-65 to 5	10	±0.5	±5°
LCPM-16040-70BC	160	-65 to 5	10	±1.0	±3°

FREQUENCY DISCRIMINATORS

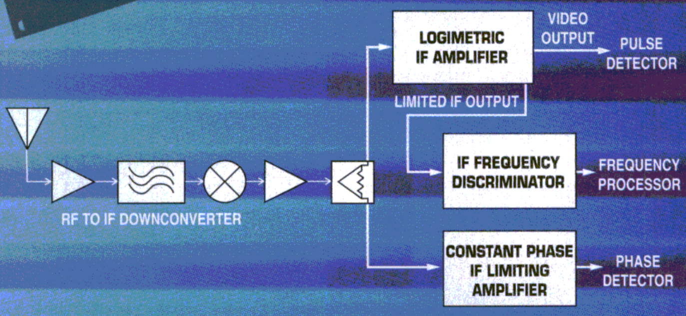


MODEL NUMBER	CENTER FREQUENCY (MHz)	LINEAR BANDWIDTH (MHz, Min.)	SENSITIVITY (mV/MHz, Typ.)	LINEARITY (%, Max.)	RISE TIME (ns, Max.)
FMDM-30/6-3BC	30	6	1000	±3	120
FMDM-60/16-4BC	60	16	250	±3	90
FMDM-70/36-10AC	70	36	50	±2	50
FMDM-160/35-15BC	160	35	100	±2	30
FMDM-160/50-15AC	160	50	40	±2	25
FMDM-750/150-20BC	750	150	20	±3	20
FMDM-1000/300-50AC	1000	300	10	±5	7

AUTOMATIC GAIN CONTROL LINEAR AMPLIFIERS



MODEL NUMBER	CENTER FREQUENCY (MHz)	BANDWIDTH (-3 dB) (MHz, Min.)	DYNAMIC RANGE (dBm, Min.)	OUTPUT POWER (dBm, Min.)	POWER VARIATION (dB, Max.)
AGC-7-10.7/4AC	10.7	4	-70 to 0	10	±0.5
AGC-7-21.4/10AC	21.4	10	-70 to 0	10	±0.5
AGC-5-70/30AC	70	30	-50 to 0	-4	±0.5
AGC-7-160/30AC	160	30	-70 to 0	8	±1.5
AGC-7-300/400AC	300	400	-65 to 0	3	±1.0



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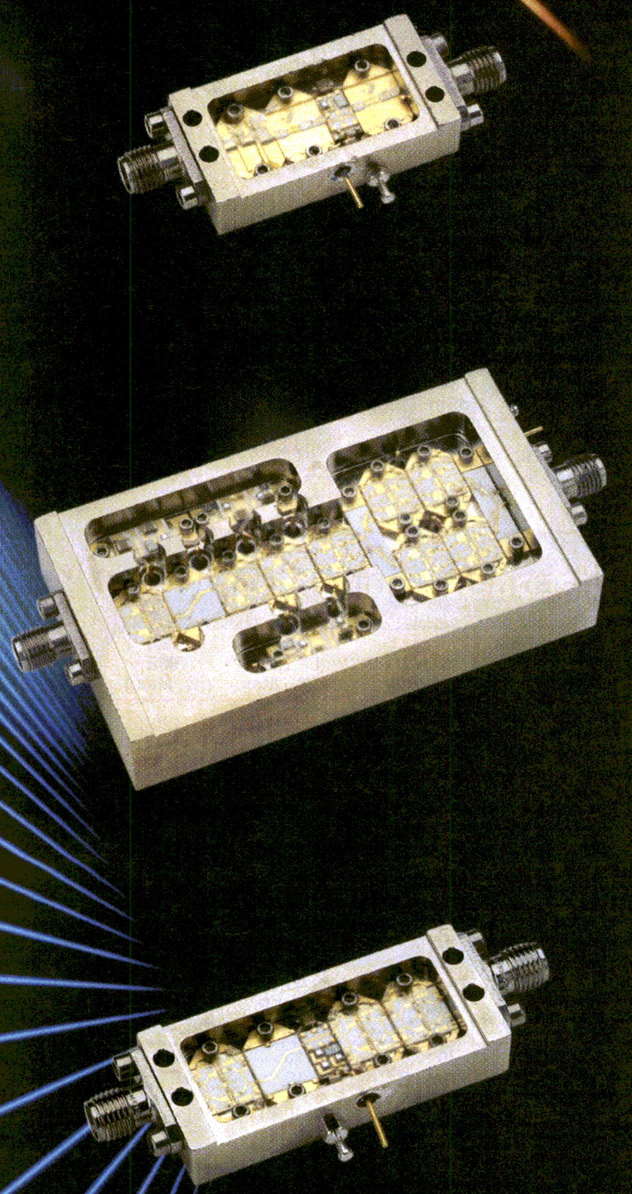

ULTRA BROAD BAND

Model	Freq. Range GHz	Gain dB min	N/F dB max	Gain Flat +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Curren mA
JCA018-203	0.5-18.0	20	5.0	2.5	7	17	2.0:1	250
JCA018-204	0.5-18.0	25	4.0	2.5	10	20	2.0:1	300
JCA218-506	2.0-18.0	35	5.0	2.5	15	25	2.0:1	400
JCA218-507	2.0-18.0	35	5.0	2.5	18	28	2.0:1	450
JCA218-407	2.0-18.0	30	5.0	2.5	21	31	2.0:1	500

MULTI OCTAVE AMPLIFIERS

Model	Freq. Range GHz	Gain dB min	N/F dB max	Gain Flat +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Curren mA
JCA04-403	0.5-4.0	27	5.0	1.5	17	27	2.0:1	550
JCA08-417	0.5-8.0	32	4.5	1.5	17	27	2.0:1	550
JCA28-305	2.0-8.0	22	5.0	1.0	20	30	2.0:1	550
JCA212-603	2.0-12.0	32	5.0	3.0	14	24	2.0:1	550
JCA618-406	6.0-18.0	20	6.0	2.0	25	35	2.0:1	600
JCA618-507	6.0-18.0	25	6.0	2.0	27	37	2.0:1	800

MEDIUM POWER AMPLIFIERS

Model	Freq. Range GHz	Gain dB min	N/F dB max	Gain Flat +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Curren mA
JCA12-P01	1.35-1.85	35	4.0	1.0	33	41	2.0:1	1000
JCA34-P02	3.1-3.5	40	4.5	1.0	37	45	2.0:1	2200
JCA56-P01	5.9-6.4	30	5.0	1.0	34	42	2.0:1	1200
JCA812-P03	8.0-12.0	40	5.0	1.5	33	40	2.0:1	1700
JCA1218-P02	12.0-18.0	22	4.0	2.0	25	35	2.0:1	700

LOW NOISE OCTAVE BAND LNA'S

Model	Freq. Range GHz	Gain dB min	N/F dB max	Gain Flat +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Curren mA
JCA12-3001	1.0-2.0	40	0.8	1.0	10	20	2.0:1	200
JCA24-3001	2.0-4.0	32	1.2	1.0	10	20	2.0:1	200
JCA48-3001	4.0-8.0	40	1.3	1.0	10	20	2.0:1	200
JCA812-3001	8.0-12.0	32	1.8	1.0	10	20	2.0:1	200
JCA1218-800	12.0-18.0	45	2.0	1.0	10	20	2.0:1	250

NARROW BAND LNA'S

Model	Freq. Range GHz	Gain dB min	N/F dB max	Gain Flat +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Current mA
JCA12-1000	1.2-1.6	25	0.75	0.5	10	20	2.0:1	80
JCA23-302	2.2-2.3	30	0.8	0.5	10	20	2.0:1	80
JCA34-301	3.7-4.2	30	1.0	0.5	10	20	2.0:1	90
JCA56-401	5.4-5.9	40	1.0	0.5	10	20	2.0:1	120
JCA78-300	7.25-7.75	27	1.2	0.5	13	23	2.0:1	120
JCA910-3000	9.0-9.5	25	1.2	0.5	13	23	1.5:1	150
JCA910-3001	9.5-10.0	25	1.2	0.5	13	23	1.5:1	150
JCA1112-3000	11.7-12.2	27	1.1	0.5	13	23	1.5:1	150
JCA1213-3001	12.2-12.7	25	1.1	0.5	10	20	2.0:1	200
JCA1415-3001	14.4-15.4	35	1.4	1.0	14	24	2.0:1	200
JCA1819-3001	18.1-18.6	25	1.8	0.5	10	20	2.0:1	200
JCA2021-3001	20.2-21.2	25	2.0	0.5	10	20	2.0:1	200

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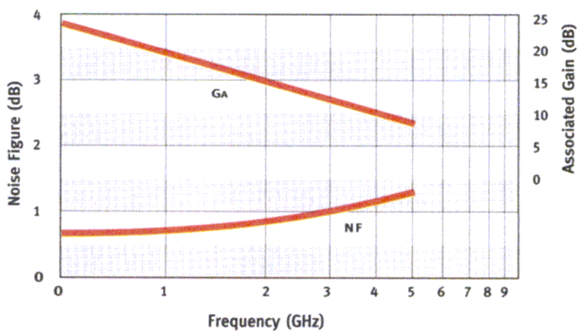
NE34018 NOISE AND GAIN PERFORMANCE



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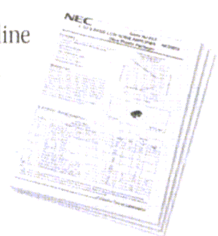

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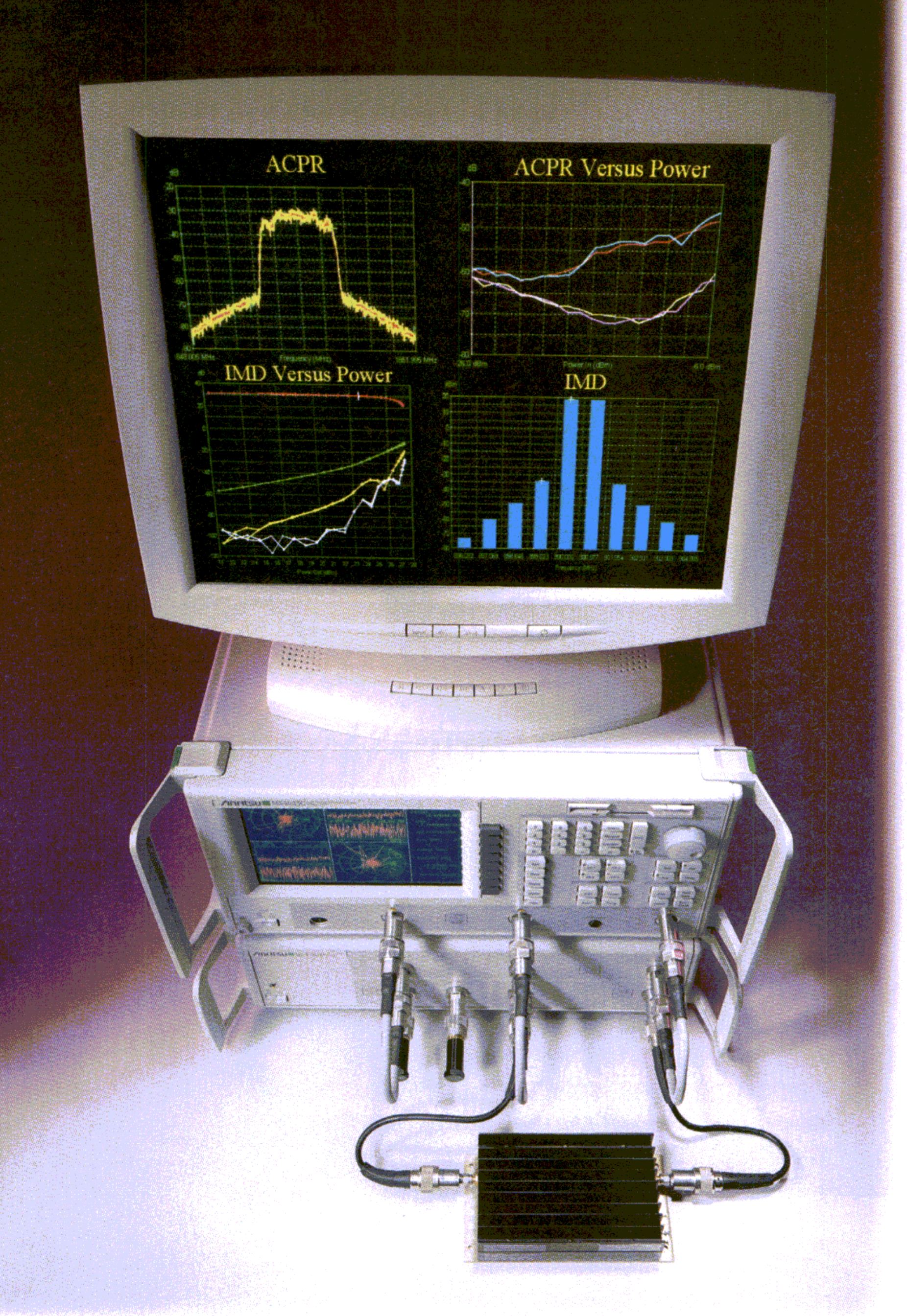

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Original Words

▶▶I WANT TO thank you for publishing my letter to the editor that appeared in the January 2001 (p. 13) issue of *Microwaves & RF*. I realize that you had to edit it to fit the space available , but somewhere in the process, a sentence got chopped and was combined which does not make sense. It is printed in the last paragraph of my first letter.

My original words were. "...RF power uses exclusively in the domain of high-power thermionic tubes are heavy particle accelerators (for science and industrial RF sources) used for dielectric heating. Klystrons and power-grid tunes are used in particle accelerators, most being larger machines than the medical linacs mentioned in the report."

What this implied is that these tubes are used in heavy particle accelerators for dielectric heating, which is not the application at all. They are used in accelerators for science and for industrial RF sources in dielectric heating. I apologize if I did not make this clearer.

Thanks for clarifying this.

John Lyles

Thorough Report

▶▶I FOUND THE Wireless Symposium Products story by Gene Heftman to be quite thorough ("Wireless Symposium Heralds New Era In Communications," March 2001, p. 39). Kudos!

Thank you for the coverage of W.L. Gore EMI gasketing technology. It never ceases to amaze me what Gore can do with that ePTFE material. I will, of course, keep your magazine posted on new developments from the company.

Charles L. Birkhead
President
Macrovision, Inc.
Doylestown, PA

Editor's Note

▶▶IN APRIL'S FEEDBACK (p. 13), the writer of "Beyond Fluff" was incorrect. It should have read James Gibson and not James Fox. We apologize for the error.

PLEASE COMMENT

Microwaves & RF welcomes mail from its readers. Letters should be typewritten and must include the writer's name and address. The magazine reserves the right to edit letters appearing in "Feedback." Address letters to:

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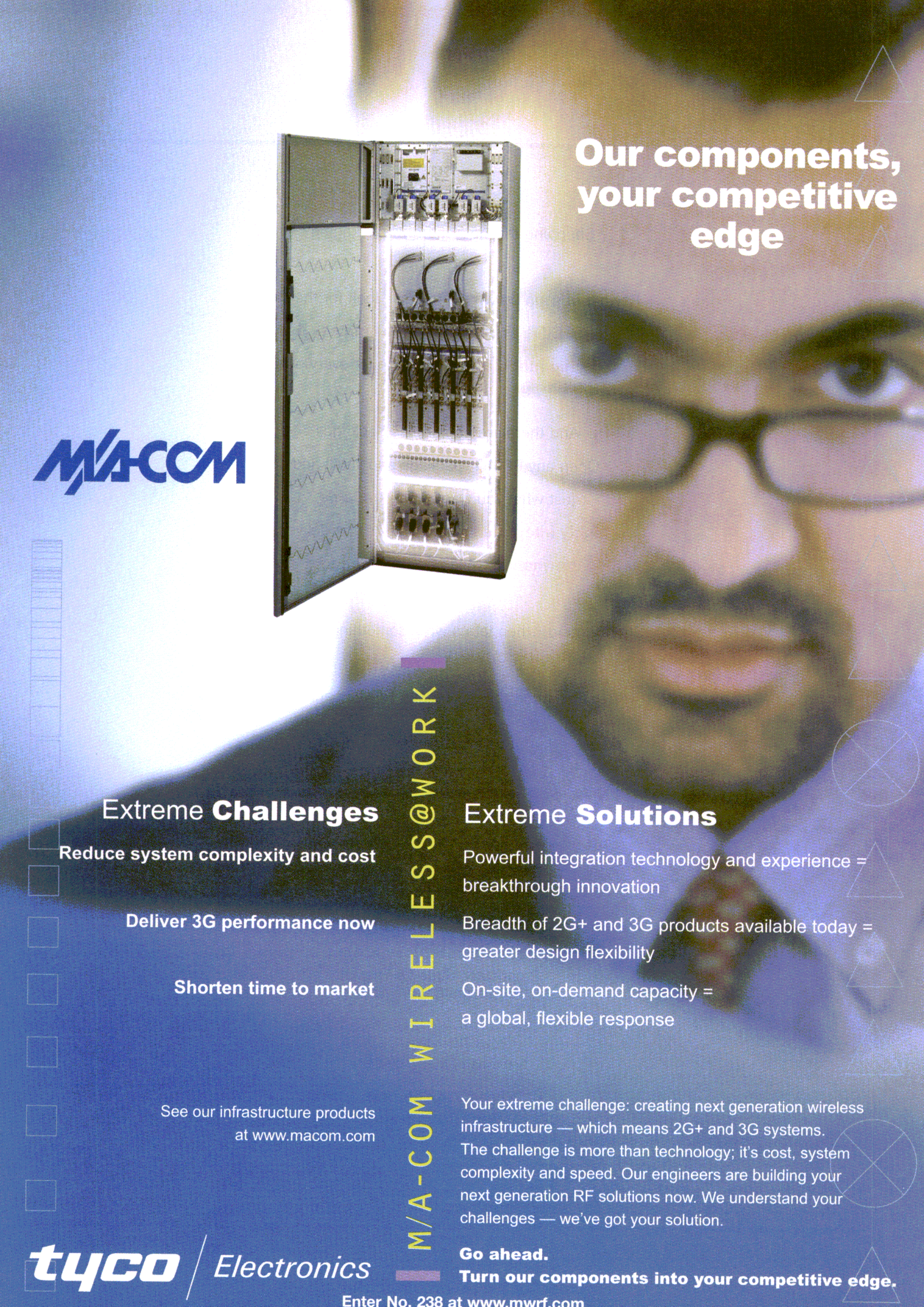
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MTT-S: A FULL WEEK OF TECHNOLOGY

MAY IS THE traditional preview issue for the annual IEEE/International Microwave Theory & Techniques Symposium (MTT-S) conference and exhibition. Due to the early dates for this year's show (May 20-25, 2001, Phoenix Civic Plaza, Phoenix, AZ), however, some readers may be seeing this issue for the first time while attending the MTT-S.

Although our economy has taken a turn for the worse since last year's MTT-S, there has been a great deal of activity in microwave R&D during the past year.

Although our economy has taken a turn for the worse since last year's MTT-S, there has been a great deal of activity in microwave R&D during the past year. The direction of the industry can often be foretold by a quick glance at the numbers and types of articles to be presented at the MTT-S.

This year, a total of 930 technical papers were submitted, with 242 student papers among them. A total of 511 papers were accepted. Since the MTT has approximately 9000 members worldwide, these 930 submissions represent participation of just over 10 percent of the MTT membership.

The MTT-S is actually three conferences in one week, with many other related events. These conferences are the 2001 Radio Frequency Integrated Circuits Symposium (RFIC2001), the 2001 International Microwave Symposium (IMS2001), and the Automatic RF Techniques Group (ARFTG). If there is a trend among the RFIC2001 papers and panel sessions, it is the large number of Bluetooth-related topics, as IC developers scramble to create the ultimate low-cost semiconductor solutions in support of 2.4-GHz Bluetooth personal wireless connectivity.

The IMS2001 is spread over three days, given the number of papers on nonlinear modeling and linear (power) amplifier design, wireless applications are still the dominant market.

The third part of "microwave week" is the one-day, 57th ARFTG, with a focus this month on wafer probing and automated measurements. In addition, a variety of special events is being held during the week, including an informative display on the 100 years of the National Institute of Science and Technology (NIST).

Approximately 10,000 people will attend this largest of microwave conferences and exhibitions. But for those who cannot attend, we have gathered a quick summary of MTT-S events beginning on p. 111. And if that is not enough, further information is available at the MTT-S website at www.ims2001.org.

Jack Browne

Publisher/Editor

Microwaves & RF

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RF POWER

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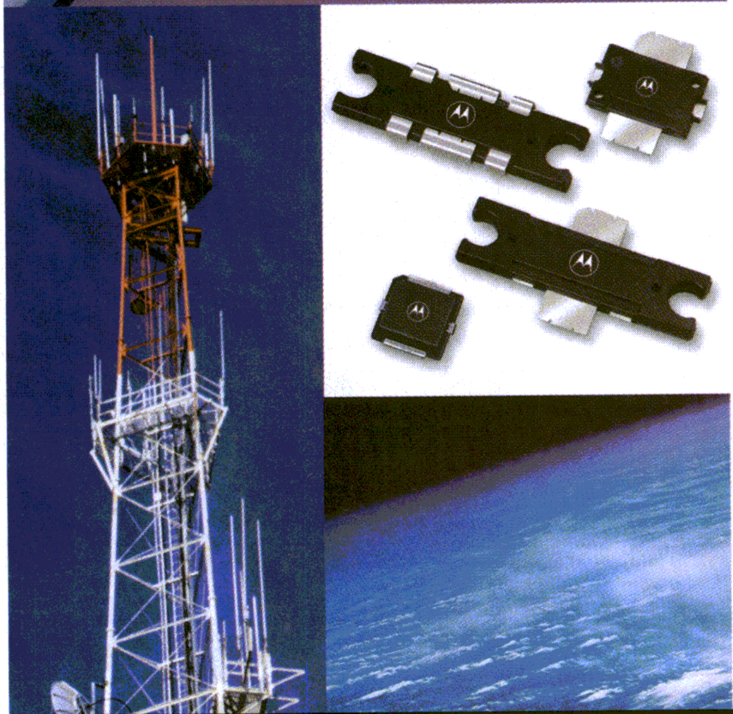
The MRF9000M series is optimized for 1.0GHz base station applications and is housed in the TO-270 and TO-272 RF power plastic packages. With guaranteed ruggedness and integrated ESD protection, this new 900MHz plastic product line will simplify handling and reduce the overall cost of cellular amplifier production.

Digital DNA™ from Motorola



For land mobile applications, Motorola developed the MRF1500 family. Designed for broadband commercial and industrial applications at frequencies up to 520 MHz, the high gain and broadband performance of this family make the devices ideal for large-signal, common source amplifier applications.

Device	Frequency	Operating Voltage	Output Power	Gain (Typ)	Eff. (Typ)	Package
MRF9030MR1	1.0 GHz	26V	30W (PEP)	19 dB	41% (two-tone)	TO-270
MRF9030MBR1	1.0 GHz	26V	30W (PEP)	19 dB	41% (two-tone)	TO-272
MRF9045MR1	1.0 GHz	28V	45W (PEP)	18.5 dB	41% (two-tone)	TO-270
MRF9045MBR1	1.0 GHz	28V	45W (PEP)	18.5 dB	41% (two-tone)	TO-272
MRF9060MR1	1.0 GHz	26V	60W (PEP)	17.7 dB	39% (two-tone)	TO-270
MRF9060MBR1	1.0 GHz	26V	60W (PEP)	17.7 dB	39% (two-tone)	TO-272
MRF1511T1	136-175 MHz	7.5V	8W	11.5 dB	55%	PLD1.5
MRF1517T1	430-520 MHz	7.5V	8W	11 dB	55%	PLD1.5
MRF1513T1	400-520 MHz	7.5/12.5V	3W	11 dB	55%	PLD1.5
MRF1518T1	400-520 MHz	12.5V	8W	11 dB	55%	PLD1.5
MRF1535T1	400-520 MHz	12.5V	35W	10 dB (min)	50% (min)	TO-272
MRF1550T1	136-175 MHz	12.5V	50W	10 dB (min)	50% (min)	TO-272

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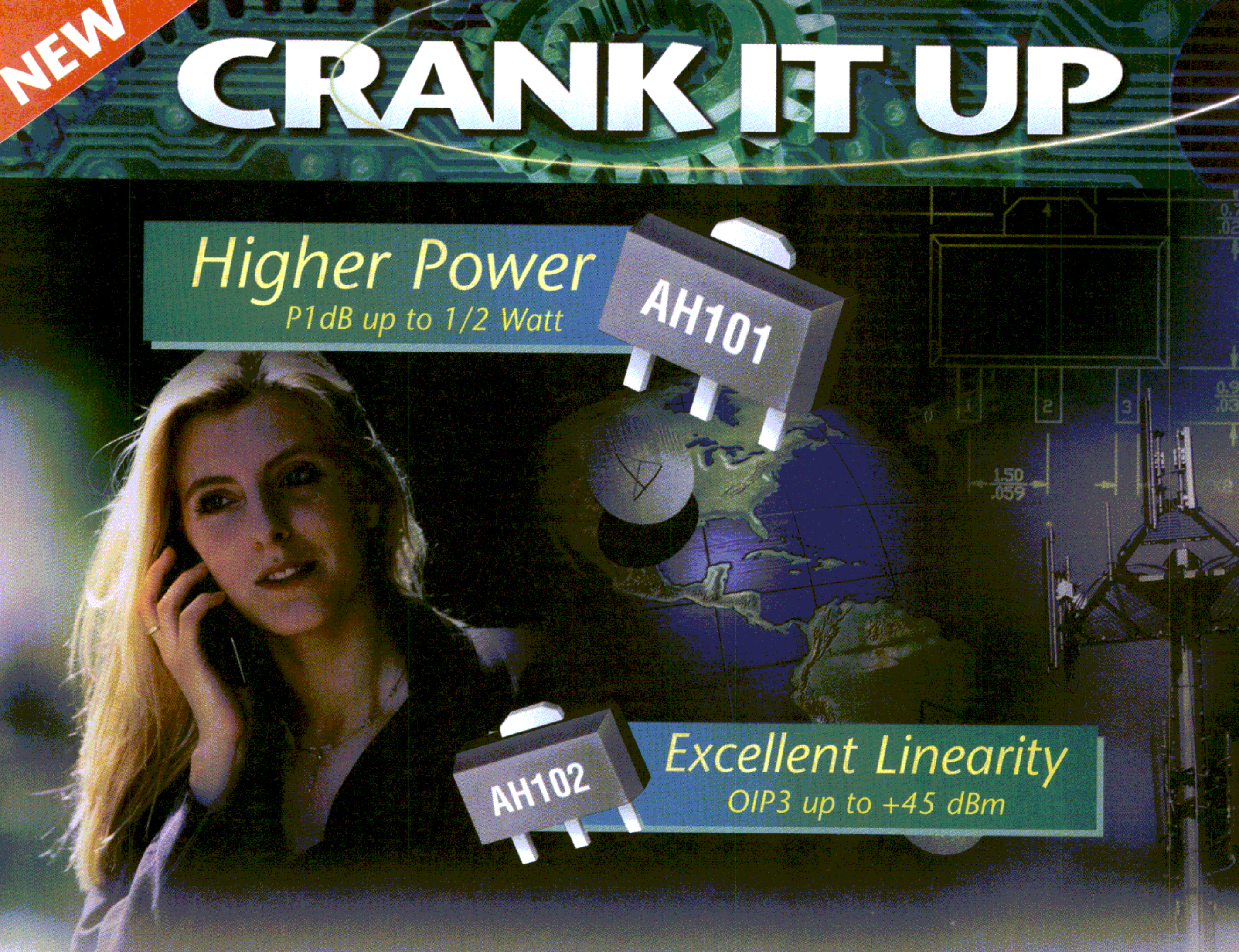
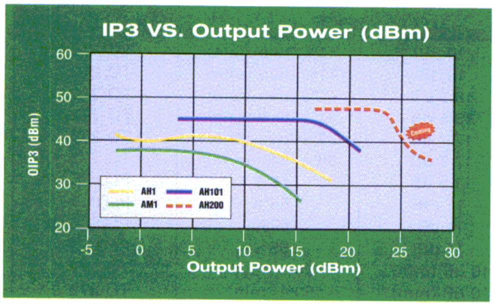


For higher power and excellent linearity, use WJ's AH101 and AH102 amplifiers.



WJ High Dynamic Range Amplifiers

Product	Frequency (MHz)	IP3 (dBm)	P1dB (dBm)	Bias current (mA)
New AH101	50-1500	45	27	200
New AH102	350-3000	45	27	200
AH1	250-3000	41	21	150
AM1	250-3000	37	18	75
Coming Soon AH200	250-6000	47	30	360

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LFOM Defined: $$\text{LFOM (dB)} = \frac{\text{OIP3 (dBm)}}{\text{DC Power (dBm)}}$$

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Broadband Fiber-Optic Ring Technology Is Deployed In Denver

DENVER, CO—Touch America Colorado, LLC has begun turning up its 250-mile fiber-optic ring that connects the Metro Denver area to TOUCHAMERICA's national high-speed broadband network.

The Metro Denver fiber ring encompasses an area from downtown Denver, east to Denver International Airport, south to the Denver Tech Center, and west to Golden. The metro network will provide the latest in supercharged wavelength services and information-transport flexibility to customers by combining state-of-the-art fiber-optic network technology with Cisco Systems' recently announced suite of optical equipment, including the first metropolitan dense-wavelength-division-multiplexing (DWDM) solution capable of delivering "wavelengths to the building."

"Denver businesses now can contract for their information-transport needs in increments, buying individual wavelengths on which to send and receive data, voice, and video. This means customers can increase their network size and capability in a scalable, affordable way," comments Shawn Hill, the director of Touch America Colorado.

Optoelectronics Market Experiences Great Growth

SAN JOSE, CA—In North America, the telecommunications market, voice and data, is experiencing unprecedented growth. The optoelectronics market, which derives from the fiber-optic industry, is the hub of this phenomenon. As manufacturers bring out new and improved technologies across different segments and continue to meet the needs of demanding end-user industries, the optoelectronic markets should experience steady upward growth throughout the next few years. According to a new research research by Frost & Sullivan, *North American Optoelectronics Markets,* the four market segments of the industry—light-emitting diodes (LEDs), optocouplers, photodetectors, and laser diodes—generated revenues of $1.97 billion in 1999. This market is forecasted to experience extraordinary growth, totaling $10.11 billion in 2006. The study identifies LEDs, photodetectors, and laser diodes as the fastest-growing segments. According to Frost & Sullivan, "The market has recently experienced a tremendous boost from the introduction of blue and green LEDs. This has greatly expanded the scope for LED applications in automotive, video displays, signage, and traffic signals."

Laser diodes have replaced LEDs as primary light sources in the fiber-optic communications market. In addition, the emergence of Vertical Cavity Surface Emitting Lasers (VCSELs) has provided fiber-optic manufacturers with the kind of low-cost light source that they have been seeking. This technology will translate into rapid growth for laser diodes. The photodetector segment, in particular, is expected to produce high returns by bundling photodetectors with laser diodes as composite optoelectronic modules.

"The demand for these new developments and technologies is very high," say Frost & Sullivan. "In fact, the situation is such that manufacturers are struggling to meet these demands as lead times for key components are increasing. However, they will have to find solutions to these issues because they would not want to lose out on ripe opportunities."

Frost & Sullivan presents awards to companies that show outstanding leadership abilities and contributions to the electronic components industry.

Technology Will Integrate Multiple Complete RF Front Ends On A Single Chip

JACKSONVILLE, FL—Ashvattha Semiconductor, Inc. announced a technology that will provide it with an ability to integrate multiple complete RF front ends on a single chip. Initial silicon (Si), manufactured using a 0.25-µm silicon-germanium (SiGe) bipolar-complementary-metal-oxide-semiconductor (BiCMOS) process technology, demonstrated all of the performance characteristics required to support the company's high-integration product strategy. Initial applications will be targeted at the cellular-phone market, integrating three separate complete RF front ends supporting wireless, Global Positioning System (GPS), and Bluetooth standards on a single chip.

"We believe SiGe offers an unbeatable combination of the best performance with the least power consumption."

"While our design actually lets us implement chips in any high-quality BiCMOS technology, for our initial product especially, we believe SiGe offers an unbeatable combination of the best performance with the least power consumption," states Guruswami Sridharan, president and chairman of Ashvattha.

The test chip includes all of the key subsystems that will be integrated into the initial product—namely, the wireless, GPS, and Bluetooth transmitters (Txs) and receivers (Rxs), as well as the Ashvattha multimode synthesizer and the critical isolation mechanisms that prevent the several on-chip radios from interfering with each other even when operating simultaneously.

While Ashvattha will initially target cellular-handset applications that need to provide multiple RF functionality, its technologies are applicable across a wide range of other application areas including wireless data networking, consumer products, and communications infrastructure.

MSM3300/gpsOne Solution Is Adopted For Japanese Security System

SAN DIEGO, CA—Qualcomm, Inc. announced that Japan's SECOM Co. Ltd. has launched CoCo SECOM, a new safety service for locating the position of people and vehicles, with nationwide availability in Japan that commenced on April 1, 2001. The new service represents the world's first commercial deployment of the Qualcomm CDMA Technologies' (QCT) MSM3300(TM) Mobile Station Modem (MSM(TM)) integrated-circuit (IC) and system software solution incorporating gpsOne(TM) position-location technology, and uses SECOM's extensive security-service network in conjunction with geographic positioning to provide affordable personal and vehicle security. This new technology uses Global Positioning Systems (GPS) satellites and KDDI's commercial code-division-multiple-access (CDMA) cellular-phone networks to provide position-based security for subscribers and communicates with the MSM3300-based personal security device.

The CoCo SECOM service locates the position of persons or vehicles needing assistance using a compact terminal that was developed exclusively for this service. Once located, SECOM informs the responsible subscriber of the person's or item's position and, if necessary, SECOM dispatches emergency personnel in order to provide assistance. CoCo SECOM services are available 24 hours a day, seven days per week.

Broadband Wireless System To Be Used In Deployment Of Broadband Direct In Chicago

SAN JOSE, CA—Hybrid Networks, Inc. has announced that Sprint Corp. is using Hybrid's two-way system for the deployment of Sprint Broadband Direct in the greater Chicago area.

Hybrid Networks is supplying Sprint with head-end equipment that manages data transmission as well as Wireless Broadband Routers(TM) for use in subscribers' homes and businesses in more than 140 municipalities throughout the Chicago metropolitan area, including Schaumberg, Northbrook, and Naperville. Hybrid's head-end equipment is linked to the transmission antenna atop the Sears Tower in downtown Chicago that Sprint is using in oprder to deliver two-way, high-speed Internet access.

"We are excited that Sprint has chosen our system to provide fixed broadband wireless service to businesses and residences throughout Chicago," says Michael D. Greenbaum, president and CEO of Hybrid Networks. "While our current system can serve a large metropolitan area like Chicago, we anticipate that the summer deployment of our new near-line-of-sight router, ThruWAVE, will enable major service providers, like Sprint, to increase their customer bases in their respective markets."

Fixed Broadband Wireless Access Technology To Be Deployed

TAMPA, FL—Radiant Networks, Inc. and Virginia Tech have signed an agreement under which Virginia Tech will be the first local-multipoint-distribution-service (LMDS) license holder to commercially deploy Radiant's technology. The first system will be deployed next month. TradeWinds Communications of Roanoke, VA will work with Virginia Tech and Radiant to deploy this technology in Virginia Tech's license areas.

Radiant Mesh technology is a new generation of broadband-access technology that allows each subscriber to connect with its neighbors rather than a base station. Radiant Mesh architecture can dramatically alter the economics of network evolution because it can avoid the high initial cost of base-station infrastructure installation and enables the network to grow and evolve at its own pace. It provides a high-data-rate connection from the operator's trunk network to the customer's premises.

"Mesh technology is a new generation of broadband-access technology that allows each subscriber to connect with its neighbors rather than a base station."

Radiant will supply systems through TradeWinds Communications that Virginia Tech will evaluate and use as a university research project in support of broadband delivery to commercial subscribers and economic development within its license area. This is a direct reflection of the demand for broadband services, and Radiant's Mesh is set to deliver a system with coverage properties in rural, densely populated areas.

"Radiant is very pleased to be working with such a strong technology leader in the US. The relationship with Virginia Tech is a significant milestone in our execution strategy for this explosive market, which is estimated to reach $16.3 billion worldwide by 2004," says Nadeem Siddiqui, COO of Radiant Networks, Inc.

Dr. Charles W. Bostian of Virginia Tech's Center for Wireless Telecommunications states, "Mesh technology offers substantial economic advantages for deployment and growth of broadband-access networks, and we are particularly excited with the possibilities of the architecture for delivering mass-market broadband services to the business and home."

"TradeWinds Communications is looking forward to this joint effort, and by combining the talents and experience TradeWinds, Radiant, and Virginia Tech bring to the market, this alliance will be uniquely positioned to develop new business and expand relationships throughout the US."

Kudos

IFR Systems, Inc. has been selected from a field of hundreds of candidates as a finalist in the EDN 2000 Innovation of the Year awards competition. This awards program, sponsored by *EDN Magazine,* is dedicated to honoring truly outstanding engineering products in the electronics industry. IFR had its 2029 vector modulator selected in the Test and Measurement category...The American Physical Society (APS) has named Dr. James E. Faller of the National Institute of Standards and Technology (NIST) as this year's recipient of the Joseph F. Keithley Award. The annual prize recognizes physicists who have made outstanding advances in measurement science through the development of original measurement techniques or equipment. Nominations are reviewed by a panel of five APS members, who select a person or persons working in the same area whose contributions have made a long-lasting impact on physics and instrumentation. Dr. Faller received the Keithley Award during this year's APS meeting held in Seattle, WA from March 12 to 14...U.S. Wireless Corp. announced that it has received a Notice of Allowance from the US Patent and Trademark office for a patent covering the remote location and tracking of wireless code-division-multiple-access (CDMA) devices, using Location Pattern Matching Technology...Flarion has won the Best of Show award in the Infrastructure category at Internet World Wireless 2001. The award was presented at the show at the Jacob K. Javits Center in New York City on February 22. During the show, Flarion demonstrated its flash-OFDM system, which provides high-speed wireless Internet connectivity. With laptops connected through its wireless modems, Flarion enabled visitors to its booth to enjoy streaming videos, while simultaneously listening to streaming MP3s, exceeding a speed of 384 kb/s...ISG Broadband has announced the assignment of a US Patent for its cable-modem-transceiver technology. This technology has enabled the company to develop the low-cost, miniature, drop-in ISG tuners that are now found in cable-television (CATV) and cable-telephony systems worldwide. Patent Number 6,160,571 was granted to Jim Wang, vice president of development engineering at ISG...Cardinal Components was awarded the Product of the Year 2000 Award by *Electronic Products Magazine.* The award was presented for Cardinal's new oscillator known as FIPO, the Field Instantly Programmable Oscillator. Cardinal Components is the only company from New Jersey to win the award. MRF

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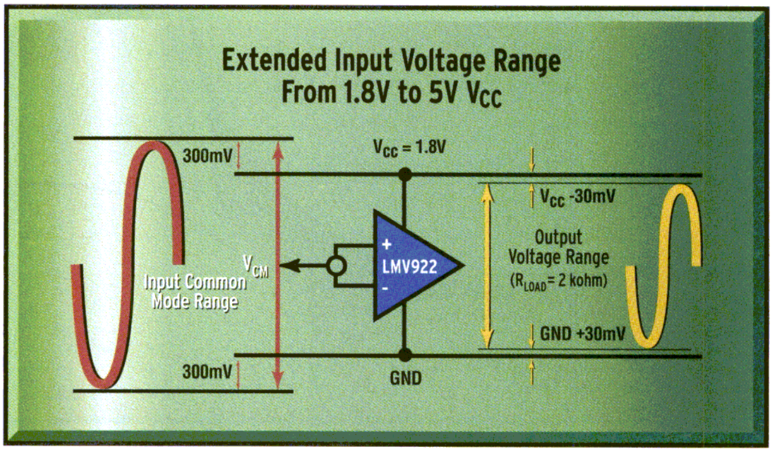

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Optics Shine On Brightly At OFC

Hundred of researchers gathered at the recent Optical Fiber Conference in search of new methods to increase the information-carrying capacities of optical-communications systems.

JACK BROWNE
Publisher/Editor

Light-wave communications systems provide long-distance communications without the loss limitations of copper (Cu) cables or the interference limitations of wireless technology. For that reason, optical technology is attractive for high-data-rate communications networks, video on demand, and Internet access. The latest developments in the technology were shared among researchers, exhibitors, and attendees at the recent Optical Fiber Conference (OFC).

The Optical Fiber Communication Conference and Exhibit was held this past March 17-22 at the Anaheim Convention Center (Anaheim, CA). Sponsored by the Optical Society of America (www.osa.org), the IEEE/Communications Society (www.comsoc.org), and the IEEE/Lasers and Electro-Optics Society (www.ieee.org/society/leos), the conference and exhibition drew approximately 40,000 attendees. While many came to visit the more than 900 exhibition booths **(see sidebar)**, engineers and system developers could be found at hundreds of technical presentations on everything from modeling approaches to new system architectures.

For example, Jonas Hansryd and Peter Andrekson from the Chalmers University of Technology (Goteborg, Sweden) reported on a single 40-GHz return-to-zero (RZ) source based on a fiber-optic parametric amplifier. The unit involves a narrowband 40-GHz sinusoidally intensity-modulated pump to obtain stable 2-to-4-ps-wide pulses. Based on a sinuslidally amplitude-modulated (AM)-pumped fiber-optic parametric amplifier, the source provided more than +10-dBm output power at operating wavelengths from 1535 to 1555 nm and from 1568 to 1585 nm.

Erbium-doped fiber amplifiers (EDFAs) can be used to increase the optical signal power of a fiber-optic link, but these amplifiers typically suffer excess noise that can degrade link performance. This problem was the target of S.J. Strutz and co-workers from the Naval Research Laboratory (Washington, DC), who revealed their work on a polarization-maintaining Erbium/Brillouin fiber amplifier with shot-noise-limited performance in the 1-to-8-GHz frequency range. The amplifier makes low-noise photonic links possible without the need for expensive solid-state lasers.

The transmission capacity of optical networks depends on the number of channels that can be carried per fiber. Y. Hida and co-workers from NTT Photonics Laboratories (Ibaraki-ken, Japan) reported on an arrayed wave-

Continued from page 31

guide grating (AWG) that is capable of 400 dense-wavelength-division-multiplex (DWDM) channels fabricated on a 6.00-in. wafer. Using a channel spacing of 25 GHz, the 400-channel AWG covers the full range of C- and L-bands to take full advantage of the typical gain-bandwidth performance of conventional EDFAs. The AWG was designed for use in the 1530-to-1610-nm-wavelength region using a fiber core size of 4.5 × 4.5 μm. On-chip losses for the 400-channel AWG ranged from 3.8 dB for the central output to 6.4 dB for the peripheral output. The 400-channel AWG can support a transmission capacity of 4 Tb/s at a bit rate of 10 Gb/s for a single channel.

M. Oguma and associates from the NTT Photonics Laboratories (Ibaraki-ken, Japan) reported on a DWDM filter with 50-GHz spacing and 102 channels fabricated by integrating two AWG filters with 100-GHz spacing and a lattice-form interleave filter with 50-GHz spacing on a single chip. The design makes it possible to double the channel count in a DWDM system.

T. Chiba and co-workers of the Optoelectronic System Laboratory of Hitachi Cable Ltd. (Ibaraki-ken, Japan) report on a novel wavelength interleaving filter with Fourier-transform-based Mach-Zehnder interferometers (MZIs) that can be used simultaneously as a multiplexer and demultiplexer. The design is based on Fourier-transform three-stage MZIs connected in a tandem configuration, where two independent interleavers are monolithically integrated by using all optical components in common, except for the input and output ports. By taking the phase conjugate relationship into consideration, chromatic dispersion compensation can be achieved on each interleaver. The final design achieves an insertion loss of less than 2 dB across 50-to-100-GHz bandwidths.

Berthold Schmidt and associates from JDS Uniphase (Zurich, Switzerland) reported on efficient 980-nm single-mode ridge-waveguide laser-diode modules capable of more than 0.5-W pump power. The narrow-stripe laser structures are based on indium-gallium-arsenide (InGaAs)/aluminum-GaAs (AlGaAs) material and are grown by molecular-beam epitaxy (MBE). By improving the overall coupling efficiency and maintaining the power-coupling efficiency above 55 percent, up to 700 mW of linear power is possible with the 980-nm laser diode, with fiber-coupled optical output power of better than 500 mW at +25°C.

M. Maiorov and associates from Princeton Lightwave, Inc. (Princeton, NJ) reported on a single-mode ridge-waveguide laser capable of more than 400-mW output power at 1500 nm. The separate-confinement-heterostructure, broad-waveguide quantum-well (SCH-BW-QW) laser structures were grown by the low-pressure metal-organic-chemical-vapor-deposition (MOCVD) process. Ridge-waveguide structures were fabricated from two different types of epitaxial structures with undoped confinement layers of 710 and 1310 nm. The width of the ridges ranges from 3.0 to 3.5 μm. The lasers were mounted onto Cu heatsinks prior to testing. Testing a 3-mm-long device yielded output power greater than 400 mW for operating current levels of 2.0 to 2.2 A.

Engineers and system developers could be found at hundreds of technical presentations on everything from modeling approaches to new systems.

B. Thedrez and associates from the Alcatel Corporate Research Center (Marcoussis, Cedex, France) address the ultimate goal of fiber to the home with their work on low-cost laser sources. Their 1300-nm high-efficiency laser sources are designed for uncooled operation without isolators in 2.5-Gb/s networks. The 1300-nm distributed-feedback (DFB) laser includes an optical-mode adapter for direct coupling to a fiber without need of an isolator. The device achieves total dispersion of 330 ps/nm with 20-dB return loss at 2.5 Gb/s, while delivering +5-dBm optical power to the fiber at +85°C. The source is suitable for optical transmissions at distances of 30 to 40 km even under severe return-loss conditions.

Generating short optical pulses at repetition rates of 10 to 40 GHz is critical to the success of large-capacity optical-communications systems. Yukio Katoh and associates from OKI Electric Industry Co. Ltd. (Tokyo, Japan) report on a monolithic distributed Bragg reflector (DBR) laser diode integrated with an electroabsorption modulator capable of producing nearly transform-limited pulses of less than 6 ps in width over a frequency range of 37.7 to 38.5 GHz. Compared to conventional laser diodes with a locking bandwidth of about 400 MHz, this design features a more-forgiving locking bandwidth of approximately 800 MHz. The wide locking bandwidth is achieved by current injection to a passive waveguide section.

Carl Davidson of TyCom Laboratories (Eatontown, NJ) reported on high-capacity WDM long-haul submarine systems. He noted that TyCom Global Network of fiber-optic cables will span approximately 250,000 km and connect 72 major telecommunications centers around the world. Initially, the system will be implemented with 64 WDM channels carrying 10 Gb/s on four fiber pairs. The initial trans-Pacific system will support cable capacity of 5.12 Tb/s on eight fiber pairs. The European network will have two, four, and six fiber pairs to transport a maximum cable capacity of 3.84 Tb/s. Service is expected to commence in various phases between 2002 and 2005.

Naomasa Shimojoh and associates from Fujitsu Laboratories Ltd. (Kawasaki, Japan) have experimented with methods for equalizing the gain bandwidth of EDFAs by using a distributed Raman amplifier (DRA) with two different Raman gain-peak wavelengths allocated at both edges of the EDFA gain

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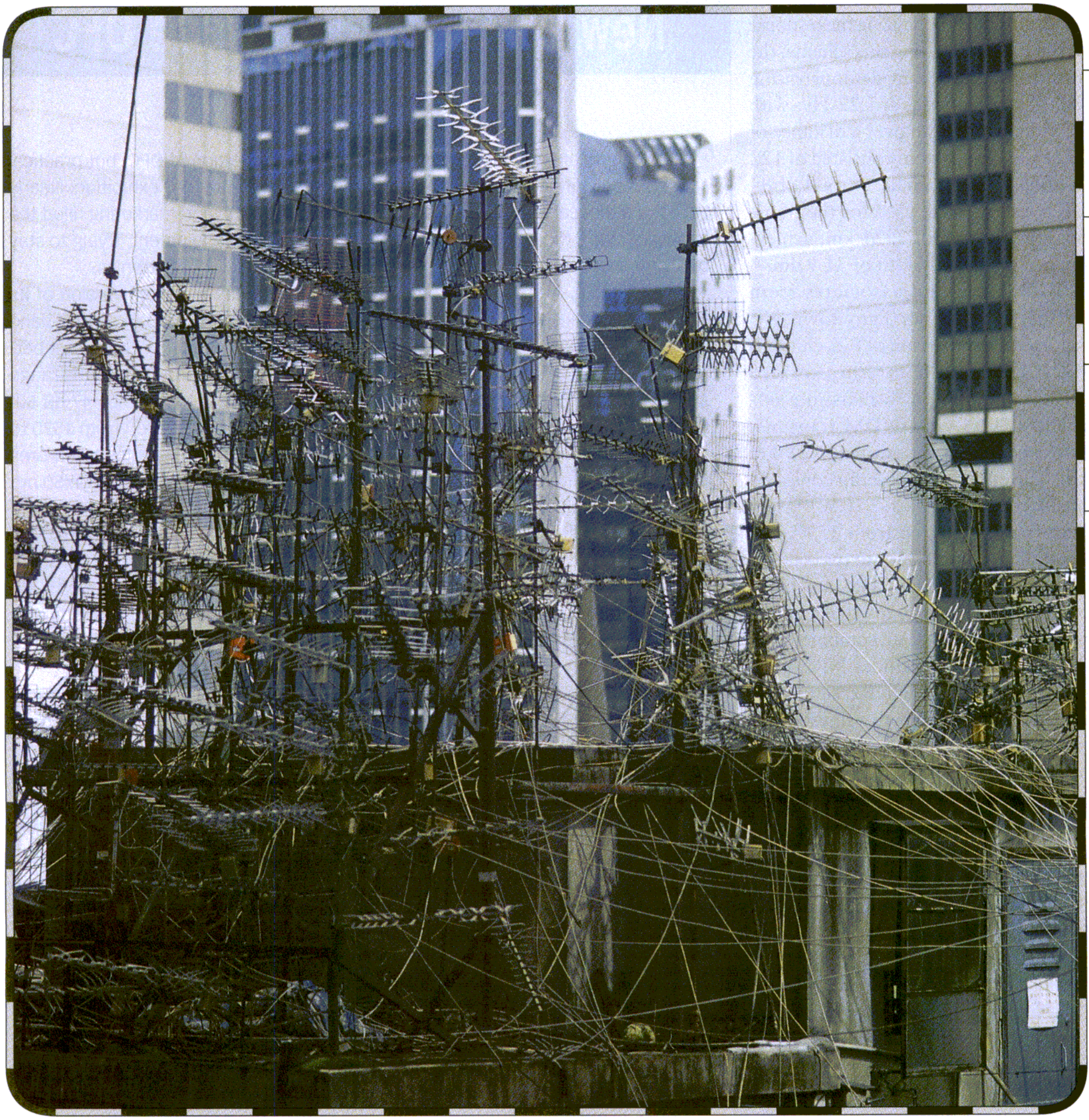

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Continued from page 32

band, effectively equalizing the response of the EDFA. By using this scheme, the authors succeeded in demonstrating WDM transmissions at 1.22 Tb/s with a 38-nm bandwidth over a distance of 7221 km. The system consisted of 122 10-Gb/s WDM signals. A total of 84 DRA/EDFAs were used for the transmission distance of 7221 km, achieving a WDM bandwidth of 31.9 nm.

B. Bakhshi and associates from TyCom Laboratories (Eatontown, NJ) reported a comparison of RZ, chirped-RZ (CRZ), and non-return-to-zero (NRZ) modulation formats in a 64-channel, 12.3-Gb/s WDM transmission experiment over a distance of 9000 km. The experimental setup consisted of 64 continuous-wave (CW) lasers with 0.4-nm spacing from 1537.4 to 1562.6 nm combined onto two optical paths, modulated with data, and combined pair-wise orthogonal in a polarization-dependent beam combiner. The data modulation includes NRZ coding at 12.3 Gb/s. The NRZ signal can also be remodulated with a sinusoidally driven amplitude modulator to form 35-ps-wide RZ signals which, in turn, can be formed to CRZ signals using a phase modulator. The experimental results show that the CRZ format is the most resistant to nonlinearities and the most suitable for high-capacity, long-haul WDM systems.

Olivier Leclerc and associates from the Alcatel Corporate Research Center (Marcoussis Cedex, France) proposed a novel regenerator scheme using a 40-Gb/s semiconductor-optical-amplifier (SOA)-based Mach-Zehnder interferometer for performing optical regeneration through synchronous modulation. Using an experimental loop, the presenters were able to emulate the performance of a 40-Gb/s transmission over a distance of 10,000 km with a $2^{23} - 1$ pseudorandom-bit-sequence (PRBS) coding signal.

Gerry Pesavento and Mark Kelsey of Alloptic, Inc. (Pleasanton, CA) spoke on the reasons why the next-generation local-access networks will evolve to an all-optical Internet-Protocol (IP)

New Products Illuminate OFC

JACK BROWNE
Publisher/Editor

Theory and technology drove the conference portion of OFC, but practical application was behind most of the displays at the OFC exhibition. Nearly a thousand firms involved in fiber-optic products and marketing filled the show floor with their latest hardware, software, and test equipment, trying to stay one step ahead of one of the fastest-moving technologies in electronics.

For example, Anritsu Co. (Morgan Hill, CA) offered an enhanced version of its MS9710C optical spectrum analyzer, with capability of making L-band and C-band measurements at channel spacing to 50 GHz. With a wavelength accuracy of better than 0.02 nm at L-band and C-band, the analyzer achieves 70-dB dynamic range at 1 nm, as well as an optical signal-to-noise ratio (OSNR) of better than 47 dB 50-GHz channel spacing. The analyzer provides level accuracy of 60.1 dB from 1520 to 1620 nm and linearity of 60.05 dB at 1550 and 1600 nm. The instrument features an optical sensitivity of 290 dBm and covers a wavelength range of 600 to 1750 nm with 50-pm resolution.

