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JANUARY 2008

HIGH FREQUENCY ELECTRONICS

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Predicting Enclosure Resonances with EM Simulation

Power Combiners, Impedance Transformers and Couplers

Technology Report—ZigBee and IEEE 802.15.4

Connectors, EM Tools & mm-Wave Product Highlights

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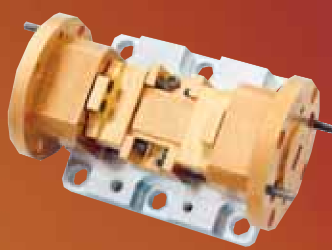
MILLIMETER WAVE COMPONENTS

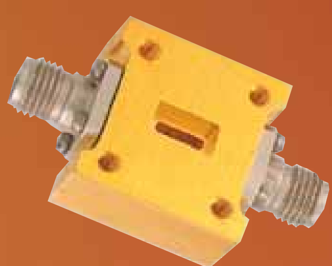
AMPLIFIERS • MIXERS • MULTIPLIERS



AMPLIFIERS

Model Number	Frequency (GHz)	Gain (dB, Min.)	Gain Flatness (±dB, Max.)	Noise Figure (dB, Max.)	In/Out VSWR (Max.)	Output Power at 1dB Comp. (dBm, Typ.)
JSW4-18002600-20-5A	18-26	34	1.5	2.0	2.0:1/2.0:1	5
JSW4-26004000-28-5A	26-40	25	2.5	2.8	2.2:1/2.0:1	5
JSW4-18004000-35-5A	18-40	21	2.5	3.5	2.5:1/2.5:1	5
JSW4-33005000-45-5A	33-50	21	2.5	4.5	2.5:1/2.5:1	5
JSW5-40006000-55-0A	40-60	18	2.5	5.5	2.75:1/2.75:1	0

Higher output power options available.



MIXER/CONVERTER PRODUCTS

Model Number	Frequency (GHz)			Conversion Gain/Loss (dB, Typ.)	Noise Figure (dB, Typ.)	Image Rejection (dB, Typ.)	LO-RF Isolation (dB, Typ.)
	RF	LO	IF				
LNB-1826-30	18-26	Internal	2-10	42	2.5	25	45
LNB-2640-40	26-40	Internal	2-16	42	3.5	25	45
IR1826N17*	18-26	18-26	DC-0.5	11	9.5	25	25
IR2640N17*	26-40	26-40	DC-0.5	11	9.5	25	25
SBW3337LG2	33-37	33-37	DC-4	-7.5	8	N/A	25
TB0440LW1	4-40	4-42	.5-20	-10	10.5	N/A	20
DB0440LW1	4-40	4-40	DC-2	-9	9.5	N/A	25
SBE0440LW1	4-40	2-20	DC-1.5	-10	10.5	N/A	20

* For IF frequency options, please contact MITEQ.

MULTIPLIERS

Model Number	Frequency (GHz)		Input Level (dBm, Min.)	Output Power (dBm, Min.)	Fundamental Feed Through Level (dBc, Min.)	DC current @+15VDC (mA, Nom.)
	Input	Output				
MAX2M260400	13-20	26-40	10	10	18	160
MAX2M200380	10-19	20-38	10	10	18	200
MAX2M300500	15-25	30-50	10	10	18	160
MAX4M400480	10-12	40-48	10	10	18	250
MAX3M300300	10	30	10	10	60	160
MAX2M360500	18-25	36-50	10	10	18	160
MAX2M200400	10-20	20-40	10	10	18	160
TD0040LA2	2-20	4-40	10	-3	30	N/A

Higher output power options available.