California Eastern Laboratories (Santa Clara, C) introduced a wide range of NEC components for optical-communications systems through 40 Gb/s. The firm's model NX8560LJ 1550-nm integrated electroabsorption modulator supports 40-Gb/s transmissions over distances to 40 km with standard fiber. The modulator offers 30-dB isolation, at least 0.5-mW optical power, and an extinction ratio of at least 10 dB.

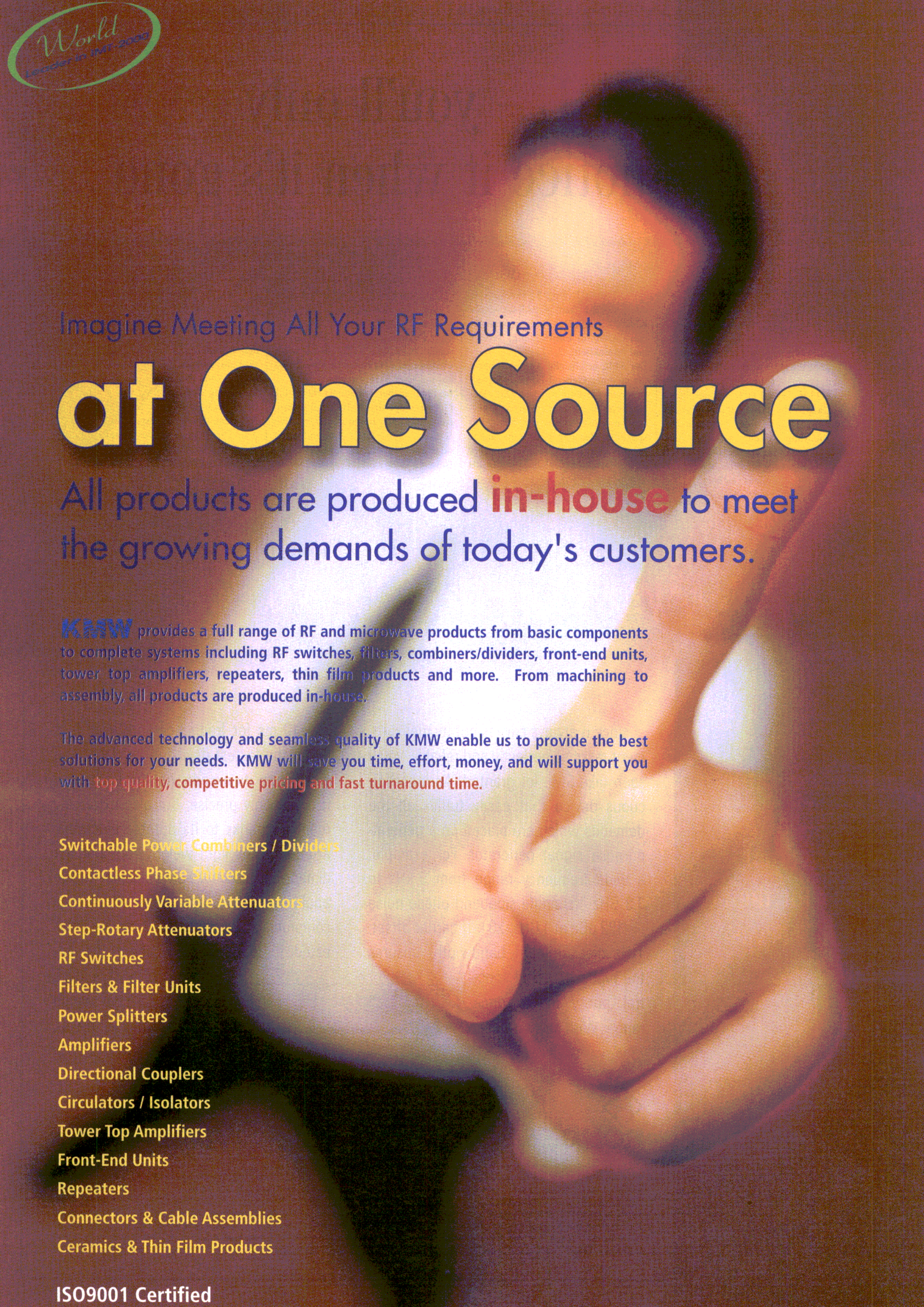
Emcore Corp. (Somerset, NJ) introduced an 850-nm oxide vertical cavity surface-emitting laser (VCSEL) with 3-dB bandwidth in excess of 10 GHz. Suitable for short-haul communications at rates to 10 Gb/s, the device has two topside coplanar contacts to simplify high-speed packaging. The laser offers optical output power of typically 1 mW with an efficient low current threshold of 1 mA.

Force, Inc. (Christiansburg, VA) displayed several of their optical transport systems, such as the DBSLinx, an L-band satellite transport link that provides distribution of 950-to-2200-MHz signals from a low-noise block downconverter (LNB) to a satellite receiver (Rx). The 1310-nm unit exhibits optical loss in the 0-to-18-dB range depending upon link distance, with +50- and +75-VDC versions available.

Primawave Photonics, Inc. (Fremont, CA) displayed a variety of their component lines, including tunable laser sources with center wavelengths ranging from 1300 to 1585 nm and wavelength-control accuracy of 60.1 nm. Depending upon the model, the lasers offer between +3- and +6-dBm optical output power with power stability of 0.03 dB over 12 hours. The tuning ranges span 40 to 80 nm. The firm also showed a single-mode wavelength-division multiplexer with wavelength windows of 1310 620 nm and 1550 620 nm. The maximum insertion loss is 0.3 dB, while the minimum isolation is 15 dB, with better than 55-dB directivity.

Celeritek (Santa Clara, CA), a new name to fiber-optics technology, introduced its WideFiber line of driver amplifiers for wide-bandwidth fiber-optic modulation applications. With bandwidths of 30 kHz to 20 GHz, 30 kHz to 30 GHz, and 30 kHz to 40 GHz, the amplifiers are suitable for OC-192 and OC-768 applications. They feature output voltages up to +7.5 VDC and associated gains as high as 10 dB.

Wideband amplifiers were also on display from Picosecond Pulse Labs (Boulder, CO), which displayed an extensive line of components suitable for OC-192 and OC-768 systems. The amplifiers include models ranging from 20 kHz to 50 GHz, such as the model 5865 with a 3-dB bandwidth in excess of 15 GHz and 10-to-90-percent risetime of 23-ps. The amplifier provides +23-dBm output power with 25-dB gain and only 6-dB noise figure.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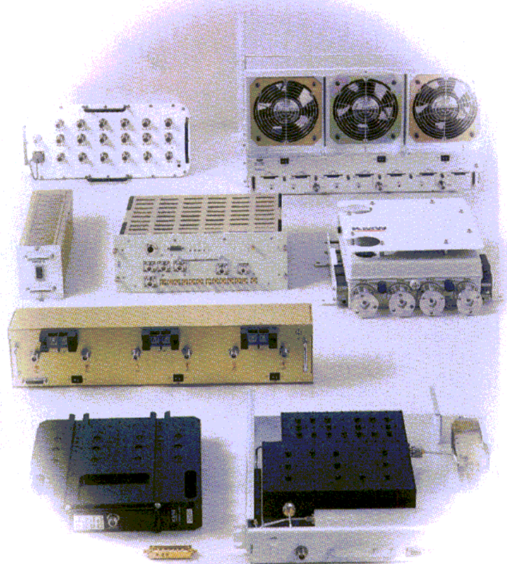

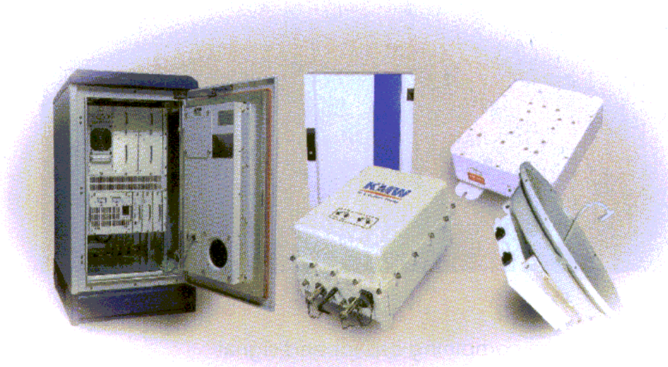

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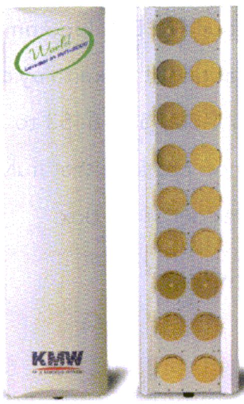
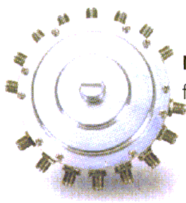


3-Way Beam Control Antenna
- Vertical Down Tilting
- Horizontal Steering
- Beamwidth Switching



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New Products Illuminate OFC

Continued from page 34

Optical Crossing (Glendale, CA) also showed amplifiers, but these were optical rather than electrical. The firm's semiconductor optical amplifiers (SOAs) offer a 3-dB optical bandwidth of better than 40 nm centered at 1540 nm, with polarization sensitivity of better than 1 dB. The SOA features an angled facet design to reduce reflectivity, while advanced fabrication and packaging techniques are used to optimize coupling for optical fibers. The SOA offers better than 20-dB gain and more than +8-dBm optical output power.

OptiMight Communications (San Jose, CA) featured their OMC 1600 optical transport system, which supports 160 bidirectional wavelengths at 10 Gb/s, for a total system capacity of 1.6 Tb/s on a single fiber. Based on the firm's full-spectrum wavelength-division-multiplex (WDM) technology, the system handles transport distances to approximately 4000 km without signal regeneration or Raman amplification. Instead, it is based on standard erbium-doped fiber amplifiers (EDFAs).

Optical Solutions (Plymouth, MN) displayed various elements of their fiber-to-the-home (FTTH) solutions for voice, video, and data services. The company's FiberPath system consists of a central-office/head-end bay, a passive optical network (PON), and a home universal demarcation point (HUDP). The first component of the system connects to standard voice switches for support of up to 80 analog cable-television (CATV) channels along with digital CATV and high-speed Internet service. These services are transported over the PON and routed to the HUDP, which is mounted on the side of a subscriber's residence. The HUDP makes the conversion of optical signals to electrical signals necessary for the subscriber's equipment, such as telephones and televisions.

Corning, Inc. (Corning, NY) introduced a high-speed modulator for 40-Gb/s dense-wavelength-division-multiplexing (DWDM) networks. With a 3-dB bandwidth in excess of 40 GHz, the modulator features insertion loss of 3.5 dB and zero chirp. Future versions of the lithium niobate ($LiNb_3$) modulator will include devices with return-to-zero (RZ) modulation capabilities and units with variable attenuators.

BroadLight, Inc. (Ramat Gan, Israel) announced its BBT series of 1.25-Gb/s single-fiber, dual-wavelength point-to-multipoint burst transceivers. The transceivers feature bidirectional models at wavelengths of 1300 and 1550 nm. They are suitable for passive optical-network applications, as well as for use in WDM systems.

Letek Communications, Inc. (Kyonggi-Do, Korea) featured its SPARK WT1000 10-Gb/s wavelength-stabilized laser transmitter (Tx). The Tx, which operates without need of an external wavelength locker, offers wavelength stability of better than 10 pm. Ideal for DWDM systems, the Tx offers 0-dBm maximum optical power with a center wavelength range of 1528 to 1563 nm. The extinction ratio is at least 8.2 dB, while the sidemode suppression ratio is at least 30 dB.

Ericsson Microelectronics (Kista, Sweden) presented their lines of optical Tx and receiver (Rx) modules for applications through 10 Gb/s. The lasers include a cooled 1510-nm distributed-feedback (DFB) laser module for applications to 155 Mb/s, a cooled DFB/EA laser module for systems through 2.5 Gb/s, and a cooled DFB/EA laser module for systems operating to 10 Gb/s. The Rx modules include avalanche photodiode (APD) and PIN Rx modules for applications to 3 Gb/s.

RSoft, Inc. (Ossining, NY) showed off their computer-aided-engineering (CAE) software tools for the design and development of optical devices and systems. Their lines include the LaserMOD software for simulation of semiconductor lasers, the FullWAVE software for full vectorial time-domain analysis of photonic devices, and the BeamPROP software for layout, simulation, and analysis of integrated optics and fiber-optic devices. Of interest to system engineers, the company's LinkSIM software is an optical-communications-system simulator that also includes an object-oriented topology-layout facility.

Continued from page 34

Ethernet architecture that supports quality of service (QoS) and management for a full range of voice, data, and video services. The presenters noted that the fiber-optic industry is entering a phase of rapid development, evidenced by the quick shift to development of 10-Gb/s hardware and then to 40-Gb/s hardware and beyond. They feel that this rapid development will reduce the costs of fiber-optic technology at a pace rivaling the advances in computer technology.

Masaru Fuse and associates from the Multimedia Development Center of Matsushita Electric Industries Co. Ltd. (Osaka, Japan) detailed the design of an extended WDM-access system for providing broadband-communications and broadcast-television services. In conventional systems of this nature, individual optical packets in each optical channel are routed to individual subscribers through each optical subband of the AWG, whereas an optical subcarrier-multiplexed (SCM) signal is distributed to all subscribers by exciting the multiple optical subbands simultaneously. In the proposed system, which is capable of accommodating large numbers of subscribers, individual optical-channel signals from the AWG are amplified and branched to end users.

In the system head end, 16 WDM optical packets from a tunable DBR laser source, ranging from 1546 to 1558 nm with 100-GHz channel spacing, are externally modulated with data at a 2.5-Gb/s rate. An optical SCM signal is generated by modulating a broadband spectrum light with an amplitude-modulation (AM)/frequency-division-multiplex (FDM) 40-channel signal (90 to 373 MHz) which is then launched through an optical bandpass filter. The optical packet streams are WDM and then amplified and transmitted to the host terminal. In the host terminal, the AWG then routes the optical packets to each branch according to the requirements of each optical channel. As a result, individual optical packets are intermittently emitted from the individual output ports of the AWG at an average cycle rate of

Continued from page 39

70 kHz. Simultaneously, the AWG divides the optical SCM signal to 16 chips in the spectral region and distributes them to each branch. The optical packets/SCM signals from the AWG are then amplified and distributed on remote nodes. They are then transmitted to ONUs, where each optical signal is split into the optical packet stream and the optical SCM signal through a broadband optical filter.

H. Schmuck and associates from the Alcatel Corporate Research Center (Stuttgart, Germany), the Fraunhofer Institute (Jena, Germany), and the University of Dortmund (Dortmund, Germany) presented results on field trials for a bidirectional optical code-division-multiplexing (CDM) system operating as part of the KomNet system in Berlin, Germany. The bidirectional system operates at 155.52 Mb/s per channel in upstream and downstream directions over a pair of 20-km standard single-mode fibers. The system is designed to operate with four independent optical channels in each direction, one of which is dedicated to the transmission of ATM packets to and from a hybrid-fiber-coax (HFC) network. Each optical CDM transmitter (Tx) consists of a directly driven fiber-coupled light-emitting diode (LED) with center wavelength in the 1550-nm range and spectral width of 60 to 70 nm. The output spectrum is encoded through Mach-Zehnder filters manufactured from standard 3-dB single-mode fiber couplers with free spectral ranges (FSRs) of 10 to 20 GHz. Each Tx is permitted a unique FSR within the range. Four channels are combined using a 4:1 passive optical splitter, with subsequent amplification through EDFA. Following transmission over the 20-km distance, chromatic dispersion is compensated for through an appropriate length of dispersion-compensating fiber. Then the signals are power split and detected by four differential Rxs with matched optical decoding filters. The optical decoding filters at the Rxs are bulk optical Mach-Zehnder filters with their FSR value matched to the respective encoding filter FSR used at the Tx.

Due to temperature fluctuations at the Tx site, there is some fluctuation in the FSRs, which induces a time-dependent variation of the detected signal levels at the Rxs. To compensate, the FSRs of the Rxs are dithered slightly around the optimum value at a frequency of approximately 100 Hz. The induced error signal in the average received optical power on one of the Rx photodiodes is detected by a lock-in amplifier and used for tracking the Rx FSR according to the drift of the Tx filter. Each Rx filter is coarsely set and then fine tuned using the local control loop. The FSR setting is adjusted through

Continued from page 40

a truncated glass prism with piezoelectric translation stage.

The currently implemented KomNet system has approximately 30 nm of available bandwidth. When necessary, the optical spectrum can be narrowed through coarse WDM couplers. A theoretical analysis of the system reveals that for a 8-nm-wide spectrum, the crosstalk and noise are controlled, with a bit-error rate (BER) below 10^{-9} for eight optical channels.

Benjamin Eggleton of Lucent Technologies' Bell Laboratories (Murray Hill, NJ) reported on dynamic dispersion-compensation devices for high-speed transmission systems. He notes that at 40 Gb/s, dispersion maps will need to be accurate within less than 50 ps/nm. At 160 Gb/s, though the accuracy must be better than 5 ps/nm, requiring the use of dispersion-compensation devices. He points out that the use of chirped fiber Bragg gratings (FBGs) can provide high dispersion control over the narrow bandwidths required for high-bit-rate operation. A packaged dispersion-compensation device using this approach was shown to have the capability to recover 2-ps pulses over a tuning range of 50 ps/nm with a system loss penalty of less than 1.3 dB. The 160-Gb/s Tx signal in the test was realized by multiplexing eight uncorrelated 20-Gb/s signals.

Maoki Suzuki and Hiroyuki Toda from the Dept. of Communcations Engineering of Osaka University (Osaka, Japan) described a quality-factor (Q) improvement in a jitter-limited optical RZ system using the nonlinearities of a normal dispersion fiber (NDF) placed at the Rx. Their experiments on a 10-Gb/s soliton transmission revealed an amplitude margin of 56 mV at a BER of 10^{-9}. With a conventional system, the measured margin was only 19.3 mV, yielding an estimated Q improvement of 5.4 dB.

M.N. Peterson, Z. Pan, and associates from the University of Southern California at Los Angeles (UCLA; Los Angeles, CA) provided highlights of their work on dispersion monitoring and compensation using a single in-band subscriber tone. The approach is suitable for optical-communications systems operating at rates of 10 Gb/s and higher. Using an 8-GHz tone and 15-percent modulation depth, the presenters described a measurement range of 975 ps/nm with a dynamic range of 10 dB when evaluating a 10-Gb/s system operating at 1550 nm. In the test setup, the optical source is modulated by a combined signal of 10-Gb/s data and a single-frequency tone between 7 and 9 GHz. The modulated signal is sent through conventional single-mode fiber of different lengths to simulate different amounts of accumulated dispersion. After detection, the subcarrier tone is extracted using a tunable electrical bandpass filter. A nonlinearly chirped FBG is controlled by the detected RF power to compensate for the accumulated dispersion. After dispersion compensation, it was possible to reduce the power penalty though a 60-km fiber from 2.0 dB to 0.5 dB.

Z. Pan also spoke on chromatic dispersion monitoring and automated compensation, based on a clock regenerating effect in NRZ systems and a clock fading effect in RZ systems. These effects enable determination of the sign and magnitude of the accumulated chromatic dispersion by extracting the clock signal without the addition of a monitoring signal. At 10 Gb/s, the researchers were able to show unambiguous measurement windows of ±900 ps/nm for NRZ systems and ±640 ps/nm for RZ systems. By using the extracted clock signals as control signals, it is possible to implement automated dynamic dispersion compensation for both systems. Since the measurement range is bit related, the technique can be scaled to 40-Gb/s and other systems.

Another approach to dispersion compensation was presented by T. Yamamoto and M. Nakazawa of the NTT Network Innovation Laboratories (Kanagawa, Japan). In their work, the presenters have shown that the third- and fourth-order dispersion of an optical transmission line could be simultaneously compensated for by applying a sinusoidal phase modulation to a linearly chirped signal pulse prior to transmission. With this technique, it was possible to suppress the pulse broadening of a 380-fs pulse train to as small as 20 fs after a 70-km transmission distance.

Hirohisa Yokota and fellow researchers from Ibaraki University (Ibaraki, Japan) offered a technique for improving the SNR in EDFA repeaters using cascaded optical-fiber gratings. The gratings act as add/drop multiplexers at the receiving end of repeaters and can be used to improve the SNR by reducing amplified-spontaneous-emission (ASE) noise in EDFA repeaters. Their single-wavelength configuration succeeded in reducing ASE by 7 dB for a conventional backward-pump EDFA with 5.3-dB gain. The use of fiber-grating couplers (FGCs) can improve the SNR by approximately 14.9 dB with an FGC drop efficiency of about 95 percent.

Y.J. Chai and associates from the University of Bristol (Bristol, England) described a quality enhancement of a WDM signal by using a dispersion-imbalanced loop mirror (DILM). The DILM was used for the nonlinear filtering of a 10-Gb/s data stream over a spectral range of 28 nm. A relative extinction ratio of −30 dB was achieved over the full spectral range.

Fittingly, E.R. Lyons and H.P. Lee of the University of California at Irvine (Irvine, CA) then spoke on an electrically tunable, all-fiber polarization controller to implement some of Westbrook's ideas. Their concept is based on the use of evaporated microheaterson short sections of polarization-maintaining (PM) fiber. The approach enables efficient birefringence tuning of approximately 1.6 deg./mW for the PM fiber microheaters, although higher efficiency could be possible by tuning the microheaters in a vacuum-sealed package.

Timothy Dimmick and associates from the Laboratory for Physical Sciences (College Park, MD) reported on a novel 3.5-nm all-fiber acousto-optical tunable bandpass filter with zero frequency shift. The design employs a single acoustic flexural wave-to-coupler light from the core mode to a cladding mode and back to the core

Continued from page 42

mode. A single-mode filter fabricated with this approach yielded high loss for the core mode and low loss for the cladding mode, with minimum loss of 5 dB and maximum loss of 35 dB (including connectors).

S. Shimotsu and co-workers from the New Technology Research Laboratories of Sumitomo Osaka Cement (Chiba, Japan) and the Communications Research Laboratory of the Ministry of Posts and Telecommunications (Tokyo, Japan) presented their work on wavelength/frequency conversion based on a lithium-niobate ($LiNb_3$) single-sideband modulator. The authors mention that semiconductor optical amplifiers (SOAs) have been used for wavelength/frequency conversion, although they require large pump powers of 50 to 100 mW. The integrated modulator provides wideband (80 nm) wavelength operation with low conversion loss (11 dB) and accurate adjustable frequency conversion in the megahertz range. The integrated modulator consists of parallel Mach-Zehnder intensity modulators, which are four optical-phase-modulator waveguides. It was used in an experiment on a 10-GHz system. Operation was found to be stable from 1500 through 1580 nm, with no degradation in the 10-GHz PRBS signal after the conversion. The conversion frequency can be selected by an electrical input signal fed to the modulator, with wide frequency conversion possible from DC to 50 GHz.

Wavelength conversion was also the topic of a discussion by Fenghai Liu and associates from the Technical University of Denmark (Lyngby, Denmark) working in conjunction with Jim Fraser and his team from Nortel Networks (Devon, England). Their wavelength-conversion technique is based on cross-phase modulation in a semiconductor Mach-Zehnder modulator. They successfully demonstrated the technique as a reverse-biased semiconductor Mach-Zehnder device originally designed as a 10-Gb/s Tx. But as a modulator, the device exhibited an extinction ratio of better than 13 dB at 10 Gb/s with a power penalty of less than 1.5 dB for NRZ and RZ modulation formats.

Kohsuke Nishimura and associates from KDD R&D Laboratories, Inc. (Saitama, Japan) used an electroabsorption waveguide as a phase modulator to achieve wavelength conversion without pattern effects at 40 Gb/s. Using cross-phase modulation in a semiconductor electroabsorption waveguide, the researchers were able to achieve good performance with no dependence upon the pattern length, due to fast

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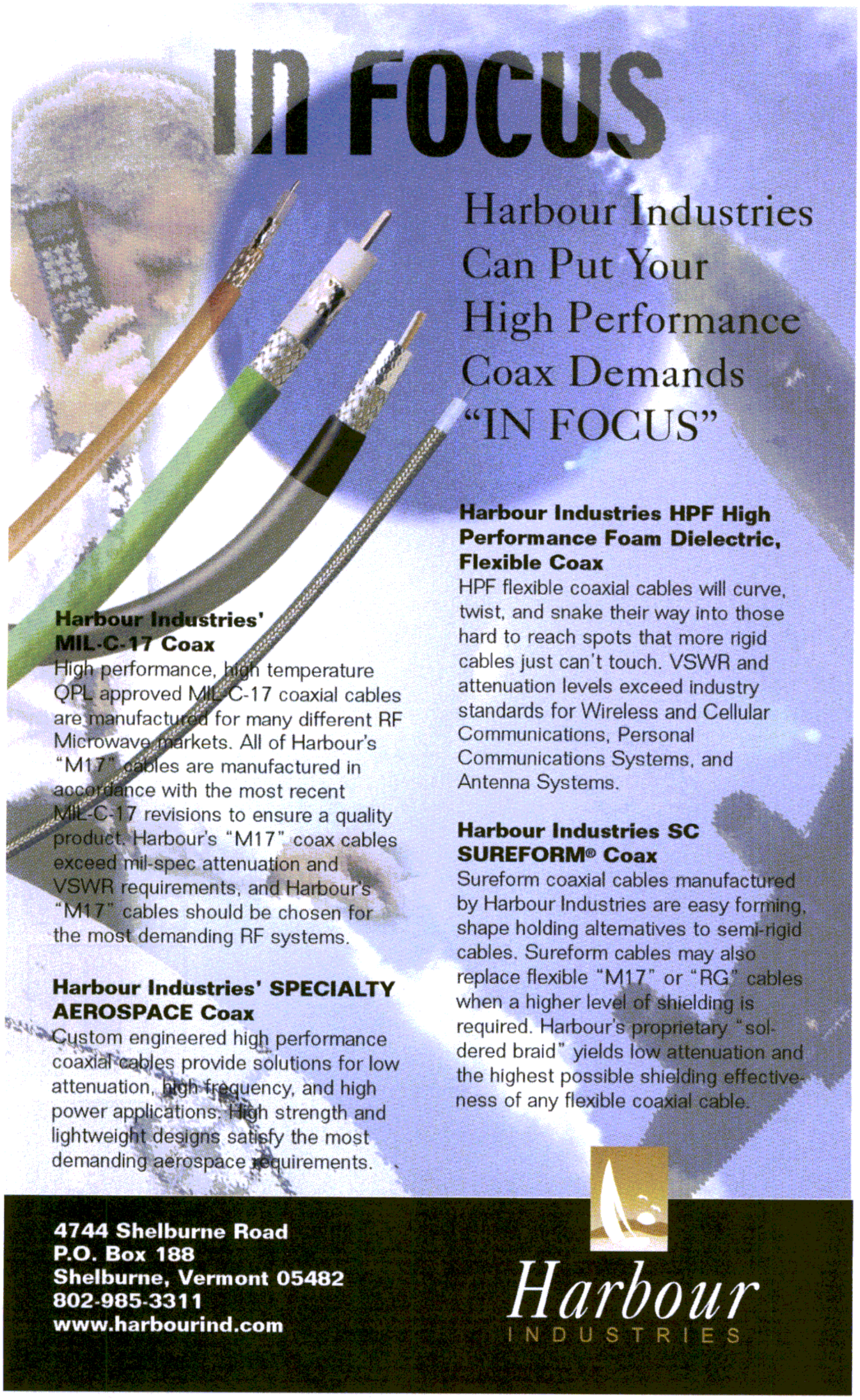

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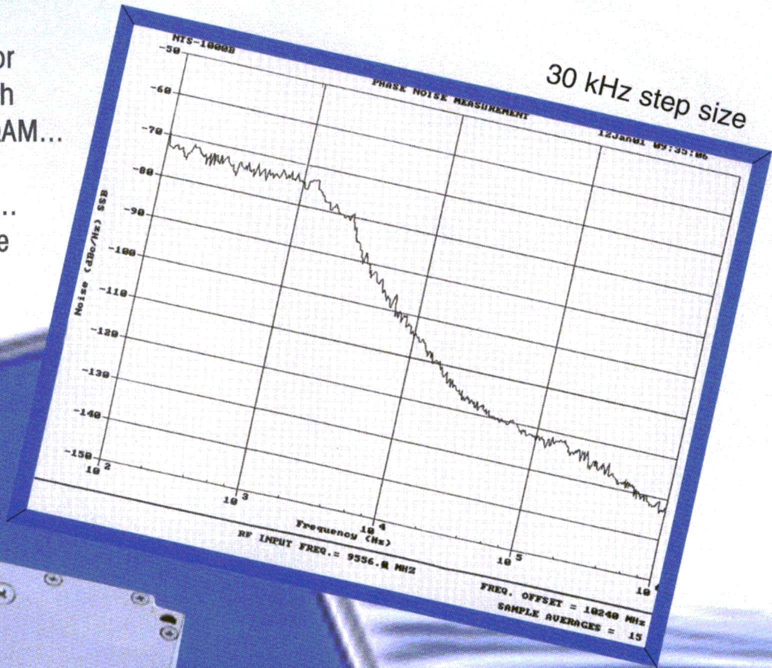

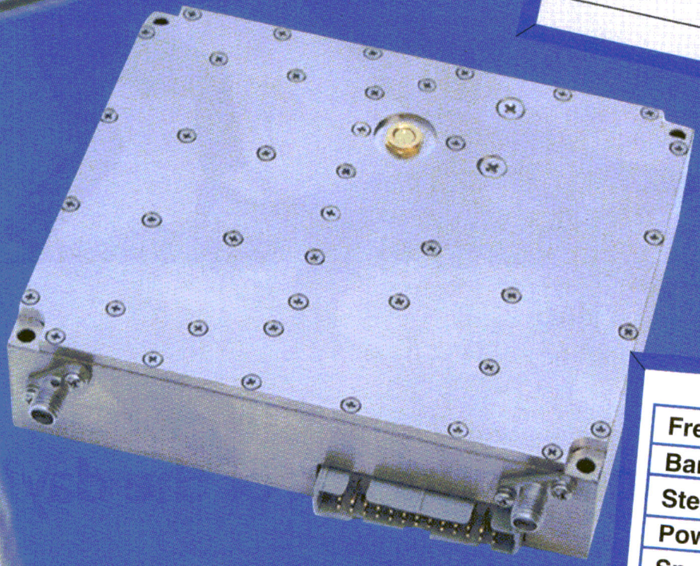

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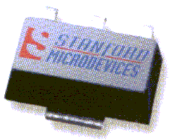

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		3	165	22.5	35	18	12	2.2
SGA-9289	DC-3000	5	270	28	41	18	11	2.9
		3	315	26	39	17	11	2.6

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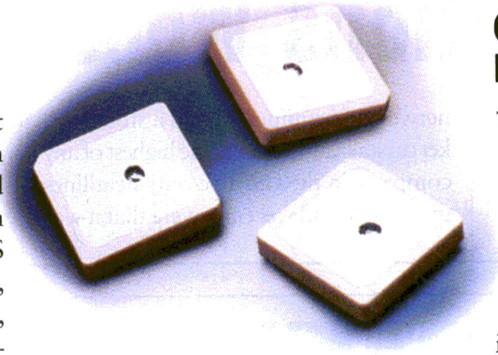
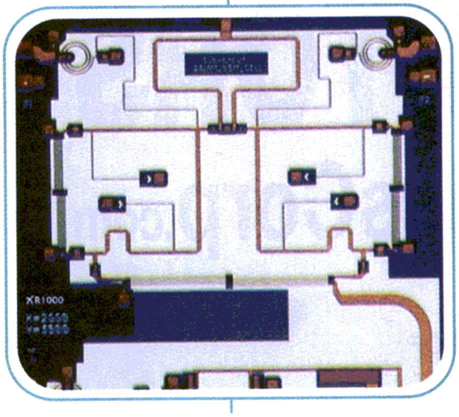


SPECTRUM CONTROL PATCH ANTENNAS



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Communications Woes Mount

GO BACK ONLY a year ago and Cisco Systems was sitting atop the communications world with glowing news reports as the leading manufacturer of computer networking equipment and a stockmarket capitalization among the highest of any company in the US. The only headlines that Cisco made recently were that it was cutting its workforce by up to 5000 workers and that some of its products would be discontinued. These are the fortunes of the beleagured communications industry, hammered by the spending cuts of large telecom companies and the failure of many Internet service providers.

Even the few equipment makers still in the black are sending warning signals that the telecom business is very uncertain in the near term. Juniper Networks, for example, a manufacturer of Internet communications equipment, reported first-quarter earnings in April that met the expectations of Wall Street analysts. And revenue was reported at $332.1 million, up from $63.9 million, in the first quarter of last year. The market responded to the news by boosting the company's shares from $7.62 to $50.38, an 18-percent gain.

Despite the good news, Juniper executives are pessimistic about the telecommunications outlook since they cut this year's revenue forecast to a range of $1.25 to $1.35 billion, approximately twice the 2000 revenue, but down from their earlier prediction of $1.5 to $1.6 billion. Some Wall Street analysts remain high on the company due to its fundamental business and the role it plays in the economy. As one analyst put it, increased Internet traffic will soon force service providers and telecom companies to improve their infrastructure, regardless of the economy, and companies such as Juniper will be needed to produce the hardware.

Powerwave Technologies, a manufacturer of PAs for mobile-phone base stations is, like Cisco, another victim of the slowdown in the telecom market. The firm's sales for the quarter ending April 1 were $73 million, down from $103.9 million a year earlier. Powerwave is focusing on PAs for 3G wireless networks and has been shipping products to big-name infrastructure providers such as Nortel Networks and Nokia. But the deployment of 3G in the US is a moving target that depends on technical factors and the state of the economy, neither of which seem to be in robust health at the present time. MRF

CONTRACTS

Renaissance Electronics Corp.—Was awarded a contract to supply isolators and circulators to BAE Systems Canada, Inc. for the GRC 512 Program. In addition, REC has been chosen to supply isolators for BAE's High Capacity Line of Sight Program. The agreements will span seven years and have a total value of approximately $2.8 million.

ADC—Announced an agreement of up to $2.8 million with RomTelecom, the Romanian telecommunications operator. According to the agreement, ADC will provide RomTelecom with the BroadAccess Multiservice Access Platform for connecting thousands of subscribers, mainly in suburban and rural applications.

Motorola, Inc.'s Global Telecom Solutions Sector (GTSS)—Has been awarded a $40 million contract from the Japanese cellular group TU-KA group to provide its high-speed wireless access on its PDC system. With this feature, subscribers will have the ability to wirelessly access the Internet at speeds up to 28.8 kb/s.

EMS Technologies, Inc.—Announced that its SATCOM division has won a contract valued at $2.5 million from the Argentine Navy and Air Force for ground-based equipment to support search-and-rescue operations over the Cospas-Sarsat satellite system. The US, Russia, Canada, and France jointly operate the Cospas-Sarsat system, which provides distress-alert and location data to assist search-and-rescue operations.

BAE SYSTEMS—Has received a contract for more than $30 million from Lockheed Martin Millimeterwave Technologies, Inc. to manufacture millimeter-wave transceivers for the Longbow Hellfire Missile System. The missile will be deployed on US Army AH-64D and United Kingdom Army WAH-64 Apache helicopters.

Channel Master and ViaSat—Have signed an agreement in which Channel Master has been selected as the Outdoor Unit prime contractor for Astrolink's global satellite program. Under the terms of this multiyear contract, Channel Master will develop, manufacture, and supply the complete Outdoor Unit portion of the Astrolink user terminal.

OmniE Labs—Has been contracted by 2pipe.com, an international telecommunications company, to design and build an advanced IP-over-satellite network for high-speed voice and data transmission between the US and Nigeria.

FRESH STARTS

MobileOne (M1)—Has signed separate Memoranda of Understanding with SignalSoft and Webraska, two international providers of location services, to develop a range of mobile-location-based applications appropriate to the Singapore market and which is targeted to be introduced by the middle of this year.

ParkerVision, Inc. and PrairieComm, Inc.—Have signed a definitive agreement to jointly develop advanced chip sets and reference designs for cellular handsets and other wireless devices. The chip sets will use PrairieComm's baseband IC platforms with ParkerVision's Direct2Data direct-conversion radio technology.

Avnet Electronics Marketing—Has opened a 35,000-sq.-ft. sales, logistics/materials-management, and warehouse facility in Guadalajara, Mexico as part of its plan to increase its services to OEMs and contract manufacturer customers in Mexico. The new facility, currently employing approximately 25 people, serves as a sales office, a warehouse and device-programming center, and a base for Avnet Integrated Material Services personnel.

Flash Networks, Inc.—Announced that it will join the Adaptive Content Exchange Partner Alliance of CacheFlow, Inc., a provider of content-intelligent networking solutions. Flash Networks and CacheFlow together will provide enhanced satellite-link and HTTP optimization and caching capabilities, delivering to the end user a fully optimized end-to-end connection.

Touch America—Announced that its high-speed nationwide IP product deployment is under way, coinciding with the company's fiber-optic network expansion to 26,000 route miles this year.

National Semiconductor Corp.—Has selected 3DSP Corp., a designer of configurable DSP cores, as a key development partner. In designing a new architecture for low-power and configurable SoC products, National will incorporate a 3DSP DSP core, and will use HiFl™—the 3DSP design environment for DSP IP SoC—to tailor the SP-X™ DSP core to meet 3G wireless requirements.

Tyco Electronics—Has opened a new Demonstration Center featuring application equipment for electrical- and electronic-connection products in Harrisburg, PA. The Tyco Electronics Application Equipment Customer Demonstration Center includes a wide variety of hand tools, bench materials, and fully automated application machinery that compose Tyco Electronics' complete offering.

World Wireless Communications, Inc.—Announced that its X-traWeb subsidiary has signed a letter of understanding with Texaco Natural Gas, Inc., a unit of Texaco, Inc., for the co-development, marketing, and sale of the World Wireless' embedded X-traWeb technology to selected gas-distribution customers of Texaco Natural Gas. Under the terms of the agreement, X-traWeb and Texaco Natural Gas have committed to the development and sale of natural gas metering equipment for natural gas distributors, resellers, and gas-service providers, which will includeX-traWeb's X-Node™ Web Server, X-Gate™ Internet gateway, and its Micro Hopper™ digital transceiver technology.

Turnkey Manufacturing Solutions, Inc. —Announced the opening of its new San Diego, CA facility. This new facility, which tripled its previous size, is Turnkey's business and engineering center, developing the company's worldwide business and RF IC test technology. It also has production-test capability for pilot demonstration, as well as for supporting local customers with small-volume production deeds. High-volume testing is performed in Taiwan, which is its world-production base. MRF

HOUSHOLDER

Housholder Joins Antenna Specialists In New Position

ANNE E. HOUSHOLDER has been named to the newly created position of application support specialist. Prior to joining Allen Telecom, she was a customer-service representative and computer technician analyst for Anderson BDG.

Endwave Corp.—CAROL HEROD SHARER to the board of directors; remains as CEO of McKinley Marketing Partners, Inc.

Enea OSE Systems—MELANIE K. GILL to vice president of worldwide marketing communications; formerly executive development leader at Nortel Networks.

Microwave Device Technology Corp.—DENIS P. RITCHIE to president; formerly director of marketing and sales for Analogic Corp.

NTRU—WILLIAM WHYTE to director of cryptographic research and development; formerly chief cryptographer at Baltimore Technologies.

Quake Wireless, Inc.—RAY CALHOUN to president and CEO; formerly employed with Titan Corp.

ADC—RICHARD (RICK) R. ROSCITT to chairman and CEO; formerly president of AT&T business services. Also, LYNN DAVIS to president and COO; formerly president of the Broadband Connectivity Group.

Hybrid Networks, Inc.—WILLIAM F. GIVEN to vice president of customer service; formerly general manager of logistics and executive director of general contracting for SBC Services.

MAYA Design—MICKEY MCMANUS to president and COO; formerly senior vice president for creative vision and strategy at élan communications.

The Interconnection Technology Research Institute—JERRY SIEGMUND to CEO; formerly senior marketing executive at Circuit-Wise, Inc.

Polar Instruments—KEN TAYLOR to product manager for the signal-integrity tools for PCB design and manufacture range; formerly business-development manager for high-performance products in the Americas and Asia at Tektronix.

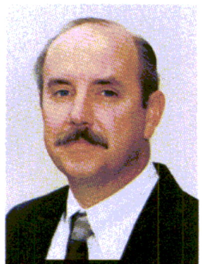
PreForm Adhesives—DAN LEESER to technical manager; formerly responsible for the Application Support and Product Testing groups at ITW Plexus.

BAE SYSTEMS—SUSAN L. FINKEL to vice president of legal and contracts for the Information & Electronic Systems Integration Sector; formerly vice president of legal and contracts for the Aerospace Sector.

American Technical Ceramics—DAVID OTT to senior vice president of New York Operations; formerly vice president of New York Manufacturing.

VertexRSI—DAVID R. CASWELL to business manager of the State College, PA facility; remains as controller.

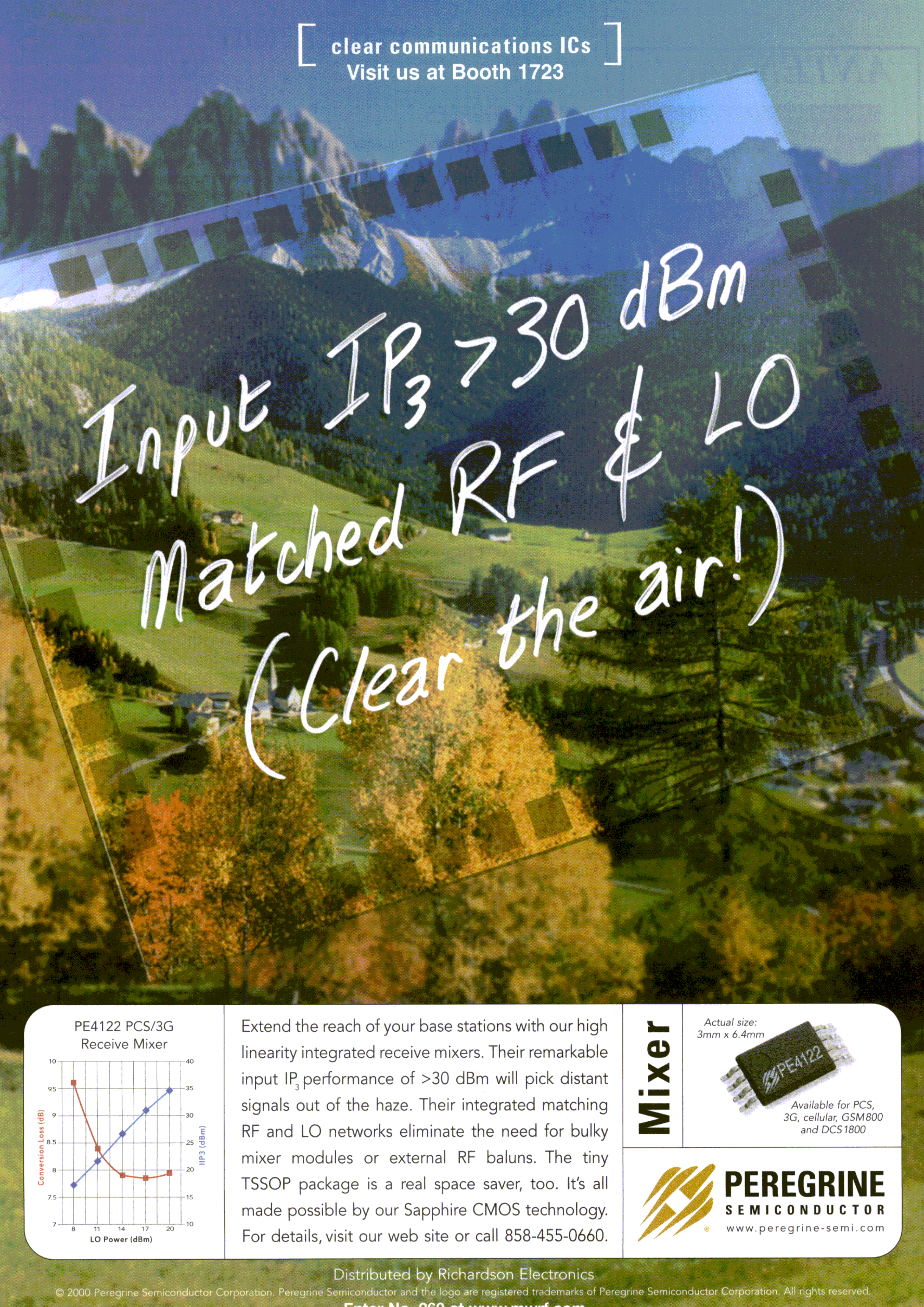
CASWELL



SMITH

Trompeter Electronics—GARY SMITH to vice president of operations; formerly vice president of the Automotive Products Division with Special Devices, Inc.

Advanced Control Components, Inc.—RON GALLI to the position of vice president; formerly manager of the Controlled Components Division. Also, DON WHEAT to the position of senior design engineer; formerly employed at GT Microwave. MRF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System Calculates Arrival Paths of Indoor Radio-Wave Source

MEASURING THE STRENGTH, angles, and times at which a set of radio waves transmitted from a single source arrives at a Rx can help researchers develop wireless systems that reduce interference, especially in indoor environments. These measurements may also aid in the development of systems that track the location of the radio source. Future applications for this technology might include tracking products in a warehouse, tracking firefighters in a burning building, or tracking soldiers in an urban conflict. IEEE Member Robert D. Tingley and IEEE Fellow Kaveh Pahlavan have devised a system to measure these propagation parameters more accurately than prevous methods, the best of which had achieved a spatial resolution of 6 deg. and a temporal resolution of 3 ns. The authors devised an array of eight identical quarter-wave monopole antennas mounted at a constant radius and separated by one-third of a wavelength. The signal received at each antenna is fed to a VNA through an eight-channel switch to select the antenna under test. A PC is used to control the switch and perform calculations on the VNA measurements. The VNA also provides a synthesized microwave source, swept from 2.35 to 2.55 GHz, to a remote antenna. Using a discrete-maximum-likelyhood algorithm, the authors achieved a spatial resolution of 2 deg. and a temporal resolution of 1 ns. See "Space-Time Measurement of Indoor Radio Propagation," *IEEE Transactions on Instrumentation and Measurement*, February 2001, Vol. 50, No. 1, pp. 22-31.

Wide-View Satellite Antenna Receives Multiple Signals

TV SERVICES THAT are broadcast through satellite are experiencing rapid growth, especially in countries where CATV services are not well-established. In these markets, it is common to have several satellites available, each supporitng its own package of TV channels and programs. Most geostationary TV-broadcast satellites occupy orbital positions that are tens of degrees apart. But a traditional parabolic antenna has a very narrow field of view—approximately 2 deg. There are other types of satellite antennas that could be used to receive signals from multiple satellites, but they are too complex and expensive for domestic applications. So, to receive more than one TV package, subscribers have three options: install more than one satellite antenna, mount a single antenna on a motorized positioning system, or manually position the antenna. To avoid these inconveniences, Antonio Garcia Pino, J. Oscar Rubinos Lopez, and A. Marcos Arias Acuna of the Departmento Tecnologias de las Comunicaciones, Universidad de Vigo, Spain, have developed an unusually shaped satellite antenna that can receive signals from widely separated satellites. The proposed antenna has a reflector that is slightly oversized and is shaped to "illuminate" different portions of the reflector to accommodate the reception of signals from widely sepatated satellites. An additional improvement to the design is to allow the antenna to scan along a line in space (rather than a 3D plane), to accommodate signals from a satellite between the two extremes. See "A Single Shaped-Reflector Antenna with Wide-Geostationary-Arc Field of View," *Microwave and Optical Technology Letters*, February 5, 2001, Vol. 28, No. 3, pp. 216-219.

Model Simulates Radio-Wave Propagation Through a Forest

ACCURATE PREDICTION OF radio-wave propagation in a communications channel is essential for the design of efficient and low-cost wireless systems. Accurate models of the behavior of radio waves must accommodate the trade-off between radiated power and signal processing by addressing issues such as coherency, field variations, multipath, and path-delay effects. And the path of the radio waves in many communication channels often inlcudes forests. IEEE Fellow Kamal Surabandi and IEEE Student Member Il-Suek Koh have developed a physics-based model accounting for the above-mentioned effects when radio waves travel through a forest. In the HF and UHF bands, most of the wave propagation through a forest is a lateral wave that propagates at the interface of the forest canopy and the air above it. The tree trunks scatter the waves and cause field fluctuations. The authors studied this scattering effect using full-wave analysis and Monte-Carlo simulations, and found that only the trees near the source and the Rx contribute significantly to the field fluctuations. This drastically simplified the complexity of the model. See "A Complete Physics-Based Channel Parameter Simulation for Wave Propagation in a Forest Environment," *IEEE Transactions on Antennas and Propagation*, February 2001, Vol. 49, No. 2, pp. 260-271.

DESIGN

Low-Cost Manufacturing Holds The Key To LMDS Success

Plastic substrate surface-mount packaging methods are economical for the mass production of low-cost millimeter-wave circuits.

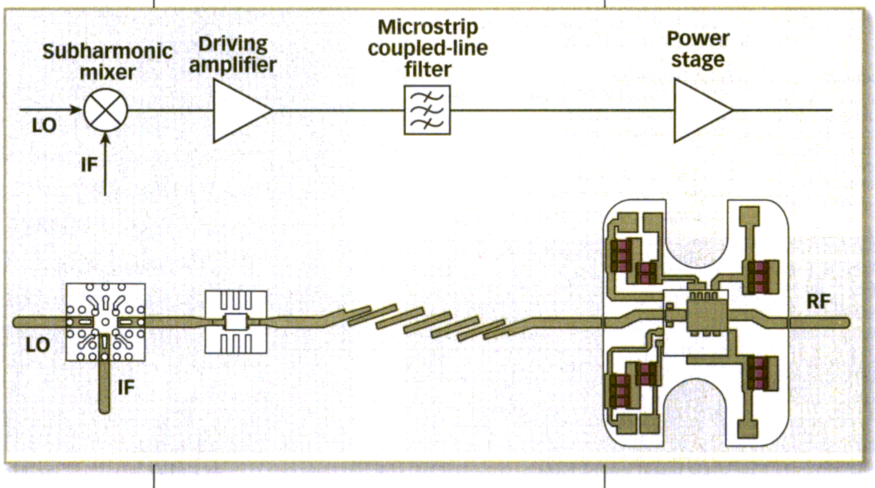
FRANCISCO JAVIER ORTEGA-GONZALEZ, ALBERTO ASENSIO-LOPEZ, GERMAN TORREGROSA-PENALVA
Universidad Politecnica de Madrid; e-mail: fjortega@diac.upm.

Millimeter-wave bands are quickly evolving from being a part of the spectrum reserved for military applications, where cost is not a major concern, into a band for the consumer market. The new uses of millimeter-wave bands for local multipoint-distribution systems (LMDS) and other communications applications require low cost, easy-to-manufacture equipment for commercial applications. The blend of low-tolerance microwave production techniques with mass production constitutes a new challenge for the microwave engineer.

Packaged monolithic integrated circuits (ICs) and packaged transistors have been traditionally employed for the mass production of low-cost RF and microwave communications equipment. The devices are mounted with automatic surface-mount technology (SMT) techniques on soft plastic substrates. Obviously, the most direct and cost effective solution for the problem of manufacturing millimeter wave equipment is to use those ready available SMT mounting techniques used at lower frequency ranges.

Currently, there are three major ways for manufacturing millimeter wave transceiver circuits (aside from classical technologies such as waveguide)

1. Multichip modules on hard ceramic substrates (alumina and aluminum nitride [AlN])
2. Hybrid circuits on soft plastic polytetrafluoroethylene (PTFE) substrates with discrete packaged integrat-



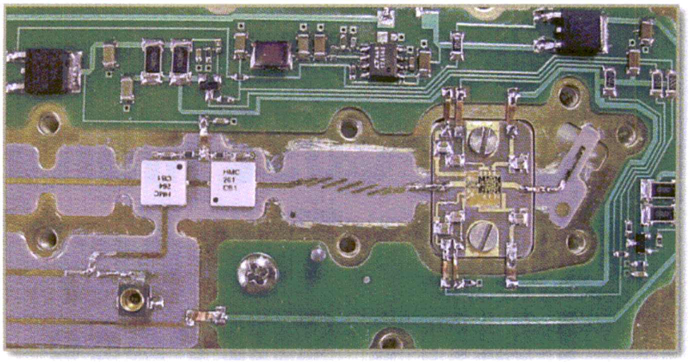
1. This block diagram illustrates a Tx module for LMDS applications designed with the packaging techniques described in the article.

Continued from page 59

ed circuits (ICs).

3. Hybrid circuits on soft plastic PTFE substrates with discrete packaged transistors.

Multichip modules can be fabricated on hard substrates where several millimeter-wave chips are integrated onto a hard ceramic substrate[1]. Thin film techniques are used for transmission-line implementation. Classic chip-attachment techniques and wire bonding are used for manufacturing. The resulting module is normally packaged in a metal enclosure. However, this manufacturing technique requires precise and expensive chip-manipulating capabilities (chip soldering, wire bonding, flip-chip, etc.), expensive hard substrates and manufacturing processes. The main advantage of this technique is that many components—mainly bare-die ICs, low-noise amplifiers (LNAs), power amplifiers (PAs), and frequency multipliers—are readily available in the market from several manufacturers. These components are usually intended for specific applications in the millimeter wave region, such as LMDS. Several discrete transistors (in die form) are also on the market, but this solution will not be considered because it has the same disadvantages of chips and with fewer benefits.