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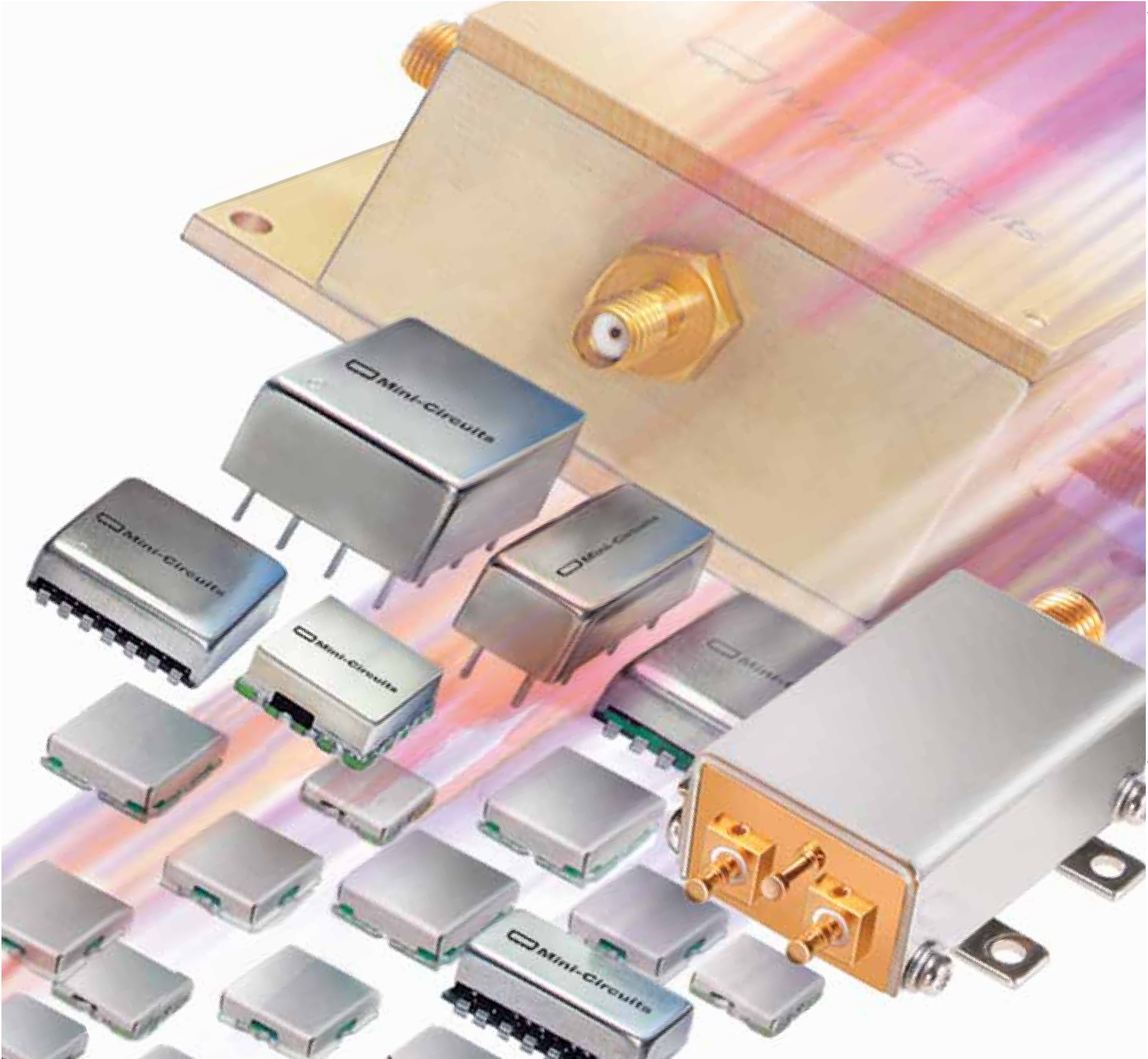

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JANUARY 2008
Vol. 7 No. 1

HIGH FREQUENCY ELECTRONICS

You can view this issue page-by-page, or click on any of the articles or columns in the Table of Contents below

Regular Columns

On the Cover—Our cover artwork is provided courtesy of Agilent EEsof EDA, to introduce ADS 2008, a major upgrade to its Advanced Design System.

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High Frequency Electronics (USPS 024-316) is published monthly by Summit Technical Media, LLC, 3 Hawk Dr., Bedford, NH 03110. Vol. 7 No. 1, January 2008. Periodicals Postage Paid at Manchester, NH and at additional mailing offices.