2. This is a photograph of the Tx module in Fig. 1

Hybrid circuits on soft plastic PTFE substrates with discrete packaged ICs are something new in this range of frequencies. But there are only a few commercially packaged ICs for these bands that are suitable for surface-mounting techniques. These packages are usually based on ball-grid arrays (BGAs). There are other packages not suitable for surface mounting and therefore will not be considered in this article. A BGA package is a type of chip carrier based on thin-film techniques on a ceramic (alumina or AlN) substrate.[2] A millimeter-wave chip is soldered or glued, and wire bonded to its RF and DC pads (flip-chip techniques are also possi-

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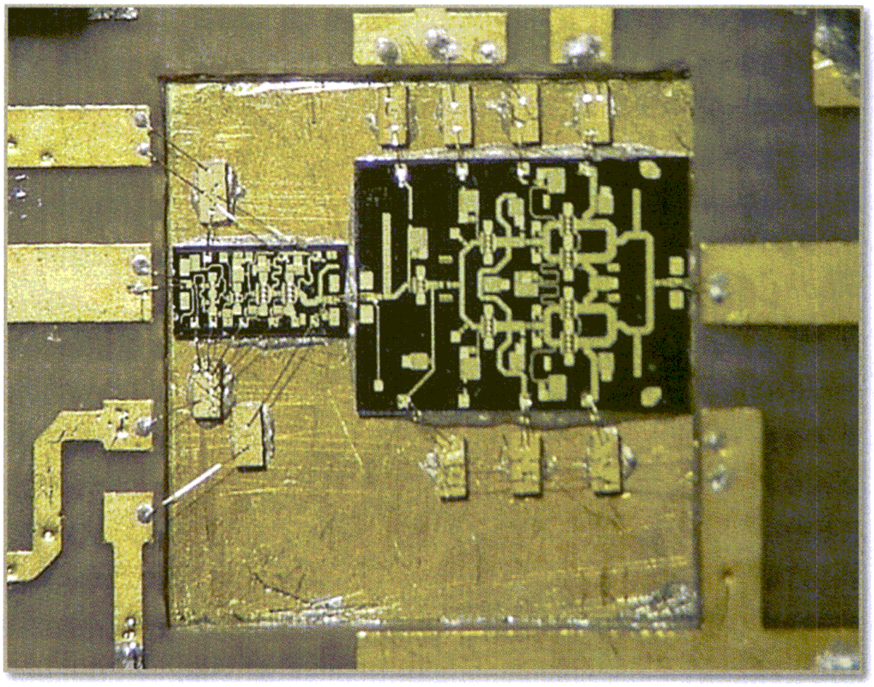
Continued from page 60

ble[3]). The package is soldered or glued to the circuit through a set of metal balls below the carrier. This carrier is covered with a plastic or ceramic lid so it is suitable for surface-mounting machines or manual insertion.

Hybrid circuits with packaged transistors are well known in the microwave band. Low-noise blocks (LNBs) for satellite direct-broadcasting receivers (Rxs) have extensively employed this technology. Nevertheless, this is a limited solution at these frequencies due to the poor behavior of standard packages (the widely used P70 is an example).

The selection of one of these technologies is a trade off between technical and cost considerations. **Table 1** provides a comparison of the three different approaches.



3. Two cascaded power chips on this carrier enable it to generate two different power levels, making it adaptable to various applications.

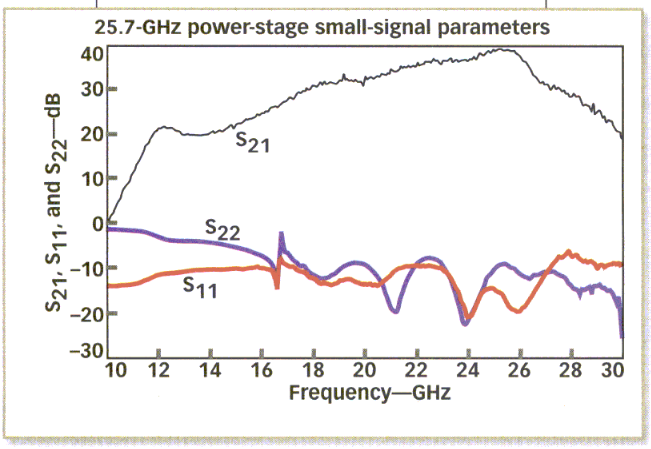
An LMDS Transmitter

A millimeter-wave transmitter module for a mass-produced LMDS transmitter (Tx) has been designed by the authors **(Figs. 1 and 2.)** It reveals a conventional topology consisting of four main sections: an upconverter, driving amplifier, bandpass filter, and a high-power amplifier.

An upconverter translates the modulated input signal from the intermediate frequency (IF) to the 26- and 31-GHz band. To perform this function, a subharmonic mixer packaged in a BGA is used. Being subharmonic, the mixer supports the use of a local oscillator (LO) at half the operating frequency (14 GHz). This saves a frequency multiplier and simplifies the circuit. The level at the output of the mixer is only −14 dBm, so further amplification is needed before filtering to avoid degradation of the system signal-to-noise ratio (SNR). A driving amplifier performs this function.

The driving amplifier amplifies the signal at the output of the mixer to a level of −2 dBm. This driver is also packaged in a BGA. The 1-dB compression point (P1dB) of this amplifier is 12 dBm, so the gain is 12 dB at 26 and 31 GHz. After this amplification stage the signal is ready to be filtered in the next stage to eliminate the LO signal.

A bandpass filter "cleans" the transmitted signal to be radiated. It uses standard open-circuit microstrip coupled lines on a 0.254-mm high PTFE substrate. The filter was designed using conventional techniques and optimized with the Advanced Design System (ADS) standard-element models. Tolerance analyses were also performed and tolerances up to 25 µm showed very small effects on the filter behavior. The losses at the center of the bandpass are only 3 dB. But the losses improve stability. The bandwidths are 1.5 GHz and 2 GHz at 26 and 31 GHz, respectively. At this point, the entire circuit can be mounted on soft substrates with surface-mounting techniques, but the signal must be amplified up to the desired output-power level.



4. The S-parameter responses for the power module in Fig. 3 show high gain and good return loss over a bandwidth from 10 to 30 GHz.

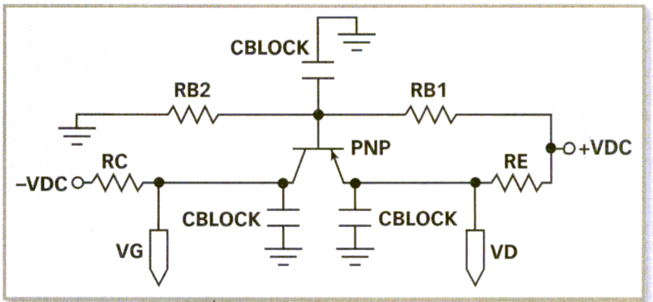
At present, the most powerful commercial amplifier packaged in a BGA package delivers an output P1dB of only 23 dBm. The Tx needs a P1dB of 26 dBm at 31 GHz, so the BGA solution was impossible at this stage. An alternative module was used. The key for complete SMT manufacturing is the integration of high-power chips onto substrates.

Various techniques were used to design and construct the building blocks mentioned in the previous section. Rather than a block-by-block descrip-

Continued from page 62

tion of the design techniques for the main circuits, those techniques common to any block will be described.

In 1999, some manufacturers released packaged millimeter-wave ICs (mainly in BGAs) for LMDS application—LNAs, mixers, and medium-power amplifiers. At that time, the technology of packaged millimeter-wave chips on BGAs was completely new and it proved to be the most effective method for mass production of LMDS transceivers. Good electrical performance at moderate cost was announced for these mounting techniques.



5. A simple bias-servo circuit is needed to automatically set the gate bias for the GaAs FETs used in the design, eliminating the need for manual bias adjustment.

The first task was to obtain some samples of these packages to test their capabilities. Following manufacturer recommendations, ceramic single-layer capacitors were attached to the package for DC filtering. This increased the system cost, but they were removed during subsequent tests with no degradation of performance. These packages were attached to 0.254-mm high, $\epsilon_r = 2.17$ reinforced PTFE substrates. The packages were manually soldered using conventional 60/40 tin-lead (SnPb) alloy. The resulting circuits were tested on 50-Ω test fixtures with 2.4-mm connectors and a DC path filtered with multilayer 0603 ceramic chip capacitors. Several tests and experiments carried out with the circuit and mounting techniques showed that the key factor for best performance from the packaged chip was the quality of the ground plane in the plastic substrate, just below the package. This ground connection must not only provide a good return path for the source current, but also a good thermal path to extract heat from the package. Most of the problems found with this package, from lower power gain than expected to spur oscillations, came from a poor ground plane or ground connection.

The following rules could be useful for the printed-circuit design.

1.Use thin substrates of a height equal to or less than 0.25-mm thickness.

Continued from page 64

2.Introduce a large number of plated holes below the package, just below the area where the package is attached.

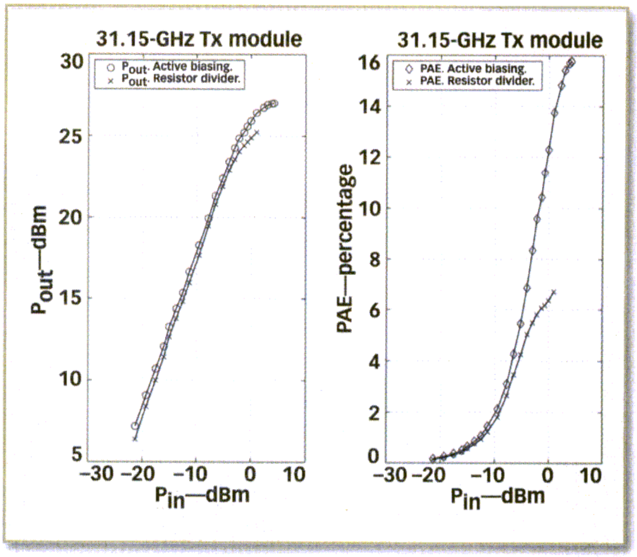
3.Focus on proper positioning, soldering, or glueing, of the circuit.

Currently, the main drawback of these packages, usually made of alumina, is thatpower handling is limited. power. This could change in the future, but now there are no commercially available packaged amplifiers with saturation power above 24 dBm. But applications such as LMDS transceivers require higher output power. Several commercial bare-die amplifiers with P1db of more than 1 W are available. These chips cannot be packaged on currently available BGAs due to their high power derating and large size.

This is a major obstacle for mass production of circuits based on these amplifiers, because if the chip cannot be packaged and mounted using SMT techniques, the entire mounting process on plastic substrates must be reconsidered and many of the advantages could be lost. A hybrid solution was employed to solve this problem. The entire Tx, with the exception of the high-power amplifier, was mounted on a plastic substrate with packaged chips suitable for SMT techniques. The high-power stage was mounted on an auxiliary carrier.

This carrier has a metal base plate where a piece of 0.254-mm high PTFE plastic substrate is attached. The high-power chip (or chips) is glued with conductive epoxy to the base plate through a hole in the substrate. The chip is wire bonded to the RF lines and DC pads printed on the plastic substrate. Although wire bonding on plastic substrates is reliable with proper precautions,[5] a drop of conductive epoxy is dispensed over these connections to further improve their reliability. Finally, the carrier is covered with a plastic lid to protect the assembly from dust and other contaminants. Using this chip carrier makes it possible to separate the manufacturing process of the Tx from the manufacturing process of the high power stage. This also makes it easy to manufacture two versions of the Tx with two different output power levels.

Figure 3 shows a photograph of this carrier with two cascaded power chips attached on it. **Figure 4** presents some of the key scattering-parameter measurements of the device. It also shows that the amplifier mounted on the carrier exhibits high gain and good return losses over a broad bandwidth. The gain is very high at 26 GHz (approximately 40 dB). Therefore, care must be taken to avoid oscillations due to the output-to-input feedback. Absorptive materials are employed with the enclosure to avoid these types of problems. Thus, the mounting of high-power chips is the key factor in easy mass-production manufacturing of low-cost Txs in the millimeter-wave band.



6. An active bias circuit such as that in Fig. 5 provides better performance of the output-power stages than a passive (resistor divider) type, as illustrated by these two sets of curves.

Some manufacturers have announced packages with improved thermalconductivity and larger sizes, but packaged high-power amplifiers (P1dB approximately 1 W) are still not available in the market.

Filters And Passives

Several technologies have been employed to implement the filters of the transceiver. Coupled-line microstrip filters have been used successfully. Obviously, common-sense precautions must be considered, suc as avoiding short-circuited structures, etc. All the microstrip filters were designed with conventional techniques and optimized with ADS models. The filter was implemented on a PTFE substrate (ϵ_r = 2.17, height = 0.254 mm). The performance was good even with manufacturing tolerances up to 25 µm.

The passive components were selected according to the low-cost objectives of the transceiver. Very specific and expensive components for millimeter-wave applications were avoided when possible. For example, single-layer ceramic capacitors are not inexpensive and cannot be mounted with standard SMT procedures. Instead, multilayer ceramic 0603 capacitors were used for bias filtering, etc.

When designing the bias circuits for the transceiver, it must be understood that virtually all active devices are based on gallium-arsenide (GaAs) field-effect transistors (FETs). It is well known that their transconductance can be very different from device to device. Therefore, an adjustable bias circuit for the gate of the FETs is a must in order to obtain the desired bias conditions. To achieve low manufacturing cost and reduce the manpower needed to perform calibrations, automatic biasing systems were selected. Active biasing enables automatic adjustment of the gate bias to achieve the desired drain current and the desired drain-to-source voltage. Bias servos can be implemented using simple PNP bipolar transistors[6] or with specific ICs designed for this purpose. **Figure 5** shows the basic scheme of a bias servo using a PNP transistor. Besides the

Continued on page 185

Design A Tunable Resonant-Tank Circuit

By including the parasitic-circuit elements, this analysis and design approach efficiently and effectively aids the development of resonant-tank circuits.

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Tunable resonant tanks are vital parts of certain RF circuits, such as oscillators. Designing a resonant tank with the required tuning range and figure of merit using a minimum number of components is not trivial. Hopefully, this report will explain how to select the correct components for a particular tank circuit and how the properties of those components can affect final tank performance.

The most common varactor-diode-based resonant-tank circuits are the single-varactor circuit **(Fig. 1a)**, a circuit with two varactor diodes and a single parallel capacitor **(Fig. 1b)**, a circuit with two varactor diodes and one series capacitor **(Fig. 1c)**, and any circuit with two varactor diodes and two series capacitors **(Fig. 1d)**. Any of the circuits with two varactor diodes may be single-ended or balanced, depending upon the ground connections. Balanced circuits are grounded in the middle of the inductors or varactor diodes, while single-ended circuits are grounded at any

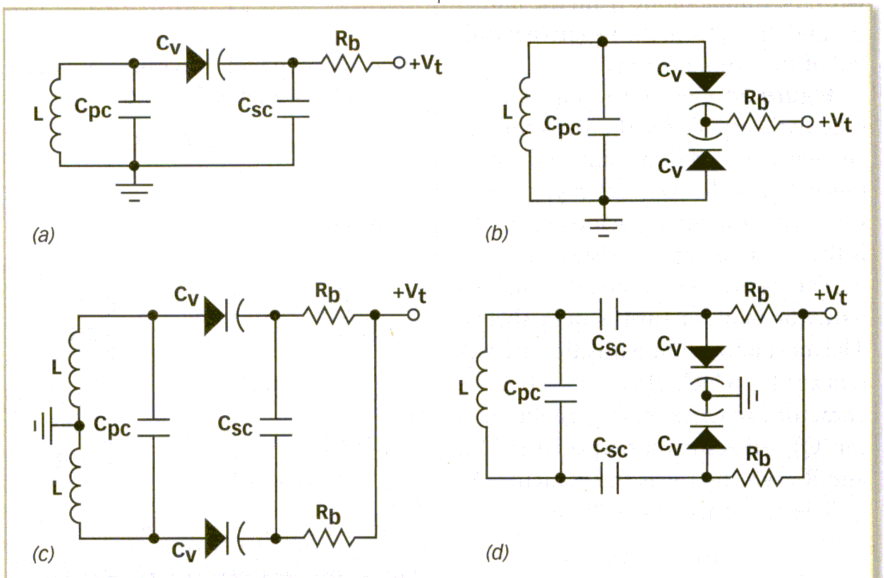

Fig. 1 Common configurations for the varactor-tunable resonant tank can be seen here.

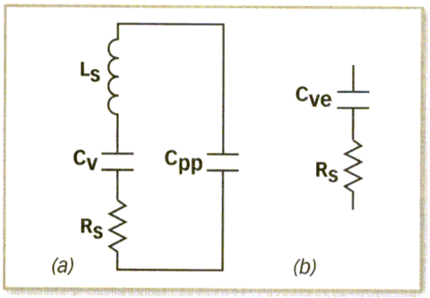

Fig. 2 Equivalent schematics of varactor circuits are shown.

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of the inductor's leads.

Configurations with two varactor diodes, series-connected in opposition, provide good high-frequency linearity. This arrangement has the advantage that the capacitance shift caused by the AC modulation takes effect in opposite directions in these diodes and, therefore, cancels itself.[1] If linearity is not an issue, a single varactor can be used and, assuming that all other conditions are the same, a wider tuning range will be achieved. Varactors can be represented by one capacitor with a total capacitance C_{ve}. Parallel and series-correcting capacitors C_{pc} and C_{sc}, respectively, provide tuning-range corrections. Capacitor C_{sc}, which is series-connected to the varactor diode, completes the AC portion of the circuit, but isolates the tuning diode from the inductor and, thus, from the negative terminal of the tuning voltage.

Figure 2a shows the equivalent schematic circuit for the varactor circuit where L_s is the parasitic lead inductance, C_{pp} is the package capacitance, C_v is the varactor capacitance, and R_s is the varactor series resistance.

These parameters can be found in a varactor manufacturer's data sheets. The most important parasitic parameters are L_s, which affects the effective varactor capacitance, C_{ve}, quality factor (Q), self-resonant frequency (SRF), and R_s, which affects the varactor Q.

The reactance of **Fig. 2a** is:

$$X_v = \omega L_s - 1/\omega C_v = - 1/\omega C_{ve} \qquad (1)$$

Parameter C_{ve} (**Fig. 2b**) is:

$$C_{ve} = C_v/(1 - \omega^2 L_s C_v) \qquad (2)$$

or, when using convenient RF units:

$$C_{ve} = (2.5 \times 10^8 \times C_v) / (2.5 \times 10^8 - \pi^2 F^2 L_s C_v) \qquad (3)$$

where:

C_v = the varactor capacitance (in pF, from the device data sheet),

F = the frequency of operation (in MHz), and

L_s = the parasitic varactor lead inductance (in nH).

The varactor Q, Q_v, is:[1]

$$Q_v = 10^6/\omega C_{ve} R_s \qquad (4)$$

From Eqs. 3 and 4, it is apparent that L_s and R_s can dramatically affect C_{ve} and the effective Q of the varactor diode. Parameter L_s increases C_{ve}, thereby reducing the SRF of the varactor circuit.

Package parasitic capacitance C_{pp} and the inductance of the printed-circuit-board (PCB) signal traces, L_t, between the varactor and the tank, affect the varactor parameters similarly. Conversion of C_{pp} to C_{ve} (**Fig. 2b**) for a single-varactor circuit is:

$$C_{v1} = (2.5 \times 10^8 \times C_v) / (2.5 \times 10^8 - \pi^2 F^2 L_s C_v) + C_{pp} \qquad (5)$$

or for a circuit with two varactor diodes:

$$C_{v1} = 1.25 \times 10^8 \times C_v / 2.5 \times 10^8 - \pi^2 F^2 L_s C_v + (C_{pp}/2) \qquad (6)$$

where:

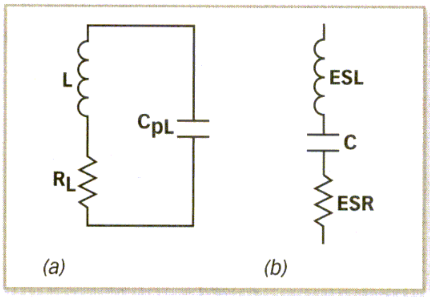


Fig. 3 The equivalent schematics for inductor (a) and capacitor (b) appear here.

C_{pp} = the capacitance of the package (in pF).

By including the effects of the PCB traces, Eq. 6 can be rewritten as:

$$C_{ve} = 2.5 \times 10^8 \times C_{v1}/ 2.5 \times 10^8 - \pi^2 \times F^2 \times L_t \times C_{v1} \qquad (7)$$

where:

C_{v1} = the capacitance of the network comprised of the varactor capacitance C_v and inductance L_s (in PF), and

L_t = the inductance of the PCB traces between the varactor(s) and the tank (in nH).

After C_{ve} has been calculated, it is necessary to determine the SRF for the varactor circuit from:

$$SRF = (5.0329 \times 10^3) / [(L_s + L_t) C_{ve}]^{0.5} \qquad (8)$$

The SRF should be well above the tuning frequency of interest or else it is necessary to choose another varactor diode or decrease the inductance of the PCB traces.

The effective capacitance of the varactor approaching the SRF increases and can reach a high value:

$$C_{veff} = C_{ve}/[1 - (f / SRF)^2] \qquad (9)$$

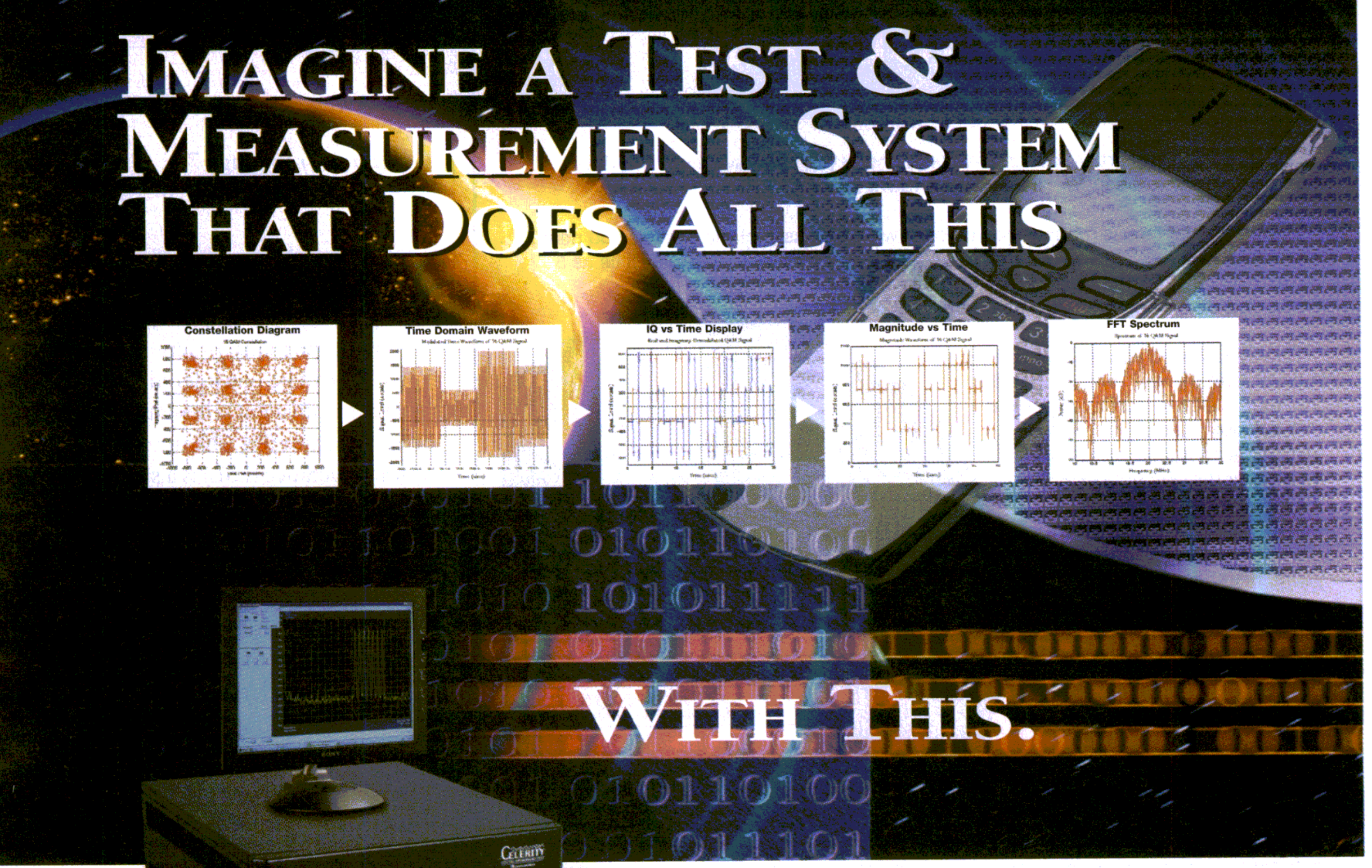
Similarly, Q_{veff} decreases in proximity to the SRF, and can drop to zero:

$$Q_{veff} = Q_v[1 - (f/SRF)^2] \qquad (10)$$

The real parameters of inductors and capacitors can be represented by the schematic diagrams of **Figs. 3a** and **3b**. The parallel parasitic capacitance of inductor C_{pl} (Fig. 3a) is comprised of the inductor-spread capacitance and the package capacitance. This capacitance leads to resonance with the coil inductance at the SRF. An inductor has its own SRF and can only be used below this frequency. If the inductor is used near the SRF, its effective inductance increases and can be determined from Eq. 11:[2]

$$L_e = \frac{L}{1 - \left(\frac{f}{SRF}\right)^2} \qquad (11)$$

The Q of the inductor can be found



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from:[2]

$$Q_L = \omega L/R_L \qquad (12)$$

In general, R_L is frequency dependent although, for many practical applications, R_L can be considered constant.

In the equivalent schematic diagram of the capacitor **(Fig. 3b)**, the equivalent-series inductance (ESL) is a stray inductance due to the leads and electrodes. The ESL reflects series and parallel resistance, so that the loss of these elements can be expressed as a loss in a single-resistor electrostatic resistance (ESR) in the equivalent circuit. The ESL leads to resonance with the capacitor capacitance at the SRF. If the capacitor is used near its SRF, its effective capacitance increases and can be determined from:[3]

$$C_e = \frac{C}{1 - \left(\frac{f}{SRF}\right)^2} \qquad (13)$$

The capacitor Q is:

$$Q = \frac{1}{\omega CESR} \qquad (14)$$

From Eq. 14, it is apparent how to increase capacitor Q. If a capacitor consists of two equal capacitors, each having a capacitance of one-half the total, the resulting ESR decreases by a factor of two while the Q increases accordingly, but the total capacitance remains the same.

Since the varactor circuit does not operate at resonance, the inductance and capacitance slopes in the network are not equal. If the network is represented as a series connection of resistance R_j and reactance X_I, then its Q can be found as:[5]

$$Q = \sum_{i=1}^{n} xi + \omega \sum_{i=1}^{n} |dXi/d\omega| \Big/ 2\sum_{j=1}^{m} Rj \qquad (15)$$

Continued from page 72

where:

Q = the quality factor of the network,
i = the index of summation for the n-series reactance,
n = the number of the reactance,
X_i = the series-connected reactance,
ω = the radian frequency,
j = the index of summation for the m series resistance,
m = the number of the resistance,
R_j = the series-connected resistance, and
dXi/dω = the reactance slope.

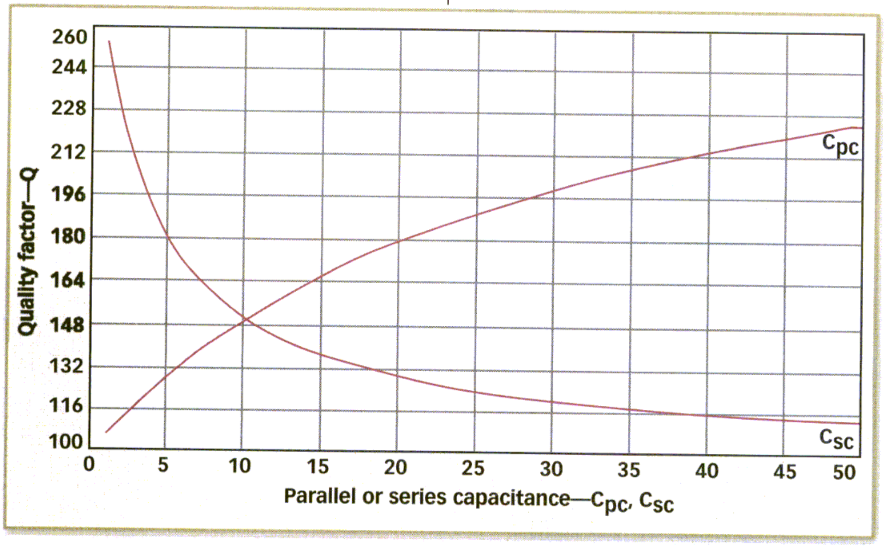


Fig. 4 The Q of varactor and capacitors network versus C pc and Csc values are illustrated.

It can be verified that for series-connected inductor and capacitor, the relationship can be reduced to:

$$Q = [\omega L - (1/\omega c)] / (R_c + R_L) \quad (16)$$

where:

R_C = the capacitor series resistance, and

R_L = the inductor series resistance.

By substituting Eqs. 17 and 18 into Eq. 16, Eq. 19 results:

$$R_C = \frac{1}{\omega C Q_c} \quad (17)$$

$$R_L = \frac{\omega L}{Q_L} \quad (18)$$

$$Q = Q_L Q_C(\omega^2 LC - 1) / (Q_L + \omega^2 LCQ_c) \quad (19)$$

In practice, it is often true that $Q_L >> \omega^2 L_C Q_C$, so that Eq. 19 can be reduced to:

$$Q = Q_c(\omega^2 LC - 1) \quad (20)$$

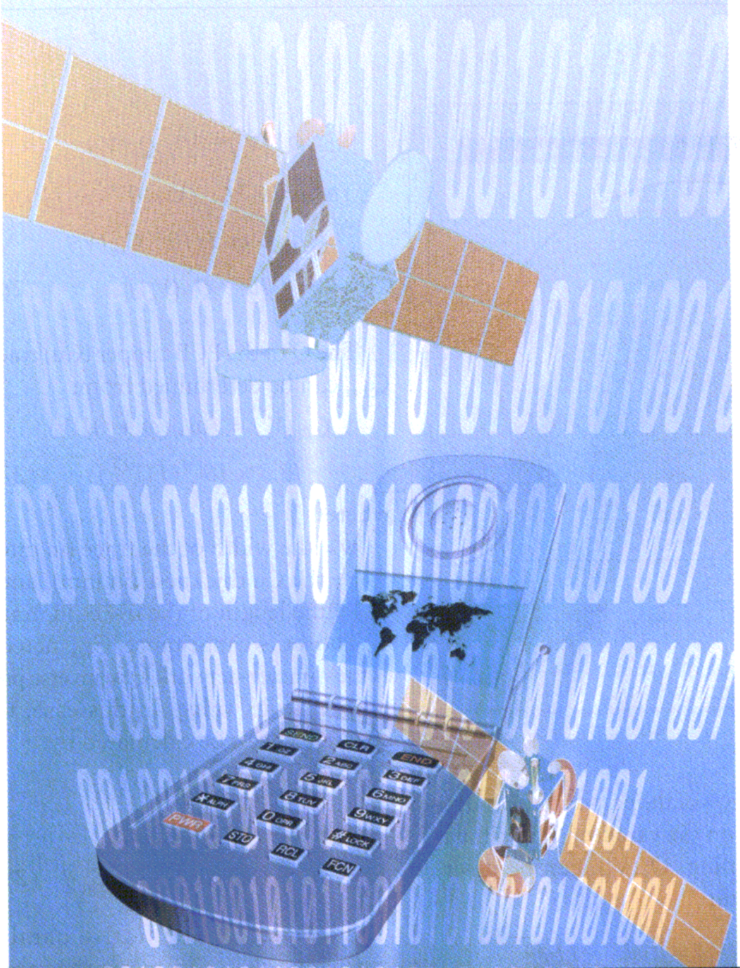
Similarly, for series-connected capacitors, it can be shown that:

$$Q = Q_1 Q_2 (C_1 + C_2) / [(Q_1 C_1) + (Q_2 C_2)] \quad (21)$$

In the same way, for parallel-connected capacitors:

$$Q = Q_1 Q_2 (C_1 + C_2) / (Q_1 C_2) + (Q_2 C_1) \quad (22)$$

The next step in this analysis is to determine the Q of a real varactor circuit with trace inductance and tuning-range-correcting capacitors. The varactor Q is usually specified on data sheets in two ways: directly through Q values or indirectly through the series resistance, R_s. The Q or R_s values must be determined for the entire tuning range or at least for



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TYPE	Case	Config.	Limits		Rd (W)typ		Cd (pF)typ	
			V_R(V)	I_F(mA)	@.5mA	@10mA	@0V	@20v
BAP50-03	SOD323	Single	50	50	25	3	0.45	0.3@5V
BAP50-04	SOT23	Series	50	50	25	3	0.45	0.3@5V
BAP50-05	SOT23	CC	50	50	25	3	0.45	0.3@5V
BAP64-02	SOD523	Single	200	100	20	2	0.52	0.23
BAP64-03	SOD323	Single	200	100	20	2	0.52	0.23
BAP64-04	SOT23	Series	200	100	20	2	0.52	0.23
BAP64-04W	SOT323	Series	200	100	20	2	0.52	0.23
BAP64-05	SOT23	CC	200	100	20	2	0.52	0.23
BAP64-05W	SOT323	CC	200	100	20	2	0.52	0.23
BAP64-06	SOT23	CA	200	100	20	2	0.52	0.23
BAP51-02	SOD523	Single	60	60	5.5	1.5	0.4	0.2@5V
BAP51-03	SOD323	Single	60	60	5.5	1.5	0.4	0.2@5V
BAP51-05W	SOT323	CC	60	60	5.5	1.5	0.4	0.2@5V
BAP65-02	SOD523	Single	30	100	-	0.56	0.65	0.375
BAP65-03	SOD323	Single	30	100	-	0.56	0.65	0.375

Types in bold are included in this kit.

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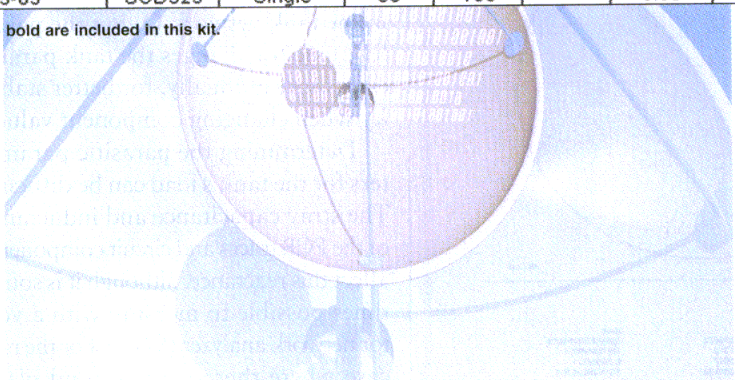
To request a free PIN diodes Designer's Sample Kit containing a selection of new RF PIN diodes, a CD ROM diskette with datasheets, application notes, and S-parameters, please visit: **www.em.avnet.com/rfm/pindiodes.html** or call **1-800-261-9602, ext. 352.**



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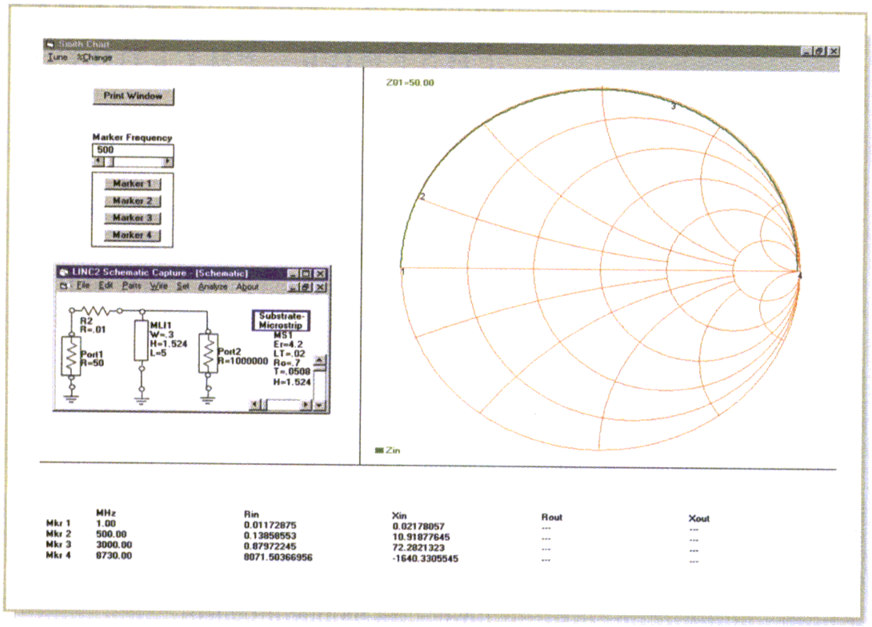

Fig. 5 A PCB stub simulation can be seen here.

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its minimum and maximum frequencies. Historically, varactor manufacturers have specified Q values at 50 MHz. In this case, the varactor Q can be calculated for the frequency of interest by:[1]

$$Q_{(f1)} = Q_{(f=50)}(50 / f_1) \quad (23)$$

or, if the varactor Q had been determined for a frequency other than 50 MHz:

$$Q_{(f1)} = Q_{(f2)}(f_2 / f_1) \quad (24)$$

The effects of the parasitic lead inductance (L_S) on the varactor Q as a function of tuning, $Q_v(V_t)$, can be determined from:

$$Q_v(V_t) = |\{\omega L_s - [1 / \omega C_v(V_t)] / R_s(V_t)\}| \quad (25)$$

The effects of the PCB traces can be found by:

$$Q_{ve}(V_t) = |Q_{Lt}Q_v(V_t) [\omega^2 Lt 10^{-9} C_{ve}(Vt)10^{-12} - 1] [Q_{Lt} + \omega^2 Lt 10^{-9} C_{ve}(V_t) 10^{-12} Q_V(V_t)]| \quad (26)$$

The Q of the PCB copper (Cu) trace, Q_{Lt}, can be determined from:

$$Q_{Lt}(V_t) = [\omega L_t(\omega + t)] / [1.3 \times 10^{-4}(Fl)^{0.5}] \quad (27)$$

where:

w = the width of the trace (in mm),
t = the Cu thickness (in mm), and
l = the length of the trace (in mm).

The series capacitance, C_{sc}, increases the varactor-network Q in inverse proportion to its value. In this case, the effective Q can be calculated by:

$$Q_{vs}(V_t) = \{Q_{ve}(V_t)Q_{sc} [C_{ve}(V_t) + C_{sc}]\} / [Q_{ve}(V_t)C_{ve}(V_t) + Q_{sc}C_{sc}] \quad (28)$$

Conversely, the effective parallel capacitance, C_{pce}, increases the varactor network's Q in direct proportion:

$$Q_c(V_t) = \{Q_{vs}(V_t)Q_{pce} [C_{vs}(V_t) + C_{pce}] / Q_{vs}(V_t)C_{pce} + Q_{pce}C_{vs}(V_t) \quad (29)$$

Note that C_{pce} represents the sum of the capacitance of the parallel correcting capacitor and the tank circuit's parasitic components.

Figure 4 shows how the varactor network Q changes as a result of the series and parallel-connected capacitors. Both approaches offer relative improvements in the tank network Q, but the parallel capacitor changes the tank parameters more gradually, for better stability when changing component values.

Determining the parasitic parameters for the tank's load can be difficult. The stray capacitance and inductance of the PCB traces and circuit components affect this reactance, although it is sometimes possible to measure with a vector network analyzer (VNA). For the rare case where there is no ground plane under the trace, the parasitic inductance can be calculated using Eq. 30:[9]

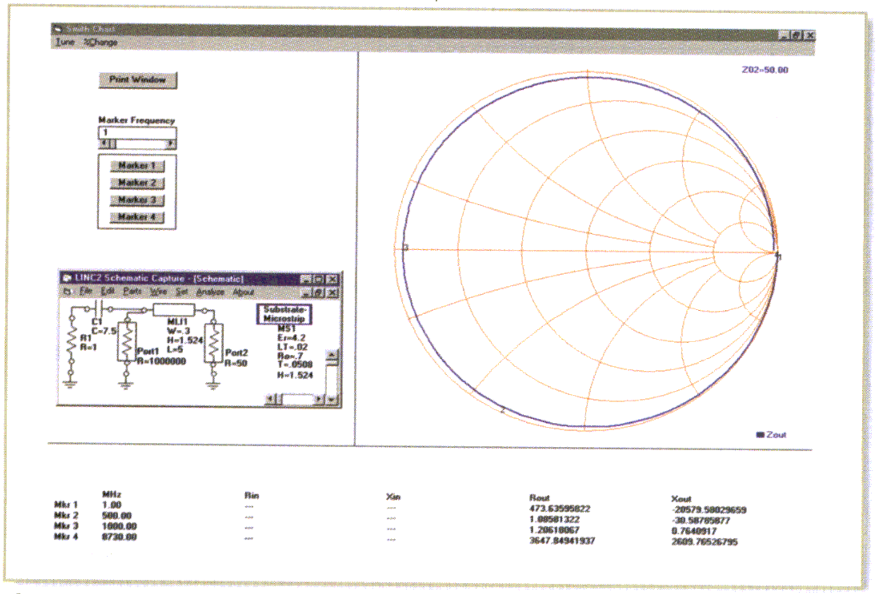

Fig. 6 PCB trace simulation is shown above.

Application Profile

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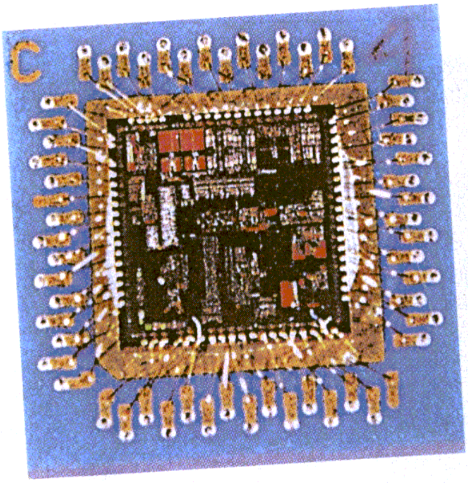

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$$L_t = 0.2l\left\{\ln\left[\frac{l}{(w+t)}\right] + 1.193 + 0.2235\left[\frac{(w+t)}{l}\right]\right\} \quad (30)$$

where:

L_t = the trace inductance (in nH).

For the more common case when there is a ground plane under the trace, correction factor, Kg, can be calculated from Eq. 31:[9]

$$K_g = 0.57 - 0.145\ln\left(\frac{w}{H}\right) \quad (31)$$

The effective inductance of the PCB trace over the ground plane L_g now is determined from the simple formula:

$$Lg = L_t K_g \quad (32)$$

The alternative method is to simulate the trace with a computer-aided-engineering (CAE) program such as LINC2 from Applied Computational Sciences (Escondido, CA). For example, a grounded trace (shown on **Fig. 5**) with known geometry is first simulated and reactance X is determined. Then, inductance L is calculated as L = X/ω.[4] Note that the impedance for the second port must be set to a high value to avoid double loading the transmission-line model. The value of 1000000 Ω will work well for any real trace. The substrate model is used as a separate part from the CAE program's parts menu. Note that known microstrip-line parameters such as trace width W = 0.3 mm, substrate height H = 1.524 mm, and trace length L = 5 mm were used for the ML model. The dielectric constant of substrate Er = 4.2 (average number for FR4 material), loss tangent LT = 0.02, relative metal resistivity R_o = 0.7 (for Cu), and Cu trace thickness T = 0.0508 mm were used for the substrate model. The program calculates microstrip-line resistance and reactance and shows them beneath the Smith chart. Since there is the need for only one set of parameters indication of R_{out} and X_{out}, results are turned off for simplicity. The sought inductance of the trace can be easily calculated as L = X/ω. For these microstrip-line parameters, L=10.92/6.28*500*106 = 3.48 nH is provided. It is easy to see from the Smith chart in **Fig. 5** that a grounded stub with a particular geometry can be used as an inductor to approximately 8 GHz.

In the case of a series-connected PCB trace, the schematic diagram of **Fig. 6** can be used for the simulation. In this case, there are opposite impedance values for ports since port 1 should not distort the input loading of the PCB trace. As in the

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previous case, the software's input-parameter indication is turned off for the sake of simplicity. A PCB trace with the same geometry was simulated and the effective value of the capacitor referred to the trace output can be calculated as $C_e = 1/6.28 \times 500 \times 10^6 \times 30.59 = 10.4$ pF. The 5-mm-long trace increases the capacitance from 7.5 to 10.4 pF at 500 MHz.

Calculations made according to Eqs. 30, 31, 32, and 7 provide $L_g = 3.33$ nH and for the same PCB geometry effective capacitance $C_e = 10$ pF. The tolerance of these calculations is approximately 4 percent referred to the simulation, which is acceptable for this analysis.

The effect of the bias resistor (R_b) can be considered as an additional equivalent shunt resistance (R_c). For the different configurations of Fig. 1, the following equations can be applied:

For Figure 1a

$$R_c = R_b\left[1 + \frac{C_{sc}}{C_v}\right]^2 \qquad (33)$$

For Figure 1b

$$R_c = 4R_b \qquad (34)$$

For Figure 1c

$$R_c = 2R_b \times \left(1 + \frac{2C_{sc}}{C_v}\right)^2 \qquad (35)$$

For Figure 1d

$$R_c = 2R_b \times \left(\frac{1 + C_v}{C_{sc}}\right)^2 \qquad (36)$$

The resulting effective quality factor of the LC tank (Q_e) considering the effect of this shunt resistance, R_c, is:[6]

$$Q_e = \frac{QR_c}{R_c + Q\sqrt{\frac{L}{C}}} \qquad (37)$$

where:

Q_e = resulting Q of the tank,

Q = tank Q without considering R_c,

R_c = shunt resistance (in ohms) resulting from bias resistor R_b,

L = the tank inductance (in H), and

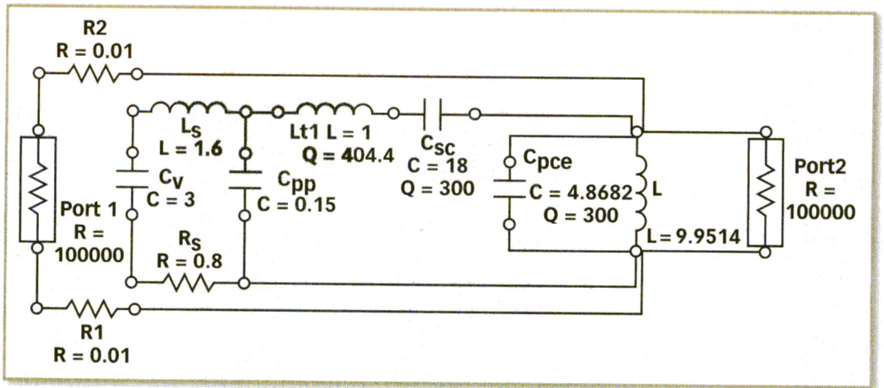

Fig. 7 **A simulation schematic for a particular design appears above.**

C = tank capacitance (in F).

The parasitic components of the tank are the reason for the shifting of resonant frequency from the predicted value according to Thomson's formula.

$$\omega = \frac{1}{\sqrt{LC}} \qquad (38)$$

For calculating the exact resonant frequency of the real tank, the following formula can be used:

$$F = 1/[2\pi(LC)^{0.5}] \times \left\{\left[(L/C) - R_L^{\,2}\right] / \left[(L/C) - R_c^{\,2}\right]\right\}^{0.5} \qquad (39)$$

where:

F = the resonant frequency (in Hz).

The Q for the inductors used in the tank circuit can be found from data sheets or extrapolated for the desired frequency. In the case where a homemade or PCB inductor is used, the Q can be measured or determined from Eq. 12. At this point, it is necessary to determine how to find R_L for a trace or a coil. For the DC resistance of a PCB trace, Eq. 40 can be used:

$$R_{DC} = \frac{1.7241 \times 10^{-5} l}{wt} \qquad (40)$$

Similarly, the value of DC resistance for a coil (R_{DC}) can be calculated from:[7]

$$R_{DC} = \frac{1.7241 \times 10^{-6} l}{S} \qquad (41)$$

where:

l = the coil wire length (in cm), and

S = the bare area for the coil wire (cm^2).

Note that the AC resistance depends on frequency and is determined by:[8]

$$R_{AC} = \frac{2.61 \times 10^{-4}\sqrt{F}\, l}{2(w + t)} \qquad (42)$$

where:

F = the frequency of interest (in megahertz).

The same formula may be used for coils. In this case, πD must be substituted for the trace perimeter 2(w + t), where D = the bare-wire diameter of the coil (in mm).

Since the inductor- and capacitor-reactance slopes are equal at resonance, the overall Q of a parallel LC tank can be calculated by:

$$Q = \frac{Q_C Q_L}{Q_C + Q_L} \qquad (43)$$

Provided with this background, it should now be possible to perform a practical design for a tunable resonant-tank circuit. The design parameters are:

F_1 = the maximal required frequency (in MHz),

F_2 = the minimal required frequency (in MHz),

V_{tl} = the lowest tuning voltage (in VDC),

V_{th} = the highest tuning voltage (in VDC),

C_p = the tank's load parasitic capacitance (in pF), and

m_l , m_h = the required lower- and upper-frequency margins (in MHz).

The first step is to determine the tank tuning range. For the maximal

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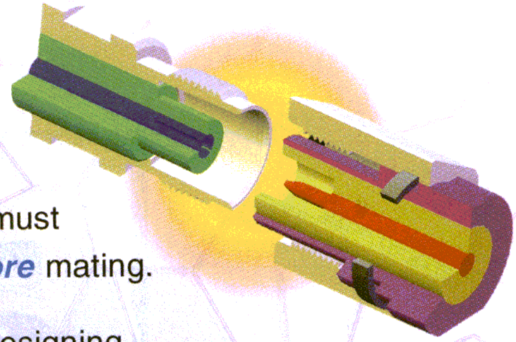

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(F_{max}) and minimal (F_{min}) frequencies,

$$F_{max} = F_1 + m_b$$
$$F_{min} = F2 - m_l \qquad (44)$$

Therefore, the required frequency ratio is:

$$K_f = \frac{F_{max}}{F_{min}} \qquad (45)$$

The next step is to determine the "first-pass" value of the inductor. It could be a known value from a schematic design or some standard value. Once the inductor value is known, the maximal C_{trmax} and minimal C_{trmin} required tank capacitances can be determined from:

$$C_{tr\ max} = \frac{2.533 \times 10^7}{F_{min}^{\ 2} L} \qquad (46a)$$

$$C_{tr\ min} = \frac{2.533 \times 10^7}{F_{max}^{\ 2} L} \qquad (46b)$$

The value of C_{trmin} should be greater than the parasitic capacitance, C_p. In another words, C_{trmin} must be realistic. Otherwise, the value of the inductor must be decreased.

The capacitance range ΔCr is:

$$\Delta C_r = \left(Kf^2 - 1\right) \times C_{tr\ min} \qquad (47)$$

The required capacitance range for a single varactor is:

$$C_{vr\ max} = (C_{tr\ max} - C_p) \qquad (48a)$$

$$C_{vr\ min} = (C_{tr\ min} - C_p) \qquad (48b)$$

For a two-varactor circuit, these values must be doubled.

The required capacitance ratio for the varactor network is:

$$K_c \geq K_f^{\ 2} \qquad (49)$$

Knowing C_{vrmax}, the C_{vrmin} and K_c values for the varactor can be chosen. The closer the resulting varactor capacitances C_{vmax} and C_{vmin} are to the required values of C_{trmax} and C_{trmin}, the less correcting capacitances C_{pc} or C_{sc} are needed to correct the tuning range. For a two-varactor circuit, the values of C_{vmax} and C_{vmin} are equal to one-half of the corresponding varactor capacitance.

The next step is to calculate the effective varactor capacitance C_{vemax}, $C_{ve\ min}$, and its range ΔC_{ve}:

$$C_{ve\ min} = [2.5 \times 10^8 C_{v\ min} / (2.5 \times 10^8 - \pi^2 F_{max}^{\ 2} 2L_s C_{v\ min})] + (C_{pp} / 2) \qquad (50a)$$

Continued from page 83

$$C_{ve\ max} = 2.5 \times 10^8 C_{v\ max} /$$
$$2.5 \times 10^8 - \pi^2 F_{min}{}^2 2Ls\, C_{v\ max} +$$
$$(C_{pp} / 2) \quad (50b)$$

These formulas are for a two-varactor circuit. In the case of a single-varactor network, instead of $C_{pp}/2$ for the second quantity, C_{pp} should be used. Similarly, multiplier 2 for L_s must be omitted for the single-varactor network or if a designer knows the exact value of L_s for a double-varactor package.

The effective capacitance range for the chosen varactors can be found from:

$$\Delta C_{ve} = C_{ve\ max} - C_{ve\ min} \quad (51)$$

and the capacitance ratio can be found from:

$$K_c = \frac{C_{ve\ max}}{C_{ve\ min}} \quad (52)$$

In comparing the value of K_c with that of K_f^2, K_c must be equal or greater than K_f^2. The SRF for the varactor diodes can then be checked through:

$$SRF_{min} = \frac{5.0329 \times 10^3}{\sqrt{2 \times Ls \times C_{v\ max}}} \quad (53)$$

If the value of SRF_{min} is too close to F_{max}, another varactor diode must be chosen. When using Eq. 5, the same consideration must be provided for L_s, as was performed in Eq. 50.

The value of the series-correction capacitor (C_{sc}) for the required bandwidth can be found from:

$$C_{SC} = [(C_{ve}\ max + C_{ve\ min})\Delta C_r] /$$
$$[2(\Delta C_{ve} - \Delta C_r)] \times$$
$$\{1 + [4 C_{ve\ max} C_{ve\ min} (\Delta C_{ve} - \Delta C_r)] /$$
$$[\Delta C_r (C_{ve\ max} + C_{ve\ min})^2]\}^{0.5} \quad (54)$$

The closest available standard value must be used for C_{sc}. For the balanced schematic (Fig. 1c), capacitor C_{sc} should be split into two equal capacitors, double the nominal value, but as close as possible to standard values.