POSTMASTER: Send address corrections to *High Frequency Electronics*, PO Box 10621, Bedford, NH 03110-0621.

Subscriptions are free to qualified technical and management personnel involved in the design, manufacture and distribution of electronic equipment and systems at high frequencies.

Engineering Tasks Keep Moving to the Suppliers

Gary Breed
Editorial Director

Applications engineers at supplier companies have always been important. Many of the best known "classic" technical references are application notes from component, instrument and software companies. Today, the importance of that specialized knowledge is greater than ever—even replacing typical design engineering that has traditionally been done at the OEM companies!

This trend has been developing gradually for many years. To appreciate the magnitude of this shift in core high frequency expertise, all we need to do is list some of the specific reasons:

- Higher levels of integration, and a growing range of available technologies at the component level.
- More complex communication systems, supported by similarly complex EDA tools and instruments.
- The desire to add wireless communications functions to a wide variety of product types—quickly, easily and cheaply.
- The sheer number of high frequency applications, which has diluted the pool of available engineers who have the necessary expertise.

Most of these reasons mean *more*—more information needed, more specialization required, more work to be done. All this "more" stuff needs to be done in *less* time and with *less* staffing! This is an equation that does not balance at the OEM level. It requires more capability in the engineering tools and components that are purchased, and more help from the applications specialists at the supplier companies.

I won't characterize this situation as a problem, except the part about the diluted pool of engineering talent. But, it is a change in the way companies do business and the way engineers do their jobs.

Fifteen or twenty years ago, new engineers usually started their careers working on one building block—one specific function in a larger system. As they gained experience, their responsibilities broadened to include more of the system. Eventually, as an experienced engineer or manager, they would get involved at the start of the process, creating an overall system architecture and its performance specifications. Then the individual elements of the project would be parceled out to a new group of young engineers.

Now, the opposite is often true. A new engineer may be involved in development of the overall design architecture—the “big picture”—instead of concentrating on one small piece. With more functionality at the component level, an OEM engineer’s job includes fewer small pieces that need to be designed from scratch. Instead, his or her job is to identify the functionality and performance needed in those pieces, which are now acquired as complete functional components.

To address this change, this month’s tutorial article offers notes to help new engineers appreciate top-down design methodology that was previously reserved for the most experienced engineers and managers. The process is very different from university classroom and laboratory projects. Dealing with a wide range of technical matters can be a daunting challenge, as can the need to change from the one-way process of learning, to the type of two-way interaction needed within a diverse design team.

Engineering at the Supplier Companies

One major point of this commentary on changes in the classic OEM engineer’s job is that those tasks are not gone. They have simply moved to another place, often using very different technologies—integrated circuits, multi-chip modules, low temperature co-fired ceramics (LTCC), chip-and-wire hybrids, etc.

In addition to knowledge of specialized manufacturing techniques, engineers at these companies are the top experts in their particular design niche. For example, it only makes sense that a company making mixer ICs have a top mixer designer who can work closely with highly-qualified chip designers to achieve the best result. This sounds pretty good if you are an OEM looking for the best device to incorporate into your next product!

Hopefully, all new engineering graduates are aware that they are entering a dynamic work environment. Although there may be fewer “traditional” jobs, there is a now a much broader range of opportunities at companies large and small, OEM and component-level. And those jobs may have very different requirements than typical jobs of just one generation ago.