The resulting capacitance for the varactor and the series-correction capacitance (C_{sc}) can be found from:

$$C_{vs\ min} = \frac{C_{ve\ min} C_{sc}}{C_{ve\ min} + C_{sc}} \quad (55a)$$

$$C_{vs\ max} = \frac{C_{ve\ max} C_{sc}}{C_{ve\ max} + C_{sc}} \quad (55b)$$

Continued from page 85

By considering any influence from the inductance of the PCB traces (L_t), the effective capacitance of the varactor network (including the series capacitor) can be found from:

$$C_{vse}(V_t) = \left[2.5 \times 10^8 C_{vs}(V_t)\right] / \left[2.5 \times 10^8 - \pi^2 F_{max}{}^2 L_t C_{vs}(V_t)\right] \quad (56)$$

The next step is to check the whole varactor network, including the series capacitor and the inductance of the PCB traces, for the SRF:

$$SRF_{min} = \frac{5.0329 \times 10^3}{\sqrt{L_t C_{vs}(V_t)_{max}}} \quad (57)$$

If SRF_{min} is too close to F_{max}, then L_t or the capacitance of C_{vs} must be decreased.

The capacitance range for the varactor network can be found from:

$$\Delta C_{vse} = C_{vse\ max} - C_{vse\ min} \quad (58)$$

The required value for inductor L can be calculated from:

$$L = (2.533 \times 10^7 / \Delta C_{vse}) \left[(1/F_{min}{}^2) - (1/F_{max}{}^2)\right] \quad (59)$$

This is the final value for the inductor, which should be as close as possible to this value in order to maintain the required tuning range with a minimal K_v factor.

The value of the parallel correction capacitor (C_{pc}) can be found from:

$$C_{pc} = (2.533 \times 10^7 / F_{max}{}^2) - C_p - C_{vse\ min} \quad (60)$$

It is now possible to determine the tank Q. The Q for the varactor itself can be found from its data sheet or by calculating it from the known C_v and R_s values. It is usually enough to determine the Q for the minimum and maximum frequencies in a particular (V_t) tuning-voltage range:

Comparing inductor characteristics

L (nH)	C_{tmin} (pF)	C_{SC} (pF)	C_{pce} (pF)	m_{Fmin}	m_{Fmax}	QC_{Fmin}	QC_{Fmax}
2.7	16	100000	25.5	–26.4	20.0	62.4	248.8
3.3	16	100000	20.2	–11.5	20.6	58.2	239.5
3.9	16	100000	16.6	2.5	20.2	55.6	231.1
4.7	16	7500	13.2	18.9	20.2	53.4	220.8
5.6	14	100	10.6	18.3	21.2	58.2	213.8
6.8	12	47	8.3	20.0	20.4	63.1	206.4
8.2	10	27	6.5	17.1	20.2	69.7	200.5
10	8	20	4.8	19.0	24.0	72.8	190.4

$$Q_V F_{min} = \frac{1}{\omega_{min} C_{v\,max} R_s} \quad (61a)$$

$$Q_{v\ max} = \frac{1}{\omega_{max} C_{v\ min} R_s} \quad (61b)$$

The resulting varactor Q considers the effects of the varactor parasitic inductance L_s:

$$Q_{v1} F_{min} = \left|\omega_{min} Ls \times 10^{-9} - (10^{12} / \omega_{min} C_{v\ max}) / R_s\right| \quad (62a)$$

$$Q_{v1} F_{max} = \left|\omega_{max} L_s \times 10^{-9} - (10^{12} / \omega_{max} C_{v\ min}) / R_s\right| \quad (62b)$$

The effects of the PCB traces between the varactor and the tank circuitry can be determined by:

$$Q_{ve} F_{min} = \left|Q_{Lt\ min} Q_{vl} F_{min} (\omega^2{}_{min} L_t \times 10^{-9} C_{ve\ max} \times 10^{-12} - 1) / (Q_{Lt\ min} + \omega^2{}_{min}\ L_t \times 10^{-9} C_{ve\ max} \times 10^{-12} Q_{vl} F_{min})\right. \quad (63a)$$

$$Q_{ve} F_{max} = \left|Q_{Lt\ max} Q_{vl\ max} (\omega^2{}_{max} \times L_t \times 10^{-9} C_{ve\ min} 10^{-12} - 1) / (Q_{Lt\ max} + \omega^2{}_{max}\ Lt \times 10^{-9} C_{ve\ min} \times 10^{-12} Q_{vl\ max}\right| \quad (63b)$$

The Q of the PCB Cu trace, Q_{Lt}, can be determined from:

$$Q_{Lt\ min} = \left[\omega_{min} L_t 2(\omega + t)\right] / \left[2.61 \times 10^{-4} (F_{min})^{0.5} l\right] \quad (64a)$$

$$Q_{Lt\ max} = \left[\omega_{max} L_t 2(\omega + t)\right] / \left[2.61 \times 10^{-4} (F_{max})^{0.5} l\right] \quad (64b)$$

where:

F_{min} and F_{max} = the minimum and maximum frequencies of interest (in MHz).

Series capacitor C_{sc} increases the Q of the varactor network, Q_{vs}, in inverse proportion to its value. In this case, the effective Q_{vs} values can be found from:

$$Q_{vs} F_{min} = \left[Q_{ve} F_{min} Q_{sc} (C_{ve\ max} + C_{sc})\right] / (Q_{ve} F_{min} C_{ve\ max} + Q_{sc} C_{sc} \quad (65a)$$

$$Q_{vs} F_{max} = \left[Q_{ve} F_{max} Q_{sc} \times (C_{ve\ min} + C_{sc})\right] / Q_{ve} F_{max} C_{ve\ min} + Q_{sc} C_{sc} \quad (65b)$$

Conversely, the effective parallel capacitance, C_{pce}, increases the Q of the varactor network in direct proportion:

$$Q_c F_{min} = \left[Q_{vs} F_{min} Q_{pce} (C_{vs\ max} + C_{pce})\right] / (Q_{vs} F_{min} C_{pce} + Q_{pce} C_{vs\ max}) \quad (66a)$$

Continued from page 86

$$Q_c F_{max} = [Q_{vs} F_{max} Q_{pce} (C_{vs\ min} + C_{pce})] / (Q_{vs} F_{max} C_{pce} + Q_{pce} C_{vs\ min}) \quad (66b)$$

Note that capacitance C_{pce} represents the sum of the tank's parasitic components and the capacitance of the parallel correcting capacitor, C_{pc}. When the values for all components in the resonant tank have been determined, it is a good time to check the tank parameters. The total tank capacitance is:

$$C_{max} = C_{vse\ max} + C_p + C_{pc} \quad (67a)$$

$$C_{min} = C_{vse\ min} + C_p + C_{pc} \quad (67b)$$

While the maximum and minimum frequencies, F_{max} and F_{min}, respectively, can be calculated by:

$$F_{max} = \frac{5.0329 \times 10^3}{\sqrt{LC_{min}}} \quad (68a)$$

$$F_{min} = \frac{5.0329 \times 10^3}{\sqrt{LC_{max}}} \quad (68b)$$

The value of K_v for the tank is:

$$K_v = \frac{F_{max} - F_{min}}{V_{th} - V_{tl}} \quad (69)$$

while the frequency margins are:

$$\textit{Upper frequency margin } m_h = F_{max} - F_1 \quad (70a)$$

$$\textit{Lower frequency margin } m_l = F_2 - F_{min} \quad (70b)$$

Now that the relationships for the resonant-tank circuit have been developed, it is possible to apply this new-found knowledge in the creation of a practical tuning circuit for voltage-controlled oscillators and filters. Several software programs are available that allow the operator to enter these equations as part of a design routine, including the MathCAD mathematical software from Mathsoft Engineering and Education, Inc. (Cambridge, MA) as well as the versatile LINC2 linear simulation program from Applied Computational Sciences (Escondido, CA). Both programs have been reviewed in this magazine (see *Microwaves & RF*, June 2000, p. 126 for a review of MathCAD 2000 and *Microwaves & RF*, August 1999, p. 123 by Dale Henkes which offers detailed insight into the workings of the LINC2/MicroLINC software package).

It is possible to apply the new-found knowledge in the creation of a practical tuning circuit for voltage-controlled oscillators and filters.

The best way to demonstrate the effectiveness of these design equations is with an sample circuit, such as a tunable resonant tank capable of operating from 450 to 550 MHz. Next month, this two-part article will conclude with two views of this design example, using the equations shown before. Both of the software programs mentioned will be used in the analysis, and every effort will be made to implement the resonant-tank circuit with commercial "off-the-shelf" components (rather than components using custom values recommended by a software program). The analysis will include the effects of the PCB traces, component tolerances, and component parasitic elements. MRF

REFERENCES

1. U.L. Rohde and D.P. Newkirk, RF/Microwave Circuit Design for Wireless Applications, Wiley, New York, 2000.
2. W.L. Everitt and G.E. Anner, Communication Engineering, McGraw-Hill, New York, 1956.
3. R.K. Feeney and D.R. Hertling, Review of RF Engineering, Georgia Institute of Technology, Atlanta, GA, 1993.
4. D.D. Henkes, LINC2 User's Manual, San Diego, CA, 2000.
5. P. Vizmuller, RF Design Guide, Artech House, Boston, MA, 1995.
6. Y.F. Scripnikov, Resonant Circuit, Moscow, 1970.
7. S. Belkin, "Understanding Of Electrical Fundamentals Of Resistance Welding," The Fabricator, November 2000, pp. 40-44.
8. B.C. Wadell, Transmission Line Design Handbook, Artech House, Boston, MA, 1999.
9. K.C. Gupta, R. Garg, I. Bahl, and P. Bhartia, Microstrip Lines and Slotlines, Second Ed., Artech House, Boston, MA, 1996.

Understanding ACPR Measurements

Adjacent-channel power ratio can be evaluated by a number of different measurement receivers, although several factors must be considered to ensure accurate results.

Adjacent-channel power ratio (ACPR) is a defining measurement for power amplifiers (PAs) in digitally modulated wireless-communications systems. Measurement of ACPR can be difficult and time-consuming, requiring specialized test instruments and with great potential for error. Fortunately, the measurement capability is available in some integrated test systems. The first part of this two-part series on ACPR measurements will review the requirements for this system.

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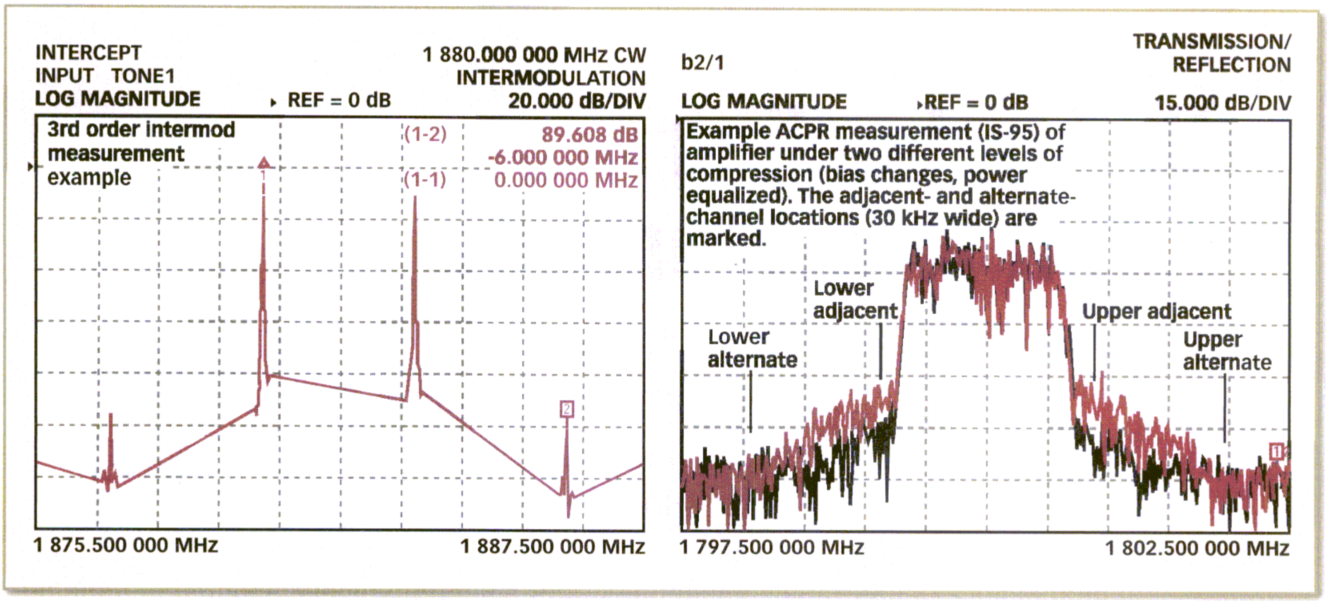
ACPR is used to characterize the distortion of amplifiers and other wireless subsystems for their tendency to cause interference with a neighboring radio system. Sometimes known as adjacent-channel leakage ratio (ACLR), ACPR is caused by nonlinearities in the communications system, notably in its PAs.

For radios with simple modulation schemes, two sine-wave signals have been used to represent two active channels. When the third-order intermodulation-distortion (IMD) products of these two tones fell within the bandwidth of a neighboring channel with sufficient energy, it could cause interference.[1] But as modulation schemes have grown in complexity, it is not as obvious that this two-tone analysis method can accurately simulate the behavior of communications channels under nonlinear conditions.

ACPR measurements extend the two-tone concept by replacing the simple tones with a more complex modulated signal **(Fig. 1)**. For obvious reasons, the interfering performance of the modulated signal is of critical interest to regulatory agencies and standards bodies.[2]

The third-order IMD product is usually defined as the ratio of the power in one of the third-order tones to the power of one of the main tones. ACPR is defined as the ratio of the power in a specified bandwidth offset from the main signal (the distortion product) to the power in a bandwidth within the main signal. The bandwidths and their offset frequencies depend on the particular standard, such as IS-95 for narrowband CDMA systems. Alternate-channel power ratio is similar to ACPR, except that it refers to the ratio of power in a bandwidth two channels away from the main signal (twice the offset of ACPR) to the power in a specified bandwidth within the main signal channel. In terms of simple two-tone IMD measurements, the level of a fifth-order IMD product or some combination of higher-order products may correspond to the alternate-channel power ratio.

Simple IMD measurements have often been used in place of direct ACPR measurements for several reasons. The ACPR measurements require a modulated signal source. And ACPR measurements



1. These plots show examples of IMD and ACPR measurements. The simple IMD measurement with two tones may do an inadequate job of predicting distortion performance under actual modulated-signal conditions.

tend to be complex, requiring the accurate measurement of power over a wide, precisely defined bandwidth. While it may be possible to use IMD measurements to evaluate ACPR, the correlation of IMD data to ACPR results can be difficult. The relationship depends on the details of the amplifier topology as well as the modulated waveform being used.[3-6] Due to this, many applications require that true ACPR measurements be performed.

The signal generator is an important part of an ACPR test system. The channel bandwidths, the necessary measurement frequencies (relative to the carrier), the required filtering, and the receiver (Rx) performance requirements are all functions of the type of signal provided.

While many standards exist, two of the more common for ACPR measurements are of the spread-spectrum CDMA variety—a narrowband and a wideband version. While the narrowband version has been standardized for some time (in documentation such as the IS-95, IS95A, and IS-97 standards), a standard for WCDMA is still in flux at present, although one well-published configuration is presented in the table as a comparison to narrowband CDMA.

Table 1: Comparing narrowband and wideband CDMA

TYPE	NB-CDMA IS-95 (Rev. link)	WB CDMA (One approach)
Main-channel measurement BW	1.23 MHz or 30 kHz	3.84 MHz
Adjacent-channel location from carrier	±885 kHz	±5 MHz
Adjacent-channel measurement BW	30 kHz	3.84 MHz
Alternate-channel location from carrier	±1.98 MHz	±10 MHz
Alternate-channel measurement BW	30 kHz	3.84 MHz

In addition to the characteristics shown in **Table 1**, two other aspects of the modulated signal must be delineated:

1. The total integrated output power of the device under test (DUT), or the total integrated power into the DUT, must be specified. As with IMD or other distortion tests, the level of distortion is a very strong function of source-power level.

2. ACPR varies strongly with modulation format. Within spread-spectrum classes, ACPR varies strongly with how a channel is loaded (the waveform must be well-known before comparisons of ACPR can be made).[7] In any comparisons of ACPR, it is critical that the channel configurations be the same.

Next month, this two-part article series will conclude with the type of Rx architectures useful for ACPR measurements, and will include a measurement example of a high-gain, medium-power CDMA amplifier. MRF

REFERENCES

1. TIA/EIA Standards, as an example TIA/EIA-98-C: "Recommended Minimum Performance Standards For Dual-Mode Spread Spectrum Mobile Stations."

2. Intermodulation Distortion, Anritsu Application Note (11410-00213).

3. J.S. Kenney and S.E. Avis, "The Relationship Between IMD and ACPR," *Wireless Design and Development*, September 2000, pp. 7-8.

4. H. Yamada, S. Ohara, T. Iwai, Y. Yamaguchi, K. Imanishi, and K.J. Oshin. "The Effect of Source Impedance on Linearity in InGaP/GaAs Power HBTs," *1996 MTT-S International Microwave Symposium Digest 96.2*, June 1996, pp. 555-558.

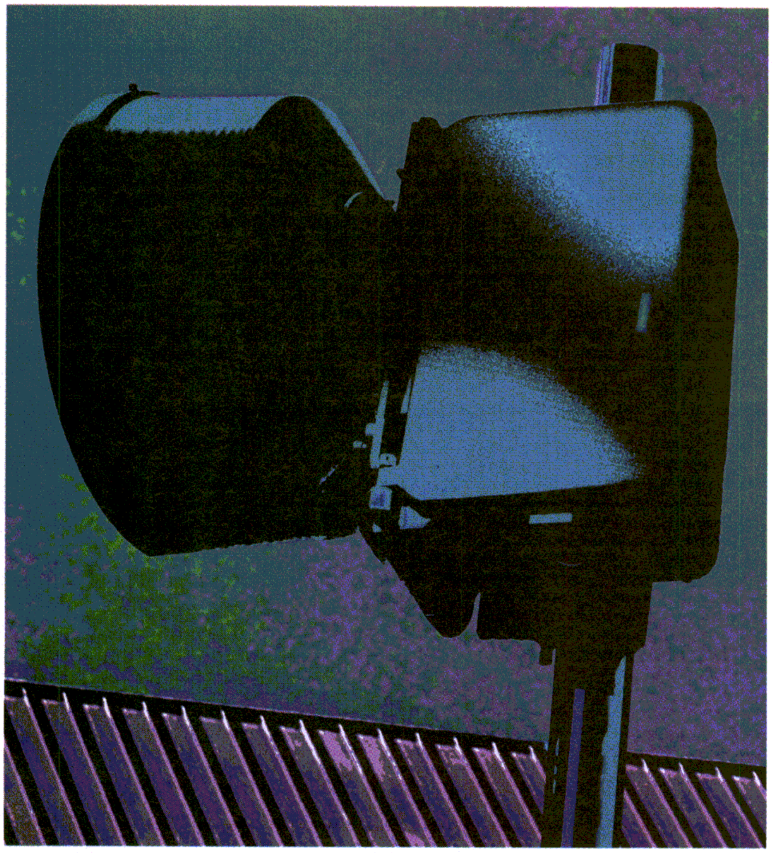
5. J.S. Ko, *et al.*, "Enhanced ACPR Technique by Class AB in PCS Driver Amplifier, " *IEEE International Conference on VLSI and CAD*, Seoul, November 1999.

6. J.S. Ko, K.S. Kim, B.K. Ko, B. Kim, and B.H. Park, "Effect of Bias Scheme on Intermodulation Distortion and Its Use for the Design PCS Tx Driver," *2000 MTT-S International Microwave Symposium*, Boston, June 2000.

7. N. Deshpande, S. Stanton, and M. Hurst, "ACPR Specs Place Demands on WCDMA Base-Station Amplifiers," *Wireless Systems Design*, August 1999, pp. 15-21.

8. S.C. Yang, *CDMA RF System Engineering*, Artech House, Norwood, MA, 1998.

9. T. Ojanpera and R. Prasad, eds., *Wideband CDMA for Third Generation Mobile Communications*, Artech House, Norwood, MA, 1998.



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In calculations, the following parameters were taken into account: L_p = 0.125 nH, C_k = 0.2 pF, r_s = 0.3 Ω, J_0 = 16 kA/cm^2, θ = 500° K, and ld = 0.5λ. Changes in position of the antispurious load (with impedance $Z_{as} = r_{as} + jX_{as}$) significantly alters the impedance Z_k included in series with the packaged diode impedance Z_{de}. When las = 0.5nλ and $X_{as} \sim 0$ in series with equivalent IMPATT diode impedance

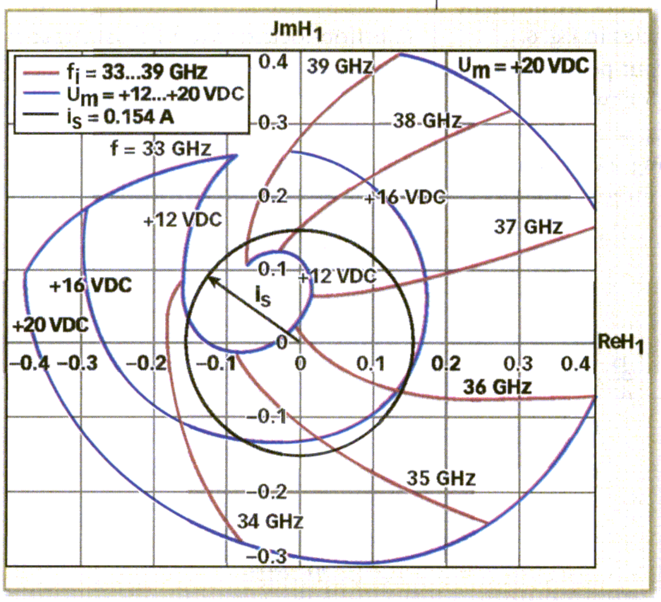
Z_{de} includes the impedance of series resonant circuit.

$$Z_k = r_{as} + j\omega_{0k}L_{as}(\omega / \omega_{0k} - \omega_{0k} / \omega) \qquad (10)$$

where:

ω_{0k} = the resonant frequency of the series resonant circuit, $L_{as} = 0.5n\pi W_{0k}/\omega_0$, n = 0, 1, 2...

The antispurious load in the coaxial line is made with reflection coefficient $\Gamma_{as} \geqslant 0.8$. It is well-known in these amplifier schemes that the compensation of reactance is reached, and as a result, the amplifier-frequency band improves. The distinctive features of this scheme are the inclusion of the diode's impedance in the parallel resonant circuit and designing an RF oscillator circuit with minimal stored energy. The methods of locking-band widening use the graphically-analytical solution of equations for the stationary



7. The functions of Fig. 6 (voltage and frequency) illustrated here include the resonant circuit and and the correction factor of the sliding waveguide post position l_{pw}.

Continued from page 95

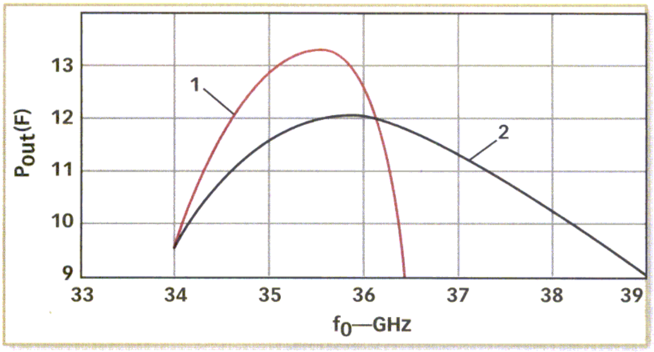
injection-locked mode.[1,2]

In **Fig. 6,** the dependencies H_1 (U_m, f_i) are presented for lack of the series compensating resonant circuit and L_{pw} = 2.55 mm. These dependencies are calculated for fixed frequencies f_i in the range33...39 GHz, in the interval of voltage amplitudes U_m = +10...+20 VDC (red curves). The blue curves correspond to fixed voltage amplitudes U_{mi}. The black circle characterizes the dependence i_s exp(jχ for i_s = 0.154 A, P_s = 0.3 W. Using the relation:

$$P_{out} = P_s + [-0.5 G_{de} U_{me}^2] \qquad (11)$$

the frequency dependence of injection-locked oscillator output power P_{out} (f) can be defined. In **Fig. 7,** the dependencies H_1 (U_m, f_i) are presented, including the resonant circuit (l_{as}, C_{as}, r_{as}) and use of the correction provided by the sliding-waveguide post position l_{pw}. For this figure, L_{as} = 1 nH, C_{as} = 0.025 pF, f_{0k} = 35.5 GHz, l_{pw} = 1.54 mm, and the other parameters are the same as for the dependencies in Fig. 6.

In **Fig. 8,** the output power Pout (f) versus frequency f for two cases—L_{as} = 0 (curve 1), and L_{as} = 1 nH (curve 2) is presented, including a compensating resonant circuit to increase the locking band. From Fig. 8, it is evident that the locking gain is $|\Gamma^2 \geqslant 15$ dB in the frequency band $\delta f_s/f_0 > 13$ percent. From Figs. 6 and 7, the widening of the locking band is connected by extending the angle x range for the stationary mode of injection-locked oscillator, that has a decrease of generalized RF system quality.



8. These plots describe power as a function of the complex reflection coefficient, Γ, versus frequency over the frequency range of 33 to 39 GHz.

The development of power-pulsed injection-locked oscillators presented here confirms the possibility of designing power-pulsed transmitters (Txs) in the millimeter-wave range with a one-stage locking gain greater than 15 dB at a frequency band above 12 percent. An illustration of this is the experimental frequency dependency of relative power level P/P_0 (f) across the oscillator's locking band **(Fig. 9)**. This dependency is defined for a two-stage injection-locked pulse Tx with Si double-drift IMPATT diodes mounted on copper (Cu) heat sinks, with full amplification of more than 30 dB.

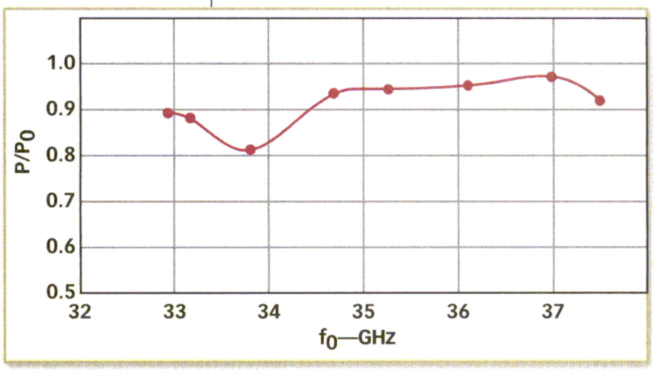
The widening of the locking band of injection-locked IMPATT oscillators is based upon the certain well-defined principles of RF circuit construction:

1. The matching of the semiconductor structure and RF load impedance is enabled by the location of the IMPATT diode structure in a parallel resonant circuit whose parameters can be defined by mounting elements of the metal-ceramic-diode package and by the choice of an RF-circuit geometry to ensure the necessary transformation of characteristic waveguide resistance to the diode terminals. Any additional matching discontinuities in the waveguide section is eliminated. The stored energy in this system is concentrated in the region of the packaged diode and the generalized quality of RF system is minimal.

2. The series resonant compensating circuit is included in series with the resonant parallel circuit of the packaged diode. As a result, the full reactance of the microwave system decreases. The series-resonant compensating circuit is created in a waveguide-to-coaxial T-junction by choosing the antispurious load that has a high reflection coefficient and properly positioning it in the coaxial line.

3. The fixing ability of oscillator at free-running mode (when input-locking signal i_s = 0, K = T_2 sin($\psi_2 - \psi_1$) must be decreased in the operating frequency band. Despite this, a spectral power density of frequency noise of the injection-locked oscillator will not deteriorate because it is defined by spectral performances of the locking signal.

4. In weak-signal mode, increasing the input-locking signal amplitude leads to widening of the locking band in direct proportion to $(P_s/P_a)^{0.5}$, where: P_a = the power in free-running mode. When P_s increases and approaches the level of P_a, predistortion must be introduced for decreasing P_a. MRF



9. The frequency dependency of relative power (P/P_0) over the oscillator's locking band (32 to 38 GHz) is illustrated by this curve.

REFERENCES

1. M.G. Ischenko, L.V. Kasatkin, V.M. Tarasjuk, A.V. Cvir, *et al.*, "Pulse Coherent Semiconductor Generator At Millimeter Wave Range For Electronic Spin Echo Spectrometer," *Proceedings of Institutes of Higher Education,* Radioelectronics. ISSN 0021-3470, Vol. 43, 2000, No. 8, pp. 50-55, Kiev, Ukraine.

2. L.V. Kasatkin and N.F. Karushkin, "Stabilization of RF Parameters Of Injection-Locked Pulsed IMPATT Oscillators, *Microwave Journal,* 2000, No. 9, pp.172-180.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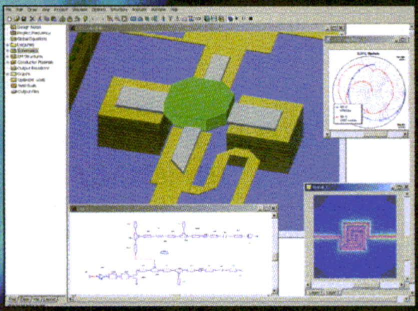

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Grasp The Meaning Of Mixed-Mode S-Parameters

Mixed-mode S-parameters are useful in the analysis of the differential circuits and components found in high-speed digital systems.

Digital systems continue to gain in speed, well beyond 1 Gb/s, requiring new methods of analysis and testing. Traditional S-parameters are useful when working with single-ended devices. But mixed-mode S-parameters provide the capability of analyzing and visualizing the signal flow through differential (balanced) lines and devices found in modern high-speed digital communications systems. Part 3 of this four-part series on S-parameters will examine mixed-mode S-parameters and how they can be applied to the analysis of high-speed digital circuits.

GARTH SUNDBERG
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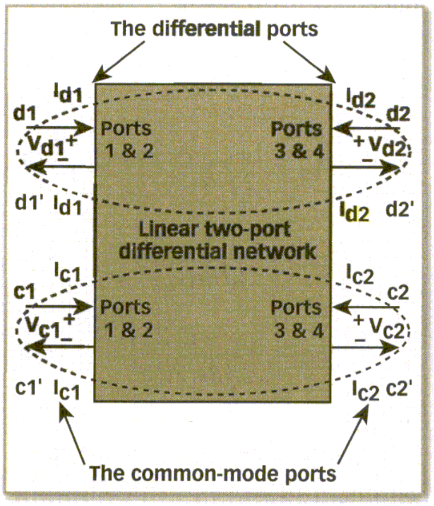
S-parameters were initially developed due to the need for analyzing circuits as distributed, rather than lumped, circuit models.[1] S-parameters can be used to describe differential networks, but a strict definition was not developed until Bockelman *et al.* addressed the issue.[2] Bockelman's work also included a study on how to adapt single-ended S-parameters for use with differential circuits.[2] This adaptation (known as mixed-mode S-parameters) reports on differential and common-mode operation, as well as conversion between the two modes of operation.



1. This example of a mixed-mode circuit shows the common-mode and differential ports.

To help understand differential S-parameters, it may be useful to use the analysis of a differential amplifier as an example (see Fig. 3 of Part 1, *Microwaves & RF*, March 2001, p. 122). To characterize this amplifier, each lead can be identified as a port and the differential circuit can be labeled as a four-port network. This approach treats the amplifier as a single-ended device. To measure the S-parameters for this single-ended approach using a two-port vector network analyzer (VNA), the two unused ports are terminated in 50 Ω and two-port S-parameter measurements are made on the two unterminated ports. The terminations are maintained and measurements continue until enough information has been gathered to construct the 4 × 4 S-parameter matrix.

Continued from page 99

With the four-port S-parameters measured, the device under test (DUT) has been accurately characterized (assuming a good calibration) for single-ended performance. Since the amplifier is designed for differential operation, however, these S-parameters do not provide much insight to the amplifier's differential (or common-mode) operation because each port contains the differential and common-mode response.

To overcome this problem, a system similar to that used to describe the four transfer gains (A_{cc}, A_{dd}, A_{cd}, and A_{dc}) introduced by Middlebrook[3]) is used. This system of S-parameters (known as mixed-mode S-parameters) was introduced by Bockelman *et al.*[2] It begins by grouping ports one and two together (to form a differential port one) and grouping ports three and four together (to form a differential port two). This grouping is shown in **the figure**. It should be noted that the network shown is only a tool to help visualize the operation of a differential circuit. In reality, there are only two differential ports—each having differential and common-mode signals.[2]

Mixed-mode S-parameters provide the capability of analyzing and visualizing the signal flow through differential (balanced) lines and devices.

The differential and common-mode voltages and currents in the figure can be defined as:[2]

$$v_{d1} = v_1 - v_2$$
$$v_{c1} = \frac{v_1 + v_2}{2} \qquad (1)$$

$$i_{d1} = \frac{i_1 - i_2}{2}$$
$$i_{c1} = i_1 + i_2 \qquad (2)$$

$$v_{d2} = v_3 - v_4$$
$$v_{c2} = \frac{v_3 + v_4}{2} \qquad (3)$$

$$i_{d2} = \frac{i_3 - i_4}{2}$$
$$i_{c2} = i_3 + i_4 \qquad (4)$$

With this conversion between single-ended voltages and currents to differential (and common-mode) voltages and currents, a way to convert from single-ended S-parameters to mixed-mode S-parameters can be found. Before the conversion is provided, a review of what has been done in the past to measure circuits differentially will be presented.

In the past, if differential measurements were desired, then a balun (or hybrid coupler) would be needed (see Fig. 5 of Part 1). The problems associated with this method include the magnitude and phase imbalance of the baluns, the lack of a method to measure mode conversion (i.e., from differential mode to common mode), the lack of a rigorous definition of mixed-mode S-parameters, and the fact that calibrating the system with baluns is not well-defined. Due to these problems, a carefully developed system is needed to describe a DUT differentially.

With the need for mixed-mode S-parameters presented, it is now convenient to define the mixed-mode S-parameters. Using the definition for the incident and returning waves,[1] a differential- and common-mode incident and returning power wave can be defined:[2]

$$a_{dn} = \frac{v_{dn} + i_{dn} Z_{dn}}{2\sqrt{Re(Z_{dn})}} \qquad (5)$$

$$b_{dn} = \frac{v_{dn} - i_{dn} Z_{dn}}{2\sqrt{Re(Z_{dn})}} \qquad (6)$$

$$a_{cn} = \frac{v_{cn} + i_{cn} Z_{nc}}{2\sqrt{Re(Z_{cn})}} \qquad (7)$$

$$b_{cn} = \frac{v_{cn} - i_{cn} Z_{cn}}{2\sqrt{Re(Z_{cn})}} \qquad (8)$$

where:

v_{dn} = the differential voltage at port n,

v_{cn} = the common-mode voltage at port n,

i_{dn} = the differential current at port n,

i_{dc} = the common-mode current at port n,

Z_{dn} = the differential-mode characteristic impedance at port n, and

Z_{cn} = the common-mode characteristic impedance at port n.

To calculate Z_d, it should be remembered that Z = V/I. To calculate Z_d, it is necessary to use v_d from Eq. 1 and divide it by I_d from Eq. 2. A similar method is needed to calculate Z_c. Following these steps yields:

$$Z_d = 2Z_{oo}$$
$$Z_c = \frac{Z_{oe}}{2} \qquad (9)$$

With the definition of the power waves in Eqs. 5 through 8, mixed-mode S-parameters can be defined as:[2]

$$b_{d1} = s_{dd11}a_{d1} + s_{dd12}a_{d2} + s_{dc11}a_{c1} + s_{dc12}a_{c2}$$
$$b_{d2} = s_{dd21}a_{d1} + s_{dd22}a_{d2} + s_{dc21}a_{c1} + s_{dc22}a_{c2}$$
$$b_{c1} = s_{cd11}a_{d1} + s_{cd12}a_{d2} + s_{cc11}a_{c1} + s_{cc12}a_{c2}$$
$$b_{c2} = s_{cd21}a_{d1} + s_{cd22}a_{d2} + s_{cc21}a_{c1} + s_{cc22}a_{c2} \qquad (10)$$

where the following notation is used:

$$S_{ghij} = S_{(output\ mode)(input\ mode)\ (output\ port)(input\ port)} \qquad (11)$$

which can be represented in the following format:

$$\begin{bmatrix} b_{d1} \\ b_{d2} \\ b_{c1} \\ b_{c2} \end{bmatrix} = \left\{ \begin{matrix} \begin{pmatrix} S_{dd11} & S_{dd12} \\ S_{dd21} & S_{dd22} \end{pmatrix} & \begin{bmatrix} S_{dc11} & S_{dc12} \\ S_{dc21} & S_{dc22} \end{bmatrix} \\ \begin{pmatrix} S_{cd11} & S_{cd12} \\ S_{cd21} & S_{cd22} \end{pmatrix} & \begin{bmatrix} S_{cc11} & S_{cc12} \\ S_{cc21} & S_{cc22} \end{bmatrix} \end{matrix} \right\} \begin{bmatrix} a_{d1} \\ a_{d2} \\ a_{c1} \\ a_{c2} \end{bmatrix} \qquad (12)$$

where:

S_{dd} = the differential S-parameters,

S_{cc} = the common-mode S-parameters,

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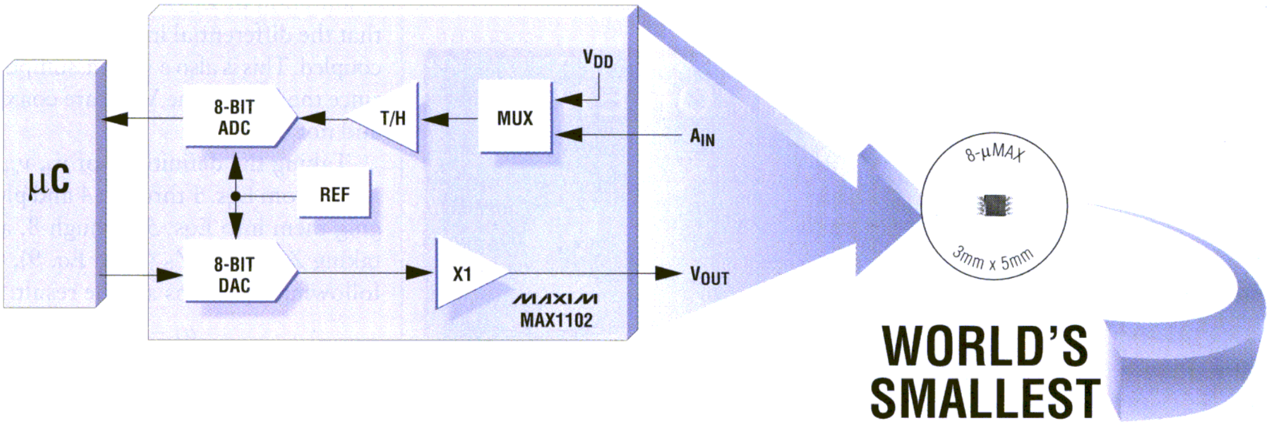

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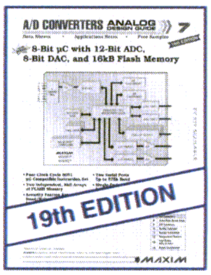

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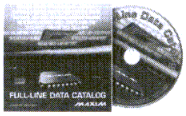

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S_{dc} = the mode conversion that occurs when the device is excited with common-mode signal and the differential signal is measured, and

S_{cd} = the mode conversion that occurs when the device is excited with a differential-mode signal and the common-mode response is measured.

This mode conversion is unavoidable because (whether intentionally or not) there is a common ground to the entire circuit or there is device mismatch and imbalance.

To convert from single-ended S-parameters to mixed-mode S-parameters, it is assumed that the DUT is being fed from differential input lines and that $Z_{oe} = Z_{oo} = Z_0$. The assumption of differential input lines is not limiting, since it is possible to define the length of the lines to be arbitrarily small. The assumption of $Z_{oe} = Z_{oo} = Z_0$ implies that the differential input lines are not coupled. This is also a valid assumption, since the lines of the VNA are coaxial, and not coupled.

Taking the definitions of v_d, v_c, i_d, and i_d from Eqs. 1 through 4 and plugging them into Eqs. 5 through 8, and taking Z_d to be $2Z_0$ (from Eq. 9), the following equations are the result:[2]

$$a_{d1} = \frac{a_1 - a_2}{\sqrt{2}}$$

$$a_{c1} = \frac{a_1 + a_2}{\sqrt{2}} \qquad (13)$$

$$b_{d1} = \frac{b_1 - b_2}{\sqrt{2}}$$

$$b_{c1} = \frac{b_1 + b_2}{\sqrt{2}} \qquad (14)$$

$$a_{d2} = \frac{a_3 - a_4}{\sqrt{2}}$$

$$a_{c2} = \frac{a_3 + a_4}{\sqrt{2}} \qquad (15)$$

$$b_{d2} = \frac{b_3 - b_4}{\sqrt{2}}$$

$$b_{c2} = \frac{b_3 + b_4}{\sqrt{2}} \qquad (16)$$

A convenient matrix representation of Eqs. 13 through 16 is given as:

$$\begin{bmatrix} a_{d1} \\ a_{d2} \\ a_{c1} \\ a_{c2} \end{bmatrix} = \frac{1}{\sqrt{2}}$$

$$\begin{pmatrix} 1 & -1 & 0 & 0 \\ 0 & 0 & 1 & -1 \\ 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \end{pmatrix} \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \end{bmatrix} \qquad (17)$$

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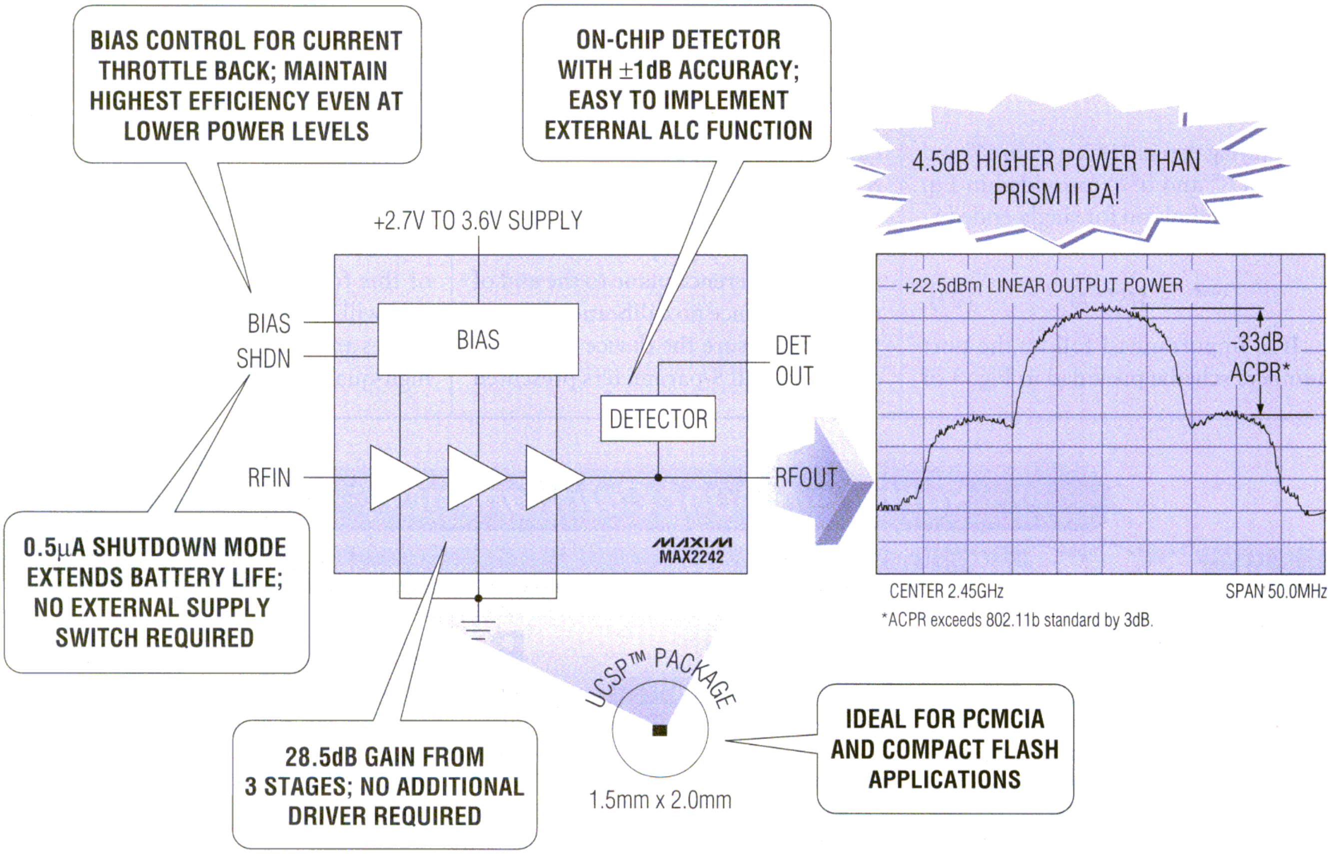

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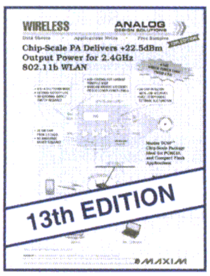

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Continued from page 102

$$a^{mm} = Ma^{std}$$
$$b^{mm} = Mb^{std} \qquad (19)$$

In Eq. 19, the superscript "mm" represents mixed mode and "std" represents the standard parameters and "M" is given by:

$$M = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & -1 & 0 & 0 \\ 0 & 0 & 1 & -1 \\ 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} \qquad (20)$$

Applying the conversion from a^{std} and b^{std} to a^{mm} and b^{mm} (provided in Eq. 19) to the definition for single-ended S-parameters[1] yields:

$$S^{mm} = MS^{std}M^{-1} \qquad (21)$$

It is important to follow the port numbers scheme provided in Fig. 3 of Part 1. If the four ports are not numbered in this fashion, then Eq. 20 for "M" will not be correct. It will have to be arranged for Eq. 21 to work correctly.

To demonstrate this technique, the return loss of the MAX3950 10-Gb/s deserializer was measured using a model 8753D VNA from Agilent Technologies (Santa Rosa, CA).[4] Since this network analyzer only operates to 6 GHz, no data beyond this point are presented, although the component is capable of operating beyond 10 GHz. The test setup is shown in Fig. 6 of Part 1.

To obtain the measured data, a standard short-open-load-through (SOLT) calibration was performed using the 85033D 3.5-mm calibration kit from Agilent Technologies. Once the calibration was performed, it moved the measurement reference plane to the end of the cables. Since no calibration kit was built to measure the device on its circuit board, all S-parameters presented include the effects of the transmission line and SMA connectors required to route the test signals from the VNA to the MAX3950. As a result, the actual return loss of the device will be better than the results presented here (which include connector and cable losses).

To obtain true differential return loss, Eq. 21 must be applied to the measured data. The results of this action are presented in Fig. 8 of Part 1. To validate the conversion process, the differential return loss of the MAX3950 on the MAX3950 EV kit was measured using the ATN-4000 series system, a true differential network analyzer from ATN Microwave (North Billerica, MA). The results of the differential analyzer are also presented in Fig. 8 of Part 1.

Next month, the final installment of this four-part series on S-parameters will examine measurement techniques and discuss the importance of a high-quality calibration. MRF

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MICROWAVE ENGINEERS generally possess a diversified set of skills and interests. As testimony to the versatility of the modern microwave engineer, the upcoming 2001 IEEE/International Microwave Theory & Techniques Symposium (MTT-S) will offer technical sessions and workshops that cover everything from automotive sensors to wireless communications.

Scheduled for May 20-25, 2001 at the Phoenix Civic Plaza (Phoenix, AZ), the 2001 IEEE/MTT-S features more than 500 technical papers on commercial and military RF/microwave technology and applications.

The show is actually a combination of three conferences, each offering its own set of technical sessions and workshops.

First, the 2001 Radio Frequency Integrated Circuits Symposium (RFIC2001) will present papers and sessions on topics such as WCDMA transcievers, RF/microwave power

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Lastly, the Automatic RF Techniques Group (ARFTG) will conduct a one-day event on topics such as a three-port VNA system, automated testing and tuning of microwave filters, along with calibrating electro-optical sampling systems.

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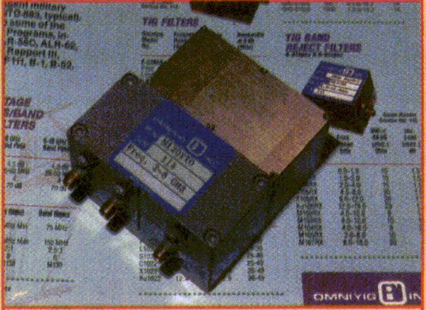

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C106	4.0 – 8.0	4.5	25–40
X106	8.0 – 12.4	4.5	25–40
Ku106	12.4 – 18.0	4.5	28–45
3-STAGE			
P103	0.5 – 1.0	5.0	14–25
L103	1.0 – 2.0	3.5	20–35
S103	2.0 – 4.0	3.0	20–35
C103	4.0 – 8.0	3.0	25–40
X103	8.0 – 12.4	3.0	25–40
Ku103	12.4 – 18.0	3.5	30–45
4-STAGE			
P104	0.5 – 1.0	6.0	12–23
L104	1.0 – 2.0	4.5	20–35
S104	2.0 – 4.0	4.0	20–35
C104	4.0 – 8.0	4.0	25–40
X104	8.0 – 12.4	4.0	25–40
Ku104	12.4 – 18.0	4.0	28–45
DUAL 2-STAGE			
P1022	0.5 – 1.0	3.5	17–30
L1022	1.0 – 2.0	3.0	24–35
S1022	2.0 – 4.0	2.5	25–40
C1022	4.0 – 8.0	2.5	25–40
X1022	8.0 – 12.4	2.5	25–40
Ku1022	12.4 – 18.0	2.5	30–45
MULTIOCTAVE BANDS			
M1611/2	1.0 – 18.0	5.5	25–65
M1612/4	2.0 – 18.0	6.5	25–75
M102/2[5]	1.0 – 12.4	5.0	25–60
M1613/2	1.0 – 12.4	5.5	25–60
M1048/4	4.0 – 18.0	6.0	25–60
M203/4[5]	1.0 – 18.0	6.5	25–70

Other Multioctave YIG Filters are available. Analog and 12-bit digital drivers are available for all YIG devices.

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OMNIYIG INC.

DETECTORS, LIMITERS and COMB GENERATORS

Since 1973 OMNIYIG has been designing and improving the performance of detectors, limiters, and comb generators. We have many new designs in many sizes. We also integrate input power amplifiers with the comb generators. Some of our standard designs are shown below. Send for our complete catalog.

ZERO BIAS SCHOTTKY DETECTORS

Omniyig Model No.	Freq. Range (GHz)	k Factor (mv/mw)	TSS (dBm)
Zero Bias			
ODZ0004A	0.1 – 18	1200	–51
ODZ0510A	0.5 – 4	1750	–53
ODZ0518A	1.0 – 12	1250	–52
ODZ0527A	2.0 – 12	1250	–52
ODZ0328A	2.0 – 18	1250	–52
Tunnel Planar			
ODT0004A	0.1 – 18	750	–50
ODT0510A	0.5 – 4	800	–50
ODT0527A	2.0 – 12	800	–50
ODT0328A	2.0 – 18	700	–50
ODT0240A	6.0 – 18	700	–50

COMB GENERATORS

Omniyig Model No.	Input Freq. (MHz)	Output Freq. Range (GHz)	Output Pwr. (dBm)
OHG10140	100	0.1 – 4	–10
OHG10118	100	0.1 – 18	–40
OHG20218	200	0.2 – 18	–34
OHG30318	250	0.25 – 18	–29
OHG51027	500	0.5 – 18	–20
OHG61027	1000	0.1 – 18	–33
OHG72027	2000	2.0 – 18	–10
OHG61026	1000	1.0 – 26	–35
OHG71026	2000	2.0 – 26	–20

TRACKING YIG FILTERS/ YIG OSCILLATORS

Omniyig Model No.	Freq. Range (GHz)	Filter IL (dB)	Tracking (MHz)
M129YTO	0.5 – 2	5.5	5
M120YTO	2 – 8	5.0	7
M121YTO	8 – 18	5.0	8

Oscillator RF power output +13 dBm. Integrated with Analog or 12-bit TTL drivers.

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OMNIYIG INC.

LIMITERS

Omniyig Model No.	Freq. Range (GHz)	Max. Ins. Loss (dB)	Max. Lkg. Pwr. (dBm)*
PIN Diode			
OLP2801A	0.1 – 0.5	0.5	+20
OLP2817A	1.0 – 4.0	0.5	+19
OLP2726A	2.0 – 8.0	1.2	+19
OLP2640A	6.0 – 18.0	2.0	+18
OLP2650A	2.0 – 18.0	2.5	+18
Schottky			
OLD2802A	0.1 – 1.0	0.5	+15
OLD2709A	0.5 – 2.0	0.5	+15
OLD2762A	2.0 – 8.0	1.0	+14
OLD2635A	4.0 – 18.0	2.5	+14
OLD2650A	2.0 – 18.0	2.5	+13

*Measured at 1 Watt CW Power

COMB GENERATORS with INTEGRATED INPUT RF AMPLIFIER

Omniyig Model No.	Input Freq. (MHz)	Output Freq. Range (GHz)	Output Pwr. (dBm)
CG252A	100–200	0.1 – 12	–24
CG253A	100	1.0 – 18	–38
CG256A	200	1.0 – 18	–35
CG259A	250	1.0 – 18	–30
CG262A	500	1.0 – 18	–18
CG265A	1000	1.0 – 18	–15
CG266A	1000	2.0 – 26	–33
CG268A	2000	2.0 – 18	–20
CG269A	2000	2.0 – 26	–35

Call Omniyig with your requirements or for a new updated catalog. We offer many other models covering a variety of frequencies.

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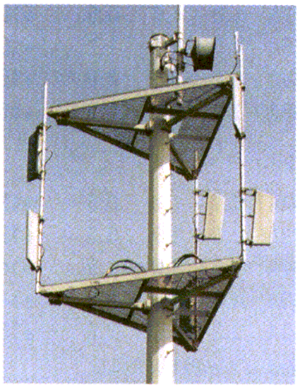
OMNIYIG INC.

WORLDWIDE WIDEBAND COVERAGE

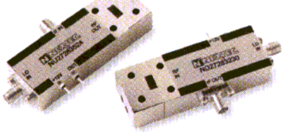
▼ LMDS ▼

IMT-2000
▼ UMTS ▼

Transceivers
- 26, 28, 31 & 38 GHz
- 7 GHz to 38 GHz Point-to-Point
- Pout up to 2 Watts
- N.F. as Low as 3.0 dB
- FSK, QPSK & QAM



Up & Downconverters
- 24 GHz to 30 GHz
- P1dB up to 2 Watts
- Rugged Thin-Film Construction
- Gain or Power Control Option
- Optional Highly Stable Power Detector



Nextec Microwave & RF, Inc. designs, manufactures and markets high quality components and subsystems for wideband communications applications – worldwide.

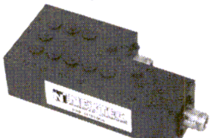
Focusing on LMDS and the new IMT-2000 and UMTS standards, Nextec is positioned to provide you with the design and production know-how to meet your requirements from component to subsystem levels.

Nextec is committed to providing on-time delivery of specification compliant, high quality products at optimum value for your investment.

Filters

Transmit
- 2110 – 2170 MHz
- 0.4 dB Insertion Loss
- -80 dBc Rejection

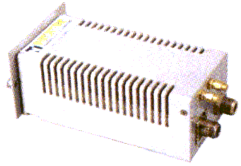
Receive
- 1910 – 1980 MHz
- 0.4 dB Insertion Loss
- -80 dBc Rejection



RF Front Ends

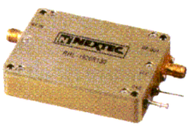
Transmit
- 2110 – 2170 MHz
- 0.5 dB Insertion Loss
- -80 dBc Rejection

Receive
- 1920 – 1980 MHz
- Up to 40 (±1.0) dB Gain
- -90 dBc Rejection



High Power Amplifiers
- 2110 – 2170 MHz
- Up to 45 dBm Output Power
- Up to 50 dB Gain

Low-Noise Amplifiers
- 1920 – 1980 MHz
- 1.2 dB Noise Figure
- Up to 40 (±1.0) dB Gain



NEXTEC
MICROWAVE & RF INCORPORATED

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Web: www.nextec-rf.com

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technical papers

Sunday, May 20, 2001
Workshops
8:00 am to 5:00 pm

WSA STATE-OF-THE-ART FILTER DESIGN USING EM AND CIRCUIT SIMULATION TECHNIQUES

Significant advances in computational electromagnetics continue to be made. This workshop will address the state of the art from component modeling to multiplexer design. Expectations of using EM simulators as effective tools in an automated design environment continue to be raised based on considerable work currently in progress. Emphasis on optimization methodologies as a cornerstone in simulation, modeling, design and manufacturing are discussed. This workshop will draw upon the popularity and success of recent workshops involving electromagnetics and CAD. A balance between theory, implementation and practical discussions of computational and design issues will be struck so that the workshop will have wide appeal.

WSB RF SYSTEMS AND CIRCUIT ISSUES OF THIRD GENERATION WIDEBAND CDMA SYSTEMS LIKE UMTS

This workshop will begin by introducing spread-spectrum and CDMA basics. The second section provides a description of the 3GPP system specifications. Sections 3 and 4 will deal in detail with RF-related 3GPP test cases and simulation issues. Section 5 will focus on the evolution from 2G to 3G transmitter and receiver architectures (e.g., Tx heterodyne and direct up-conversion, Rx heterodyne and homodyne, etc.). In Sections 6 and 7, BiCMOS and SiGe RF ICs successfully designed for commercial applications using Infineon semiconductor processes will be presented. Finally, in Section 8 the feasibility of UMTS transceivers fabricated from CMOS technologies in the 2-GHz band are investigated.

WSC RF AND HIGH SPEED APPLICATIONS OF TUNNEL DEVICES

Quantum-mechanical tunneling is a transport process that dominates as device dimensions get smaller and smaller. A tunnel diode can be integrated with a transistor resulting in a novel, multifunctional device. This workshop will present a comprehensive overview of this new tunnel-device technology and its applications in RF and digital circuits. The current status of tunnel diode physics and modeling will be reviewed along with measurement techniques and noise suppression. Tunnel device growth and issues in integrating it with other semiconductor devices and circuits will be discussed. A variety of MMIC applications, such as VCOs, amplifiers, mixers, receivers, antennas, millimeter-wave radiometry and imaging applications, and A/D circuits will be presented. Circuit and system level specifications and considerations will be discussed.

WSD MICROWAVE PHOTONIC COMPONENT, INTEGRATION, AND SYSTEM TECHNIQUES FOR BROADBAND FIBER-FED WIRELESS

This workshop will provide an overview of microwave photonic component technology and its system application in fiber-radio systems. It will begin with a tutorial introduction to fiber radio systems, followed by talks on state-of-the-art approaches to distribution of millimeter-waves over fiber and remote upconversion techniques. Attention will then turn to the component integration technologies that will be needed for low cost fiber-radio modules, including: multichip modules, MMICs, OEICs and silicon micromachining/MEMs for passive fiber alignment.

WSE ADVANCED LTCC MICROWAVE DESIGN AND MANUFACTURING ISSUES

During the past few years, LTCC (Low Temperature Cofired Ceramics) has become an enabling technology for wireless applications from GSM, CDMA, TDMA, Bluetooth, and Wireless LAN at the lower microwave frequency end up to the millimeter-wave region for applications such as LMDS at 30 GHz, etc. The workshop will bring together contributors from LTCC design and manufacturing groups worldwide. It will focus on the still-unsolved 3D multilayer design issues in close relation to volume manufacturing issues and the trends towards innovative materials, high resolution patterning, buried non-ideal ground planes, higher frequencies, as well as improved thermal management.

8:00 am to noon

WSF NEW ADVANCES IN NONLINEAR CIRCUIT DESIGN

This workshop will present in-depth tutorial discussion as well as new developments in techniques for analyzing nonlinear circuits. It will provide discussions on problems of new ideas such as application of wavelets in nonlinear network design or fundamental aspects of circuit-simulation aspects. Furthermore, this workshop will supply a forum for discussion on present important topics and possible new developments in the future. This event will also provide a platform for participants to introduce their results or suggestions by presenting their transparencies and explaining their point of view.

1:00 to 5:00 pm

WSG HIGH POWER RF SI: DEVICES, MODULES AND TRENDS

Si continues to be the workhorse of high-power solid-state applications. Device design improvements, new packaging concepts, and new high-volume manufacturing approaches have pushed Si far ahead of any other competing technology when it comes to power. Speakers who specialize in various aspect of device design, modeling, manufacturing, and testing, will review the state of the art in Si RF power technology, mechanical and electrical limitations, cost drivers, reliability issues, and new packaging approaches. Fundamental limitations to performance and cost will be identified. Application experts will be asked to predict and rationalize future trends in power, frequency, and integration.

8:00 am to 5:00 pm

WSH WEB-BASED RF AND MICROWAVE EDUCATION

The MTT Society has sponsored development of multimedia educational tools at two US universities, and is planning a special issue and an electronically published supplement of *IEEE Transactions on Microwave Theory and Techniques* dedicated to RF and Microwave Tutorials in 2002. These are the first steps by MTT Society in making Web-based RF and microwave tutorials available to MTT-S members. The goal of this workshop is to discuss what is available today in Web-based and Web-assisted RF and microwave education, what needs to be done, and how educators in the RF and microwave area can make use of Web technology for benefiting MTT-S membership. Participants are encouraged to bring a couple of viewgraphs to express their viewpoints and share their thoughts.

WSI ADVANCES IN RF MEMS: COMPONENTS, PACKAGING TECHNIQUES, RELIABILITY, AND MICROPHONICS

The purpose of this workshop is to provide the audience with an overview of the latest results obtained in US and international laboratories and to emphasize the new research/development directions (packaging, reliability, power handling issues, Brownian noise, acceleration noise, etc.) needed for the success of this field. The full-day workshop will cover a wide range of areas, such as MEMS phase shifters, MEMS tunable filters, and MEMS packaging techniques using MEMS switches and varactors. Also, the effect of Brownian, acceleration, and microphonic noise on MEMS circuits will be considered in this workshop. The workshop will conclude with a discussion on the reliability and failure modes of MEMS-based devices.

WSJ FERRITE DEVICES AND MATERIALS FOR MILLIMETER-WAVE APPLICATIONS

This workshop will review the properties, characterization, and fabrication of millimeter-wave ferrite materials for mm-wave device applications. It will describe the development and applications of high-power control components for wideband radar and satellite communications. Improvements in performance and integration into low-cost RF packaging and planar phase shifter configurations suitable for LTCC fabrication will be discussed. Ferroelectric materials and MEMS are also candidates for millimeter-wave phase shifters and their performance will be compared with the equivalent ferrite devices. Commercial and defense-systems requirements for ferrite control components, the current state of the art, potential for future device and materials developments, and comparisons with non-ferrite approaches will be reviewed in detail.

1:00 to 5:00 pm

WSK DYNAMICS OF THE MICROWAVE WORKBENCH

The growing use of digital communication systems has complicated RF circuit design. Additionally, verification of simulated measured results is an indispensable part of the design procedure. The signals generated by commercially available signal generators are not readily accessible to the simulator in use and form a significant bottleneck for verification. Furthermore, these instruments generate a limited set of complex digital signals, while the designer often requires a broader selection of complex digital signals combined with, for example, noise, phase-noise, or precorrection information. This workshop examines the trends in simulation at the system and circuit level, including the link to hardware realization, modeling, and test, with specific attention being paid to aspects of standardization in software and hardware design.

Monday, May 21, 2001
8:00 am to 5:00 pm
WORKSHOPS

WMA LINEARIZATION FOR 3G SYSTEMS

High data rates with Internet access are the objectives of 3G systems. Modulation formats with greater bandwidth efficiency are needed and high data rates are required without losing phone capacity or features. With these 3G systems, more demands are being made on the linearity of systems to meet the specifications. This workshop will first focus on the wideband CDMA and EDGE systems describing their operation and linearity requirements. Then, the various linearization techniques will be described and compared. These include predistortion, feedback, and feedforward, including DSP adaptive techniques. Other linearization issues will be discussed. Finally, speakers will address the latest linearization methods for 3G systems that show implementation as well as results.

WMB STATISTICAL DESIGN AND MODELING TECHNIQUES FOR MICROWAVE CAD

An objective of this workshop is a tutorial review of EM-based modeling, mixed linear/nonlinear field/circuit simulation, applications of wavelets, space mapping, and knowledge-based artificial-neural-network (ANN) technology for enhanced empirical modeling and CAD. The workshop will be physically and electromagnetically oriented. It will highlight advances in ANNs as an unconventional alternative to modeling and design tasks in RF and microwave CAD. An objective of this workshop is to present the theory and application of statistical design tools applicable to RF/microwave circuit design, manufacturing, and experimental research. Monte Carlo and space-domain statistical optimization techniques for yield maximization will be discussed. Characterization of random measurement errors, parametric effects, and their interactions on the outcome of an experiment will be considered. A statistical design tool known as Design of Experiments (DOE) provides a powerful methodology to systematically characterize the influence of main effects and their interactions. The theory of DOE will be covered and applied to some RF/microwave problems in the experimental arena.

WMC ICs FOR 40 Gb/s DATA RATE COMMUNICATIONS

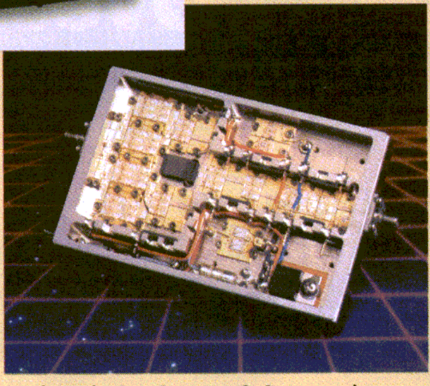
Bit rates in long-haul systems are expected to rise to STM-256 or 40 Gb/s soon after the year 2000. At these data rates, the transmitted signal spectrum is extremely broadband and contains components from as low as 30 kHz, t hrough microwave frequencies, up to millimeter-wave frequencies (40 GHz).

The Power in Broad Bandwidth Wireless Communications

Wireless Communications Products for the New Millennium

RF and microwave hardware accounts for over $7 billion within the growing wireless communications infrastructure. Since its founding in 1981, CTT has focused on the development and production of a variety of products that have become ready, cost-effective solutions to problems and requirements encountered in this broad bandwidth, worldwide market.

Nearly two decades of evolution at CTT has resulted in a solid cadre of technical expertise, a long list of satisfied customers and a line of products – with both the breadth to be chosen for a wide variety of applications and the depth of component performance – which gives designers the confidence that overall system performance will be met.



Moreover, our volume production ability has increasingly made CTT products the **hardware of choice** in the price-sensitive, **broad bandwidth**, **high linearity**, **wireless communications** market. This importance of choice, to the designer, is even more critical when understanding that CTT is providing RF functions that account for as much as one third the cost model in wireless communications base stations.

CTT's history, technical expertise, production know-how and resultant patronage allows the Company access to both monetary and production resources to excel in projects of any magnitude. At CTT Wireless we're committed to serving the wireless communications market with a simple goal: **Quality, Performance, Reliability, Service and On-Time Delivery of our products.**

To find out how we can provide you with the products and service, and cost-effective wireless solutions you are looking for, **contact CTT Wireless today.**

High Power Amplifiers
- ☑ *Power Levels to 150 Watts*
- ☑ *Frequency Coverage from 800 MHz to 14.5 GHz*

Base Station Amplifiers
- ☑ *Power Levels to 500 Watts*
- ☑ *Frequency Coverage from 800 MHz to 2.4 GHz*
- ☑ *GSM, TDMA, CDMA, WCDMA (3G)*

LMDS, Point-to-Point and Point-to-Multipoint Amplifiers/Transceivers/ODUs
- ☑ *Frequency Coverage from 12 GHz to 45 GHz*
- ☑ *Low Intermodulation Distortion*
- ☑ *Power Levels to 1 Watt*

VSAT/SATCOM Amplifiers
- ☑ *Power Levels to 40 Watts*
- ☑ *Frequency Coverage from: 5.9 – 6.4 GHz, 8.5 – 9.6 GHz and 14.0 – 14.5 GHz*

Super Broadband Amplifiers for Fiber Optics
- ☑ *50 kHz – 15 GHz*

Up and Down Converters
- ☑ *C, X, Ku, and Ka-Bands*
- ☑ *Compact, Space Saving Designs*
- ☑ *Remote Interfaces: Control, Status and Alarm*

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Digital engineers are challenged by the non-square-wave shape of the high-data-rate signal and the need to consider transmission-line effects, while analog designers are challenged by jitter specifications and the need for time-domain analysis. The aim of this workshop is to debate the mixed-signal issues involved with integrated circuit design for 40-Gb/s data-rate communications systems, and expand on the technology and techniques being used by industry leaders within this field.

WMD ADVANCES IN CERAMIC INTERCONNECT TECHNOLOGIES FOR WIRELESS, RF AND MICROWAVE APPLICATIONS

The purpose of the workshop will be to acquaint engineers with the capabilities of ceramic technologies for realizing wireless and microwave circuits and systems. For the year 2001, increased emphasis will be placed on more advanced design techniques and applications.

The reason for running the workshop is that ceramic technologies are generally less familiar to design engineers, yet offer significant benefits in terms of circuit performance, weight, and reliability. These benefits need to be communicated to design engineers, enabling them to realize appropriate circuit and system solutions. Newer technologies are further advancing these benefits, while at the same time driving costs down.

WME ULTRA-HIGH SPEED ICs FOR COMMERCIAL APPLICATIONS — PRESENT STATUS AND FUTURE TRENDS

Recent advancements in various semiconductor technologies have opened up the possibility of achieving multigigabit-IC performance. While 10-Gb/s systems are commercially deployed and 40-Gb/s systems are demonstrated at the laboratory level, several research teams are working on 100 Gb/s and beyond. This workshop will bring several experts from around the world who are working in this area of technology. The presentations will describe the latest information on design, fabrication, measurement, applications, and product development. It will start with an overview of the ultra-high-speed ICs for commercial applications. The speakers will then present multigigabit circuits implemented with various state-of-the-art integrated circuit technologies such as InP HBT, SiGe HBT, InP HEMT, etc. The workshop will also cover presentations on signal processing including multi-GS/s analog-to-digital conversion, optical networking, as well as switching VHSICs and embedding/MCM issues of multigigabit systems.

8:00 am to noon

WMF HIGH DENSITY/MULTILAYER RF INTERCONNECTS

There is a growing need to reduce the size

and cost of RF ICs and highly integrated RF systems on a chip for smaller consumer products and to enable their insertion into microwave and millimeter-wave phased array antennas. To satisfy this goal, circuits and packages are now incorporating multiple layers of wiring. Furthermore, functions other than simple routing are being performed in these multilayer circuits through the incorporation of embedded passive elements and multiple interconnects between layers. This workshop will present the challenges, state of the art, and possibilities of multilayer circuits. Presentations will describe multilayer circuits fabricated with micromachined Si wafers, as well as thin- and thick-film technologies.

1:00 to 5:00 pm

WMG HIGH-PERFORMANCE AND EMERGING FILTER TECHNOLOGIES FOR WIRELESS

This workshop begins by overviewing present and future filter requirements for wireless systems. Recent evolution of traditional filter technologies will be summarized, and new emerging filter technologies will be introduced and described, including microelectromechanical systems (MEMS), ferroelectric, micromachined (thin) film bulk-acoustic resonator (FBAR), and high-temperature superconductive (HTS) filter technologies. Some aspects of the workshop will be tutorial. The goal is to provide an interactive forum where the attendees gain a comprehensive understanding of the various filter technologies. At the conclusion of the workshop, a technology matrix will be presented to compare capabilities of the various technologies, including SAW, ceramic, and FBAR for wireless handset/mobile applications. The workshop will then close with an interactive discussion of the filter technology matrix.

Panel Session
Noon to 1:15 pm

PMA RF CMOS FOR BLUETOOTH

Advances in IC technologies have brought new opportunities to the modern-day wireless industry. These include new wireless LAN methods, such as 802.11a, Home RF, and Bluetooth. A new age of wireless LAN will be built on a combination of breakthroughs in wireless communication methods and RF processes. However, there are many challenges facing implementers of low-cost silicon RF solutions. The focus of this panel discussion will be on: Technological barriers to implementing low cost transceivers: is CMOS the right solution? What is the most appropriate system partitioning for implementing Bluetooth in the cellular handset: single Chip, Module, or an integrated component inside the transceiver baseband?

8:00 to 11:00 am
Plenary Session

MON1A ADVANCES IN RF CMOS RFIC

Chair: D. Lovelace, Co-chair: S. Kiaei

MON1A-1:Invited: Wireless LASN Revolution: From Silicon to Systems

MON1A-2:Keynote Paper: Recent Advances in RF CMOS

MON2B-3:A Nonlinear Capacitance Cancellation Technique and its Application to a CMOS Class AB Power Amplifier

8:00 to 9:40 am

TU1A TECHNIQUES FOR SYSTEM LEVEL NONLINEAR ANALYSIS AND SIMULATION

Chair: P. Draxler, Co-chair: S. Kenney

TU1A-1: Analysis of CDMA Spectral Regrowth and Waveform Quality

TU1A-2: Generalized Autocorrelation Analysis of Spectral Regrowth from Bandpass Nonlinear Circuits

TU1A-3: Application of Polyspectral Techniques to Nonlinear Modeling and Compensation

TU1A-4: Estimation of Error Vector Magnitude Using Two-Tone Intermodulation-Distortion Measurements

TU1A-5: Investigation of Behavioral Model Accuracy Using a State-Space and Convolution-Based Transient Simulator

TU1A-6: Efficient Circuit-Level Analysis of Large Microwave Systems by Krylov-Subspace Harmonic Balance

TU1B POWER COMBINERS/DIVIDERS AND DIRECTIONAL COUPLERS

Chair: C. Buntschuh

TU1B-1: A Novel 3-Way Hybrid Combiner/Divider for High-Power C-Class Microwave Amplifiers

TU1B-2: A Novel Design of 1 to 8 Power Divider/Combiner

TU1B-3: A Low-Loss Serial Power Combiner Using Novel Suspended Stripline Couplers

TU1B-4: A Compact Coaxial-Waveguide Combiner Design for Ultra-Broadband Power Amplifier

TU1B-5: Broadband Lumped-Element 180-Degree Hybrids Utilizing Lattice Circuits TU1B-6: Design of High-Directivity Directional Couplers in Multilayer Ceramic Technologies LTCC/HTCC

TU1C MICROWAVE PHOTONICS

Chair: P. Yu, Co-chair: E. Rezek

TU1C-1: Three-Dimensional Millimeter-Wave Photonic Integrated Circuits on Si

TU1C-2: Wide-Bandwidth Traveling-Wave InGaAsP/InP Electroabsorption Modulator for Millimeter-Wave Applications

TU1C-3: High-Power Photonic Microwave Generation at K- and Ku-Bands Using a Uni-traveling-Carrier Photodiode

TU1C-4: Direct Optoelectronic Synthesis of mW-Level Millimeter-Wave Signals Using an Optical Frequency Comb Generator and a Uni-Traveling-Carrier Photodiode

TU1C-5: Photodetection, Photonic Feeding Coplanar Patch Antenna and Transmitting Experiment for Radio-On-Fiber System

TU1C-6: Experimental Reduction of Dispersion-Induced Effects in Microwave/ Millimeter-Wave Optical Systems Employing SOA Boosters

TU1D FREQUENCY CONVERTERS

Chair: M. Madihian, Co-chair: L. Reynolds

TU1D-1: RF Mixers Using Standard Digital CMOS 0.35-mm Process

TU1D-2: Broadband and Compact SiBJT Balanced Upconverter MMIC using Si 3D MMIC Technology

TU1D-3: A Highly Linear Single-Balanced Mixer Based on Heterojunction Interband Tunneling Diode

TU1D-4: A 60-GHz Uniplanar MMIC 4X Subharmonic Mixer

TU1D-5: A Monolithic HEMT Diode Balanced Mixer for 100 To140 GHz

TU1D-6: A Full-Waveguide-Band MMIC Tripler for 75 To 110 GHz

TU1D-7: High-Gain PHEMT Frequency Doubler for 76-GHz Automotive Radar

TU1D-8: A Stability-Ensuring Design Approach for Frequency Triplers

TU1D-9: A Family of Q, V and W-Band Monolithic Resistive Mixers


You'll always get the highest level of reliability with our customized RF power transistors.
It's easy to see why GHz is part of so many avionics, radar and wireless applications, especially compared to ordinary off-the-shelf alternatives. Our customized RF power transistors, fully optimized for your specific project, eliminate endless tuning and rework that can cause productivity to take a nosedive. Plus, ready as we are to help your latest CW applications, we're also committed to providing unending support for pulsed applications. Ready to see more? You'll find us at www.ghz.com or at 408-986-8031, ext. 350. Give us a buzz.
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TU1E SMART ANTENNAS

Chair: M. Thursby, Co-chair: B. Perlman

TU1E-1: A Novel Planar-Array Smart Antenna System with Hybrid Analog-Digital Beamforming
TU1E-2: Digital Beamforming for Smart Antennas
TU1E-3: Smart Lens Antenna Arrays
TU1E-4: Adaptive Beamforming of ESPAR Antenna Using Sequential Perturbation
TU1E-5: Microwave Device-Combining Filtering and Radiating Functions for Telecommunication Satellites
TU1E-6: An Internet-Controlled Calibration System for TDMA Smart -Antenna Wireless Base Stations

TU1F BIOLOGICAL EFFECTS AND MEDICAL APPLICATIONS

Chair: J. Pribetich, Co-chair: P. Yu

TU1F-1: Temperature Rise for the Human Head for Cellular Phones and for Peak SARs Prescribed in Safety Guidelines
TU1F-2: Power Absorption and Temperature Elevations Induced in the Human Head by Dual-Band Phones
TU1F-3: Miniature Sensor for Measurement and Control of Temperatures by Microwave Radiometry in Medical Applications
TU1F-4: Analysis of Planar Strip-Array Antenna for MRI
R.F. Lee, C.R. Westgate
TU1F-5: Resonant Slot Antennas as Transducers of DNA Hybridization: A Computational Feasibility Study
TU1F-6: A Zeeman-Stark/Markov Model Approach to Study the EM Exposure of a Potassium Channel
TU1F-7: Non-Invasive Measurement of Blood Sugar Level by Millimeter Waves
TU1F-8: A Microwave Radio for Doppler Radar Sensing of Vital Signs

Noon to 1:15 pm

PTA ONE CHIP RADIO

What is one-chip radio? Is this a reality in today's technology or in the future? Where is the System on Chip (SOC) appropriate: WLAN, CDMA, Bluetooth, or ever? What module technologies, if any, will provide System-On-Package (SOP) solutions? This panel will debate the potential of these integration paradigms from various perspectives, including Technology mix: RF, MEMS, passive components, DSPs and sensors; time to market, yield and cost; device technologies: SiGe, GaAs, CMOS and BiCMOS; reusable functional blocks; integral and embedded passive components; system architectures and testing; on-chip and off-chip components; applications and examples of SOC and SOP.

1:20 to 3:00 pm

TUE3A RF TRANSCEIVERS

Chair: S. Heinen, Co-chair: N. Camilleri

TUE3A-1: A Single-Chip ASK/FSK 900-MHz Transceiver in a Standard

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0.25-mm CMOS Technology
TUE3A-2: A Highly Integrated UHF Data Receiver for Vehicle Applications
TUE3A-3: 1-W 900-MHz Direct-Conversion CMOS Transmitter for Paging Applications
TUE3A-4: A One-Chip RF Transceiver MMIC for ETC with Surface Via-Hole Isolation Technique
TUE3A-5: A 1-to-5-GHz Low-Power Single-Chip Receiver IC for Optical Video-Distribution System

TU3B BALUNS, SPIRAL INDUCTORS, AND RESONATORS

Chair: A. Fathy, Co-chair: George Ponchak

TU3B-1: Sandwich Type Ferromagnetic RF Integrated Inductor
TU3B-2: Improved Three-Dimensional GaAs Inductors
TU3B-3: Development of Vertical Planar Coil Inductors Using Plastic Deformation Magnetic Assembly (PDMA)
TU3B-4: A Low-Loss Planar Microwave Balun with an Integrated Bias Scheme for Push-Pull Amplifiers
TU3B-5: Graphical Design of Air-Gap-Stacked Marchand Balun
TU3B-6: High-Q Frequency-Stable Dual-mode Whispering Gallery Sapphire Resonator

TU3C MEMS FOR ANTENNA APPLICATIONS

Chair: S. Barker, Co-chair: T. Weller

TU3C-1: 2D Mechanical Beam-Steering Antenna Fabricated Using MEMS Technology
TU3C-2: Microelectromechanical Systems (MEMS) Actuators for Antenna Reconfigurability
TU3C-3: 2- and 4-bit DC-To-16-GHz Microstrip MEMS Distributed Phase Shifters
TU3C-4: MEMS X-Band Low-Loss Quad Time-Delay Unit
TU3C-5: Lifetime Characterization of Capacitive RF MEMS Switches

TU3D CONTROL DEVICES

Chair: M. Goldfarb, Co-chair: S. Brozovich

TU3D-1: A Novel Digital Phase-Shifter Design at X-Band
TU3D-2: An Ultra-Broadband Reflection Type 180-Deg. Phase Shifter with Series and Parallel LC Circuits
TU3D-3: A High-Performance GaAs SP3T Switch for Digital Cellular Systems
TU3D-4: High Isolation V-band SPDT Switch MMIC for High Power Use
TU3D-5: Switches with Capacitor-Cancelled Parasitic Inductance of FET
TU3D-6: A V-Band MMIC SPDT Passive HEMT Switch Using Impedance Transformation Networks

TU3E PHASED ARRAY ANTENNAS

Chair: K. Chang, Co-chair: R. Sudbury

ITU3E-1: New Phase Shifter and Phased Antenna Array Designs Based on Ferroelectric Materials and CTS Technologies
TU3E-2: A Bi-directionally Steering Phased Array Antenna Controlled by Dual Piezoelectric Transducers
TU3E-3: A Novel Millimeter-wave Beam-steering Technique using a Dielectric-image-line-fed Grating Film
TU3E-4: A Method for Determining Noise Coupling in a Phased Array Antenna
TU3E-5: Performance of Thinned Antenna Arrays using Nonlinear Processing in DBF Radar Applications

TUE3F CONTROL CIRCUITS FOR RECEIVERS AND TRANSMITTERS

Chair: F. Ali, Co-chair: B. Thompson

TUE3F-1: Power Controller for Dual Band TDMA Power Amplifiers
TUE3F-2: A 450 MHz CMOS RF Power Detector
TUE3F-3: Design of an LTCC Switch Diplexer Frond-end Module for GSM/DCS/PCS Applications
TUE3F-4: A Monolithic Si PCS-CDMA Power Amplifier with an Impedance-controllable Biasing Scheme

2:30 to 5:00 pm

TUIF INTERACTIVE FORUM

Chair: TBA, Co-Chair: TBA

TUIF-1: LDMOS Electro-Thermal Model Validation from Large-Signal Time-Domain Measurements

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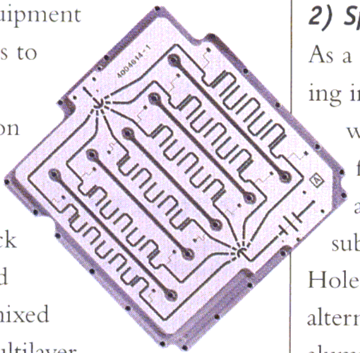
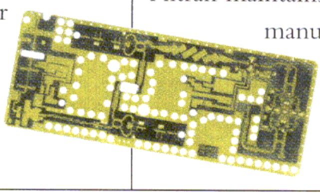
As a leader in our field since 1983, we've developed our own equipment and processes to manufacture truly precision microstrip, bonded stripline, thick metal-backed PFTE and mixed dielectric multilayer circuits. Take a closer look at Filtran's many superior manufacturing capabilities, and you'll see why we're the manufacturer of choice for microwave circuit designers worldwide:





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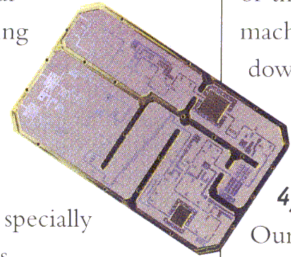

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As a leader in the vacuum sputtering industry with several patents, we can sputter-deposit thin films, including resistors, onto a variety of hard and soft substrates. Our Sputtered Blind Hole process offers a superior alternative to chemical PTH on aluminum-backed PTFE substrates.

3) Accurate, On-site Machining Capabilities
Filtran maintains complete on-site manual and computer-aided machining facilities to accurately punch, rout or mill thin substrates or thick metal backings with machining tolerances: ±.005", down to ±.001". We also have a close association with a local laser machining facility.

4) Proprietary Sodium Etchant
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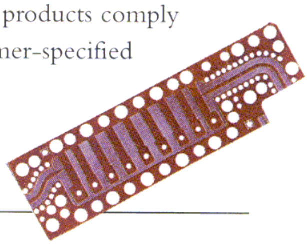
5) Strict Quality Assurance
Our stringent program of in-process inspection results in high yields on the most complex circuits. We strictly monitor all production processes, and our upfront engineering, SPC and final inspection all help to ensure that products comply with customer-specified standards.



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TUIF-2: Tunnel-Diode Nonlinear Model for Microwave Circuits and Active Antennas
TUIF-3: A Simple Bias-Dependent LF Noise Model for CAD
TUIF-4: Temperature-dependent Modeling of High-Power MESFET Using Thermal FDTD Method
TUIF-5: Full-Wave Analysis of FET Fingers Using Various Semiconductor Physical Models
TUIF-6: Generation of Multicarrier Complex Lowpass Models of RF ICs
TUIF-7: A Measurement-Based Distributed Low-Frequency-Noise HEMT Model: Application to Design of Millimeter-Wave Automotive Radar Chip Sets
TUIF-8: Pulse Characterization of Trapping and Thermal Effects of Microwave GaN Power FETs
TUIF-9: Thermal Transients in Microwave Active Devices and Their Influence on Intermodulation Distortion
TUIF-10: A Krylov-Subspace Technique for the Global Stability Analysis of Large Nonlinear Microwave Circuits
TUIF-11: Two-Tone Intermodulation-Distortion Simulations in the Time Domain Using a Quasi-2D Physical pHEMT Model
TUIF-12: Nonlinear Analysis of a Microwave Synthesizer Based on a Sampling-Phase Detector
TUIF-13: Comparison of Wavelet- and Time-Marching-Based Microwave-Circuit Transient Analyses
TUIF-14: Efficient Algorithm for Steady-State Stability Analysis of Large Analog/RF Circuits.
TUIF-15: Novel Artificial Frequency-Mapping Techniques for Multitone Simulation of Mixers
TUIF-16: New System-Level Simulation of Noise Spectral Distortion in FM-CW Autonomous Cruise-Control Radars.
TUIF-17: Spectrum Management of Pulse Transmission Line by High-Cut Filter Using Magnetic Loss
TUIF-18: Null-Pattern Synthesis of Ferroelectric Smart Antennas
TUIF-19: Ferroelectric Thin-Film-Based Electrically Tunable Ku-Band Coplanar-Waveguide Components
TUIF-20: Performance and Modeling of SAW Tooth-Edge-Mode Isolators
TUIF-21: Possibility of Ultrafine Isolator for Portable Phone
TUIF-22: Modeling Coplanar-Waveguide Structures Constructed of Ferromagnetic Metal
TUIF-23: Planar Ka-Band High-Temperature Superconducting Filters for Space Applications
TUIF-24: Multistage Dual-Mode Cross-Slotted Superconducting Filters for Telecommunication Application
TUIF-25: Design of an Image-Type Dielectric Resonator to Measure Surface Resistance of a High-TC Superconductor Film
TUIF-26: Planar Superconducting Lumped-Element Bandpass Filter with Spiral Inductors
TUIF-27: Performance of a Superconducting Detector Circuit Using a Schottky Barrier Diode for Bandwidth Modulation
TUIF-28: Bias Circuits for GaAs HBT Power Amplifiers
TUIF-29: High-Efficiency Low-IM Microwave PA Design
TUIF-30: Highly Linear CMOS RF MMIC Amplifier Using Multiple Gated Transistors and Its Volterra Series Analysis
TUIF-31: A Novel High-Efficiency Multioctave Amplifier Using Cascaded Reactively Terminated Single-Stage Distributed Amplifiers for EW System Applications
TUIF-32: A 2.4-GHz Integrated CMOS Power Amplifier with Micromachined Inductors
TUIF-33: Monolithic 6-W Ka-Band High-Power Amplifier.
TUIF-34: A Novel Method for Closed-Loop Error-Correction Microwave and Millimeter-Wave QPSK Modulator
TUIF-35: Micromachined Sub-Millimeter and Millimeter-Wave Variable Polarisation Compensator
TUIF-36: Membrane-Supported Copper E-Plane Circuits
TUIF-37: Suppression of Parasitic Substrate Modes in Flip-Chip-Packaged Coplanar W-Band Amplifier MMICs
TUIF-38: A 60-GHz Circular Horn Antenna Excited with Quasi-Yagi Antenna
TUIF-39: Design of a Nonradiative Dielectric Rotman Lens in the Millimeter-Wave Frequency
TUIF-40: Nonlinear Distortion Suppression in Directly Modulated DFB Lasers by Sidemode Optical Injection

TUIF-41: A New, Compact Model for High-Speed Electro-Optic Modulators Fully Integrated Within a Microwave CAD Environment
TUIF-42: Electromagnetic and Thermal Modeling of the Lucite Cone Applicator for Superficial Hyperthermia
TUIF-43: Conformal Imaging with a Non-contacting Microwave Antenna Array
TUIF-44: A Low-Power Direct-Conversion Receiver Module for C-Band Wireless Applications
TUIF-45: A GaAs HBT 5.8-GHz OFDM Transmitter MMIC Chip Set
TUIF-46: A +2.5-VDC CMOS Differential Active Inductor with Tunable L and Q for Frequencies Up To 5 GHz
TUIF-47: Temperature Dependence of Inter-modulation and Linearity in GaN-based Amplifiers
TUIF-48: A New T-Circuit Topology for the Broadband Modelling of Symmetric Inductors Fabricated in CMOS Technology
TUIF-49: Modeling of Inductors and Transformers
TUIF-50: 15-GHz Wideband Amplifier with 2.8-dB Noise Figure in SiGe Bipolar Technology
TUIF-51: 40-Gb/s D-type Flip-Flop and Multiplexer Circuits Using InP HEMT
TUIF-52: A Direct Ku-Band Linear Subhar-monically Pumped BPSK and I/Q Vector Modulator in Multilayer Thin-Film MCM-D

3:30 to 5:10 pm

TU4A LOW NOISE AMPLIFIERS (LNAS) JOINT IMS/RFIC SESSION

Chair: S. Lloyd, Co-chair: K. Ashby

TU4A-1: A Wide-Dynamic-Range Switched-LNA in SiGe BiCMOS
TU4A-2: Dual Bias Feed SiGe HBT Low-Noise Linear Amplifier
TU4A-3: A 1.4-dB NF Variable Gain LNA with Continuous Control for 2-GHz-Band Mobile Phone Using InGaP Emitter HBT
TU4A-4: A 1.7-mA Low Noise Amplifier with Integrated Bypass Switch for Wireless 0.05-6-GHz Portable Applications

TU4B INNOVATIVE STRUCTURES

Chair: J. Owens

TU4B-1: Passive Electromagnetic Compen-sation of Permittivity Changes in Microwave Circuits
TU4B-2: 360-Deg. Linear Analog Phase-Shifter Design Using Tunable Short-Circuit-Terminated Combline Filters
TU4B-3: A Novel Low-Loss Slow-Wave CPW Periodic Structure for Filter Applications
TU4B-4: Overlapping, Multiple CPW Stub Structures for High-Density MMICs
TU4B-5: LTCC-MLC Balun for WLAN/Blue-tooth

TU4C MEMS CONTROL CIRCUITS

Chair: C. Goldsmith, Co-chair: C. Nguyen

TU4C-1: MEMS Single-Pole, Double-Throw (SPDT) X- and K-band Switching Circuits
TU4C-2: DC-to-26-GHz MEMS Series-Shunt Absorptive Switches
TU4C-3: MEMS High-Q Microwave Inductors Using Solder-Surface Tension Self-Assembly
TU4C-4: Micromachined Frequency-Variable-Impedance Tuners Using Resonant Unit Cells
TU4C-5: A Reconfigurable Double-Stub Tuner Using MEMS Devices
TU4C-6: Tunable-Lumped Components with Applications to Reconfigurable MEMS Filters
TU4C-7: A Micromachined Tunable CPW Resonator

TU4D ACOUSTIC DEVICES FOR WIRELESS COMMUNICATIONS AND SENSING

Chair: R. Weigel, Co-chair: C.C.W. Ruppel

TU4D-1: Invited: SAW Filter Solutions to the Needs of 3G Cellular Phones
TU4D-2: Optimized Design and Fabrication of a Wireless Pressure and Temperature Sensor Unit Based on SAW Transponder Technology
TU4D-3: Spurious Suppression Technique of Edge-Trap-Type SAW Resonators and Their Applications to 1-GHz Wideband SAW-VCOs for Mobile Communications
TU4D-4: The Application of Dielectric Thin Films to Enhance the Properties of SAW Devices
TU4D-5: A Film Bulk-Acoustic-Resonator (FBAR) Duplexer for USPCS Handset Applications.
TU4D-6: FBAR Dispersion Relation and Laser Measurements

TU4E NOVEL ANTENNAS AND APPLICATIONS

Chair: W. Shiroma, Co-chair: D. McQuiddy

TU4E-1: Silicon-Based Reconfigurable Antennas
TU4E-2: Hilbert Curve Fractal Antennas with Reconfigurable Characteristics
TU4E-3: Active Antenna Using Multilayer Ceramic-Polyimide Substrates for Wireless Communication Systems
TU4E-4: A Ka-Band High-Efficiency Dielectric Lens Antenna with a Silicon Micromachined Microstrip Patch Radiator
TU4E-5: A Multifunctional Antenna for Terrestrial and Satellite Radio Applications

TUE4F BUILDING BLOCK FRONT ENDS

Chair: S. Lloyd, Co-chair: K. Ashby

TUE4F-1: +1.8-VDC RF AGC and Mixer Implemented with a Novel Four-Terminal HBT (FHBT)
TUE4F-2: Design and Performance of a Highly Integrated Wideband Active Down-converter MMIC
TUE4F-3: A 2.5-GHz Low-Noise High-Lineari-ty LNA/Mixer IC in SiGe BiCMOS Technology
TUE4F-4: A 1.9-GHz Double-Balanced Subharmonic Mixer for Direct-Conversion Receivers
TUE4F-5: A 1 GHz-Band Low-Distortion Up-converter with a Linear in Decibel-Control VGA for Digital TV Tuner

Wednesday, May 23, 2001 8:00 to 9:40 am

WE1A MODE CONVERSION BETWEEN DISSIMILAR TRANS-MISSION MEDIA

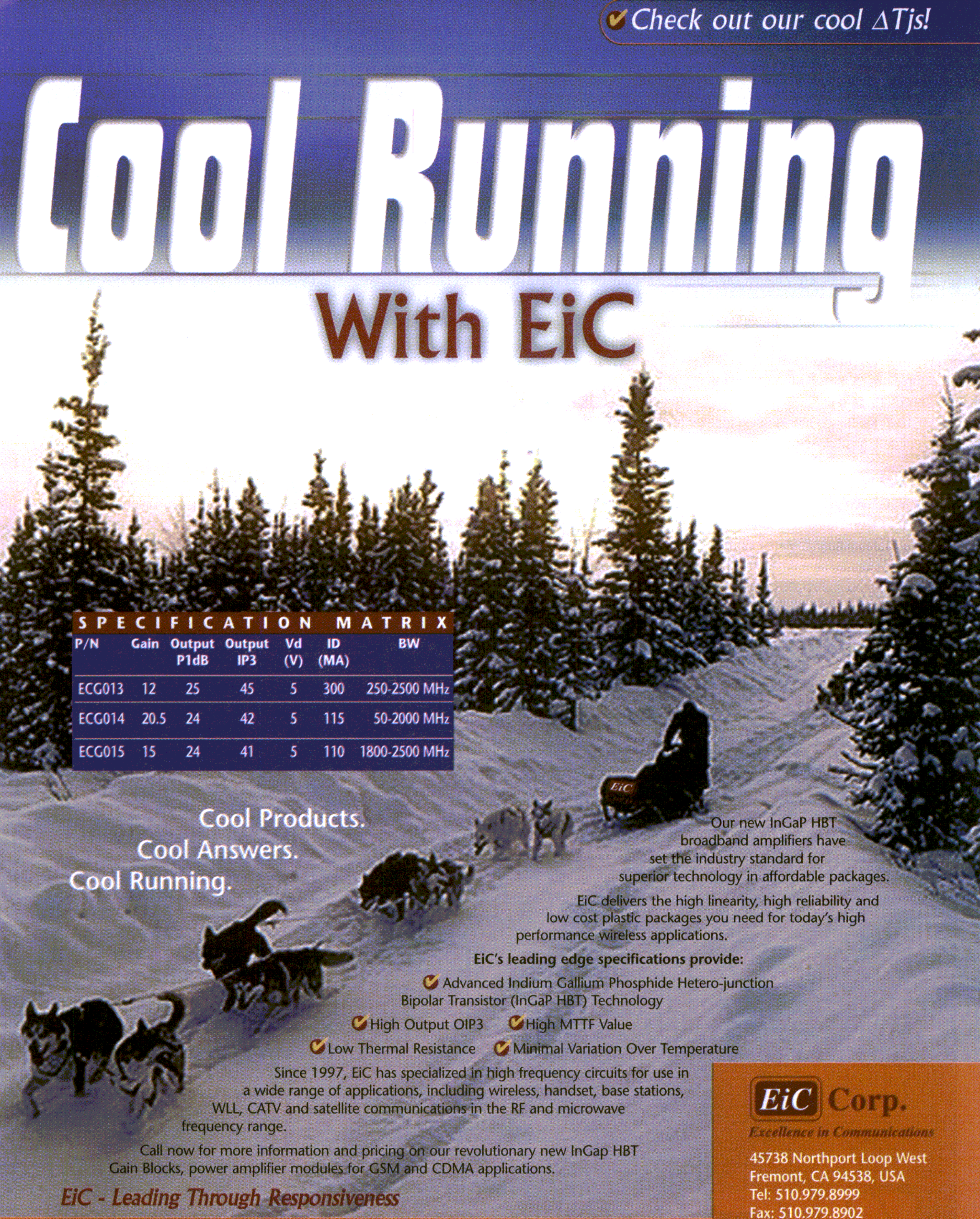
Chair: C.P. Wen, Co-chair: E. Godshalk, Maxim Corp.

WE1A-1: Novel Design for Coplanar Waveguide to Microstrip Transition
WE1A-2: Microstrip Feed Coplanar-Stripline Tee Junction Using Coupled Coplanar Stripline
WE1A-3: Novel Lumped-Element Coplanar Waveguide-To-Coplanar Stripline Transitions
WE1A-4: Integrated Transition of Coplanar and Rectangular Waveguides
WE1A-5: A Novel Microstrip Mode to Waveguide-Mode Transformer and Its Applications
WE1A-6: Design of HNRD Guide to E-Plane Waveguide Transitions and Directional Cou-plers by Transverse Resonance Technique

WE1B HIGH POWER AMPLI-FIERS AND DEVICES

Chair: J. Schellenberg, Co-chair: S. Patel

WE1B-1: High-Voltage GaAs Power-HBTs



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WE1B-2: A Power pHEMT Device Technology for Broadband Wireless Access WE1B-3: Silicon-Carbide Performances and Application in Broadcast Power Amplifiers
WE1B-4: A 240-W Power Heterojunction FET with High Efficiency for WCDMA Base Stations
WE1B-5: A Ultra-Broadband 300-W GaAs Power FET for WCDMA Base Stations
WE1B-6: High-Power S-Band Solid-State Amplifiers for Surveillance and Traffic-Control Radars
WE1B-7: Ku-Band Quadri-SSPA for Stentor Satellite Transmit Active Antenna

WE1C NONLINEAR DEVICE MODELING

Chair: J Hwang

WE1C-1: Nonlinear III-V HBT Compact Models: Do We Have What We Need?
WE1C-2: Global Electrothermal CAD of Complex Nonlinear 3D Systems Based on a Fully Physical Time-Dependent Compact- Thermal Model
WE1C-3: Improved Large-Signal Model and Model-Extraction Procedure for InGaP/GaAs HBTs Under High-Current Operations
WE1C-4: Waveform Characterization and Modeling of Dynamic-Charge Behavior of InGaP-GaAs HBTs
WE1C-5: Scalable Large-Signal Device Model for High-Power-Density AlGaN/GaN HEMTs on SiC
WE1C-6: On the Gunn Effect in GaAs HBTs

WE1D FREQUENCY CONTROL ADVANCES FOR WIRELESS APPLICATIONS

Chair: R. Newgard, Co-chair: S. Wetenkamp

WE1D-1: Invited: Nonlinear Effects in Oscillators and Synthesizers
WE1D-2: PLL Synthesizers: PLL Switching Speed and Speed-Up Mechanisms
WE1D-3: An Agile-Stored SD Sequence Fractional-N Synthesiser
WE1D-4: 6.7-GHz Frequency Synthesizer in 0.8-mm Silicon-Bipolar Production Technology WE1D-5: GSM-900/DCS-1800 Fractional-N Frequency Synthesizer with Very-Fast Settling Time
WE1D-6: Phase-Decrement-Type Direct Frequency Synthesizer Driven by a DDS

WE1E DISPERSION PROPERTIES OF PERIODIC STRUCTURES AND UNIFORM TRANSMISSION LINES

Chair: P.Lampariello, Co-chair: J. Zehentner

WE1E-1: Effect of Losses on the Spectral Transition of Modal Poles between the Improper and the Proper Riemann Sheets
WE1E-2: Low-Frequency-Dispersion Features of a New Complex Mode for a Periodic Strip Grating on a Grounded Dielectric Slab
WE1E-3: Guided-Wave Properties of Synthesized Nonradiative Dielectric Waveguide for Substrate Integrated Circuits (SICs)
WE1E-4: Slow-Wave Propagation of Microstrip Consisting of Electric-Magnetic-Electric (EME) Composite Metal Strips
WE1E-5: TEM Properties of Shielded Homogeneous Multiconductor Transmission Lines with PEC and PMC Walls
WE1E-6: Explicit Eigenvalue Approach to the Efficient Determination of the Hybrid Spectrum of Ferrite-Loaded Circular Waveguide

WE1F ADVANCES IN TIME DOMAIN METHODS I

Chair: P. Russer, Co-chair: W. Gwarek

WE1F-1: Envelope-Finite-Element (EVFE) Technique—2D Guided-Wave Examples
WE1F-2: Evaluation and Enhancement of Supraconvergence Effects on Nonuniform and Conformal FDTD meshes
WE1F-3: Fundamental Gridding-Related Dispersion Effects in Multiresolution Time-Domain Schemes
WE1F-4: Development and Application of an Efficient FDTD/Haar MRTD Numerical Interface
WE1F-5: A Novel Adaptivity for EM Time-Domain Methods: Scale-Adaptive Time Steps (SATS)

10:10 to 11:50 am

WE2A NOVEL TRANSMISSION LINES, PROPERTIES AND APPLICATIONS

Chair: M. Dydyk, Co-chair: Ching-Kuang Tzuang

WE2A-1: Transmission-Line Noise from

Standard and Proton-Implanted Si

WE2A-3: Dielectric Properties of Oxidized Porous Silicon in a Low-Resistivity Substrate

WE2A-3: A Novel CPW Structure for High-Speed Interconnects

WE2A-4: Small-Size Delay Line Based on a Periodically Loaded Waveguide

WE2A-5: Frequency Dependence of Bloch Impedance in a Periodic Transmission-Line Structure

WE2A-6: A Photonic Crystal Seam (PCS) for Metallic Waveguides

WE2B TECHNIQUES TO ADVANCE POWER AMPLIFIER LINEARITY AND EFFICIENCY

Chair: A. Katz, Co-chair: E. James Crescenzi, Jr.

WE2B-1: Efficient Baseband/RF Feedforward Linearizer Through a Mirror Power Amplifier Using Software-Defined Radio and Quadrature Digital Upconversion

WE2B-2: Adaptive RF Cartesian Predistorter Based on the Low-Frequency Even-Order IM Terms

WE2B-3: A High-Efficiency Feedforward Amplifier with a Series-Diode Linearizer for Cellular Base Stations

WE2B-4: A Gain/Phase-Imbalance Minimization Technique for LINC Transmitter

WE2B-5: A Novel DSP Architecture of Adaptive Feedforward Linearizer for RF Amplifiers

WE2B-6: The Novel-Programmable RF Predistortion Linearizer

WE2C NONLINEAR FET MODELING

Chair: M Mallavarpu, Co-chair: M Calcatera

WE2C-1: A GaAs MESFET Transient Model Capable of Predicting Trap-Induced Memory Effects Under Complex Digital Modulation WE2C-2: Intermodulation-Distortion Simulation Using Physical GaAs FET Model

WE2C-3: Full Extraction of pHEMT State Functions Using Time-Domain Measurements

WE2C-4: Large-Signal Look-Up Table Model for InP HEMTs, Including Non-Quasistatic and Impact Ionization Effects

WE2C-5: Nonlinear Noise Modeling of a pHEMT Device through Residual Phase Noise and Low-Frequency Noise Measurements

WE2C-6: Intrinsic Noise Currents in Deep-Submicron MOSFETs

WE2D THE NBS/NIST CENTENNIAL: ONE HUNDRED YEARS OF RF METROLOGY AND STANDARDS

Chair: K. Remley, Co-chair: C. Weil

WE2D-1: NIST: Responding to Basic Needs, Responding to Special Needs

WE2D-2: Radio-Frequency Metrology from NBS to NIST, the Legacy

WE2D-3: Primary Atomic Frequency Standards at NIST

WE2D-4: Broadband Josephson Voltage Standards

WE2D-5: The Electronic Kilogram

WE2E LEAKY-WAVE EXCITATION AND GUIDANCE IN PRINTED TRANSMISSION LINES

Chair: N.K. Das, Co-chair: A.S. Omar

WE2E-1: Behavioral Feature of Fast-Wave Modes on Printed-Circuit Transmission Lines of Open and Packaged Types

WE2E-2: Structural Conditions for Offering High-Performance Printed-Circuit Devices in Millimeter-Wave Range

WE2E-3: High-Frequency Leaky-Mode Excitation on Microstrip Line

WE2E-4: Spurious Radiation from a Practical Source on a Leaky-Covered Microstrip Line

WE2E-5: Proper Definition of Voltage for a Leaky Two-Layer Stripline Consistent with Its Characteristic Impedance

WE2F ADVANCES IN TIME-DOMAIN METHODS II

Chair: A. Beyer, Co-chair: V. Fouad-Hanna

WE2F-1: A Generalized Approach to Wideband S-parameter Extraction from FD-TD Simulations Applicable to Evanescent Modes In Inhomogeneous Guides

WE2F-2: Modified Yee's Cell for Finite-Difference Time-Domain Modeling of Periodic Boundary Guiding Structure

WE2F-3: A New Multiresolution Near-Field to Near-Field Transform Suitable for Multiregion FDTD Schemes

WE2F-4: A Global Modeling Approach Using Interpolating Wavelets

WE2F-5: Performance of Three-Dimensional-Graded ADI-FDTD Algorithm

WE2F-6: Reconstruction of Microwave Structures Using Two-Dimensional Inverse TLM (Transmission-Line Matrix) Method

Noon-1:15 pm

PWA AUTOMOTIVE RADAR

This panel discusses circuit and antenna

technologies that can be used for automotive radars, and tries to clarify the features that must be met by these components. The panel will address the following questions:

What functions should an automotive radar be equipped with, now and in the future?
What is the best automotive radar scheme?
What device and circuit technologies will be most appropriate?
What antenna technologies will be most appropriate?
What issues still need to be addressed and solved?