CONFERENCES

January 20-25, 2008
2008 IEEE Radio Wireless Week
Orlando, FL
(Including Power Amplifier Symposium, Radio & Wireless Symposium incorporating WAMICON, & Silicon Monolithic Integrated Circuits in RF Systems Symposium)
Information: Conference Web site
http://www.radiowirelessweek.org

January 23-25, 2008
8th Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems (SiRF 2008)
Orlando, FL
Information: Conference Web site
http://www.eng.auburn.edu/~niuguof/sirf/index.htm

January 29-February 1, 2008
WCA 14th Annual International Symposium and Business Expo
San Jose, CA
Information: WCA
Tel: 202-452-7823
http://www.wcai.com

February 4, 2008
5th CST North American Users' Forum
Santa Clara, CA
Information: Forum Web site
http://www.cst.com/Content/Events/Details.aspx?eventId=719

February 25-28, 2008
IDGA 6th Annual Software Radio Summit
Vienna, VA
Information: IDGA Web site.
http://www.idga.org

March 31-April 3, 2008
WCNC 2008—IEEE Wireless Communications and Networking Conference
Las Vegas, NV
Information: Conference Web site
http://www.ieee-wcnc.org/2008

April 1-3, 2008
CTIA Wireless 2008
Las Vegas, NV
Information: Conference Web site
http://www.ctiawireless.com

April 11-17, 2008
2008 NAB Show
Las Vegas, NV
Information: Conference Web site
http://www.nabshow.com

April 16-17, 2008
2008 IEEE International Conference on RFID
Las Vegas, NV
Information: Conference Web site
http://www.ieee-rfid.org/2008

April 28-30, 2008
2008 IEEE Sarnoff Symposium
Princeton, NJ
Information: Conference Web site
http://www.sarnoffsymposium.org

June 15-20, 2008
2008 IEEE MTT-S International Microwave Symposium
Atlanta, GA
Information: Conference Web site
http://www.ims2008.org

SHORT COURSES

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Applied RF Techniques I
February 25-29, 2008, San Diego, CA
Antennas & Propagation for Wireless Communications
February 25-27, 2008, San Diego, CA
Frequency Synthesis and Phase-Locked Loop Design
February 25-27, 2008, San Diego, CA
RF CMOS Design
February 25-26, 2008, San Diego, CA
Security for 802.11 Wireless LAN
February 25-27, 2008, San Diego, CA
Radio System Design - Theory and Practice
February 25-29, 2008, San Diego, CA
RF and Wireless Made Simple
February 27-29, 2008, San Diego, CA
DSP Made Simple for Engineers
February 27-29, 2008, San Diego, CA
RF and High Speed PC Board Design Fundamentals
February 27-29, 2008, San Diego, CA
Designing High Efficiency RF Power Amplifiers
February 27-29, 2008, San Diego, CA
Mobile Broadband Wireless Access
February 27-29, 2008, San Diego, CA

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http://www.winmec.ucla.edu:80/rfid/experience/Feb2008
RFID Hands on Workshop
February 26, 2008, Los Angeles, CA

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Department of Engineering
Professional Development
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Madison, WI 53706
Tel: 800-462-0876; Fax: 608-263-3160
E-mail: danbeck@engr.wisc.edu
http://epd.engr.wisc.edu

Intro to Planning and Designing Fiber to the Premises
February 7, 2008, Las Vegas, NV

Electrical Grounding of Communications Systems
March 3-5, 2008, Las Vegas, NV

DC Power System Design for Telecommunications
March 4-6, 2008, Las Vegas, NV

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http://www.doceotech.com

WiMAX Forum RF Network Engineer ™ Certification Boot Camp
January 15-18, 2008, San Jose, CA
January 28-31, 2008, Kona, HI (at the WiMAX Forum member meeting

WiMAX and 802.16e: Broadband Wireless Standards
January 28-29, 2008, Kona, HI (at the WiMAX Forum member meeting

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http://www.emiguru.com/seminartek.htm

EMC/Signal Integrity Seminar
February 11-13, 2008, Orlando, FL
February 18-20, 2008, San Diego, CA

CALLS FOR PAPERS

2008 Global Symposium on Millimeter Waves

Location: Nanjing, China
Conference Dates: April 21-24, 2008
Submission Deadline: January 20, 2008

Topics:

Relevant topics of interest include, but are not lmited to the following: frequency management and utilization, millimeter-wave communication systems, devices and circuit technologies, wireless access systems, mobile access systems, millimeter-wave satellite communications, millimeter-wave LANs and PANs, millimeter-wave home link systems, millimeter-wave photonics, millimeter-wave antennas and propagation, millimeter-wave phased array antennas, millimeter-wave signal processing, wearable devices and systems, automotive radars and remote sensing, and supporting and related technologies.