PWB UNIVERSITY-INDUSTRY INTERACTIONS

Universities routinely offer digital and VLSI design courses at the undergraduate and graduate levels. The availability of high-frequency analog, RF, microwave,and millimeter-wave design courses is far less pervasive. This panel will discuss the ways in which universities and industry can work together to increase the supply of engineers who can design circuits for wireless and broadband applications. Questions that will be discussed include the following:

Is industry handicapped by a real and persistent shortage of RF and microwave designers?
What difficulties do universities face in establishing RF and microwave design courses?
What does the microwave industry need from universities?
What do universities need from the microwave industry?
What different forms of collaboration between industry and universities are being deployed?
What are the advantages and disadvantages of each form of collaboration?
Should government play a role in promoting interactions between industry and universities?
What new approaches to collaboration can meet the needs of industry and universities?

1:20 to 3:00 pm

WE3A POWER AMPLIFIERS FOR WIRELESS APPLICATIONS

Chair: D. Teeter, Co-chair: A. Platzker

WE3A-1: A 1-W CMOS Power Amplifier for GSM-1800 with 55% PAE
WE3A-2: A High-Efficiency 0.25-mm CMOS PA with LTCC Multilayer High-Q Integrated Passives for 2.4-GHz ISM Band
WE3A-3: Variable-Gain Power Amplifier for Mobile WCDMA Applications
WE3A-4: A Single-Supply High-Performance PA MMIC for GSM Handsets Using Quasi-Enhancement-Mode PHEMT
WE3A-5: E-pHEMT, Single-Supply, High-Efficient Power Amplifiers for GSM and DCS Applications
WE3A-6: An Extended Doherty Amplifier with High Efficiency Over a Wide Power Range
WE3A-7: Analysis and Experimental Study of an L-band New Topology Doherty Amplifier
WE3A-8: Current-Mode Class D Power Amplifiers for High-Eficiency RF Applications

WE3B WIDEBAND COMMUNICATION SYSTEMS

Chair: H.C. Huang, Co-chair: L. Raffaelli

WE3B-1: A Compact LTCC Ku-Band Transmitter Module with Integrated Filter for Satellite-Communication Applications
WE3B-2: A Microwave Frequency Generation Unit for Space Applications
WE3B-3: Low-Cost Ka-Band Transmitter Modules for LMDS Equipment Mass Production
WE3B-4: A Complete Integrated Tx/Rx Front End Combining 3D Topologies and Global Synthesis.
WE3B-5: Design and Characterization of a Low-Cost ISM-Band Subcarrier Multiplexed Broadband Digital Microwave Radio Link

WE3C NONLINEAR MODELING OF SILICON DEVICES AND POWER AMPLIFIERS

Chair: S. Goodnick

WE3C-1: RF LDMOS Characterization and Its Compact Modeling
WE3C-2: Direct Extraction and Modeling Method for Temperature Dependent Large- Signal CAD Model of Si-BJT
WE3C-3: An Accurate Large-Signal Model for a High-Efficient Si Bipolar GSM Power Transistor
WE3C-4: Analysis of Low-Frequency Memory and Influence on Solid-State HPA Intermodulation Characteristics
WE3C-5: An Improved Behavioral Modeling Technique for High-Power Amplifiers with Memory

WE3D MICROWAVE AND OPTICAL BROADBAND INTERNET ACCESS

Chair: C. Cox

WE3D-1: Invited: Broadband-Access

Networks: Evolution and Convergence Implications for Equipment Providers
WE3D-2: Invited: Wireless Aspects of Broadband Access
WE3D-3: A Combined Optical Wireless Broadband Internet Access: Transmission Challenges
WE3D-4: In-Band Optical Crosstalk in Fiber-Radio WDM Networks

WE3E CAD WITH NEURAL NETWORKS AND EM TECHNIQUES

Chair: A. Sharma, Co-chair: R. Biernacki

WE3E-1: Neural Inverse Space-Mapping EM Optimization
WE3E-2: An Approach for Knowledge-Aided-Design (KAD) of Microwave Circuits Using Artificial Neural Networks
WE3E-3: Exact Adjoint Sensitivity Analysis for Neural-Based Microwave Modeling and Design
WE3E-4: New Technique using Poles and Modes Derivatives for Frequency and Geometry Parameterization of Microwave Structures
WE3E-5: Extending SPICE-Like Analog Simulator with a Time-Domain Full-Wave Field Solver

WE3F APPLICATIONS OF TIME DOMAIN METHODS

Chair: R. Vahldieck, Co-chair: L. Roselli

WE3F-1: Efficient FDTD Modeling of Irises/Slots in Microwave Structures
WE3F-2: Time-Domain Characterization of Multichip Module Elements
WE3F-3: Full-Wave Analysis and Model-based Parameter Estimation Approaches for Y-Matrix Computation of Microwave-Distributed RF Circuits
WE3F-4: Analysis of Signal Integrity in High-Speed Digital ICs by Combining MOSFET Modeling and the LE-FDTD Method
WE3F-5: Interpolating Wavelet Galerkin Model of Time-Dependent Inhomogeneous Electrically Large Optical Waveguide Problems
WE3F-6: Time-Domain Optical Response of Electro-Optic Modulator using FDTD

2:30 to 5:00 pm

WEIF INTERACTIVE FORUM

Chair: TBA, Co-Chair: TBA

WEIF-1: Waveguiding Properties of a Line of Periodically Arranged Passive Dipole Scatterers
WEIF-2: New Type of Millimeter-Wave Antenna by Using the NRD Guide with LSE-Mode Transmission
WEIF-3: Efficient Method for Solving 3D Dielectric Planar Circuit with Parabolic Equation Method
WEIF-4: Design of Surface-Wave Bandgaps for Planar Integrated Circuits Using Multiple Periodic Metallic Patch Arrays
WEIF-5: Space Leakage of Power From the Slotline
WEIF-6: Derivation of Analytical Dyadic Green's Function Modifications for Microstrip Attenuation in Transmission Layered Structures
WEIF-7: On the Penetration of the Longitudinal Component of EM Fields into Metals.
WEIF-8: Modal Cutoff in Coaxial Transmission Lines of Conical and Cylindrical Geometries
WEIF-9: Full-Wave Analysis of Transverse and Longitudinal Couplings in Silicon RF IC Effect of Buried Diffusions.
WEIF-10: Frequency/Time-Domain Modeling of Microstrip Circuits by a Modified Spectral-Domain Approach
WEIF-11: Efficient Analysis of Waveguide-To-Microstrip and Waveguide-To-Coplanar-Line Transitions
WEIF-12: A 3D Method of Moments for the Analysis of Real-Life MMICs
WEIF-13: Generalized Polygonal Basis Functions for the Electromagnetic Simulation of Complex Geometrical Planar Structures
WEIF-14: FD-FD GSM Technique for the CAD and Optimization of Combline Filters
WEIF-15: Electromagnetic Modeling of Multilayer Microwave Circuits by the Longitudinal Decomposition Approach
WEIF-16: A Novel Cold-FET Method for Determining Extrinsic Capacitances using a Capacitive Transmission-Line Model
WEIF-17: Modeling of 3D Planar Conducting Structures on Lossy Silicon Substrate in High-Frequency Integrated Circuits
WEIF-18: Modeling and Investigation of Instabilities in Heterojunction Interband Tunnel Diodes for Microwave Applications
WEIF-19: MOSFET Bulk-Effect Behaviour and Estimation for Microwave-Frequency Modeling
WEIF-20: A New Analytical Small-Signal Model of Dual-Gate GaAs MESFET
WEIF-21: Measurement-Based Extrinsic Modeling of RF Components
WEIF-22: Design and Implementation of Micromachined Lumped Quardature Hybrids
WEIF-23: Q-Enhancement of Spiral Inductor with N+ Diffusion-Patterned Ground Shields
WEIF-24: A Design Mapping Formula of Asymmetrical Multielement Coupled-Line Directional Couplers
WEIF-25: A General Design Formula of Multisection Power Divider Based on Singly Terminated Filter-Design Theory
WEIF-26: A New Balanced Amplifier Using 6-Port Power Divider
WEIF-27: 60-GHz Coplanar-Waveguide Couplers and Slotline Transition on Polished Beryllium Oxide.
WEIF-28: Integration of Optimized Lowpass Filters in Bandpass Filters for Out-Of-Band Improvement.
WEIF-29: Nonadjacent Resonators Effects on Coupling and Resonant Frequency in Combline Filters
WEIF-30: Evanescent-Mode Bandpass Filters Based on Ridged Waveguide Sections and Inductive Strips
WEIF-31: A Compact Elliptic-Function BPF Using Triple-Mode Cavities for Terrestrial Digital-Television Transmitters
WEIF-32: Circular-To-Rectangular Waveguide Diplexers
WEIF-33: K-Band Monolithic Double-Balanced Resistive Mixer with Integrated Balanced Oscillator
WEIF-34: Fundamental Limitations of Conversion Loss and Output Power on an Even Harmonic Mixer with Junction Capacitance
WEIF-35: A K-Band Subharmonic Downconverter in a GaAs Metamorphic HEMT Process
WEIF-36: Performance Comparison of Single- and Dual-Stage MMIC Limiters
WEIF-37: Novel Frequency Doubler Using Feedforward for Fundamental Frequency Component Suppression
WEIF-38: A Compact T/R Switching Circuit Using Quadrature Couplers and Drain-Driven HPAs
WEIF-39: Comparison of Different Adaptation Algorithms for Adaptive Digital Predistortion based on EDGE Standard
WEIF-40: An Internally Matched LTCC 3G WCDMA LDMOS 180-W Power Amplifier
WEIF-41: Effect of Efficiency Optimization on Linearity of LINC Amplifiers with CDMA Signal
WEIF-42: Ultralinear Distributed Class-AB LDMOS RF Power Amplifier for Base Stations
WEIF-43: Experimental Investigation on Efficiency and Linearity of Microwave Doherty Amplifier

SAWTEK DELIVERS DREAM DUPLEXER

Sawtek...Your Total SAW Solution!

Everyone wished that ***one day***...SAW duplexers could be smaller, cost less and offer superior electrical performance...

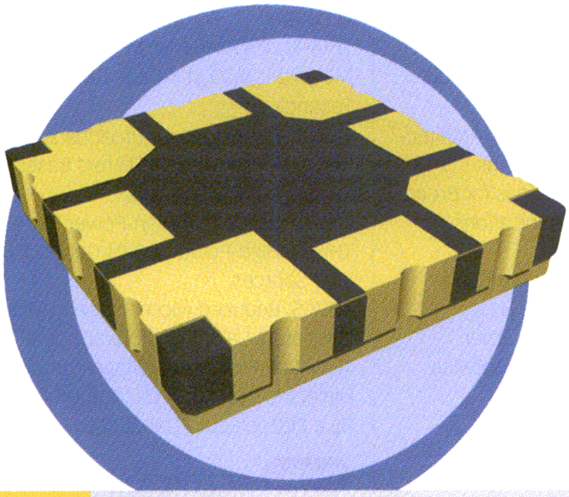
THAT DAY IS NOW!

Sawtek's new cellular RF SAW duplexer is the smallest in the world, measuring a petite 5x5x1.5 mm^3. **That's a whopping 95% smaller than the ceramic solution and 74% smaller than first-generation SAW duplexers.** This mini duplexer delivers "maxi" electrical performance compared to older SAW devices while meeting the high power handling requirements of CDMA/TDMA/AMPS architectures.

Remember the Sawtek solution when consumers clamor from smaller, slimmer multimode/multiband phones: Size + Performance + A Highly Competitive Price = Sawtek Cellular RF SAW Duplexers.

Insertion Loss: 2.3dB – Tx; 3.4dB – Rx*
Isolation: 65dB from 824 MHz to 849 MHz*
48dB from 869 MHz to 894 MHz*

* Specifications indicate typical Tx and Rx performance; data sheets available upon request.
Package Size: 5x5x1.5 mm^3



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SAWTEK INCORPORATED

Visit Sawtek at booth #2117 at MTT-S in Phoenix.

WEIF-44: Numerical Investigation of Vertical Contactless Transitions for Multilayer Circuits
WEIF-45: Direct-Conversion Receiver for Digital Beamforming at 8.45 GHz
WEIF-46: Reflective Antenna Arrays Based on Shorted Ring Slots
WEIF-47: Analysis and Design of Active Antenna Arrays
WEIF-48: Direction Finding Using Spectral Estimation with Arbitrary Antenna Arrays
WEIF-49: Broadband Planar Antenna with Low-Side Lobes Levels Capabilities and High Cross-Polarization Rejection for DBS Reception
WEIF-50: A Low-Noise Active Integrated Antenna Receiver for Monopulse Radar Applications
WEIF-51: A Quasi-Optical Linearizer
WEIF-52: Study of Design Parameters in Waveguide-Based Spatial Power Combining Amplifier Arrays Using FDTD
WEIF-53: Broadband Analysis of a D-band Holographic Power-Combining Circuit

3:30 to 5:10 pm

WE4A NEXT GENERATION POWER AMPLIFIER TECHNIQUES

Chair: J. Heaton, Co-chair: P. Asbeck

WE4A-1: A 6-GHz 50-W Low-Distortion Push-Pull GaAs Power FET Optimized for +12-VDC Class-AB Operation
WE4A-2: High-Power Broadband AlGaN/GaN HEMT MMICs on SiC Substrates
WE4A-3: New Design Method of Nonuniform Distributed Power Amplifiers. Application to a Single-Stage (1 W/4.5-18 GHz) pHEMT MMIC.
WE4A-4: 20-to-30-GHz Broadband MMIC Power Amplifiers with Compact Flat-Gain pHEMT Cells
WE4A-5: X-band MMIC Power Amplifier with an On-Chip Temperature-Compensation Circuit
WE4A-6: A Novel Base-Feed Design for High-Power, High-Frequency Heterojunction Bipolar Transistors.
WE4A-7: High-Efficiency S-band Class AB Push-Pull Power Amplifier with Wideband Harmonic Suppression

WE4B NEW TECHNOLOGIES FOR WIRELESS COMMUNICATIONS SYSTEMS

Chair: H. Ogawa, Co-chair: J.K. McKinney

WE4B-1: A Flexible Multiband Front End for Software Radios Using High IF and Active Interference Cancellation
WE4B-2: A Highly Integrated Low-Power Direct-Conversion Receiver MMIC for Broadband Wireless Applications
WE4B-3: High-Speed, Low-Cost, Direct-Conversion Digital Receiver
WE4B-4: A 156-Mb/s Compact FSK Modulator Module for 38-GHz Wireless LANs
WE4B-5: An Electromagnetic Characterization of Indoor Radio Environment in Microwave WLAN Systems

WE4C WIRELESS SENSORS FOR AUTOMOTIVE, RFID, AND COMMUNICATIONS SYSTEMS

Chair: H. Kondoh, Hitachi, Co-chair: R. Camisa

WE4C-1: A Low-Profile 77 GHz Three-Beam Antenna for Automotive Radar
WE4C-2: Proposal of Millimeter-Wave Holographic Radar with Antenna Switching
WE4C-3: Fully Integrated Automotive Radar Sensor with Versatile Resolution
WE4C-4: A Reconfigurable Active Retrodirective/Direct-Conversion Receiver Array for Wireless Sensor Systems
WE4C-5: A Novel Card-Type Transponder Designed Using Retrodirective Antenna Array

WE4D INTERNET VIA SATELLITES

Chair: R.K. Gupta, Co-chair: B. Geller

WE4D-1: Satellite Systems for Multimedia and Internet Traffic
WE4D-2: Ka-Band Satellite System Architecture for Local-Loop Internet Access
WE4D-3: User Terminal Antennas for Broadband NGSO Satellite-Communications Systems
WE4D-4: Outdoor Units for Ka/Ku-Band Satellite Interactive Terminals
WE4D-5: Performance of Multicarrier 16QAM Over a Linearized TWTA Satellite Channel

WE4E CAD PROCEDURES AND OPTIMIZATION

Chair: K.C. Gupta, Co-chair: M. Mongiardo

WE4E-1: Expanded Space-Mapping Design Framework Exploiting Preassigned Parameters
WE4E-2: Multilevel Passive-Order Reduction of Interconnect Networks
WE4E-3: Fast Analysis and Optimization of Combine Filters Using FEM
WE4E-4: Integrated CAD Procedure for Iris Design in a Multimode Waveguide Environment
WE4E-5: Decomposition Synthesis Approach to Design of RF and Microwave Active Circuits

WE4F FERRITE AND FERROELECTRIC DEVICES

Chair: D. Webb, Co-chair: B. Elsharawy

WE4F-1: UHF Frequency-Selective Limiters
WE4F-2: Very-Low-Loss Wideband Isolators for Millimeter Wavelengths
WE4F-3: A Novel Nonreciprocal Ferrite Image Guide
WE4F-4: An Ultraminiature Isolator with Broadband Isolation Using Ferrite Gyrator
WE4F-5: A Method of Effective Ferrite Use for Microwave Absorber
WE4F-6: Phase Shifters Using (Ba,Sr) TiO3 Thin Films on Sapphire and Glass Substrates
WE4F-7: MOS Varactors with Ferroelectric Films

Thursday May 24, 2001 8:00 to 9:40 am

TH1A MICROWAVE SIGNAL SOURCES

Chair: Johann-F. Luy, Co-chair: O. Llopis

THIA-1: Low Phase Noise, Fully Integrated Monolithic VCO In X-Band Based on HBT Technology
THIA-2: Conditions for Broadband MMIC Voltage-Controlled Oscillators Based on Theory and Experiments
THIA-3: Solid-State High-Power RF Oscillator
THIA-4: High-Power AlGaN/GaN FET-Based VCO Sources
THIA-5: Reduced Flicker Noise in Microwave Oscillators Using Feedforward Amplifiers
THIA-6: A Wideband Voltage-Tunable Dielectric Resonator Oscillator-Controlled By a Piezoelectric Transducer

TH1B5 ACTIVE AND TUNABLE FILTERS

Chair: M. Guglielmi, Co-chair: P. Guillon

THIB-1: Compact High-Order Planar-Ring-Resonator Filters Optimized in Noise in Coplanar Technology
THIB-2: Tunable Active Filters Having Multilayer Structure Using LTCC
THIB-3: Full-Wave Analysis and Design of RF-Tunable Filters

THIB-4: Tunable RF Filters Using Thin-Film Barium-Strontium-Titanate-Based Capacitors
THIB-5: Hybrid Resonator Microstrip-Line Electrically Tunable Filter
THIB-6: Design of Tunable Ferroelectric Filters with a Constant Fractional Bandwidth

TH1C PASSIVE FILTERS AND MULTIPLEXERS 1

Chair: R.V. Snyder, Co-chair: Chi Wang

THIC-1: Design of CT and CQ Filters Using Approximation and Optimization
THIC-2: A Method for the Direct Synthesis of General Sections
THIC-3: Temperature Characteristics of Combline Resonators and Filters
THIC-4: Periodic Structures for Original Design of Voluminous and Planar Microwave Filters
THIC-5: A Design of Planar Elliptic Bandpass Filter Using SMD-Type Partially Metallized Rectangular Dielectric Resonators
THIC-6: Full-Wave Design of Canonical Waveguide Filters By Optimization
THIC-7: Length Reduction of Evanescent-mode Ridge-Waveguide Filters
THIC-8: Zolotarev Bandpass Filters

TH1D HF/VHF/UHF POWER AMPLIFIERS

Chair: F.H. Raab, Co-chair: M. Eron

THID-1: Current Status and Emerging Trends in RF Power FET Technologies
THID-2: 7-MHz, 1.1-kW Demonstration of the New E/F2, Odd Switching Amplifier Class
THID-3: High-Eficiency Inductor-Coupled SEPIC for Use in Dynamic Envelope Tracking CDMA RF Power Amplifiers
THID-4: Electronically Tunable Class E Power Amplifier
THID-5: A GSM-EDGE High-Power Amplifier Using Digital Linearisation

TH1E PROBING AND AUTOMATED MEASUREMENTS JOINT IMS/ARFTG SESSION

Chair: E. Strid, Co-chair: B. Szendrenyi

THIE-1: Integrated Electrothermal Probe
THIE-2: Calibrating Electro-Optic Sampling Systems
THIE-3: A Three-Port Vector Network Analyzer-Measurement System, Calibration and Results
THIE-4: Microwave On-Wafer Characterization of Three-Port Devices Using Shield-based Test-fixtures
THIE-5: Accurate Transmission-Line Characterization on High-and Low-Resistivity Substrates
THIE-6: Automatic Test and Tuning System for Microwave Filters

TH1F AL GROSS MEMORIAL SPECIAL SESSION

Chair: V. Nair

10:20 am to noon

TH2A MILLIMETER-WAVE SIGNAL SOURCES

Chair: J.H. Kuno, Co-chair: R. Alm

TH2A-1: Low-Phase-Noise GaInP/GaAs-HBT MMIC Oscillators Up To 36 GHz
TH2A-2: Monolithic 38-GHz Coplanar Feedback VCOs Fabricated By a Production pHEMT Technology
TH2A-3: Low Phase-Noise pHEMT-Based MMIC VCOs for LMDS Applications
TH2A-4: Coplanar and Microstrip Oscillators in SiGe SIMMWIC Technology
TH2A-5: Low-Jitter Silicon Bipolar-Based VCOs for Applications in High-Speed Communication Systems.

TH2A-6: Push-Push Oscillators for 94 and 140-GHz Applications Using Standard Pseudomorphic GaAs HEMTs

TH2B ACTIVE AND PLANAR FILTERS

Chair: D.G. Swanson, Jr

TH2B-1: Negative Resistance Optimized in Noise for Losses Compensation in Microstrip Resonators
TH2B-2: Using a Negative Capacitance to Increase the Tuning Range of a Varactor Diode in MMIC Technology
TH2B-3: Compact MMIC Active Inductor
TH2B-4: Microstrip Miniaturized Loop Filters with High Out-Of-Band Rejection for Future Mobile Terminals
TH2B-5: Wideband Bandpass Filter Design with Three-Line Microstrip Structures
TH2B-6: A 60-GHz-Band Planar Dielectric Waveguide Filter for Flip-Chip Modules

TH2C PASSIVE FILTERS AND MULTIPLEXERS 2

Chair: J. Modelski, Co-chair: H. Clark Bell

TH2C-1: Design of Coupled Resonators Group-Delay Equalizers
TH2C-2: High-Power C-Band Dielectric Resonator Filters for Output Multiplexers
TH2C-3: Analysis of Power-Handling Capacity of Bandpass Filters
TH2C-4: Low-Loss Filters in Rectangular Waveguide with Rigorous Control of Spurious Responses Through a Smart Model Filter
TH2C-5: Observations on the Stopband Performance of Tapped-Line Filters
TH2C-6: Stop-Band Improvement of Rectangular Waveguide Filters Using Different Width Resonators: Selection of Resonator Widths
TH2C-7: Diplexer Design Using Presynthesized Waveguide Filters with Strongly Dispersive Inverters
TH2C-8: Filter Topologies with Minimum-Peak Stored Energy

TH2D MILLIMETER WAVE MULTIPLIERS AND MIXERS

Chair: D. Choudhury, Co-chair: P. Saunier

TH2D-1: 2.7 THz Waveguide Tripler Using Monolithic Membrane Diodes
TH2D-2: Fabrication of 200-To-2700-GHz Multiplier Devices Using GaAs and Metal Membranes
TH2D-3: A 200-to-300-GHz SIS Mixer-Preamplifier with 8-GHz IF Bandwidth
TH2D-4: 200-, 400-, and 800-GHz Schottky Diode "Substrateless" Multipliers: Design and Results
TH2D-5: An I-Q Mixer at 76.5 GHz Using Flip-Chip Mounted Silicon Schottky Diodes
TH2D-6: Performance of a 1.2-THz Frequency Tripler Using a GaAs Frameless Membrane Monolithic Circuit
TH2D-7: A 5-mW, 290-GHz Heterostructure Barrier Tripler in a Waveguide Configuration

TH2E MEASUREMENTS OF NOLINEAR DEVICES AND SYSTEMS — JOINT IMS/ARFTG SESSION

Chair: J. Barr, Co-chair: L. Dunleavy

TH2E-1: A Method to Compare Vector Nonlinear Network Analyzers
TH2E-2: Analysis and Measurement of Multitone Intermodulation Distortion of Microwave Frequency Converters
TH2E-3: NPR & Co-Channel Distortion Ratio: A Happy Marriage?
TH2E-4: Linearity Optimization of a Distributed Base-Station Amplifier Using an Automated High-Speed-Measurement Protocol
TH2E-5: Ultralinear Power-Amplifier Characterization Using Dynamic-Range Extension Techniques
TH2E-6: Direct Measurement of the Maximum Operating Region in GaAs HBTs for RF Power Amplifiers

TH2F HIGH-SPEED HBT TECHNOLOGY AND APPLICATIONS

Chair: L. Kushner, Co-chair: H.A. Hung

TH2F-1: Benefits of SiGe over Silicon-Bipolar Technology for Broadband Mixers with Bandwidth Above 10 GHz
TH2F-2: 40-Gb/s 4:1 Multiplexer and 1:4 Demultiplexer IC Module Using SiGe HBTs
TH2F-3: 40-Gb/s Analog IC Chip Set for Optical Receiver—AGC Amplifier, Full-Wave Rectifier and Decision Circuit— Implemented using Self-Aligned SiGe HBTs
TH2F-4: Low-Frequency Noise and Phase-Noise Behavior of Advanced SiGe HBTs
TH2F-5: Power SiGe Heterojunction Bipolar Transistors (HBTs) Fabricated by Fully Self-Aligned Double Mesa Technology
TH2F-6: 185-GHz Monolithic Amplifier in InGaAs/InAlAs Transferred-Substrate HBT Technology

Noon to 1:15 pm

PTHA COMMERCIAL EXPLOITATION OF 92-TO-96 GHZ SPECTRUM

1:20 to 3:00 pm

TH3A MULTILAYER PACKAGING TECHNIQUES

Chair: K. Varian, Co-chair: J. Pavio

TH3A-1: A New Via Fence Structure for Crosstalk Reduction in High-Density Stripline Packages
TH3A-2: Coupling Between Microstrip Lines Embedded in Polyimide Layers for 3D-MMICs on Si
TH3A-3: Silicon Substrate Coupling Noise Modeling, Analysis and Experimental Verification for Mixed-Signal Integrated-Circuit Design
TH3A-4: RF-Microwave Multilayer Integrated Passives using Fully Organic System-On-Package (SOP) Technology
TH3A-5: Design of Embedded High-Q Inductors in MCM-L Technology
TH3A-6: A Highly Integrated Transceiver Module for 5.8-GHz OFDM Communication System Using Multilayer Packaging Technology

TH3B LINEAR MODELING OF DEVICES AND COMPONENTS

Chair: M. Megahed, Co-chair: R.W. Jackson

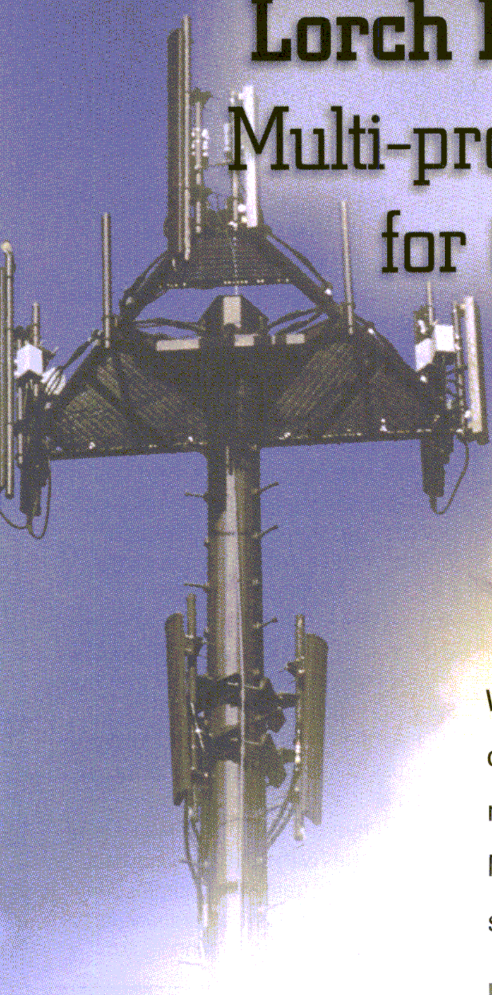
TH3B-1: EM-Based Multidimensional Parameterized Modeling of General Passive Planar Components
TH3B-2: Using Efficient Multivariate Adaptive Sampling by Minimizing the Number of CEM Analyses Needed to Establish Accurate Interpolation Models of Microwave Circuits
TH3B-3: Accurate Closed-Form Expressions for the Frequency-Dependent Line Parameters of On-Chip Interconnects on Lossy Silicon Substrate
TH3B-4: Microstrip Line on Ground Plane with Closely Spaced Perforations of Simple CAD Formulas by Synthetic Asymptote
TH3B-5: An Extrinsic-Inductance Independent Approach for Direct Extraction of HBT Intrinsic-Circuit Parameters
TH3B-6: Consistent Small-Signal and RF-Noise Parameter Modeling of Carbon-Doped InP/InGaAs HBT

TH3C PASSIVE FILTERS AND MULTIPLEXERS 3

Chair: D. Schmidt, Co-chair: J.J. Herren

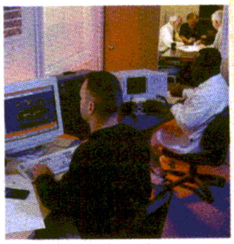
TH3C-1: Dual-Mode and Quad-Mode Moebius Bandpass Filters
TH3C-2: Analysis and Design of Mass-Producible Cross-Coupled, Folded E-Plane Filters

Lorch Microwave: Multi-product Solutions for Commercial Wireless Applications



With over 35 years experience designing and manufacturing microwave components, Lorch Microwave provides filtering solutions to the commercial market

- from base station to microwave radio links
- from less than 1MHz to 40GHz
- from high volume to small custom runs

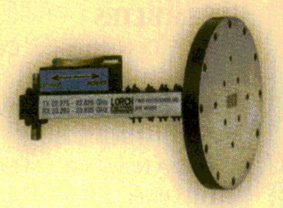


Diverse engineering and manufacturing capabilities allow Lorch Microwave to quickly respond to customer needs and provide custom tailored solutions, all with trademark service and satisfaction.

Commercial, High Performance & Custom-Designed Products

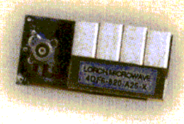
WIRELESS FILTERS AND DUPLEXERS

- cellular and PCS base stations filters, duplexers and assemblies
- delay assemblies for feed forward amplifier applications



WAVEGUIDE DIPLEXERS

- point-to-point microwave radio links to 40GHz
- terrestrial communication networks



CERAMIC FILTERS

- filters and diplexers to 5.8GHz
- specialized cellular and PCS applications
- diplexers and finite pole placed topologies available

OTHER COMMERCIAL AND MILITARY APPLICATIONS

- cavity filters
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TH3C-3: Modified Conductor-Loaded Cavity Resonator with Improved Spurious Performance

TH3C-4: A Practical Triple-Mode Monoblock Bandpass Filter for Base-Station Applications

TH3C-5: Low-Cost Dual-Mode Asymmetric Filters in Rectangular Waveguide

TH3C-6: Analysis and Design of Grooved Circular-Waveguide Dual-Mode Filters

TH3C-7: Small Filters Based on Slotted Cylindrical Ring Resonators

TH3C-8: Dual-Mode Filters for Cellular Base Stations Using Metallized Dielectric Resonators

TH3D MILLIMETER-WAVE TRANSCEIVER ELEMENTS AND ASSEMBLIES

Chair: E.C. Niehenke, Co-chair: F. Sullivan

TH3D-1: 65145-GHz InP MMIC HEMT Medium Power Amplifiers

TH3D-2: A New Direct Millimeter-Wave Six-Port Receiver

TH3D-3: Wireless Multichannel TV-Signal Distribution System By Using NRD Guide Transmitter and Receiver at 60 GHz

TH3D-4: Wideband Low-Phase-Noise High-Power W-Band Signal Sources

TH3D-5: 155-Mb/s Data Transmission at 60 GHz using a 1 x 4 Patch-Array Antenna with Variable Optical-Delay Lines

TH3E SPATIAL COMBINING AND ACTIVE ANTENNAS

Chair: J. Harvey, Co-chair: Z. Popovic

TH3E-1: Fault-Tolerance Analysis and Measurement of a Spatial Power Amplifier

TH3E-2: A K-Band Full-Duplex Transmit-Receive Lens Array

TH3E-3: Quasi-Optical Power Amplifier Using TEM Waveguide Concept

TH3E-4: A 16-Element Reflection Grid Amplifier With Improved Heat Sinking

TH3E-5: A 1-W, 38-GHz Monolithic Grid Oscillator

TH3E-6: A 94-GHz Overmoded-Waveguide Oscillator with Gunn Diodes

TH3E-7: A Retrodirective Diode Grid Array Using Four-Wave Mixing

TH3E-8: An Experimental and Theoretical Characterization of a Broadband Arbitrarily-Polarized Rectenna Array

TH3E-9: 5.8-GHz Circular-Polarized Rectifying Antenna For Microwave Power Transmission

TH3F HIGH-PERFORMANCE MMIC TECHNOLOGIES

Chair: Z. Bardai, Co-chair: T. Lee

Technology that may enable significant cost savings by putting high-performance InP devices on low-cost GaAs substrates.

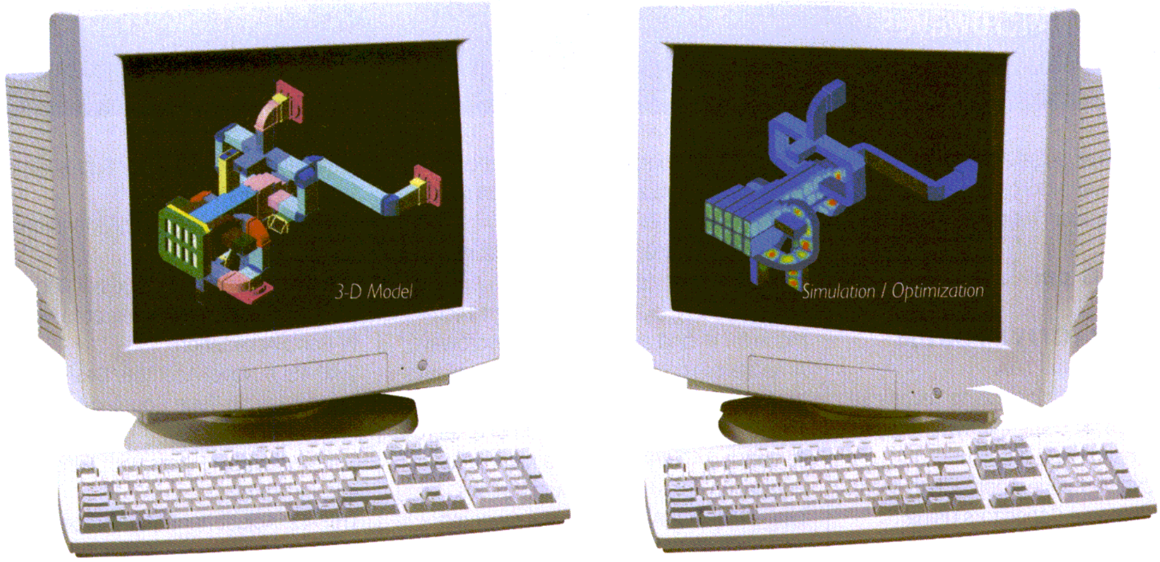
TH3F-1: A 1-to-10-GHz 0.18-mm CMOS Chip Set for Multimode Wireless Applications

TH3F-2: An 0.18-mm Foundry RF CMOS Technology with 70 GHz f_T for Single-Chip System Solutions

TH3F-3: Deep Trench Guard Technology to Suppress Coupling Between Inductors in Silicon RF ICs

TH3F-4: Physics and Compact Modeling of SOI Substrates with Buried Ground Plane (GPSOI) for Substrate Noise Suppression

TH3F-5: Low-Loss Passive Components on BCB-Based 3D MMIC Technology



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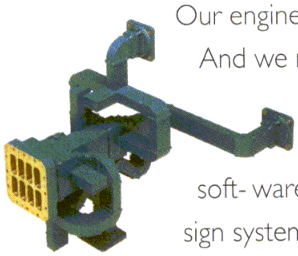

Our engineers are at the top of their profession. And we make it our business to provide them with the finest tools available. Aside from employing proprietary MDL soft- ware, they work with computerized de- sign systems, utilizing SolidWorks to render 3-D models and Ansoft HFSS to compute a full complement of performance characteristics. Then our skilled professionals manufacture, braze, finish, and test every product right here in our plant. So design challenges become reality in impressively little time.

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TH3F-6: Microwave Noise and Power Performance of Metamorphic InP Heterojunction Bipolar Transistors (HBTs)

2:30 to 5:00 pm

THIF INTERACTIVE FORUM

Chair: TBA, Co-chair: TBA

THIF-1: Generalized Multigridding Technique for the TLM Method Using the Symmetrical Super-Condensed Node (SSCN)
THIF-2: A Novel Adaptive Approach to Modeling MEMS-Tunable Capacitors Using MRTD and FDTD Techniques
THIF-3: A Multithreaded Time-Domain TLM Algorithm for Symmetric Multiprocessing Computers
THIF-4: Construction of Solutions to Electromagnetic Problems in Terms of Two Colinear Vector Potentials
THIF-5: Analysis of Lumped-Element Transistor Structures Using MRTD: The Equivalent Source Method
THIF-6: Efficient Time-Domain Electromagnetic Analysis Using CDF Biorthogonal Wavelet Expansion
THIF-7: A Wavelet-Based FDTD-Multigrid Method
THIF-8: Analysis and Design of a Planar Antenna for a Millimeter-Wave Emitter Using TLM
THIF-9: Analysis of Differential Vias in a Multilayer Parallel-Plate Environment Using a Physics-Based CAD Model
THIF-10: 3D-FDTD Subgridding Technique Applied to Radiating Structures
THIF-11: Enhanced Forward-Coupling Phenomena Between Microstrip Lines on Periodically Patterned Ground Plane
THIF-12: Coupled TLM-Thermal Analysis in the Time Domain
THIF-13: Lumped and Distributed Device Embedding Techniques in Time-Domain TLM Field Models
THIF-14: Analysis of Multiport Waveguide Structures By a Higher-Order FDTD Methodology Based on Nonorthogonal Curvilinear Grids
THIF-15: FDTD Study of Resonance Processes in Microstrip Ring Resonators with Different Excitation Geometries
THIF-16: An Unconditionally Stable Finite-Element Time-Domain Solution of Active Nonlinear Microwave Circuits Using Perfectly Matched Layers
THIF-17: Optimal-Shape Design of Dielectric Structure Using FDTD and Topology Optimization
THIF-18: Electronic-Design-Assistance Tool for Circuit Optimization. Application to Microwave Power Amplifiers.
THIF-19: Nonlinear Statistical Modeling of Large-Signal Device Behavior
THIF-20: A Computer-Aided-Design Technique for Hybrid and Monolithic Microwave Amplifiers Employing Distributed Equalizers With Lumped Discontinuities
THIF-21: Statistical Construction of a Representative CAD Model From a Measured Population For RF Design Applications
THIF-22: SMX—A Novel Object-Oriented Optimization System
THIF-23: A Robust Algorithm for Automatic Development of Neural-Network Models for Microwave Applications
THIF-24: Steady-State Determination for RF Circuits Using Krylov-Subspace Methods in SPICE
THIF-25: Interactive "Visual" Design of Matching and Compensation Networks for Microwave Active Circuits
THIF-26: Efficient Sensitivity Analysis of Lossy Multiconductor Transmission Lines with Nonlinear Terminations
THIF-27: Software Tool for the Design of Narrowband Bandpass Filters
THIF-28: Optimization of Waveguide Diplexers Using Shadow Specifications
THIF-29: Micromachined RF MEMS-Tunable Capacitors Using Piezoelectric Actuators
THIF-30: Digitally Controllable Variable High-Q MEMS Capacitor for RF Applications
THIF-31: Nonlinear Electromechanical Modeling of MEMS Switches
THIF-33: An Electromechanical Model for MEMS Switches
THIF-34: Digital Generation of RF Signals for Wireless Communications with Bandpass Delta-Sigma Modulation
THIF-35: A CMOS 6-b, 1 GHz ADC For IF-Sampling Applications
THIF-36: A Silicon-On-Insulator +28-VDC RF Power LDMOSFET for 1-GHz Integrated Power-Amplifier Applications
THIF-37: Receiving Weak Signals With a Software GPS Receiver
THIF-38: Simple Design Equations for Broadband Class E Power Amplifiers With Reactance Compensation
THIF-39: Multiharmonic Tuning Behavior of MOSFET RF Power Amplifiers
THIF-40: Study of Self-heating Effects in GaN HEMTs
THIF-41: InGaP PHEMTs for Wireless Power Applications
THIF-42: Novel Asymmetric Gate-Recess Fabrication Technique for Sub-Millimeter-Wave InP-Based HEMTs
THIF-43: A Calibrated RF/IF Monolithic Vector Analyzer
THIF-44: Design Techniques of Reducing Chip Area and Highly Integrated MMIC For W-Band Application
THIF-45: A Novel Accurate Design Method for the Hairpin-Type Coupled-Line Bandpass Filters
THIF-46: Hairpin Filters With Tunable Transmission Zeros
THIF-47: Adjustment of a Temperature-Compensated Ka-Band Ring Resonator VCO Using Fully Automated Laser Trimming
THIF-48: Monolithic Quantum Tunnel Diode-Based C-Band Oscillator and LNA
THIF-49: Calibrated Linear and Nonlinear-Pulsed RF Measurements on an Amplifier
THIF-50: Measurement of Group Velocities of Various Microwave Transmission Lines Through FM Reflectometry
THIF-51: Millimeter-Wave Measurements of Temperature Dependence of Complex Permittivity of GaAs Plates by a Circular Waveguide Method
THIF-52: Infrared Temperature Characterization of High-Power RF Devices
THIF-53: Near-Field Microwave Microscopy of Thin-Film Resonators
THIF-54: 28-GHz LMDS Channel Measurements and Modeling for Parameterized Urban Environments
THIF-55: C/Ku-Band Pulsed Transmitters for Poseidon 2 Altimeter
THIF-56: The RF Module Design for W-CDMA/GSM Dual-Band and Dual-Mode Handset
THIF-57: Bias-Control Technique for CDMA Driver Amplifier to Decrease Current
THIF-58: Multicarrier Microwave Breakdown in Air-Filled Components
THIF-59: Analysis of Proposals to Reduce SAR Levels From GSM Terminals
THIF-60: High-Accuracy Digital 5-b 0.8-2 GHz MMIC RF Attenuator for Cellular Phones
THIF-61: Micromachined 60-GHz GaAs Power Sensor with Integrated Receiving Antenna
THIF-62: A Sensor System Based on SiGe MMICs for 24-GHz Automotive Applications
THIF-63: Acoustic Sensing Using Radio-Frequency Detection and Capacitive Micromachined Ultrasonic Transducers
THIF-64: Millimeter-Wave Printed-Circuit Antenna System for Automotive Applications


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THIF-65: Spectrum Correlation of Beat Signals in the FM-CW Radar-Level Meter and Application for Precise Distance Measurement

THIF-66: K-Band Direct-Detect MMIC SI Micromachined Radiometer

THIF-67: A Rugged Active Sensor for Microwave Aquametry

3:30 to 5:10 pm

TH4A PACKAGING-INTERCONNECT TECHNIQUES

Chair: J. Laskar, Co-chair: M. Harris

TH4A-1: Broadband Time-Domain Characterization of Multiple Flip-Chip Interconnects

TH4A-2: Ka-Band Power pHEMT Technology for Space-Power Flip-Chip Assembly

TH4A-3: Design and Analysis of Low-Cost IC Package Solution for 10-Gb/s Applications

TH4A-4: LTCC As MCM Substrate: Design of Strip-Line Structures and Flip-Chip Interconnects

TH4A-5: Vertical Transitions in Low-Temperature Cofired Ceramics for LMDS Applications

TH4A-6: Characterization of High-Density Micromachined Interconnects

TH4A-7: Design and Optimization for Coaxial-To-Microstrip Transition on Multilayer Substrate

TH4A-8: Temperature-Compensated Planar Narrowband Notch Filter with Fully Automated Laser Trimming

TH4B FREQUENCY-DOMAIN EM TECHNIQUES

Chair: R. Sorrentino, Co-chair: J. Rautio

TH4B-1: MoM/BI-RME Analysis of Boxed Microwave Circuits Based on Arbitrarily Shaped Elements

TH4B-2: Fast Electromagnetic Analysis of Dense-Shielded Integrated Circuits using the Adaptive Integral Method (AIM)

TH4B-3: Full-Wave Analysis of Electromagnetic Coupling in Realistic RF Multilayer PCB Layouts using Cascaded Parallel-Plate Waveguide Model

TH4B-4: A New Global-Analysis Model for Microwave Circuits With Lumped Elements

TH4B-5: Analysis of Multilayer Integrated Inductors with Wave Concept Iterative Procedure (WCIP)

TH4B-6: Numerical Cost of Gradient Computation Within the Method of Moments and Its Reduction Using a Novel Boundary-Layer Concept

TH4B-7: Automated Intelligent-Mode Selection for Fast-Mode Matching Analysis of Waveguide Discontinuities

TH4C LOW-NOISE COMPONENTS AND TECHNIQUES

Chair: P. Smith, Co-chair: L. Boglione

TH4C-1: A 183-GHz Low-Noise-Amplifier Module 7.1-dB Noise Figure For the Conical-scanning Microwave Imager (CMIS) Program

TH4C-2: Low-Noise Amplifiers in InP Technology for Pseudo Correlating Millimeter-Wave Radiometer

TH4C-3: Simple Model for Dynamic-Range Estimate of GaAs Transistors

TH4C-4: Modeling of Low-Frequency Noise In GaInP/GaAs Hetero-Bipolar Transistors

TH4C-5: Microwave Noise and Small-Signal Parameters Scaling of InP/InGaAs DHBT With High DC-Current Gain

TH4D MICROWAVE APPLICATIONS OF SUPERCONDUCTIVITY

Chair: C. Jackson, Co-chair: M. Nisenoff

TH4D-1: An All-Cryogenic Low-Phase-Noise Hybrid K-Band Oscillator for Satellite Communication

TH4D-2: Dual 5-MHz PCS Receiver Front End

TH4D-3: Compact Quasi-Lumped-Element HTS Microstrip Filters

TH4D-4: Optoelectronic RF Harmonic Generation and Mixing in High-Tc Superconducting Film

TH4D-5: Novel Method for Calculation and Measurement of Unloaded Q-Factor of Superconducting Dielectric Resonators

Friday
May 25, 2001
8:00 am to noon

WFA INDUSTRIAL APPLICATIONS OF ELECTROMAGENTIC (EM) SOLVERS

This workshop will explore the extent to which electromagnetic (EM) solvers are being successfully used in industrial applications. The workshop will attempt to identify the successful uses, the practical ramifications of solver limitations, and identify those areas where solver developers need to focus their future work. Accordingly, the workshop will have a threefold focus, as follows: 1. To learn about the successful applications of EM solvers to problems faced by the industrial community. It is anticipated that frequency-domain solvers are more mature and are finding their way into use.These successes will be discussed. However, it will also be of considerable interest to learn whether industry has made progress in applying time-domain solvers. It will be of interest to learn whether EM solvers are being used to study EM interactions of circuit features that are supposed to be isolated within packages

2. To learn about how the time- and, possibly, storage-intensive nature of these computations is limiting the application of EM solvers in the industrial setting. It will be of interest to learn how this affects the types of problems for which industrial users find them valuable. It will be of interest to learn whether industry is making use of the ability of time-domain EM solvers to address nonlinear behavior in components.

3. To learn about those aspects of EM solvers that industrial users would like to see improved. Are solvers as user-friendly as they need to be? To what extent can a traditional RF or microwave design engineer make use of these solvers without dedicating their career to becoming the guru on this subject within their company? What kind of advancements need to be made in the state of commercially available EM solvers? For which computing platforms and operating systems is it desired to have EM solvers available?

WFB RF PASSIVE COMPONENT EVALUATION TECHNIQUES

Today's wireless electronic equipment is continuing to place more stringent requirements on RF components. The advent of new technology RF components is providing circuit designers with the ability to meet their requirements if they can verify how those components will actually work n their designs. This workshop will cover impedance measurements, including definitions, measurement technique selection, compensation and error-correction, and fixturing. The impedance portion will close with a discussion and measurement examples of RF inductors and capacitors. The workshop will also review basic 2-port device evaluation with an emphasis on RF filters.

Radar System Performance Modeling

G. RICHARD CURRY

RADAR SYSTEMS HAVE long been viewed as the ultimate modeling challenge. Not only are the systems themselves composed of many component parts, but the functions of a radar are complex—transmitting and then detecting reflected pulses amidst obstacles including multipath distortion and clutter. *Radar System Performance Modeling* by G. Richard Curry addressees the needs of system analysts for radar models. The book provides equations and explains them fully, offers a variety of computational methods, and presents useful data for modeling radar performance at the system level. The test also provides a great deal of insight on how to use its models for accurate radar-system analysis.

Radars are increasingly used as integral parts of more complex systems. Examples include air-traffic-control systems, ballistic-missile defense systems, air-defense systems, and land-attack targeting systems. Analysis of radars in these systems requires representing the radar's operation and performance in the context of the overall system and the external environment. Radar performance must be evaluated in the context of performing essential system tasks, and the impact of radar operation on system performance must be quantified.

The radar models described in the book can be used by system analysts to evaluate designs that include radar electronics, and by modelers and programmers involved in simulating the performance of embedded radars. Several of the key radar models are programmed into custom functions for use in Excel spreadsheets

The book's 11 chapters cover topics such as basic radar concepts, radar-system configurations, radar-performance parameters (needed for modeling), different types of waveforms found in radar systems, the famous radar-range equation for estimating the useful operating distance of a particular radar system, the radar signal-detection process, radar-search modes, measurement techniques for evaluating the performance of a radar system, the effects of environmental factors (such as clutter and propagation) on radar-system performance, radar countermeasure techniques, and a collection of radar-performance modeling examples. The modeling examples cover false-alarm probability optimization; cumulative detection over long periods; cued search using a dish radar; composite measurement errors; and detection in the presence of jamming, chaff, and noise. The book includes a radar-system-performance modeling software program for Windows-based PCs. (2001, 336 pp., hardback, ISBN: 1-58053-095-8, $99.00.) **Artech House, 685 Canton St., Norwood, MA 02062; (781) 769-9750, (800) 225-9977, FAX: (781)-769-6334, Internet: www.artechouse.com.**

New Millennium Products Journey Begins at IMS2001

GENE HEFTMAN
Senior Editor

With 2001 being the official beginning of the millennium, it is appropriate that the theme of the International Microwave Symposium 2001 (IMS2001) is "A Microwave Odyssey," marking the beginning of a long voyage through the coming century. Many changes of fortunes occur during an odyssey, and suppliers of hardware and software to the communications industry are hoping for a change of fortune to recapture the spark of past years. This will occur in the hot desert of Phoenix, AZ beginning on May 20. While current business conditions are decidedly cool, plenty of technology is sitting on the front burner in need of product solutions when the sluggish economy awakens. The more obvious candidates are IEEE 802.11 wireless local-area-network (WLAN) connectivity, single-chip Bluetooth, HomeRF, and third-generation (3G) wireless communications. Some of the products that will be on display at the Symposium to address the needs of these and other developing technologies are described in the following pages.

products

SOURCE METER TESTS HIGH-POWER LASERS

The Keithley Model 2440 SourceMeter is a precision source-measurement system intended to test the latest generation of high-power pump lasers used in optical amplifiers for dense-wavelength-division-multiplexing (DWDM) fiber-optic communications systems. It is rated for a continuous 50-W, 5-A output and can serve in test applications requiring a continuous 40-W source up to +40 VDC. The instrument is half-rack size and is capable of 4- and 6-wire remote sense-resistance measurements ranging from 1 $\mu\Omega$ to 200 $M\Omega$. Typical measurement accuracy is $\pm$0.015 percent on the +40-VDC range and $\pm$0.1 percent on the 5-A range. P&A: $5995; stock.

Keithley Instruments, Inc., 2875 Aurora Rd., Cleveland, OH 44139-1891; (888) 534-8453, FAX: (440) 248-6168, e-mail: product_info@keithley.com, Internet: www.keithley.com.

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BLUETOOTH TRANSCEIVER MEETS PROTOCOL SPECS

A single-chip Bluetooth transceiver that is implemented in 0.25-μm RF complementary-metal-oxide-semiconductor (CMOS) technology is qualified for Bluetooth protocol 1.1, Class 2 products. It was jointly developed with Chartered Semiconductor Technology of Singapore, which is a leading silicon (Si) foundry. The Bluetooth transceiver has a peak f_T of 39 GHz with an f_{max} of 45 GHz. It operates at a core voltage of +2.5 VDC. A 0.25-μm RF CMOS design kit is available that includes RF transistors, passive components, as well as device models that are jointly developed by Ericsson Microelectronics and Chartered Semiconductor. Future applications are targeted at migrating to a 0.18-μm process that can be used for system-on-a-chip (SOC) applications.

Ericsson Microelectronics; +46 8 757 5367, Internet: www.ericsson.com/rfpower.

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MICRO CONNECTOR FITS IN TIGHT SPACES

The small dimensions of the Micro Miniature Board Connectors (MMBX) allow them to be integrated into existing and future-generation communication systems. Available as straight-cable plugs, right-angle cable plugs, straight printed-circuit-board (PCB) plugs/jacks, they are suitable for vertical board-to-board or sandwich-card connections. MMBX connectors require less than 7 mm of space and feature a misalignment compensation of 0.4 mm axial and 0.7 mm radial.

Huber+Suhner, Inc., 19 Thompson Dr., Essex Junction, VT 05452; (802) 878-0555, Internet: www.hubersuhnerinc.com

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AMPLIFIER OPERATES FROM 50 TO 1500 MHz

Suitable for narrowband and broadband communications, the AH101 medium-power, high-linearity amplifier spans a frequency range of 50 to 1500 MHz. Described as a medium-power gain block, the third-order intermodulation (IM) product is specified at +45 dBm typical while the P1dB output power is rated at +27 dBm typical. The 4-pin packed device operates from a single supply voltage of +9 VDC and over a case-temperature range of −40 to +85°C. Internally matched transistors make the amplifier unconditionally stable. It is supplied in an SOT-89 surface-mount package.

WJ Communications, Inc., (800) 951-4401, FAX: (408) 433-5649, e-mail: sales@wj.com, Internet: www.wj.com.

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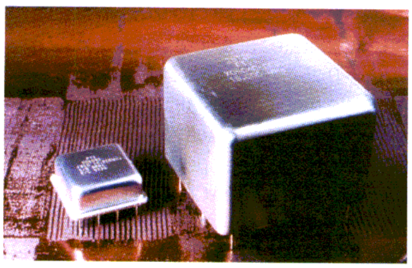
HIGH-STABILITY OSCILLATOR IS OVEN CONTROLLED



For application requirements that can only be met by an oven-controlled crystal oscillator (OCXO), the XO5080 family addresses user needs for lower life-cycle costs. The oscillators are available in frequencies between 10 and 125 MHz using either AT-cut or SC-cut resonator technology. Frequency stability over temperature (0 to 70°C) is ±0.07 PPM for the AT-cut and ±0.02 PPM for the SC-cut. The oscillators operate from a single +5-VDC supply and are housed in a surface-mount-technology (SMT) reflow package (a through-hole version is also available) measuring 1.03 x 1.16 x 0.53 in. (2.61 x 2.95 x 1.35 cm.). The family is available with either sine-wave output or high-performance complementary-metal-oxide-semiconductor (HCMOS) logic output.

Piezo Technology, Inc., 2525 Shader Rd., Orlando, FL 32804; (407) 298-2000, FAX: (407) 293-2979, e-mail: sales@piezotech.com, Internet: www.piezotech.com

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POWER TRANSISTORS TARGET BASE STATIONS

A family of high-power microwave transistors (3.2, 12, and 20 W) is designed for base-station operation in the personal-communications-services (PCS) [1930-to-1990-MHz] band. The 1920A05 (3.2 W), 1920A12 (12 W), and 1920A20 (20 W) are specified for Class A operation running from supply voltages of +25 VDC. Typical gain is 9.3 dB for the A05, 7.5 dB for the A12, and 9.0 dB for the A20. VSWR under load is rated at 3.1:1 for all models.

GHz Technology, Inc., 3350 Scott Blvd., Santa Clara, CA 95054; (408) 986-8031, FAX: (408) 986-8120, Internet: www.ghz.com/

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WAVEGUIDE HANDLES EXTREME INSTALLATIONS

Waveguide that is bendable and twistable is necessary for the most extreme, unforgiving installations. Two of the most flexible types are constructed from MSBS (seamless brass) and MSDS [Seamless beryllium-copper (BeCu)]. Intended for space applications where light weight and low outgassing are important parameters, the waveguides can withstand pressure without the use of Neoprene, silicone, or vinyl jackets. Twistable waveguide (twist-flex) can have its return loss measured while it is flexing, tied in a knot. A full line of rectangular flexible waveguide from L-band (WR650, 1.12 GHz) to W-band (WR10, 100 GHz) is available.

Microtech, Inc., 1425 Highland Ave., Cheshire, CT 06410; (203) 272-3234, FAX: (203) 271-0352, e-mail: sales@microtech-inc.com, Internet: www.microtech-inc.com.

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COMBINERS RECONFIGURE BASE-STATION TRANSMITTERS

High-power transmitter (Tx) combiners with a minimum of 75-dB channel-to-channel isolation can be used to reconfigure the output power of base-station Txs. The combiners can handle peak-power levels of 300 W, and 70 W per channel can be applied simultaneously with up to eight inputs. The modular building-block construction allows the units to be configured in any combination of inputs from two to eight by adding additional model types to expand the number of ports. Internally, the units use special ferrite circulators and high-power terminating resistors to achieve very low intermodulation (IM) performance. The combiners are supplied with brackets for base-station mounting with minimum modification to the base-station equipment.

KDI/triangle Corp., 60 S. Jefferson Rd., Whippany, NJ 07981; (973) 887-8100, FAX: (973) 884-0445, e-mail: sales@kditriangle.com, Internet: www.kditriangle.com.

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UPCONVERTER/DRIVER OFFERED IN A SINGLE IC

A fully integrated upconverter/driver incorporating an intermediate-frequency (IF) amplifier, upconverting mixer, two-stage driver amplifier, and local-oscillator (LO) buffer amplifier is available in a 4-mm, 20-pin plastic quad flat pack. The MD59-0062 operates over the 1710-to-1910-MHz frequency range and is designed for code-division-multiple-access (CDMA) handset transmitters (Tx) in the US and Korean personal-communications-services (PCS) bands that require high linearity and low power consumption. CDMA linear output power is rated at +7 dBm typical at 56-dBc adjacent-channel power ratio (ACPR) and noise figure is 10 dB. The integrated circuit (IC) can operate at supply voltages from +2.7 to +5.0 VDC and has a low-power mode where the supply current is 46 mA.

M/A-COM, 1011 Pawtucket Blvd., Lowell, MA 01853-3295; (800) 366-2266, FAX: (800) 618-8883, Internet: www.macom.com

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A signal-analysis instrument, the 2319E RF test system, is an RF digitizer for second-generation (2G), second-and-a-half-generation (2.5G), and third-generation (3G) digital cellular testing. It enables manufacturers to convert broadband RF signals into high-quality, digitized data for external processing by a personal computer (PC). When combined with an optional high-power digital-signal-processing (DSP) card and proprietary software, the 2319E can be used as a substitute base station during the early research-and-development (R&D) phase of new mobile phones. The instrument is available in benchtop or rack-mounted versions. It covers a frequency range of 500 to 2500 MHz and has a digitization bandwidth of 20 MHz. The sampling rate is 65.28 MSamples/s and the analog-to-digital (ADC) resolution is 12 b. P&A: $31,351 for the base instrument and $6,420 for individual software modules.

IFR Systems, Inc., 10200 W. York St., Wichita, KS 67215-8999; (800) 835-2352, e-mail: info@ifrsys.com, Internet: www.ifrsys.com.

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LEADED PACKAGE HANDLES HIGH-POWER DEVICES

A leaded ceramic package that permits easy manufacturing of devices with high thermal-management needs, such as power amplifiers (PAs), is aimed at local-multipoint-distribution-system (LMDS) systems. It is said to the be the first of these leaded package for use at Ka-band (26 to 31 GHz). Known as the 580403, it is an off-the-shelf (OTS) package that can hold a device, such as an amplifier, that is ready for conventional soldering and assembly. It can also be used for low-noise amplifiers (LNAs) and customized for multichip modules (MCMs). It is fabricated with a standard copper (Cu) composite base incorporated with the company's patented microstrip-embedded microstrip-microstrip transition design. A plastic cap lid finishes the structure and provides protection for the device inside. Outside dimensions are 0.45 × 0.45 in. (11.43 × 11.43 mm). The cavity dimensions are 0.250 × 0.250 in. (6.35 × 6.35 mm).

StratEdge, 4393 Viewridge Ave., San Diego, CA 02123; (858) 569-5000, FAX: (858) 560-6877, Internet: www.stratedge.com.

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POWER AMPLIFIERS DELIVER HIGH LINEARITY

The SPA series of RF integrated-circuit (RF IC) power amplifiers (PAs) is gallium-arsenide (GaAs) devices that cover the 850-, 1950-, and 2150-MHz frequency bands and provide high linearity for demanding wireless network systems. They are powered from a single +5-VDC supply and are rated for a third-order intercept point (IP3) of +48 dBm. The PAs are suitable as driver amplifiers in base stations and repeaters. They come in standard surface-mount SOIC 8-pin plastic packages. P&A: $10.95 (50,000 qty.).

Stanford Microdevices, Inc., (408) 616-5464, FAX: (408) 739-0970, e-mail: info@stanfordmicro.com, Internet: www.stanfordmicro.com.

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EDA SOFTWARE SOLVES RF DESIGN PROBLEMS

Virtually any type of circuit can be simulated using a variety of analysis methods with the APLAC Circuit Simulator and Design Package. Any part of a system can be optimized or tuned with respect to all other parts, and a Monte-Carlo statistical feature is available with every analysis method. The software contains an RF design tool consisting of an extensive set of microwave components and special nonlinear analysis methods for RF circuits at the printed-circuit-board (PCB) and integrated-circuit (IC) design levels. An electromagnetic (EM) tool enables the study of complex electrical structures and multiple radiation sources. Most support for the package is provided through e-mail since most APLAC input files are sufficiently concise that they can be submitted for review by a support specialist. Secret or proprietary information can be deleted from simulation files and sent to the company without affecting the technical answer.

APLAC Solutions Corp., Atomitie 5 C, 00370 Helsinki, Finland; +358-9-5404-5028, FAX: +358-9-5404-5040, Internet: www.aplac.com.

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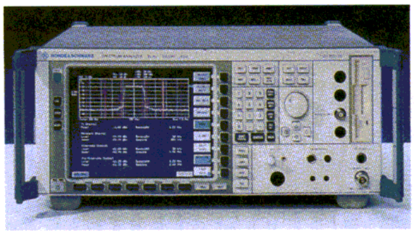
SPECTRUM ANALYZERS TEST NEXT-GENERATION WIRELESS



Two spectrum analyzers—the FSU3 (20 Hz to 3.6 GHz) and the FSU8 (20 Hz to 8 GHz)—can perform measurements on advanced wireless technologies such as wideband code-division multiple access (WCDMA), Enhanced Data Rates for GSM Evolution (EDGE), and existing telecommunications standards. The analyzers can be used in laboratory and production environments. In manufacturing, the instrument's automated testing and test-control architecture increase manufacturing throughput. A key measurement capability is adjacent-channel leakage ratio (ACLR) for base-station transmitters (Txs). The wide measurement margin afforded by the instruments' wide dynamic range—77.5 dB for 3GPP systems—leads to greater accuracy in this measurement. P&A: $41,950; stock to 16 wks. ARO.

Tektronix, Inc., Beaverton, OR 97077; (503) 627-2001, Internet: www.tektronix.com.

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MICROWAVE SUBSTRATES HAVE VERY-LOW LOSSES

Microwave and ultra-high-frequency (UHF) applications that must operate with extremely low losses require laminates and dielectrics such as PolyGuide, fabricated from high-quality polyolefin. In either clad or unclad form, the material is very resistant to chemical attack. It is essentially inert to solutions and solvents used in microwave processing and fabrication. The clad and unclad versions can be easily and accurately routed, punched, or drilled using standard shop techniques. The electrical properties remain constant through a broad range of operating conditions and frequencies up to 18 GHz.

Polyflon Co., One Willard Rd., Norwalk, CT 06851; (203) 840-7555, FAX: (203) 840-7565, e-mail: info@ployflon.com,

Internet: www.polyflon.com.
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SCHOTTKY DETECTORS SPAN 10 MHz TO 40 GHz

The Model 203S Zero Bias Schottky detectors operate from 10 MHz to 40 GHz. Frequency response is ±0.5 dB to 20 GHz, ±0.8 dB to 26.5 GHz, and ±1.5 dB to 40 GHz. Maximum VSWR over the same bands is 1.35:1, 1.50:1, and 2.00:1, respectively. The standard input connector is a 2.4 mm

male or K male. Low-level sensitivity is 0.5 mV/μW.
Krytar, 1292 Anvilwood Ct., Sunnyvale, CA 94089; (408) 734-5999, FAX: (408) 734-3017, Internet: www.krytar.com
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CABLE ASSEMBLIES ENHANCE TEST EQUIPMENT

Cable assemblies specially designed for microwave and high-speed digital test equipment can improve the performance of instruments such as vector network analyzers (VNAs), scalar network analyzers, and automated gear. The next-generation assemblies are designed for measurement through 65 GHz. Another type, Phaseflex, is rated up to 26.5 GHz. Both types are rated for an amplitude stability of ±0.08 dB and phase stability of ±2.8 deg. (±4.7 deg. for Phaseflex types). The cables are extremely flexible. Both types are rated for a life of 100,000 flex cycles.
W.L. Gore & Associates, Inc., 1901 Barkdale Rd., Newark, DE 19711; (800) 356-4622, FAX: (302) 738-5993, Internet: www.gore.com
Enter No 78 at www. mwrf.com

EDA SOFTWARE ADDS CIRCUIT SIMULATOR

An RF and broadband circuit simulator, GoldenGate 3.0, addresses key issues for RF designers. The software is integrated into the Analog Design Framework EDA software of Cadence Design Systems. Determining third-order intermodulation (IM) products (a time-domain technique) and making noise-figure and oscillator analyses (frequency-domain problems) can be handled by the simulator since it uses a hybrid combination of frequency- and time-domain techniques. Design cycles can be sped up because the package can solve problems in the frequency domain much faster than in the time domain. The envelope-transient capability (harmonic-balance simulator) can be used to calculate the important CDMA parameters, adjacent-channel power ratio (ACPR). Envelope transient simulation is said to reduce simulation by 100 times. The software has a methodology for the simulation of high-frequency broadband circuits used in optical networking, SONET, cable modems, and others.

Xpedion Design Systems, Inc., 4677 Old Ironsides Dr., Santa Clara, CA 95054; (408) 987-0603, FAX: (408) 987-0615, e-mail: info@xpedion.com, Internet: www.xpedion.com

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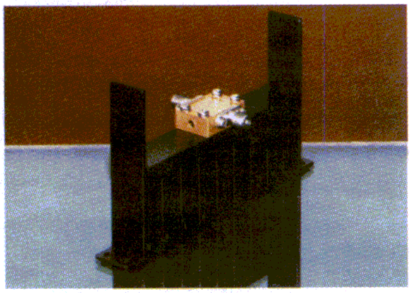
POWER AMPLIFIER OPERATES IN MILLIMETER-WAVE BAND



The AMF-8F-265325-80-29P is a power amplifier (PA) designed to operate over the 26.5-to-32.5-GHz range. It features an output power of +30 dBm typical (+29 dBm minimum), noise figure of 8 dB, and minimum gain of 30 dB. Various electrical options and connector combinations are available.

MITEQ, Inc. 100 Davids Dr., Hauppauge, NY 11788; (631) 436-7400, FAX: (631) 436-7430, Internet: www.miteq.com.

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PULSE AMPLIFIER WORKS IN RADAR SYSTEMS

A high-power pulse amplifier, the model CPHC128148-1000, is designed specifically to operate in battery-operated radar systems. Peak power output is more than 1000 W for extended operational times on battery power, even in severe environmental conditions. Pulse widths up to 8 μs at 5-percent duty cycle are fully supportable with protection circuitry against over-pulse width. Phase runout across the pulse is 7 deg. typical from 1215 to 1400 MHz. Included in the package is an isolator and high-power termination for VSWR protection. All video inputs and outputs are differential for noise immunity. The amplifier weighs less than 9 lbs. due to its advanced RF and packaging technologies.

Comtech PST, 105 Baylis Rd., Melville, NY 11747; (516) 777-8900, FAX: (516) 777-8877, Internet: www.comtech-pst.com.

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Design drivers for YIG filters and oscillators

YIG IS A HIGH-Q material used in the manufacture of filters with excellent out-of-band rejection and oscillators with low phase noise. Components based on YIG materials provide electronically tunable bandwidths through applied current—rather than voltage—as in voltage-controlled filters and oscillators. A four-page application note from Micro Lambda, Inc. (Fremont, CA), "YIG Drivers," provides basic coil-driver circuits for tuning the main and the FM coils of YIG components.

YIG-based components use applied current to tune over a specified operating frequency range. The range and amount of tuning current required are determined by the designed frequency range and the tuning sensitivity of the YIG component. As the note describes, a typical YIG oscillator with a range of 8 to 18 GHz has a main tuning coil sensitivity of 20 mHz/mA. Thus, it required 400-mA tuning current at 8 GHz [8 GHz(20 MHz/mA)] and 900 mA at 18 GHz [18 GHz(20 MHz/mA)]. YIG drivers are used to convert control commands to tuning current. Either analog or digital control-command formats may be used with a YIG component. Analog drivers typically convert voltages in the range of 0 to +10 VDC to tuning current while digital drivers typically convert 12-to-16-b digital commands to tuning current.

Digital tuning resolution is defined as the total operating frequency range divided by the total number of possible digital tuning commands. For example, a 12-b YIG oscillator designed for use from 2 to 8 GHz would have tuning resolution of approximately 1.5 MHz, based on dividing the 6-GHz (6000-MHz) bandwidth by 4096 possible digital commands. The tuning resolution can be modified to larger integers, such as 2 MHz/b, by setting the tuning end points to an imaginary frequency (i.e., out of the operating frequency range of the filter or oscillator) at either the low- or high-frequency side of the operating frequency range.

The application note is available upon request from Micro Lambda. It provides information on tuning accuracy, sweep speed, supply voltage and current, mounting and heat-sinking advice for the YIG driver, control-signal connections, power-supply connections, and calibration. It also offers design information that focuses on the implementation of an FM driver. The note features typical driver circuits for main and FM tuning coils, along with expected performance.

Micro Lambda, Inc., 48041 Fremont Blvd., Fremont, CA 94538; (510) 770-9221, FAX: (510) 770-9213, Internet: www.micro-lambda.com.

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A four-page note, "YIG Drivers," offers basic coil-driver circuits for tuning the main and FM coils of YIG-based components.

Optimize an LNA for Bluetooth applications

BLUETOOTH HAS BEEN hailed as the next great wireless application. This 2.4-GHz wireless standard for personal connectivity allows users to provide invisible links between electronic devices, such as computers and printers, with data capacity of 1 Mb/s. This allows the simple remote control of electronic devices around the home and office, without the clutter of wired connections. In support of future Bluetooth designs, application note AN1037 from California Eastern Laboratories, Inc. (Santa Clara, CA) details the steps required to achieve optimal performance from an LNA based on the company's model NE662MO4 silicon-bipolar transistor.

The LNA design uses inductive emitter feedback through a high-impedance printed transmission line; all other matching elements are lumped components. The emitter inductance of approximately 0.7 nH enables matching the transistor for the minimum noise figure while also maintaining acceptable input impedance matching. It also enhances the in-band stability performance of the LNA and helps improve the linearity. There is a trade-off, however, in the small-signal gain of the device, along with an added potential for high-frequency oscillations. The oscillations can be avoided by carefully choosing the out-of-band matching elements.

The four-page application note is available in PDF file format from the company's website. The note provides a schematic diagram of the LNA, a layout diagram, and assembly drawing (showing the positioning of RF connectors and bias/ground pins). The note also includes several plots of expected linearity, gain, and output-power performance at 2.4 GHz.

California Eastern Laboratories, Inc., 4590 Patrick Henry Dr., Santa Clara, CA 95054-1817; (408) 988-3500, FAX: (408) 988-0279, (800) 390-3232, Internet: www.cel.com.

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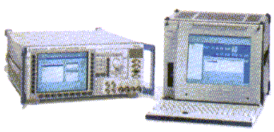

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cover story

Compact Receive Module Shrinks CDMA Circuits

This SiGe front-end module minimizes PCB board space and eliminates more than 20 RF matching and biasing components while providing high cascaded electrical performance in CDMA cellular and PCS handsets.

DAVID COVEYOU
Design Group Leader

ROBERT KINCAID AND CHARLES WANG
Senior Design Technician

JIM HENNESSY
Senior RF Technician

RF Micro Devices, 7628 Thorndike Rd., Greensboro, NC 27409; (336) 664-1233
FAX: (336) 931-7524, Internet: www.rfmd.com

Integration usually means miniaturization. In the case of the new RF3404 code-division-multiple-access (CDMA) front-end module from RF Micro Devices (Greensboro, NC), the latest wireless telephones can continue to shrink in size. The space-liberating 8 × 8-mm module, which takes up approximately one-half of the printed-circuit-board (PCB) real estate as other CDMA front-end solutions, includes the low-noise amplifiers (LNAs), surface-acoustic-wave (SAW) filters, and mixers to support dual-band trimode applications. It requires almost no off-chip components, and provides a cost-effective solution for designers of CDMA-based handsets and personal data assistants (PDAs).

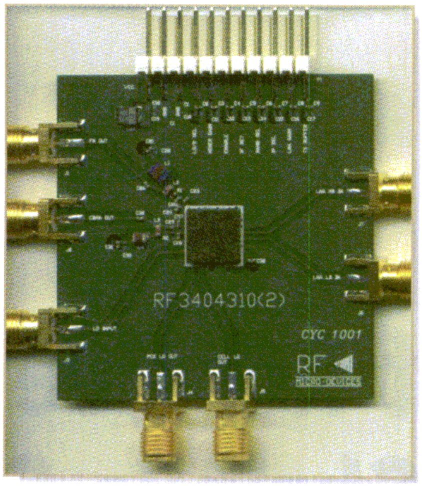
Mobile handsets continue to get smaller with the customer's desire for miniaturization. Customers also want more features and functions, which significantly drive the need for smaller-sized components. Handsets with MP3 digital audio players are already available, as well as telephones with Bluetooth™ capability, Global Positioning System (GPS) circuitry, and even digital cameras. An increasing number of handsets are being introduced with some form of wireless Internet capability. In addition, the days of building single-band or single-mode telephones are quickly fading.

Many new handsets have two to five separate radios built into the same

Continued from page 155

small physical space that users have come to expect from a mobile telephone. The handsets of the future will have two or three voice/data radios along with a GPS receiver (Rx) and a complete 2.4-GHz frequency-hopped Bluetooth radio. Component integration and miniaturization support all of this additional functionality in the same physical board space.

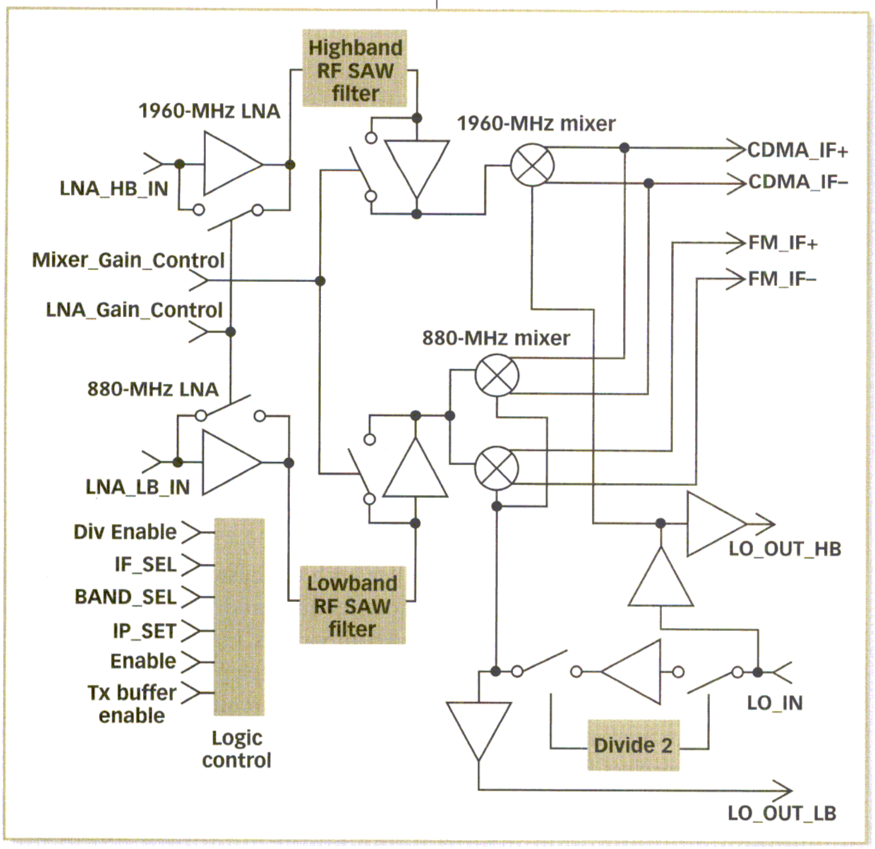
CDMA telephone handsets for the North American markets are typically dual-band, trimode units. They are designed to handle the 880-MHz cellular and 1960-MHz personal-communications-services (PCS) CDMA bands, as well as the 880-MHz analog Advanced Mobile Phone Service (AMPS) band. To accommodate the trend away from single-band, single-mode telephones and toward more advanced units, the evolution in components has been from discrete LNAs, switches, and mixers for each band to fully integrated LNA/mixer monolithic microwave integrated circuits (MMICs) for each



1. The RF3404 is mounted on an evaluation board with external current combiner IF-matching circuitry.

band, and finally to fully integrated dual-band, tri-mode single-chip MMICs. The small-signal products at RF Micro Devices have also followed this trend.

In an attempt to save space on a PCB, integrated MMICs have been made available in increasingly smaller leadless packages, with package sizes of



2. A block diagram of RF3404 module can be seen here.

5 × 5 mm fairly commonplace. Although these LNA/mixers may be the smallest in the world, they still require approximately 20 to 30 surface-mount capacitors, inductors, and resistors for RF matching circuitry, DC decoupling, bypassing, and bias setting. These additional surface-mount devices significantly add to the bill of materials (BOM) and increase the requirements for PCB area.

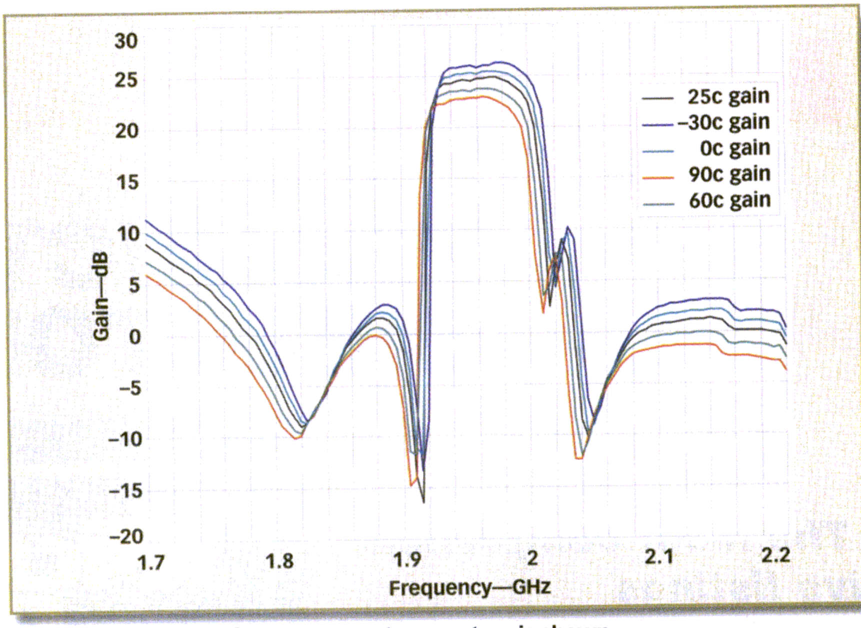
RF Micro Devices has been a leading supplier of advanced semiconductor technologies, including gallium-arsenide (GaAs) heterojunction bipolar transistors (HBTs) and silicon-germanium (SiGe) CDMA Rx chip sets, and has continued development of its semiconductor solutions to include fully integrated CDMA front-end modules. The RF3404 is an example of this advanced module technology. The module, which only measures 8 × 8 mm and takes up only 64 mm^2 of PCB area, is less than half the size of available alternative solutions, which typically occupy more than 200 mm^2 of board area. The fully integrated dual-band, tri-mode module contains an LNA, RF image-rejection SAW filter, a mixer, mixer preamplifier, and local-oscillator (LO) buffer amplifiers as shown in **Fig. 1**. The module also contains all of the RF matching components, bias-setting components, and decoupling components that are required. The differential intermediate-frequency (IF) output matching is external to the module in part due to the varying range of IFs that are used by customers and the physical size of IF SAW filters.

The RF3404 is control compatible with existing IF-to-baseband solutions. **Figure 2** shows a picture of the module mounted on an available evaluation board. The off-chip components to the left are the differential-to-single-ended current combining networks to facilitate testing. The heart of the module is the RF2489 SiGe MMIC based on a high-performance SiGe process. The SiGe process is capable of fabricating NPN transistors with transition frequency (f_T) of 47 GHz. The module achieves 30 dB of gain control in the 880-MHz

Continued from page 156

band, which is used for CDMA and AMPS systems. The gain-control range is obtained with switches around the LNA and mixer preamplifier. By itself, the LNA features 15-dB small-signal gain and a typical noise figure of 1.1 dB when drawing 4-mA current from a +2.75-VDC supply.

A complementary-metal-oxide-semiconductor (CMOS)-enabled control line makes it possible to select an increased LNA input third-order intercept point (IIP3) of +10 dBm to meet the cross-modulation requirements of the IS-95B CDMA specification. The RF3404's LNA is followed by a miniature RF SAW filter. It provides RF image rejection, as well as transmit-band rejection. All impedance matching to the RF SAW filter is achieved within the module. The module's RF2489 SiGe MMIC contains two high-frequency mixers that handle downconversion of the CDMA and AMPS signals at 880 MHz. The module provides a common IF port for the CDMA cellular and PCS band output signal and a separate output port for the AMPS-band IF output signals. These Gilbert-



3. PCS passband performance over temperature is shown.

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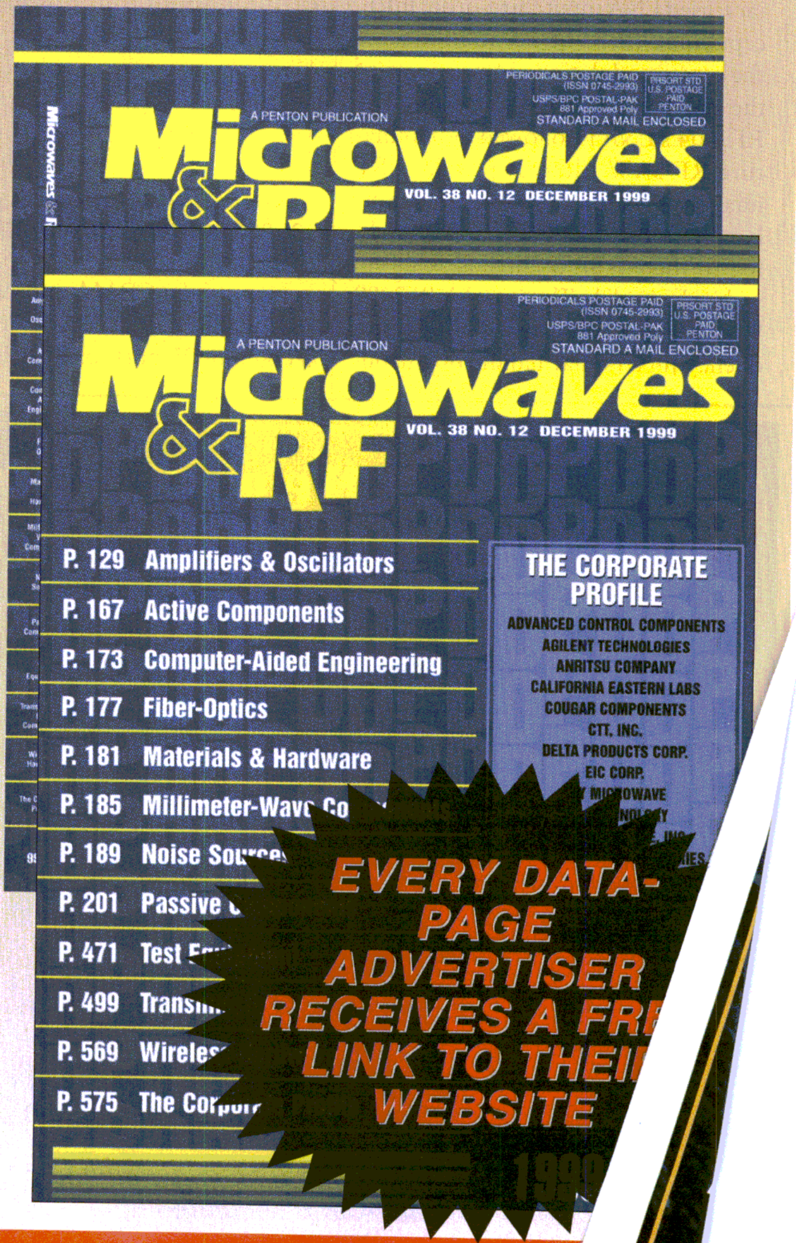

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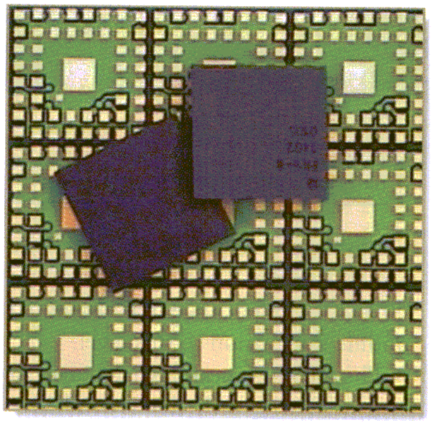
Continued from page 159

cell mixers and their integrated preamplifiers achieve a noise figure of 7 dB, gain of 14 dB, and IIP3 of +3 dBm. A bypass switch around the mixer preamplifier is integrated to support those systems using a two-step gain approach for meeting the three test conditions of IS-95B intermodulation (IM) performance. A module version that will meet all IS-95B requirements with only a single gain step will be available in the near future.

The 1960-MHz PCS CDMA signal path is similar to the cellular path in many ways. The PCS LNA has a typical gain of 16 dB with a noise figure of 1.3 dB. The LNA can also be bypassed and has a setting for high IIP3 point of +8 dBm. The PCS mixer features 13-dB gain, 8-dB noise figure, and IIP3 of +3 dBm. Again, all of the RF impedance matching to the LNA and SAW filters is included in the module.



4. Dual-band tri-mode LNA/SAW filter/mixer module can be seen.

For mobile-telephone designers, it is the cascaded performance of the RF3404 that is important, rather than the performance of its individual components. As **Table 1** shows, the cascaded noise figure is 2.1 dB in the cellular band, with cascaded gain of 25 dB and an IIP3 of −8.5 dBm. In the PCS band, the cascaded noise figure is 2.5 dB while the cascaded gain is 25 dB and the IIP3 is −9 dBm. These cascaded performance levels demonstrate the capability of the module approach to eliminate the effects of package parasitic elements.

The bias current draw is typically between 18 and 28 mA from a +2.75-VDC supply depending on the mode of operation and functions commanded. Despite its small size, the RF3404 module typically achieves 22 dB of rejection in the PCS transmit band, even at temperatures from +30 to +90°C, without compromising the in-band performance **(Fig. 3)**.

The RF3404 module is flexible enough to accommodate either single or dual voltage-controlled-oscillator (VCO) architectures. The cellular band has the selectable option of running the LO directly to the cellular mixers or routed through a divide-by-two frequency prescaler for systems that have migrat-

Continued from page 161

ed to a single VCO architecture. A buffered transmit LO output with +6-dBm output power is also supplied for the PCS and cellular bands. The RF3404 requires an input LO power range of −10 to −4 dBm. The LO input port is matched to +50 Ω. The LO outputs can be tied together externally to support single-transmit LO applications and each has a VSWR of better than 2.0:1.

The RF3404 is built around a laminate module technology geared to high-volume manufacturing and the low-cost structure mandated by the wireless industry. RF Micro Devices has already built millions of power-amplifier (PA) modules using the same material sets, supply chain, and manufacturing rules used for the RF3404. **Figure 4** shows a completed (overmolded) RF3404 CDMA receive module on a portion of an unsingulated substrate on which the land-grid-array (LGA) pattern can be seen.

A simple two-layer PCB provides the most cost-effective substrate arrangement for this type of module. The topside-etched pattern supports direct-chip mounting along with the attachment of various surface-mount capacitors, resistors, inductors, and SAW filters. The surface finish is a nickel (Ni)/gold (Au) metallization compatible with 1-mil Au-bond wires. The IC die is attached by epoxy to the surface, with the surface-mount devices (SMDs) attached by solder. Small 0402-sized SMD components are used when it is not cost-effective to fabricate them as part of the SiGe MMIC and when the components cannot be integrated into the PCB.

Many of the inductors that would normally be mounted on the PCB have been integrated into the module's etched copper (Cu) pattern, enabling significant reduction in cost and BOM. Inductors are always the most expensive of the SMDs and are often the main focus of integrated pas-

Table 1: The RF3404's cascaded performance at a glance

	CELLULAR BAND	PCS BAND
Gain	25 dB	25 dB
Noise figure	2.1 dB	2.5 dB
Third-order intercept point	–8.5 dBm	–9.0 dBm

mounting of SAW devices within the miniature 2.0 × 2.5 mm or sometimes 2.0 × 2.0-mm packages has facilitated module integration to this level.

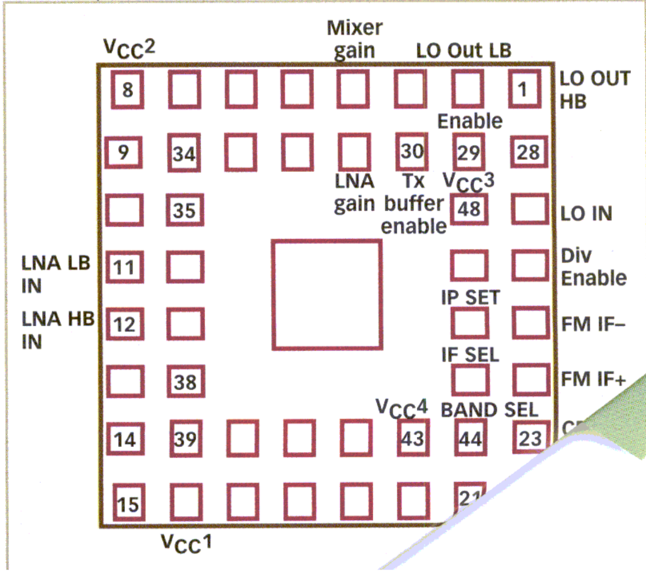
The RF3404 modules are built in a large-area-array strip that is conducive to high-volume production assembly. The strips are overmolded with a compound that has a finished overall thickness consisting of 1.6 mm. The backside pattern of the 8 × 8-mm module is a 48-pin LGA with a double row of input/output (I/O) connections to ease trace routing. A total of 21 of these I/O pads are actual signal interconnections, with the remainder being ground connections **(Fig. 5).**

The I/O pads are a generous 0.5 × 0.6 mm in size on a 1.0-mm pitch. The outer ring of I/O pads contains all of the RF connections along with the voltage supply (V_{cc}) and some control lines. The inner ring of I/Os contains only DC control signal lines and V_{cc} connections. A 1.5-mm^2 ground pad in the center of the module backplane supplies additional RF grounding and also ensures a robust mechanical attachment to the cellular/PCS-telephone PCBs. The dual row I/Os aid in the telephone PCB layout by reducing the number of traces that are required to converge on the perimeter of the module. Routing is eased by via holes that can be placed between the inner row of connections and the center ground pad in the cellular/PCS-telephone PCB.

Mechanical attachment and reliability are improved with this module technology due to a variety of factors.

The first and most obvious factor is the elimination of numerous components and solder joints, which directly aids overall phone reliability. Another important factor is the ideally matched coefficient of thermal expansion (CTE) that is between the laminate module and the cellular/PCS-telephone PCB. This eliminates much of the solder stress potential that is found in low-temperature-cofired-ceramic (LTCC) or chip-scale modules and should provide the most robust solution for the stringent mechanical shock and drop tests that mobile-telephone hardware must survive.

An integrated module, such as the RF3404, offers numerous advantages over other design approaches when constructing cellular/PCS handsets **(Table 2).** The key advan- tages include the signifi smaller number tional passive such as ca and



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JACK BROWNE
Publisher/Editor

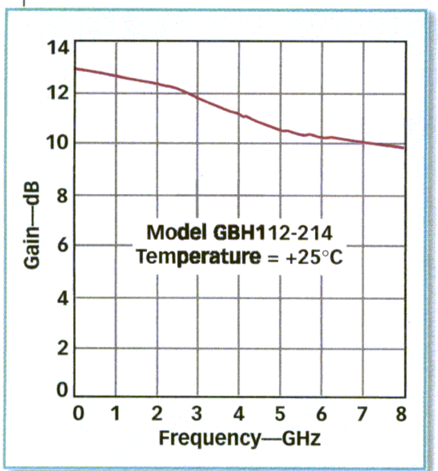
Gain blocks offer a way of "dropping in" a signal boost wherever needed in a design. The latest line of Micro-X packaged gain blocks from Alpha Industries (Woburn, MA) simplifies the process with input and output (I/O) ports matched to 50 Ω and operation from a single voltage supply. Four models are available with a maximum frequency range of DC to 8 GHz. The general-purpose, plastic-packaged ampli-fiers are well-suited for television-tuner, wireless local-area-network (WLAN), and direct-broadcast-satellite (DBS) use.

The lowest-frequency member of the cascadable gain-block family is the DC-to-3-GHz model GBH121-214. It offers 22-dB typical small-signal gain at 2 GHz, with gain flatness of typically ±1.5 dB from 0.1 to 2.0 GHz. The amplifier, which draws 35-mA current from a +3.5-VDC supply, has a typical noise figure of 3.5 dB at 2 GHz. It achieves +12-dBm output power at 1-dB compression at 2 GHz, with an output third-order intercept point of +25 dBm at 2 GHz.

In ascending order of increasing bandwidth is the DC-to-4-GHz model GBH120-214. It delivers 18-dB typical small-signal gain, with gain flatness of typically ±1.5 dB. The amplifier has typical noise figure of 4.5 dB at 2 GHz. At 2 GHz, the amplifier provides +18-dBm output power at 1-dB compression, with an output third-order intercept point of +33 dBm.

Next in line is the DC-to-6-GHz model GBH114-214. Designed for use at +4.7 VDC with a typical current draw of 65 mA at that voltage, the cascadable gain block features 15-dB typical small-signal gain, with gain flatness of ±1.0 dB from 0.1 to 4.0 GHz. The amplifier exhibits noise figure of 4.5 dB at 2 GHz with reverse isolation of 17 dB from 0.1 to 4.0 GHz. At 2 GHz, the amplifier delivers +16-dBm output power at 1-dB compression, with an output third-order intercept point of +31 dBm from 0.1 to 2.0 GHz.

The widest-bandwidth unit is the DC-to-8-GHz model GBH112-214. It provides typical small-signal gain of 13 dB, with gain flatness of typically ±1.5 dB from 0.1 to 8.0 GHz **(see figure)**. The typical noise figure is 3.5 dB at 2 GHz, with typical reverse isolation of 17 dB from 0.1 to 8.0 GHz. At 2 GHz, the amplifier boasts +12.5-dBm output power at 1-dB compression, with output third-order intercept point of +25 dBm from 0.1 to 2.0 GHz.



The model GBH112-214 cascadable amplifier is specified for a gain flatness of ±1.5 dB from 0.1 to 8.0 GHz.

Standard units are supplied in plastic Micro-X packages, although they are also available in ceramic Micro-X packages. **Alpha Industries, Inc., 20 Sylvan Rd., Woburn, MA 01801; (781) 935-5150, FAX: (617) 824-4579, e-mail: sales@alphaind.com, Internet: www.alphaind.com.** MRF

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PRODUCT *technology*

Low-Noise Synthesizers Aid Broadband Testing

These frequency synthesizers, with generous output power and low phase noise, are designed for testing the latest broadband commercial and military electronic systems.

JACK BROWNE
Publisher/Editor

Broadband-communications systems are under development to meet future needs for high-speed data and Internet access. Evaluating these systems requires a test generator capable of producing extremely clean and accurate signals over wide frequency ranges—in short, one of the Performance Signal Generators (PSGs) from Agilent Technologies (Santa Rosa, CA). These new signal generators provide frequency coverage as wide as 250 kHz to 40 GHz with low phase noise, 0.01-Hz frequency resolution, and high output power for handling a wide range of broadband commercial and military measurement applications.

The PSG frequency synthesizers follow a strong tradition of broadband signal generators that includes the modular 8350 swept sources and the synthesized models 8340, 8360, and 8370. Each of these sources was capable of tuning across wide frequency ranges with relatively flat output power and low phase noise. The PSG series of broadband signal generators improves upon their predecessors in several areas, notably output power and phase noise. In fact, the PSG sources are code compatible with the earlier 8360 and 8370 signal generators, facilitating their replacement in automatic-test-equipment (ATE) systems.

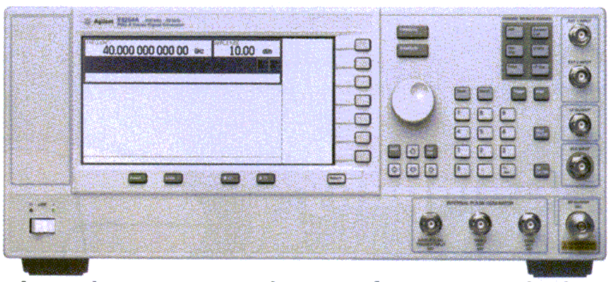

Fig. 1. The E6432A VXI microwave frequency synthesizer covers a range of 10 MHz to 20 GHz with 1-Hz resolution and an assortment of modulation formats.

The PSG line currently includes four models: the 250-kHz-to-20-GHz models E8241A and E8251A and the 250-kHz-to-40-GHz models E8244A and E8254A. The E8241A and E8244A are meant for use as precision local oscillators (LOs) and do not include modulation, while the E8251A and E8254A provide analog modulation in the form of amplitude modulation (AM), frequency modulation (FM), phase modulation, and pulse modulation. The instruments are distinguished by their uncluttered and straightforward front panel (designed in the manner of the firm's ESG digital signal-generator line) and large, easy-to-read display screen **(see figure)**. They are characterized by extremely low phase noise of −110 dBc/Hz offset 20 kHz from a 10-GHz carrier. Through option UNJ, the phase noise can be improved close to the carrier to

Continued from page 167

−104 dBc/Hz offset 500 Hz from a 10-GHz carrier. The low phase noise is based on the use of a precise oven-controlled crystal oscillator (OCXO) in both cases.

Both 20-GHz models feature an output-power range of −20 to +13 dBm from 250 kHz to 20 GHz. Option 1EA is also available to push the output-power range of these instruments to −20 to +16 dBm from 250 kHz to 3.2 GHz and −20 to +20 dBm from 3.2 to 20 GHz. An optional step attenuator extends the standard output-power range of the 20-GHz instruments to −135 to +11 dBm, with up to +18-dBm output power with option 1EA and the optional step attenuator. The 40-GHz models offer standard output-power levels of −20 to +9 dBm across the full 250-kHz-to-40-GHz range, with up to +14-dBm output power at 40 GHz with option 1EA. A step attenuator extends the output-power range in the 40-GHz units to −35 to +7 dBm, with up to +12-dBm output power with option 1EA. These high output-power levels enable the testing of low-loss devices, and support the use of the company's 83550 series of millimeter-wave (multiplier) heads without additional amplification.

All of the signal generators offer outstanding level accuracy. For power levels that are greater than +10 dBm, the level accuracy is ±1.3 dB ranging from 250 kHz to 20 GHz. For power levels of −10 to +10 dBm, the level accuracy is better than ±0.9 dB from 250 kHz to 40 GHz. Power levels in the PSG synthesizers can be adjusted with 0.01-dB resolution. In addition, a user-programmed flatness feature allows operators to compensate for output-power losses from connectors, cables, and other components in the output signal chain.

The E8251A and E8254A provide flexible analog modulation for the generation of sine waves, square waves, triangle waves, Gaussian noise, swept sine waves, as well as dual sine waves at rates to 1 MHz. For example, AM and phase-modulation bandwidths are available to 100 kHz, while FM bandwidths are available from DC to 10 MHz. An internal pulse generator can also deliver pulse modulation at maximum pulse repetition frequencies up to 14 MHz. All four signal generators are equipped with a large, 7.75-in. (19.69-cm) display screen and straightforward menu-driven user interface. P&A: $20,000 (model E8241), $30,000 (model E8251), $31,000 (model E8244), and $42,000 (model E8254); 30 days. **Agilent Technologies, Test and Measurement Organization, 5301 Stevens Creek Blvd., MS 54LAK, Santa Clara, CA 95052; Internet: www.agilent.com.**

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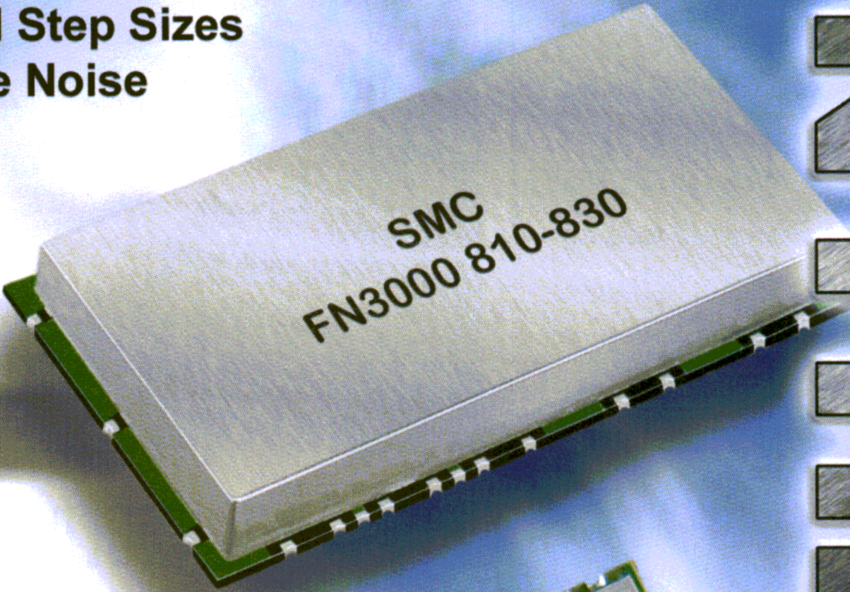

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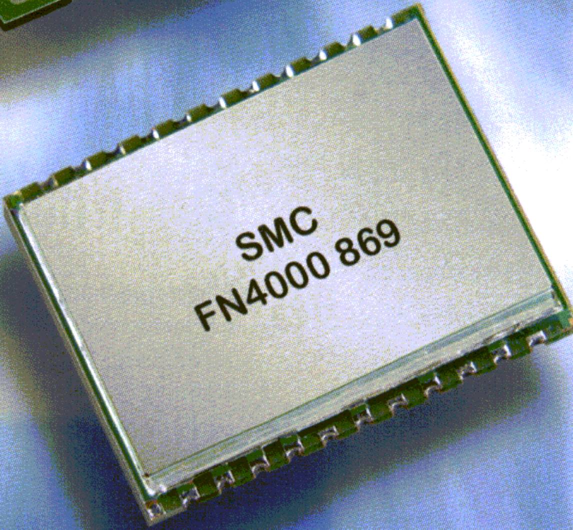

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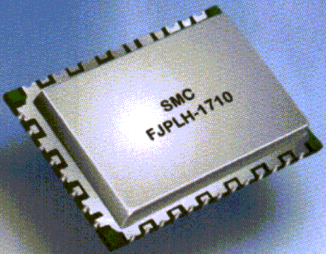

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Direct-Conversion IC Fits GSM Needs

This single-chip transceiver cuts the cost of multiband GSM handsets by eliminating extra IF conversion steps.

JACK BROWNE
Publisher/Editor

Global System for Mobile Communications (GSM) is the world's most popular mobile wireless-communications standard, with millions of subscribers worldwide. Due to its broad appeal, designers of GSM handsets are constantly seeking ways to cut costs and reduce manufacturing time. The CX74017 direct-conversion transceiver integrated circuit (IC) from Conexant Systems, Inc. (Newport Beach, CA) is certainly a step in the right direction, since it supports the design of GSM handsets without additional, costly intermediate-frequency (IF) conversion steps. By using the CX74017, a cellular or personal-communications-services (PCS) handset designer can cut the number of external components that are required to build a mobile handset by one-third, significantly reducing the cost, size, and power requirements of next-generation GSM handsets. The CX74017 is designed for use with any commercially available GSM baseband IC, further shortening handset development cycles and speeding time to market.

The CX74017 transceiver **(see figure)** is suitable for single-, dual-, or triband GSM handset applications at 900, 1800, and 1900 MHz. It achieves over 18-dB RF gain and more than 100-dB baseband gain, adjustable in 2-dB steps. The transmit path includes a frequency-translation loop designed to provide upconversion with high spectral purity. The translation loop structure consists of an in-phase (I) and quadrature (Q) modulator, an offset mixer, a phase/frequency detector, a charge pump, and high-power transmit voltage-controlled oscillators (VCOs) that do not require an external tank circuit or additional buffer amplification, thus reducing the total external parts count with the CX74017.

In contrast to standard superheterodyne architectures, the receiver (Rx) portion of the CX74017 features a direct-downconversion architecture that eliminates the need for IF components, such as mixers, filters, and amplifiers, as well as expensive surface-acoustic-wave (SAW) filters. In a superheterodyne architecture, RF signals are first downconverted to an IF stage, and then further downconverted to a baseband signal, generally using one LO/mixer combination for the RF-to-IF conversion and one LO/mixer combination for the IF-to-baseband conversion. A number of SAW filters are used during the first conversion stage—one filter for each of the bands supported by a multiband design. The CX74017's Rx provides direct conversion of RF signals to baseband signals, eliminating the need for the SAW filters. In fact, since filtering is performed at lower frequencies, low-

Continued from page 170

cost filtering can be implemented directly on-chip. The CX74017's Rx section consists of integrated low-noise amplifiers (LNAs), a quadrature demodulator, baseband filters, and a direct-current (DC) offset-correction sequencer. A lowpass filter is employed to reject in-band blocking signals and adjacent-channel and alternate-channel power levels.

The CX74017 transceiver supports general-packet radio service (GPRS) as well as Enhanced Data Rates for Global Evolution (EDGE) standards on its downlinks, and provides a well-defined roadmap to dual-mode, wideband-code-division-multiple-access (WCDMA)/GSM Universal Mobile Telecommunications System (UMTS) handsets. These handsets are being designed for multimedia applications, as well as for use as Wireless Access Protocol (WAP) devices for mobile Internet access applications.

DSP Support

The CX74017 transceiver incorporates several new patent-pending techniques to ease the implementation of direct-conversion technology. Until now, direct-conversion solutions have required a significant level of digital-signal-processing (DSP) support from the handset's baseband circuitry, and have generally provided poorer performance than the more common superheterodyne Rxs. In contrast, the CX74017 does not require extensive DSP processing power to match the performance of standard superheterodyne transceiver architectures in dual- or tri-band handset designs, allowing mobile units to be built with a fraction of the components needed for similar superheterodyne designs.