Information:

All submissions must be electronic in PDF format only. Hard copies will not be accepted. Authors are encouraged to select one or two suggest topics and give clear indication of that in submission. Papers must be written in English and limited to four pages including text, references, and figures. Each submitted paper should be an IEEE Xplore® compliant PDF file. The paper template and instructions on how to create PDF files for IEEE Xplore are available at the conference Web site, http://www.gsmm2008.org.

2008 International Conference on Microwave and Millimeter Wave Technology

Location: Nanjing, China
Conference Dates: April 21-24, 2008
Submission Deadline: January 20, 2008

Topics:

Relevant topics of interest include, but are not limited to the following: solid state device and circuits; low-noise devices and techniques; high-power devices and techniques; monolithic integrated circuits; passive devices and circuits; packaging, interconnects, and MCMs; ferrite and SAW components; superconducting components and technology; microwave-optical design; computer aided design; instrumentation and measurement techniques; electromagnetic field theory; computational electromagnetics; microwave antennas; smart antennas, phased and active; scattering propagation; other relevant topics.

Information:

All submissions must be electronic in PDF format only. Hard copies will not be accepted. Authors are encouraged to select one or two suggest topics and give clear indication of that in submission. Papers must be written in English and limited to four pages including text, references, and figures. Each submitted paper should be an IEEE Xplore® compliant PDF file. The paper template and instructions on how to create PDF files for IEEE Xplore are available at the conference Web site, http://www.icmmt2008.org.

IEEE 2008 International Conference on Ultra-Wideband

Location: Hannover, Germany
Conference Dates: September 10-12, 2008
Submission Deadline: February 10, 2008

Topics:

Topics shall include (but not limited to): antennas and propagation, including UWB antennas and arrays and channel measurements and modling; UWB communication systems and signal processing, including MIMO, synchronization, and time reversal; hardware

architecture and implementation, including IC designs, OFDM implementations, and system architectures; standardization and regulatory issues, including signal modeling and co-existence; applications, including home networking, radar, and consumer electronics; and UWB cognitive and cooperative, including radio networks and radio access protocols and architectures.

Information:

Prospective authors are invited to submit technical papers (4 pages in PDF format) emphasizing their contributions beyond the state of the art via the ICUWB 2008 Web site at http://www.icuwb2008.org.

European Wireless Technology Conference (EuWiT)

Location: Amsterdam, The Netherlands
Conference Dates: October 27-28, 2008
Submission Deadline: February 24, 2008

Topics:

Part of European Microwave Week, EuWiT covers a wide range of topics in wireless communications including key technologies, components and subsystems, antennas and propagation, systems and signal processing as well as applications and standards.

Information:

Authors should submit a 4-page preliminary paper in the standard conference proceedings layout. A template can be downloaded from the EuMW2008 Web site: www.eumweek.com. Paper must be uploaded in pdf format. Maximum file size is 1 MB.

2008 IEEE Compound Semiconductor IC Symposium

Location: Monterey, CA
Conference Dates: October 12-15, 2008
Submission Deadline: May 12, 2008

Topics:

Specific technical areas of interest include: innovative RFIC device & circuit concepts, millimeter-wave/high-speed CMOS IC, circuit design & fabrication, manufacturing technology & cost issues, CAD/CAM/CAT tools & techniques, IC testing & methodology, packaging technology, reliability, advanced device applications, system applications (e.g., wireless, vehicular, RADAR, military), and optoelectronic and OEIC applications.

Information:

Authors must submit an abstract (not more than 4 pages including figures and other supporting material) of results not previously published or not already accepted by another conference. Papers will be selected on the basis of the abstract. Abstracts must be submitted electronically using the symposium Web page, http://www.csics.org. The only accepted file format is PDF. Authors will be informed regarding the results of their submissions by June 24, 2008. All symposium information can be found on the Web site.