The CX74017 transceiver offers the flexibility to be combined with any of a variety of readily available digital baseband processor chip sets. Its onboard LO is based on a fractional-N phase-locked loop (PLL) with all of the components integrated on-chip, except for an external passive loop filter. The fractional-N synthesizer LO provides agile channel-switching support for GPRS multislot operation. The CX74107 is housed in a 9 × 9-mm land-grid-array (LGA) package. P&A: $8.50 (10,000 qty.). **Conexant Systems, Inc., 4311 Jamboree Rd., P.O. Box C, Newport Beach, CA 92660-3007; (800) 854-8099, (949) 483-6996, Internet: www.conexant.com.** MRF

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BOOKmark

Microwave Materials and Fabrication Techniques

THOMAS S. LAVERGHETTA

Microwave circuit designers in need of a quick reference on materials will find it in Microwave Materials and Fabrication Techniques. If designers are familiar with the techniques discussed in each chapter, they will avoid many problems and have a design that will perform as well on the bench as it does on paper or on a computer screen. The book is an attempt to present the most recent information about microwave materials, circuit fabrication, soldering and epoxy bonding, and packaging. It also includes the latest circuit-board materials and specifications.

Chapter 1 introduces the reader to microwaves, microwave terminology, and why dimensions are important in microwave designs. Chapter 2 presents microwave materials, with a selection of more than 30 materials varieties. The topics that are reviewed include dielectric constant, anisotropy, dissipation factor, as well as dielectric thickness. Also discussed is the impact of copper (Cu) weight, coefficient of thermal expansion, and peel strength. Chapter 3 covers different conductive metals. Chapter 4 highlights microwave artwork and is divided into initial layout, final layout, and photo process.

Chapter 5 explains etching and plating techniques. Topics include methods of cleaning materials, cleaning solutions, artwork placement and exposure, and photoresists. Other topics include etching with a review of the agitation process, the importance of heating the solution to the correct temperature, and the components required for a safe etching environment. Also reviewed is plating and plated through holes, plating metals, and alternate methods of producing circuit boards.

Bonding techniques are reviewed in Chapter 6. Subjects include the use and application of solder, a review of the requirements for a good solder connection, types of solder mixes and applications, and epoxy. Other topics include bonds, thermocompression bonding, wedge bonding, ball bonding, ultrasonic bonding, thermosonic bonding, as well as component and substrate attachment. Also included is a review of vapor-phase soldering and epoxy handling, mixing, and storage techniques.

The final chapter introduces microwave packaging. Topics include a review of microwave transmission media in cases, assembly of packaging levels, microstrip packages, stripline packaging, connectors and connector launching, package sealing, and electromagnetic-interference (EMI) considerations. The book also contains an excellent appendix that includes dielectric constants of materials presented in the book, material coefficient of expansion, chemical symbols, melting point of metals, a temperature-conversion chart, and data sheets for microwave laminates from major suppliers. (2000, 287 pp., hardback, ISBN: 1-58053-064-8, $89.00.) Artech House, 685 Canton St., Norwood, MA 02062; (800) 225-9977, (781) 769-9750, FAX: (781) 769-6334, Internet: www.artechouse.com.

FM Transceivers Connect Short-Range Applications

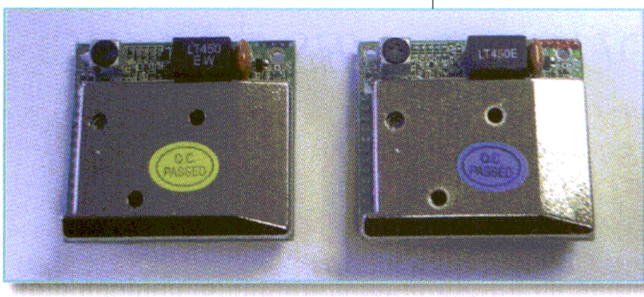
Designed to link a base station and a mobile unit, these full-duplex transceiver modules support voice and low-data-rate communications in the unlicensed 900-MHz ISM band.

ANDREW LAUNDRIE
Contributing Editor

Full-duplex RF transceiver modules are widely used in cordless telephones. These applications require high noise immunity and low cost. However, a wide range of other applications can benefit from the availability of FM transceiver models from Laipac Technology, Inc. (Richmond Hill, Ontario, Canada). Model RF900CLP transceivers interface easily to a digital controller and establish a two-way channel for audio and low-speed digital signals.

Each module **(see figure)** measures 1.72 × 1.55 × 0.49 in. (43.6 × 39.4 × 12.5 mm) and includes two arrays of connector pins for easy attachment to a motherboard. The base transceiver operates from +5.0 VDC and the mobile unit requires +3.6 VDC. The maximum current drain is 75 mA. The Tx can be switched off while receiving to conserve battery power.

The modules are designed for use in unlicensed ISM bands. The base unit transmits from 902.125 to 903.125 MHz while the mobile unit transmits from 926.125 to 927.125 MHz. The transmit power is nominally −1.0 dBm into a 50-Ω load. Spurious outputs are less than −67 dBm below 1 GHz and less than −53 dBm at frequencies above 1 GHz.



These low-power FM transceiver modules support voice and low-data-rate communications in the unlicensed 900-MHz ISM band.

PLLs in each transceiver settle to a final frequency within 20 ms, while received signals are normally detected within 20 ms, enabling the rapid selection of a clear channel. The use of FM yields static-free signals. Sensitivity is better than −110 dBm with a signal-to-noise ratio of 20 dB. The standard number of channels is 40, with channels spaced by 25 kHz. Adjacent-channel selectivity is better than 30 dB.

Analog signals are received with an SNR exceeding 40 dB when the carrier is modulated with 3-kHz deviation. The maximum audio distortion is 2.5 percent. The nominal modulation signal level is 40 mV RMS.

The transceivers are fully shielded for use in high-EMI environments. Channels are programmed through a three-wire serial interface. A carrier detect output becomes active when the received signal-to-noise ratio exceeds 12 dB. P&A: $7.20 to $12.00, depending on quantity. **Laipac Technology, Inc., 105 W. Beaver Creek Rd., Unit 207, Richmond Hill, Ontario L4B 1C6, Canada; (905) 762-1228, FAX: (905) 770-6143, Internet: www.laipac.com.** MRF

Since its inception 21 years ago, Metelics has supplied microwave diodes for a vast array of commercial, military, and high-reliability applications. Today, Metelics is in the forefront of technology, with diodes that ride on commercial telecommunications satellites, the space shuttle, and a wide range of fixed and mobile wireless systems and test applications.

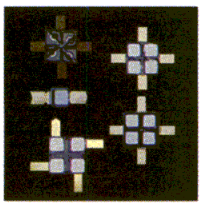
Schottky Diodes

Metelics manufactures a broad range of Schottky diodes for RF and microwave mixers, sampling bridges, limiters, and fast switches.

High-reliability devices can be provided up through S-level. These devices feature low Rd, very low capacitances, high uniformity, and are 100% tested and visually inspected. Diodes are available in rings, bridges, series T, antiparallel pairs, and singles. Surface mount packages are available in SOT 23, 0805, and epoxy-coated lead packages. Ceramic packages also available.

Pin Diode Chips and Beam Leads for Switch and Attenuator Applications

Metelics provides a wide selection of PIN diodes, SRDs, and varactors in chip, beam lead, and packaged configurations for RF and microwave requirements. Products range from very low-capacitance, high-speed switch devices to long-lifetime, high-power switch and attenuator types.

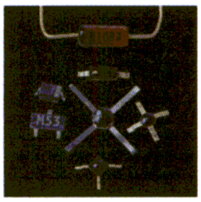


SRD (Step Recovery Diodes) and Tuning Varactors

Compared to packaged or chip devices, Metelics' silicon mesa beam lead step recovery diodes provide low-capacitance, very fast transition times, and low inductance, along with low parasitic capacitance. Tuning varactors are available from .5 to 20 pF (Cj4) in chips or packages.

RF/Microwave Components and Subassemblies

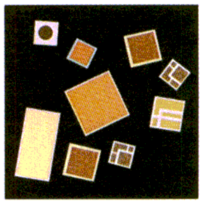
Metelics' years of experience in microwave diode beam lead and chip assembly are reflected in our enhanced performance, lower cost, and highly reliable state-of-the-art assemblies. Metelics' multi-device components include:



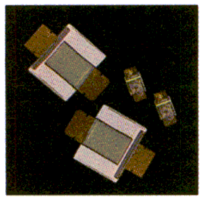
- switches
- detectors: Schottky, tunnel
- limiters
- sampling phase detectors
- tunnel diodes
- drop-in, bolt-down microstrip designs

Capacitors

MIS (Metal-Insulating Layer-Silicon) chip capacitors have very high Q and small size for use in microwave hybrid circuit applications. Large bonding pads are supplied on most chips; the contact periphery is typically 2 mils from the edge, allowing wire or ribbon bonding near the edge for the lowest practical inductance. Beam lead MIS caps are also available.



Metelics' capacitors provide better performance than other types of ceramic capacitors, with low loss in supply decoupling circuits and GaAs FET transistor source bypass (providing more gain per stage). They can also be used as tuning elements in filters and matching networks.



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Test Systems Offer CDMA Solutions

This series of hardware- and software-based performance analysis tools is tailored to the needs of design engineers working on cdma2000 wireless terminals and base stations.

DAWN PRIOR
Editorial Assisistant

Digital cellular communications based on CDMA technology require advanced measurement tools. Spirent Communications (Eatontown, NJ) recently introduced a set of solutions for cdma2000, which is the most popular variant of CDMA. The product lineup includes the TAS cdma2000 Interference Lab (TAS CIL), the AirAccess C2K Protocol Test System, the Universal Tool Suite (UTS) software, and the PocketDM diagnostic monitor.

The TAS CIL combines the new TAS 5600C Universal Interference Emulator and the TAS 4600A Noise and Interference Emulator to replace the multiple signal generators used in 3G cellular testing. The TAS 4600A accurately measures the power of incoming RF signals, and adds the noise or interference needed for a desired C/I or CNR. The TAS 5600C generates two low-phase-noise CW tones needed for adjacent-channel testing of mobile units and base stations. Phase noise is better than −144 dBc/Hz offset 285 kHz at a 1-GHz carrier and that same level at 635 kHz offset at a 2-GHz carrier. The TAS CIL provides frequency coverage of 820 to 970 MHz and 1700 to 2200 MHz with one or two channels, and two programmable frequency bands per channel. It provides an absolute power accuracy of ±0.50 dB, amplitude resolution of 0.25 dB, and output-power range of −120 to −7 dBm.

The AirAccess C2K Protocol Test System provides complete emulation of a multicell cdma2000 network. The system, which combines Windows-based software and test instruments, covers the entire network from the switching center to the mobile terminal antenna. The test system provides high-speed packet-data rates of simultaneous, bidirectional 153.6-kb/s data, packet segmentation, automatic logging and decoding of over-the-air messages, and display of device information using the system's Universal Diagnostic Monitor.

The UTS software enables the development of applications and test systems that can be used with virtually any CDMA device for performance analysis and provisioning purposes. This is accomplished through the use of a UTS Device Driver. The UTS Device Drivers are developed using the UTS Software Development Kit (SDK).

Finally, the Pocket DM is a diagnostic monitor that runs on a Compaq iPAQ device. It is based on the UTS architecture and includes the most commonly used CDMA diagnostic monitor functions. **Spirent Communications, 541 Industrial Way West, Eatontown, NJ 07724; (732) 544-8700, FAX: (732) 544-8347, e-mail: tassales@spirentcom.com, Internet: www.spirentcom.com.** MRF

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Cell-Pack RF ICs Simplify Communications Design

Complete RF IC functions housed in tiny surface-mount packages offer convenience and functionality for communication designs.

GENE HEFTMAN
Senior Editor

With the explosive growth in today's communications markets, the need for smaller and more highly integrated components to support shrinking form factors is on the rise. In addition, designers face continual pressure to streamline design cycles and speed time to market. Toshiba America Electronics Components, Inc.'s new RF ICs, known as Cell Packs, are designed to address these challenges. Cell Packs provide a way to implement a variety of functions in cellular phones, PDAs, Bluetooth devices, and cable-TV/modem applications. By integrating all discrete components for a particular function in one package, Cell Packs enable RF designers to reduce design time and save board space, since a single Cell Pack replaces multiple discrete devices.

The Cell Pack lineup includes Bluetooth devices, a wideband amplifier family, a crystal-oscillator family, and amplifiers for CATV tuner and modem applications.

For tuner and cable-modem applications, the company offers its TA4107F, a double-balanced mixer and oscillator buffer amplifier in a single package. Also in this group are the TA4018F IF gain-control amplifier and the TA4019F PA **(see figure)**. The 4018F incorporates functions that eliminate the need for a bandpass filter near the demodulation IC, while the 4019F's gain-control feature provides a designer with additional flexibility in selecting the circuit's output-power level. Each IC comes in a small, 8-pin, surface-mount package that measures 4.0 × 2.9 × 1.1 mm.

All three devices have good IMD characteristics resulting in high values of IP3. For example, IP3 output for the TA4107F is specified at +12 dBm, while for the TA4019F, IP3 output is rated at +21.5 dBm. The TA 4018F is specified for an IP3 output of +14 dBm. **Toshiba America Electronic Components, Inc., 9775 Toledo Way, Irvine, CA 92618; (800) 879-4963, Internet: www.chips.toshiba.com.** MRF

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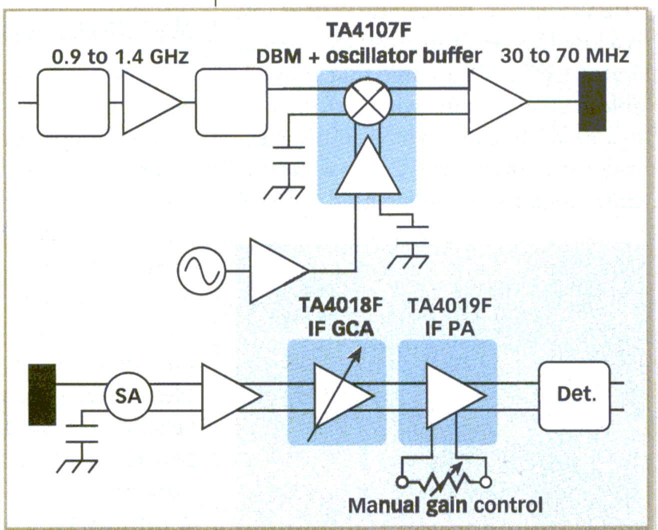
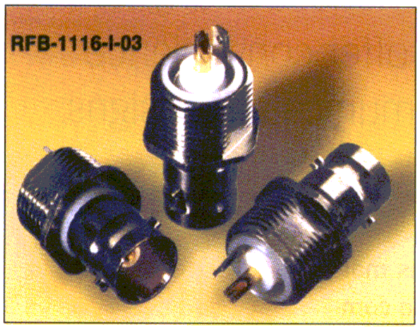


In this digital tuner circuit, Toshiba RF Cell Packs combine multiple functions in single ICs that conserve board space and shorten design cycles.

Receptacle Sports Gold-Plated Contact

THE RFB-1116-I-03 is an isolated ground BNC receptacle for use in applications requiring insulation between the main connector body and threaded mounting surface. This electrically isolates the ground signal of the circuit from the panel attachment. The circuit ground



signal passes through the panel through the solder lug for termination inside a device or other grounding point. The BNC jack mates with any standard BNC plug and features gold (Au)-plated contact, nickel (Ni)-plated body, and valox insulation.

RF Connectors, 7610 Miramar Rd., San Diego, CA 92126; (800) 233-1728, (858) 549-6340, e-mail: rfi@rfindustries.com, Internet: www.rfindustries.com.

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Gaskets Provide EMI Shielding

AS AN RF grounding pad or interconnect, the Gore-Shield® surface-mount-technology (SMT) electromagnetic-interference (EMI) gaskets conduct currents of a primary RF signal in much the same way a connector conducts RF currents from a printed-circuit board (PCB) to a coaxial cable. Suitable applications include situations where an RF signal needs to be sent from one PCB to another and the two boards are sandwiched together. The gaskets also provide shielding to protect against EMI emissions as compared to metal spring contacts. Since the parts are designed with SMT in mind, they can be placed on a PCB in any configuration that will maximize the RF performance and minimize the cost.

W.L. Gore & Associates, Inc., 750 Otts Chapel Rd., Newark, DE 19714; (800) 445-4673, FAX: (302) 737-2819, Internet: www.gore.com/electronics.

● **Enter No. 98 at www. mwrf.com**

Converters Feature +12-VDC Input

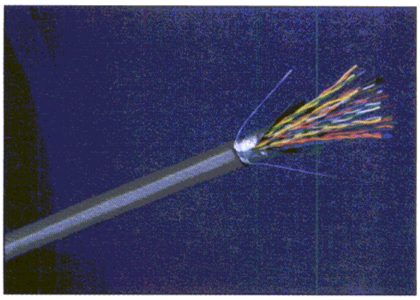
AVAILABLE IN +12-,+24-, and +28-VDC output models, the series 1675 DC-to-DC converters are designed to power sensitive electronic loads, including radio transceivers, modems, and other telecommunications equipment from +12-VDC battery systems. Operating efficiencies are above 80 percent, no-load current drain is less than 250 mA, and operating temperature range is −40 to +70°C. Protection against load short circuits and accidental reversal of DC input polarity is provided. The converters provide an isolated, regulated 200-W output and are suitable for stationary and mobile applications. P&A: $302.00 (10 qty.); stock.

Wilmore Electronics Co., Inc., P.O. Box 1329, Hillsborough, NC 27278; (919) 732-9351, FAX: (919) 732-9359.

● **Enter No. 99 at www. mwrf.com**

Cable Offers 6-dB Attenuation

THE MODEL CBL-3712 central-office cable is a low-loss, arbitrary-waveform-generator (AWG) T-1 cable that is available in up to 50 pairs with performance to 550 ft. The cable exhibits 6-dB attenuation per 1000 ft. at 772 kHz with near-end crosstalk that is referenced to 58 dB



at 1 MHz. The cable is UL-type CMR and C(UL) CMG listed, and has a 75°C temperature rating. It is manufactured from solid-tinned 24 AWG (0.4-mm) copper (Cu) with polyethylene insulation, a foil-laminate shield with a drain wire, an outer PVC jacket, and color-coded conductors that are twisted into pairs and stranded into a core.

Montrose/CDT, 28 Sword St., Auburn, MA 01501; (800) 346-6626, FAX: (508) 793-9862, e-mail: sales@montrose-cdt.com, Internet: www.montrose-cdt.com.

● **Enter No. 100 at www. mwrf.com**

Antennas Span 0.5 to 18 GHz

A LINE OF broadband antennas covers the 0.50-to-18.00-GHz frequency range. The antennas may be used for preflight confirmation of microwave systems aboard a variety of aircraft by the military and in commercial applications. The set includes a log periodic spanning 0.50 to 2.00 GHz and a dual-polarized quad-ridged horn for the 6.0-to-18.0-GHz highband.

Microtech, Inc., 1425-W Highland Ave., P.O. Box 728, Cheshire, CT 06410; (203) 272-3234, FAX: (203) 271-0352, e-mail: sales@microtech-inc.com, Internet: www.microtech-inc.com.

● **Enter No. 101 at www. mwrf.com**

VNA Targets Amplitude Measurement

A VECTOR-NETWORK-ANALYSIS SYSTEM was designed for use with microwave vector-network-analyzer (VNA) equipment to achieve millimeter-wave vector/amplitude-measurement capability. The unit can be used in either the forward direction only, with one transmit/receive (T/R) module and one T module, or in the forward and reverse direction, with two T/R modules.

Oleson Microwave Labs, 355 Woodview Dr., Suite 300, Morgan Hill, CA 95037; (408) 779-2698, FAX: (408) 778-0491, Internet: www.oml-mmw.com.

● **Enter No. 102 at www.mwrf.com**

System Tests Wafers For Defects

THE AW-2000™ is an automated system that creates images through bonded silicon-on-insulator (SOI) wafer pairs up to 8.00 in. (20.32 cm) that are joined by direct bonding, glass-frit bonding, and epoxy bonding in order to find voids, microvoids, as well as other internal defects. The system uses a robotic arm to remove a wafer from an incoming cassette and position the wafer for acoustic imaging. The very-high-frequency (VHF) ultrasonic transducer used for scanning wafers detects microvoids having a diameter as small as 5 µm. After acoustic imaging, system software classifies each wafer according to the user's requirements, and the arm places the wafer in the appropriate outgoing cassette.

Sonoscan, Inc., 2149 E. Pratt Blvd., Elk Grove Village, IL 60007; (847) 437-6400, FAX: (847) 437-1550, e-mail: info@sonoscan.com, Internet: www.sonoscan.com.

● **Enter No. 103 at www. mwrf.com**

VVA Spans DC to 8 GHz

THE HMC346MS8G IS an absorptive voltage variable attenuator (VVA) in a low-cost eight-lead surface-mount package. Bandwidth ranges from DC to 8 GHz with an attenuation range of 32 dB. An on-chip reference attenuator works with an external op-amp to provide simple single-voltage attenuation control of 0 to −3 VDC. The HMC346MS8G is suitable for designs where analog DC control must control RF signal levels over a 30-dB amplitude range.

Hittite Microwave Corp., 12 Elizabeth Dr., Chelmsford, MA 01824; (978) 250-3343, FAX: (978) 250-3373, Internet: www.hittite.com.

● **Enter No. 104 at www. mwrf.com**

Modulators Integrate Mixed Technologies

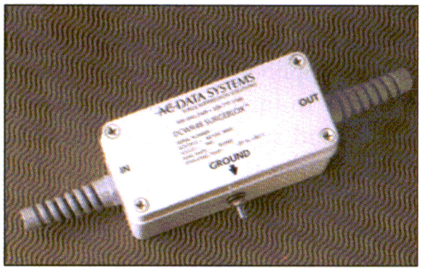
THE VM SERIES of vector modulators is an eight-chip, ball-grid-array (BGA)-packaged solution that can be integrated into base-station multicarrier-power-amplifier (MCPA) applications in order to increase bandwidth efficiency and support high-speed data transmission for 2.5G systems. The modulators offer 360 deg. of phase control, less than 15-dB insertion loss, 10 dB of phase-stable amplitude adjustment range, and greater than 40 dB of maximum attenuation.

Alpha Industries, 20 Sylvan Rd., Woburn, MA 01801; (781) 935-5150, FAX: (617) 824-4564, Internet: www.alphaind.com.

Enter No. 105 at www.mwrf.com

Surge Protector Spans −20 to +70°C

THE DCWR48 SURGE protector provides high-capacity surge protection in a weather-resistant enclosure to protect outdoor or indoor equipment common to broadband, wireless installations. Rated for use in −20 to +70°C temperatures, the DCWR48 hardwires to DC power cables to safeguard outdoor equipment such as radio towers, indoor rectifiers, power systems, and other sensitive electronics powered by a −48-VDC nominal service voltage. The DCWR48 can be configured with silicon (Si) avalanche diodes and/or metal-oxide varistors surge-suppression technology to provide response times of less then 5 ns and peak transient current capacity of 50,000 A (8 × 20 μs).



AC Data Systems, 806 W. Clearwater Loop, Suite C, Post Falls, ID 83854; (800) 890-2569, (208) 777-1166, FAX: (208) 777-4466, e-mail: acdata@surgeblox.com, Internet: www.surgeblox.com.

● **Enter No. 106 at www.mwrf.com**

Bias Tee Spans 50.0 MHz To 18.5 GHz

THE MODEL BTA-104 is a broadband bias tee that operates from less than 50.0 MHz to greater than 18.5 GHz. Insertion loss at 100 MHz is 0.05 dB typical, increasing to less than 0.5 dB at 18.5 GHz. VSWR is less than 1.25:1 typical with isolation of greater than 60 dB.

Adaptive Concepts, Inc., 1450 W. McCoy Lane, Unit I/J, Santa Maria, CA 93455; (805) 928-5159, FAX: (805) 928-5868, e-mail: aci@lightspeed.net.

● **Enter No. 107 at www.mwrf.com**

Combiners Feature 80-dB Harmonic Rejection

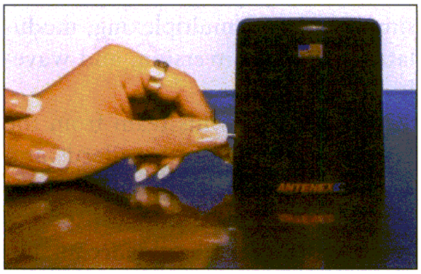
THE DB4398 SERIES of hybrid combiners is specifically designed for use with Motorola's iDENSignalling application system. The series uses dual-junction isolators to yield greater than 75-dB transmitter-to-transmitter (Tx-to-Tx) isolation typical. Insertion loss is between 3.8 and 7.1 dB and harmonic rejection is greater than 80 dB.

Decibel Products, Inc., 8635 Stemmons Freeway, Dallas, TX 75247; (800) 676-5342, (214) 634-8502, Internet: www.decibelproducts.com.

● **Enter No. 108 at www. mwrf.com**

Antennas Span 142 To 174 MHz

THE TRA(B) 1420 AND TRA(B) 1500 are field-tunable very-high-frequency (VHF) phantom antennas. The 1420 operates within the 142-to-164-MHz frequency range, while the 1500 operates across the 150-to-174-MHz frequency range. The operating coverage is approximately 1.0 to 1.5 MHz. The installation of this antenna is enhanced because the need to trim a tuning disk is no longer necessary; the tuning inductor only needs to be adjusted to achieve best VSWR performance.



Antenex, 2000-205 Bloomingdale Rd., Glendale Hts., IL 60139; (800) 323-3757, (630) 351-9007, FAX: (630) 351-9009, e-mail: sales@antenex.com, Internet: www.antenex.com.

● Enter No. 109 at www. mwrf.com

LNB Features 115-mA Current Consumption

THE MODEL BSTE8-601A is a single universal low-noise block downconverter (LNB) featuring a local-oscillator (LO) frequency of 9.75 to 10.60 GHz. Supply voltage is +11.5 to +19.0 VDC and current consumption is 115 mA typical. Noise factor is 0.7 dB typical, temperature resistance is approximately −40 to +60°C, and phase noise is 55 dB typical. With a 40-mm feedhorn, the LNB's lowband reception frequency is 10.7 to approximately 11.7 GHz.

ALPS Electric Europa GmbH, Hansaallee 203, Dusseldorf, Germany D-40549; (+49) 0211/5977-0, FAX: (+49) 0211/5977-146, e-mail: alpseuropa@alps-europe.com, Internet: www.alps-europe.com.

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absorption recovery in the electroabsorption waveguide. Error-free operation was achieved with PRBS pattern lengths as long as $2^{31} - 1$.

Stephan Hinz and co-workers from the University of Paderborn (Paderborn, Germany) explained how to apply polarization-division-multiplex methods to essentially double optical-fiber capacity. By using interference detection rather than an earlier correlation technique for polarization alignment, it was readily possible to separate the adjacent, densely packed WDM channels with orthogonal polarizations.

Hideyuki Sotobayashi and Wataru Chujo from the Communications Research Laboratory of the Ministry of Posts and Telecommunications (Tokyo, Japan), working with Takeshi Ozeki from Sophia University (Tokyo, Japan), presented information on the bidirectional photonic conversion between a 40-Gb/s optical time-division-multiplex (TDM) format and a WDM format through optical time-gating wavelength interchange. The technique involves the optical time-gating of highly chirped supercontinuum (SC) and high-speed pulse trains. The technique may be appropriate for future optical TDM (OTDM)/WDM hybrid networks.

J.M.P. Delavaux and associates from Lucent Technologies' Bell Laboratories (Murray Hill, NJ) proposed a passive-optical-network (PON) system based on quadrature-amplitude-modulated (QAM) subcarrier multiplexing (SCM) of 53 6-MHz 64QAM and 256QAM channels. Since cable-television (CATV) systems already employ QAM in 6-MHz channels, the approach is a suitable method of increasing capacity in optical cable networks. By taking advantage of advances in SCM direct-modulated lasers, the researchers achieved sensitivities of −22 and −17.5 dBm over 51 km of fiber under full-duplex and broadcast conditions for 64QAM and 256QAM approaches, respectively.

B.S. Robinson and fellow researchers from the MIT Lincoln Laboratories (Lexington, MA) described the all-optical demultiplexing of 80-Gb/s pulse-position-modulated data using a fast nonlinear interferometer. The use of pulse-position-modulated data permits a novel switch design that performs simultaneous demultiplexing, modulation-format conversion, and wavelength conversion.

Paul Hale and his team from the National Institute of Standards and Technology (NIST) [Boulder, CO] explain how standard optical sources and microwave-calibration techniques can be used to calibrate optical sources and Rxs for measurements beyond 50 GHz. The researchers note that the bandwidth of any measurement system should be approximately 10 times greater than the signal bandwidth of interest, implying measurement bandwidths of about 400 GHz for characterizing 40-Gb/s devices. The NIST team is currently evaluating frequency-domain and time-domain methods for extending current measurement methods (commercial oscilloscopes) beyond 50 GHz.

Elaine Wong and co-workers from the Australian Photonics Cooperative Research Centre of the University of Melbourne (Melbourne, Australia) demonstrated the use of optical baseband carrier-sense multiple access with collision avoidance (CSMA/CA) for photonic packet-switched networks. The basic experimental circuit yielded a sensitivity of −51.6 dBm, showing this to be a simple and practical approach to the realization of CSMA/CA for photonic packet-switched networks.

Next year, the Optical Fiber Conference is scheduled for March 17-22, 2002 at the same location (Anaheim Convention Center; Anaheim, CA). **For more information on the conference and exhibition, contact the Optical Society of America, 2010 Massachusetts Ave. NW, Washington, DC 20036-1023; (202) 416-1907, FAX: (202) 416-6140, Internet: www.osa.org.** MRF

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practical advantages, bias servos have proved to increase power-added efficiency (PAE) of the chips used in the PA stage. Moreover, intermodulation (IM) behavior is not modified using this biasing technique. **Figure 6** shows a performance comparison between active bias and resistor dividers.

Figure 6 shows that active biasing not only avoids manual adjustment of gate bias voltage but also improves the P1db more than 1 dB for a specific drain current level. PAE is dramatically improved compared to the resistor-divider biasing circuit. IM performance, a key factor in LMDS Txs, does not changed using active biasing.

Like any RF or microwave circuit, millimeter-wave transceivers need enclosures to provide shielding. In order to keep costs moderate, molding cast enclosures similar to those used in domestic LNBs for direct-broadcast-satellite (DBS) applications have been used with this transceiver.

LMDS Rxs

LMDS Rxs have different and less critical demands than LMDS transceivers. This type of equipment is intended for consumer markets that have the potential for high volumes. RF is used for receiving wideband data and telephone circuits are used for lower-rate information return. Therefore, generalized simplicity is the best weapon since low cost is a primary objective. This is even truer for systems working at the low millimeter-wave band (26 GHz) with a low power level. For these applications, it is possible to use hybrid circuits with packaged transistors on plastic substrates. P70-packaged GaAs FETs for K-band applications can work in Ka band with moderate gain (maximum available gain [MAG] = 9 dB) in some cases. No synthesized dielectric-resonator oscillators (DROs) working at the fundamental operating frequency are used for LOs. This equipment resembles a commercial LNB for DBS applications scaled at higher frequencies. This technology has been used sometimes for early low-cost LMDS Rxs to reduce their cost. They are intended for a market controlled by price.

The main disadvantage of this mounting technique is the difficulty of obtaining repeartable results.. Trimming of microstrip lines at 26 GHz on a plastic substrate is not an easy task. Nowadays complete packaged chip sets that perform the functions of a Rx are available from the market. These chip sets enable more repeatable results than packaged transistors at a moderate cost. Therefore the usefulness of hybrid circuits with packaged transistors must be seriously evaluated.

Comparison of packaging technologies

TECHNOLOGY	ADVANTAGES	DISADVANTAGES
Multichip modules on ceramic substrate	Readily available components and technology	Complex technology for mass production
	Very good performance	Expensive
	Small size	Difficult to modify and repair
	Good power derating	
	Well known behavior	
	Several manufacturers	
Hybrid circuits with discrete-packaged chips on soft substrates	SMT-compatible technique Not very expensive	Technology not available for every component and subsystem
	Easy to modify and repair Small size	Unknown behavior with high-power amps Not many manufacturers at this time
Hybrid circuits with packaged transistors	Readily available technology Very cheap SMT compatible	Poor behavior at millimeter-wave frequencies Not very repetitive assemblies

Future Trends

SMT techniques on plastic substrates appear to be the best methods for mass production of low cost millimeter-wave equipment. These mounting techniques require packaged chips and are closely related to coplanar/microstrip structures. At this time BGA packages offer good performance at moderate cost with the added benefit of surface-mounting techniques. Nevertheless, high-power devices are still not available in these packages.

An alternative system based on a carrier with plastic substrates has been suggested to solve this problem in a commercial mass production LMDS Tx in the millimeter-wave band. Working with low-cost packaged chips for millimeter-wave applications means working with novel technologies and materials recently introduced to the market. Keeping abreast of the latest trends and developments is essential. This is the first time that such a high frequency has been used for mass-production consumer applications. Several manufacturers are introducing products at different development stages very quickly. There will be many choices and evaluating those with the most promise will be a difficult task. MRF

ACKNOWLEDGEMENT

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REFERENCES

1. T. Satoh, T. Shimura, S. Ichikawa, A. Betti-Berutto, C. Poledrelli, Y. Furukawa, S. Kuroda, Y. Hasegawa, J. Fukaya. "A Compact PA MMIC Module for K-Band High Speed Wireless Systems," IEEE MTTs 2000.

2. Honqwei Liang, Joy Laskar, Mike Hyslop, Ram Panicker, "Development of a 36 GHz. Millimeter Wave BGA Package," IEEE MTT-S 2000.

3. M. Ito, K. Maruhashi, K. Ikuina, N. Senba, N. Takahashi, K. Ohata, "Low Cost Multi-Layer Ceramic Package for Flip-Chip MMIC up to W-band," IEEE MTT-S 2000

4. German Torregrosa-Penalva, Alberto Asensio-Lopez, Francisco Javier Ortega-Gozalez, Jaime Lluch-Ladron-de-Guevara, "Low Cost Transmitter Modules for LMDS Equipment Mass Production," IEEE MTT-S 2001.

5. Elizabeth Hall, Alan M. Lyons, Hohn D. Weld. "Gold Wire Bonding onto Flexible Polymeric Substrates," IEEE Transactions on Components, Packaging and Manufacturing Technology, 19(1):12-17, March 1996.

6. Guillermo González, Microwave Transistor Amplifiers : Analysis and Design, Prentice-Hall, Upper Saddle River, New Jersey, 1997.

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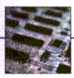
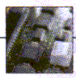
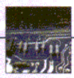

Table 2: Comparing CDMA front-end approaches

LEVEL OF INTEGRATION	NUMBER OF COMPONENTS: CAPACITORS	RESISTORS	INDUCTORS	SAWs	Total	PCB area (mm²)
RF3404 module	3	0	0	0	3	67
Dual-band MMIC	11	4	7	2	24	~200
Single-band MMIC						
Cellular band	9	4	3	1	17	140
PCS band	10	4	3	1	18	140
TOTAL					35	280
Discrete LNA/mixer						
Cellular band	12	4	3	1	20	140
PCS band	12	4	3	1	20	140
TOTAL						250

Note: The number of components does not include intermediate-frequency (IF) matching circuitry.

Continued from page 162
ular approach compared to the other methods.

The RF3404 represents a 50-to-70-percent reduction in the amount of PCB space required when compared with the most highly integrated chip solutions on the market today. Furthermore, it represents the largest-percentage improvement in PCB space savings for any of the other increased integration gains in recent years.

Another improvement when using the RF3404 is the reduction in the BOM. The RF3404 reduces the BOM from the most highly integrated alternatives available today that require approximately 25 off-chip components to only 3.

In addition, the supply chain can be significantly simplified with the elimination of two dozen components that would not need to be source selected, qualified, purchased, received, stored, coordinated, or delivered to the factory floor. Accordingly, assembly costs are also reduced. With SMD placement costs running in the range of 1.0 to 1.3 cents per placement and with the placement of die packages, SAW devices, and modules costing 2.0 to 3.5 cents per placement, it is possible to eliminate approximately 35 cents from the cost of telephone-handset assembly and improve factory throughput by using these front-end modules.

With a single-module solution, the RF engineering required to design a CDMA telephone's front end is significantly reduced. The RF3404 module supports a drop-in solution that meets all of the IS-95B requirements. The integrated modules are fully RF tested and, thus, provide good RF performance. This makes it possible to improve the manufacturing yield of telephone handsets when using modules compared to MMICs or discrete approaches, not to mention the improvement in yield due to the fact that two dozen fewer components are being placed.

The RF3404 module is one family of product solutions that will allow handset designers to bring more features and functionality in smaller packages. For example, currently under development, the RF3405 is a stand-alone module with GPS LNA, SAW filter, and mixer measuring 6 × 6 mm. The RF3406 is a tri-band CDMA module with integrated GPS Rx, interstage SAW filter, and mixer, along with all of the functionality of the RF3404. The RF3407 is a module with a cellular-band LNA, SAW filter, and mixer that measures only 6 × 6 mm. **RF Micro Devices, 7628 Thorndike Rd., Greensboro, NC 27409; (336) 664-1233, FAX: (336) 931-7454, Internet: www.rfmd.com.** MRF

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DAQ Equipment

A 32-page catalog focuses on test equipment. AC voltage sources; amplifiers; logic, network, spectrum, audio, distortion, and modulation analyzers; calibrators; component testers; data-communications equipment; frequency counters and timers; function, pulse, signal, and sweep generators; and hipot testers are covered. Light, laser, and optical equipment; microwave equipment; multimeters; voltimeters; oscilloscopes; plotters; power supplies; and master probes are also specified.

Naptech Test Equipment, Inc.; (800) 336-7723, (707) 995-7145, FAX: (707) 995-7151, e-mail: sales@naptech.com, Internet: www.naptech.com.

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Polarization Optics

An 11-page brochure offers literature from disparate sources focusing on laser and optical equipment, applications, specifications, and components. Subjects include polarization optics, lock-in amplifiers, fiber-coupled light-emitting displays (LEDs), energy detectors, positioning equipment, laser-beam diagnostics, spectroradiometers, as well as modulators. Frequency doublers, slicing systems, simulators, ceramic machining, design and analysis software, beam expanders, power supplies, and wavefront analyzers are also presented.

Laser Focus World; Internet: www.opto-electronics-world.com.

● **Enter No. 83 at www.mwrf.com**

Power Meters

A short-form catalog provides information on RF and microwave test equipment. Microwave synthesizers, power meters, and RF signal generators are presented. Features, statistics, and application information are provided. A sensor selection chart is included to help match products to exact measurement requirements.

Giga-tronics, Inc.; (925) 328-4650, FAX: (925) 328-4700, e-mail: info@gigatronics.com, Internet: www.gigatronics.com.

● **Enter No. 84 at www.mwrf.com**

Software Solutions

A four-page brochure highlights a company's capabilities to provide complete solutions to clients by building on its library of software and integration tools. Software development, systems integration, along with expertise in real-time operating systems are presented. The brochure also covers direct development costs for small-to-medium-sized projects.

RTSoft, Inc; +7-095-104-3914, FAX: +7-095-742-6829, e-mail: info@rtsoft-engineering.com, Internet: www.rtsoft-engineering.com.

● **Enter No. 85 at www.mwrf.com**

Power Inductors

A product catalog addresses specifications, design details, custom products, and designer kits for a company's four major categories of inductors. Surface-mount RF inductors, surface-mount power inductors, leaded RF inductors, along with leaded power inductors are presented. Views of application-specific devices are provided.

Gowanda Electronics; (716) 532-2234, FAX: (716) 532-2702, e-mail: sales@gowanda.com.

● **Enter No. 86 at www.mwrf.com**

Data Loggers

A 20-page catalog focuses on data loggers. Eleven families of loggers that consist of more than 20 models are presented, including units that measures ARMS, ADC, VRMS, VDC, and temperature. Sections on technical specifications, key components and connections, accessories and options, and product support are included.

AEMC Instruments; (508) 698-2115, FAX: (508) 698-2118, e-mail: sales@aemc.com, Internet: www.aemc.com.

● **Enter No. 87 at www.mwrf.com**

DC-to-DC Converters

A 20-page catalog offers literature on a myriad of subjects from disparate companies. Literature on converters, power supplies, power resistors, transformers, inductors, surge protectors, semiconductors, electronic hardware, switches, sockets, adapters, as well as interconnects is presented. Other subjects include relays, cases and cabinets, test equipment, tools, embedded computer boards, DC motors, rotary positioning systems, circuit-protection design, and DC-to-DC converters.

ECN Literature News; Internet: www.ecn-mag.com.

● **Enter No. 88 at www.mwrf.com**

Broadband ICs

A short-form catalog/data book covers a line of integrated circuits (ICs) that target the communications and broadband Internet markets. The volume contains technical data sheets on products released during the past 18 months, including ICs for fiber-optic network equipment, portable communications, embedded modems, and digital set-top boxes.

TDK Semiconductor Corp.; (714) 508-8800, FAX: (714) 508-8877, e-mail: support@tsc.tdk.com, Internet: www.tdksemiconductor.com.

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Impedance Transformers

A 10-page brochure features a selection of passive components. RF impedance transformers, RF power dividers, and RF directional couplers are offered. Application and product-installation information is provided. Outline drawings are included.

Vari-L Co., Inc.; (303) 371-1560, FAX: (303) 371-0845, e-mail: sales@vari-l.com, Internet: www.vari-l.com.

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Fiber-Optic Connectors

A 80-page catalog focuses on fiber-optic connectors. Information on interconnections, contacts, fiber types, electro-optic component and housing types, cable-fixing types and variants, and panel cut-out variants is provided. Sections on accessories, tooling, and fiber-optic tooling are included, along with technical characteristics.

LEMO USA, Inc.; (707) 578-8811, FAX: (707) 578-0869, e-mail: lemous@lemo.com, Internet: www.lemousa.com.

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Test Equipment

Test equipment is the subject of a 55-page product catalog. Oscilloscopes, arbitrary function generators, probes, DC power supplies, waveform generators, data-acquisition (DAQ) equipment, pulse generators, spectrum and network analyzers, as well as cable are specified. Reconditioned equipment offerings include power supplies, spectrum analyzers that are above and below 1 GHz, signal generators, logic analyzers, and meters.

TestEquity, Inc.; (800) 884-3457, FAX: (800) 272-4329, Internet: www.testequity.com.

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Pulse Generators

An 18-page catalog features test equipment from a variety of manufacturers. Pulse generators, logic analyzers, plotters, meters, RF signal generators, inductance-capacitance-resistance (LCR) analyzers, spectrum analyzers, precision sources, oscilloscopes, and frequency counters are offered. Telecommunications and video equipment are also available.

Test Equipment Connection Corp.; (800) 615-8378, (407) 804-1299, FAX: (800) 819-TEST, (407) 804-1277, Internet: www.testequipmentconnection.com.

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DSP Solutions

An eight-page brochure covers a range of advanced digital-signal-processing (DSP) board and system-level solutions for applications ranging from commercial and wireless telecommunications, digital radio, semiconductor fabrication, to seismic exploration/monitoring, and other data-intensive applications. Software, drivers, and board-support packages are provided. **Ixthos, Inc.; (703) 779-7800, FAX: (703) 779-7805, e-mail: sales@ixthos.com, Internet: www.ixthos.com.**

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Wireless Solutions

A 44-page guide details wireless solutions for design engineers of RF, microwave, and millimeter-wave products. The guide is cross-referenced, with tabs indexing color-coded sections where components are categorized by supplier, frequency band, and market. A reference section includes a wireless frequency guide and tables specifying S-parameters, cascaded noise figure, input third-order intercept point (IIP3) calculations, and power conversion. **Insight Electronics; (888) 488-4133 ext. 411, e-mail: insight_info@ins.memec.com, Internet: www.insight-electronics.com.**

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DAQ Hardware

A 74-page catalog focuses on data-acquisition (DAQ) hardware as well as signal-conditioning and support software. Multifunction cards with analog and digital input/output (I/O) as well as simultaneous sampling, analog output cards, and digital I/O cards are offered. A two-page product selection chart summarizes key specifications. **United Electronics Industries; (617) 924-1155, FAX: (617) 924-1441, e-mail: info@ueidaq.com, Internet: www.ueidaq.com.**

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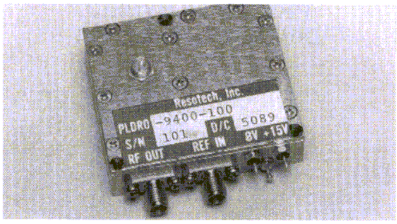

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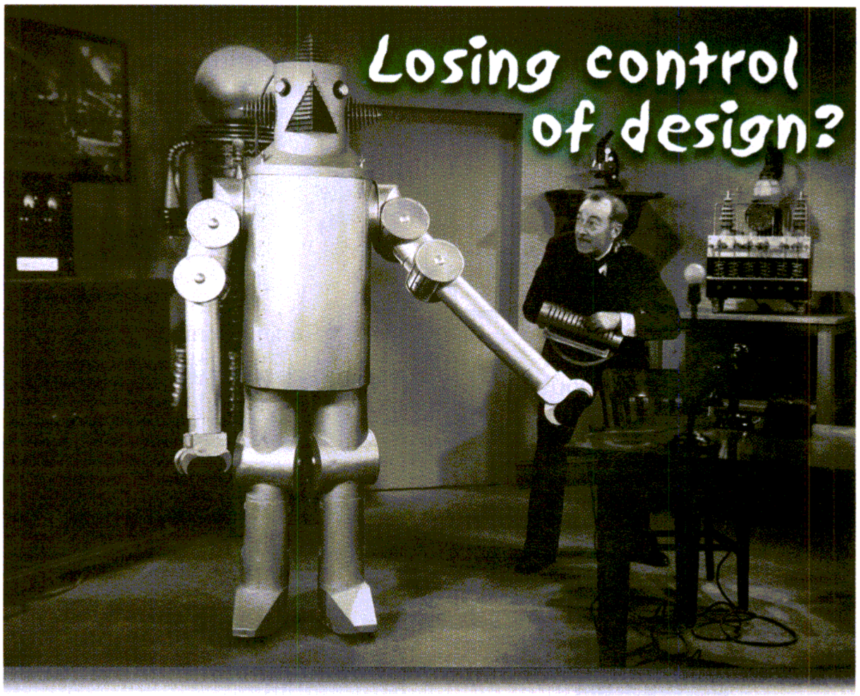

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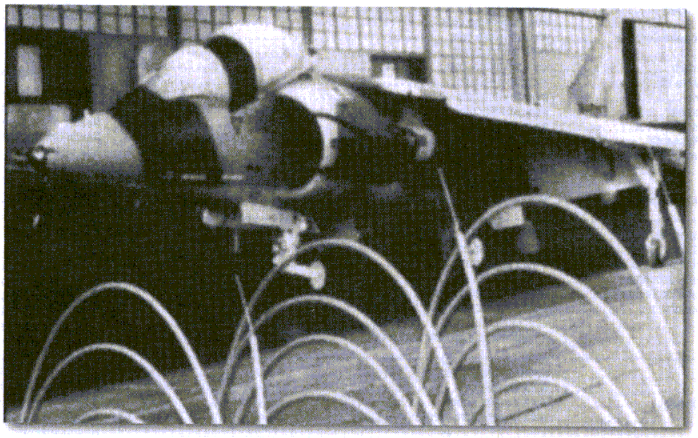

APPROXIMATELY 14 YEARS AGO, a special report focused on coverage of the Military Fiber Optics Conference (MFOC-87), which was the first exposition devoted exclusively to the use of fiber optics in government and military applications, including lines of avionics cables from the Brand-Rex Cable Systems Division of BRIntec Corp. (Willimantic, CT).

next month

Microwaves & RF June Editorial Preview

Issue Theme: Communications

News

The June issue of *Microwaves & RF* will explore one of the most enigmatic of wireless applications: local multi-point-distribution systems (LMDS). Proposed as a "last-mile" solution for bringing multimedia and broadband-communications services to the home, the success of LMDS depends on the low-cost implementation of millimeter-wave technology. Barry Manz of Manz Communications (Montville, NJ) will report on applications and key players for LMDS.

Design

The June issue offers several articles focused on the design of components for communications systems. An author from Cork, Ireland, for example, offers various design methods for creating wideband voltage-controlled oscillators (VCOs), while authors from the US provide insights into the automated tuning of microwave filters. In addition, an author from the British University of Warwick describes advances in modeling electronic cooling processes.

Product Technology

The June Product Technology section will feature the ultimate in power-splitter miniaturization: a component measuring only 0.15 × 0.15 × 0.15 in. (0.38 × 0.38 × 0.38 cm) capable of operating from 5 to 1000 MHz. Additional product features will examine a series of software programs for simulating and analyzing the performance of fiber-optic components and systems, and a frequency synthesizer that operates to 6 GHz.

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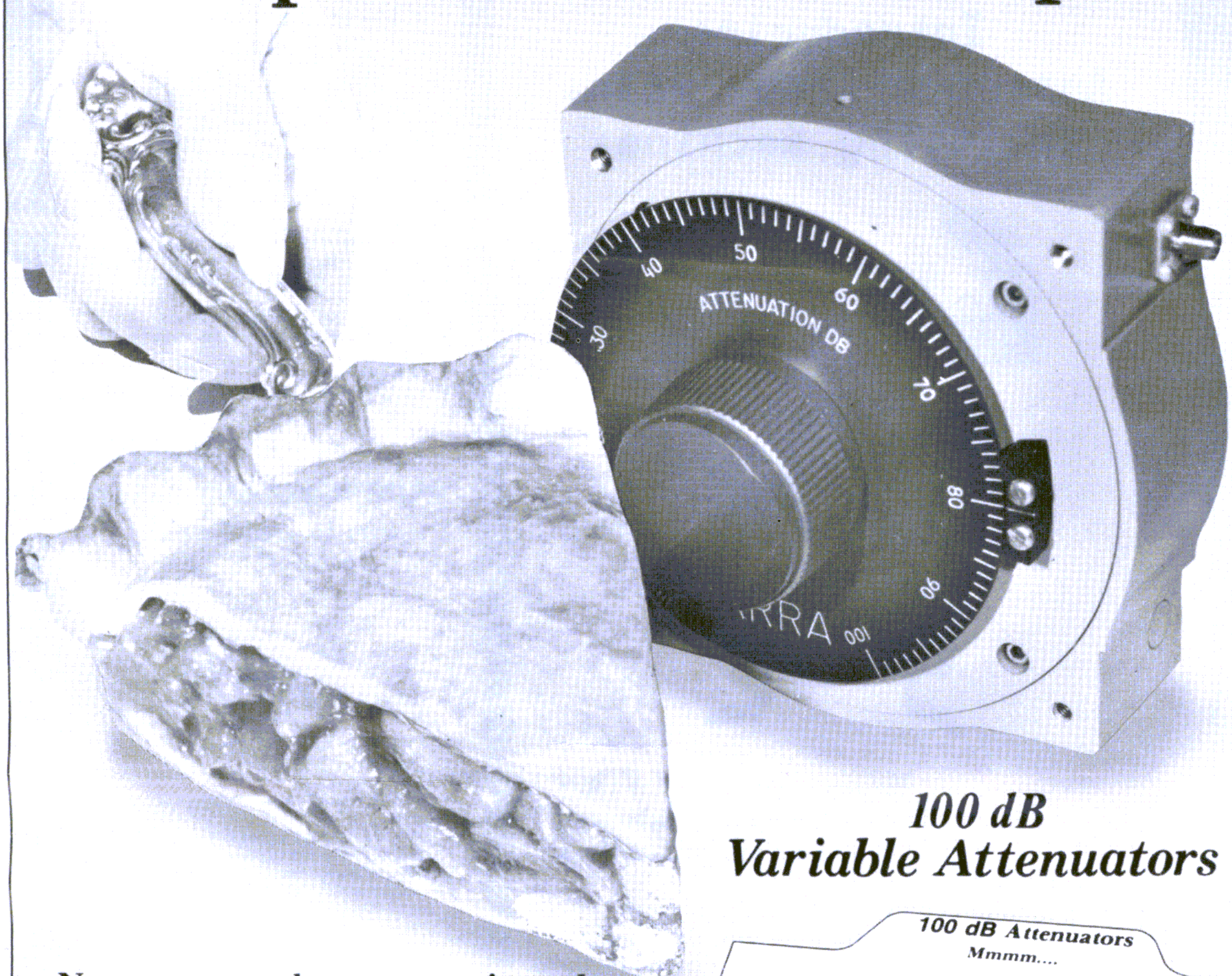

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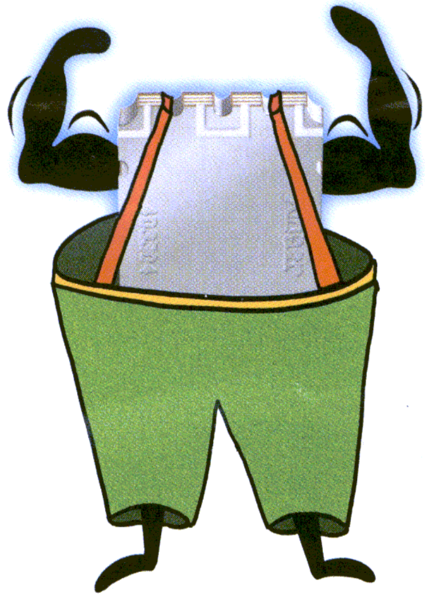

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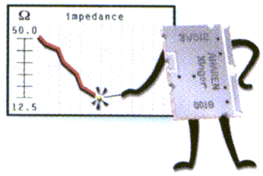

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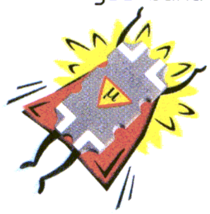

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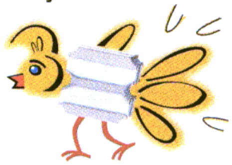

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