Business News

The **WiMAX Forum** announced its lead certification lab is now open for formal Mobile WiMAX certification testing and evaluation of Mobile WiMAX products. WiMAX Forum vendors may begin immediately submitting their 2.3 GHz and 2.5 GHz Mobile WiMAX equipment for testing. The WiMAX Forum's lead certification lab is headquartered at AT4 Wireless in Spain. The WiMAX Forum expects its four other certification labs in the U.S., Taiwan, China and Korea to open for formal Mobile WiMAX certification testing shortly.

Computer Simulation Technology (CST) announces the acquisition of the **Flomerics e**lectromagnetics simulation software business including MicroStripes and FLO/EMC with effect from 1 January 2008. Through this acquisition, CST will gain complementary EM technology for its customers; of particular interest is the transmission line matrix method, as an alternative Time Domain approach. Furthermore, Flomerics' strong position in the EMC market and related specialized product features will offer new possibilities to CST's users.

Filtronic plc announces a definitive agreement for the sale of all of the share capital of **Filtronic Compound Semiconductors Limited** to **RF Micro Devices Inc** for £12.5m cash. The transaction is expected to complete on 29 February 2008. The agreement provides for ongoing supply to Filtronic's Point to Point business for at least 3 years and for it remaining at its current site.

ARRIS announced that it has completed its acquisition of **C-COR Inc.** pursuant to the Merger Agreement signed on September 23, 2007. The proposed merger was overwhelmingly approved December 14, 2007, by the shareholders of both ARRIS and C-COR with approximately 98% of the shares voted cast in favor of the transaction. ARRIS expects to issue former C-COR shareholders approximately $366 million in cash and approximately 25.1 million shares of ARRIS common stock.

TEGAM recently joined the **LXI Consortium** as an Informational Member. LXI (LAN eXtensions for Instrumentation) puts the power of Ethernet to work for test and measurement engineers by improving the modularity, flexibility and performance. Its compact package, high-speed I/O and reliable measurements meet the needs of R&D and manufacturing engineers in many electronic market segments.

Keithley Instruments, Inc. announced that it has become a member of the **WiMAX Forum®.** The WiMAX Forum is an industry-led, non-profit organization responsible for promoting and certifying interoperable WiMAX™ products.

Mercury Computer Systems, Inc. announced it was awarded a multi-year contract by **Hughes Network Systems, LLC** (Hughes) to provide ATCA-based modules as part of a fully integrated communications platform. The contract will support multiple Hughes programs, including a satellite base-transceiver subsystem (S-BTS) and a satellite base station subsystem (SBSS). The contract calls for delivery of multiple RapidIO-based, DSP Advanced Mezzanine Cards (AMCs) mounted on ATCA blades from the Mercury Ensemble(TM) product line. The Mercury solution will support signal processing computing requirements necessary to provide mobile phone access to consumers, using a combination of satellite and terrestrial links in less densely populated areas.

Richardson Electronics announced the extension of its distribution agreement with **Wavecom SA** to include North and South America. The strategic partnership will expand Richardson's distribution of Wavecom's Wireless CPU® products and wireless communications solutions.

Anritsu Company announces that it is the first test solutions vendor to be granted membership into the **Next Generation Mobile Network Alliance** (NGMN). Anritsu's technology experts will work with the NGMN Alliance to devise strategies for maximizing the availability and service quality of the new mobile network technologies adopted by its members.

Stratos Optical Technologies, a wholly-owned subsidiary of **Emerson Network Power Connectivity Solutions,** announced shipment of the 50,000th miniature, harsh-environment optical transceiver in calendar Q4 of 2007. This product series was developed by Stratos to satisfy the specialized need of military communication networks designers, specifically fast Ethernet and avionics AFDX applications.

Nitronex has qualified its new, state-of-the-art manufacturing facility. The move from Raleigh to Durham began in first quarter 2007 and was finished in the second quarter, with qualification testing completed in October. The completed qualification verifies that Nitronex has successfully replicated the process developed in Raleigh at the new Durham fab and is prepared for volume production.

TT electronics OPTEK Technology has selected **NRC Electronics** as a global distributor of their complete product offering. Headquartered in Boca Raton, Florida, NRC Electronics will provide the necessary technical support and "on demand" distribution for OPTEK's optoelectronic sensors and fiber optic devices, along with their visible LED components and assemblies.

New Era Electronics, Ltd. (NEE), together with **EastBridge Partners, LLC,** has established **NEE International, LLC,** to act as the sales, marketing and technical service company for NEE outside of Asia. Located in Phoenix, Arizona, NEE International is chartered with creating a microwave knowledgeable sales force and expanding sales, primarily in the US and Europe.

AWR announced that December 2007 marked its 10-year anniversary of providing customers with innovative technologies and outstanding customer service, enabling them to successfully deliver next-generation wireless designs in today's competitive market. AWR began servicing its first customer on December 10th, 1997 with one seat of software. Since then, the company's customer base has grown every year, resulting in over 20,000 active users in 2007.

Agilent Technologies Inc. announced that **Maspro Denkoh Corp.** has selected Agilent's Genesys and Momentum GX software to develop its TV-receiver and satellite-broadcast equipment. The agreement includes multiple licenses and an optional upgrade path to other Agilent EEsof EDA products.

The Leica Geosystems "Geomatics Center of Excellence" opened to much excitement and high expectations from the local surveying and engineering community. This 4,000 square foot, modern high-tech facility located in Houston, Texas, will offer sales, support, and service for all Leica Geosystems surveying, hi-definition scanning products, and reference station network infrastructures.

Sales Appointments

Nordic Semiconductor ASA announced that it has appointed specialist technical sales rep—**SC Cubed**—to complement its existing sales force among the high density concentration of top US electronics companies clustered in and around Southern California.

Labtech Microwave has appointed a number of new agents to represent their business throughout Europe and the southern hemisphere. Capitalizing on the sustained demand for printed circuit boards, new territories secured include Australia, France, India, Israel, Scandinavia and Singapore with opportunities for representation still available in China, Germany and Japan. The new agents include: **DrawCom Pty Ltd** in Australia; **L-TEQ Microwave** in France; **Emco Electronics Pvt Ltd** in India; **Gtech Innovative Ltd** in Israel; **Compomill Nordic Components** in Scandinavia; and **MEDs Technologies PTE Ltd** in Singapore.

People in the News

Kyocera America, Inc. announced the executive promotion of **David Hester** to the newly created position of Vice President, Quality Assurance and Supply Chain Management. Hester joined Kyocera in January 2000 and has more than 20 years of experience in electronics manufacturing. He previously served as Executive General Manager, Quality Assurance and Supply Chain, at Kyocera America, Inc.'s San Diego headquarters. Hester holds a Bachelor of Science degree in Industrial Engineering from Purdue University, and has attained Lean Six Sigma "Black Belt" status. The creation of an executive-level position for Quality Assurance and Supply Chain Management underscores Kyocera's commitment to continually raising its quality standards and fully implementing Lean Six Sigma methodology.

Nextreme Thermal Solutions™ has appointed **Stephen Brooks** as Director of Manufacturing. Mr. Brooks has more than 24 years of experience in planning, establishing and managing the transition of high-technology companies from R&D to volume manufacturing. Prior to joining Nextreme, he served as the Director of Operations at Amkor Technology in Morrisville, NC. As Director of Manufacturing at Nextreme, Mr. Brooks will coordinate Nextreme's move into its new 14,000 square-foot facility and establish scalable and repeatable volume manufacturing systems for its recently announced Thermal Copper Pillar Bump technology. Mr. Brooks has extensive experience in the preparation, construction and operation of ISO9001 and TL9000 certified production facilities for VLSI wafer fabrication, MEMS wafer fabrication, IC assembly, IC test, SMT assembly, chip scale packaging (CSP), and die level processing. Stephen is a North Carolina native and attended North Carolina State University in Raleigh.

FKI Logistex® announces the appointment of **Matt Wicks** to vice president of systems engineering for the company's Manufacturing Systems group. Wicks' promotion follows a recent consolidation of the Systems and Conveyor Engineering groups within FKI Logistex Manufacturing Systems. Wicks began his career with FKI Logistex in 1998 as a controls engineer, steadily assuming increased management responsibility, most recently serving as director of systems engineering. As vice president, Wicks is responsible for managing controls, electrical and mechanical engineering teams, systems sales support and estimating. Wicks has a Bachelor of Science in Electrical Engineering from the University of Missouri, Rolla and a Professional Engineer (PE) license from the Missouri Division of Professional Registration.

Fujitsu Microelectronics America, Inc. (FMA) announced that semiconductor industry veteran **Steve Della Rocchetta** has joined the company as vice president of the CLSI Business Unit. He is based at FMA's U.S. headquarters in Sunnyvale, CA, and reports directly to Keith Horn, Chief Operating Officer of FMA. Della Rocchetta is responsible for day-to-day operations of FMA's ASIC, COT and COT+ business, sales and account management activities in the Americas. He has more than 30 years of experience in the industry. Prior to joining FMA, he was the executive vice president of worldwide sales and marketing at Silterra, a foundry supplier based in Malaysia. He also held executive sales positions at Chartered Semiconductor and ESM Ltd., and has 18 years of various management positions in wafer fab operations.

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

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

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Technology News

Mobile Delivery Solution Developed for Digital TV

Harris Corporation (www.broadcast.harris.com) has announced the development of MPH™ (mobile-portable-handheld) in-band mobile digital television (DTV) system. The new system provides a robust, ATSC-compatible mobile solution for local broadcasters to maximize the use of their 6-MHz, 19.39 megabit-per-second digital pathway for providing a wide range of consumer services. MPH maintains the centerpiece application, digital HDTV, for the tens of millions of fixed receivers in U.S. homes, while simultaneously reaching viewers on-the-go with a low-bit-rate digital TV signal and data services. The MPH system capitalizes on the combination of Harris' expertise in broadcast systems — including transmitters, exciters, encoders and software — and the systems development, integrated circuit design and consumer electronics experience of LG Electronics (www.lge.com) and its Zenith subsidiary.

For consumers, MPH enables users to view their favorite programs from local broadcasters, watch movies and sports, and access local news and weather information, even when traveling in fast-moving vehicles or using handheld video devices away from home. For broadcasters, this new technology has the potential to generate revenue while providing useful consumer content. Broadcasters will be able to:

- Leverage their investment in ATSC transmission
- Deliver robust DTV signals to mobile-portable-handheld devices
- Extend their local brand to mobile users
- Provide local News, Weather, Sports and traffic to consumers on-the-go
- Add 2 to 6 channels of mobile content per station
- Open new revenue streams

MPH has been in development for the past two years by LG Electronics DTV Laboratory in Seoul, South Korea, and at LG's Zenith lab near Chicago, as well as the Harris Broadcast Division headquarters in Mason, Ohio.

Report Discusses Organic Transistor Technology

According to a new market research report from NanoMarkets (www.nanomarkets.net), the growing demand for flexible, large area electronic circuitry from packaging, displays, smartcards, sensors and other industry sectors will drive the organic transistor and memory market to $21.6 billion by 2015. Highlights from the report include:

- During the past year, organic thin-film transistors (OTFTs) and memories have achieved enhanced credibility as they have achieved performance at or better than some silicon TFTs and as significant investments have been made in production facilities for these organic devices.
- Organic logic and memory may be the best chance for bringing down the cost of RFID to a point where item level tracking of moderately priced products becomes economically feasible. NanoMarkets projects RFID that uses organic circuitry will become an $11.6 billion market.
- Smartcards are an untapped opportunity for organic transistors and memory and the market for organic smart cards is expected to be worth more than $4.0 billion by 2015. However, production innovations are required to get round the problem of the high-temperature lamination that is used in card manufacture.
- OTFTs are already proving themselves in the e-paper backplanes market, but there is much massive research efforts going into using OTFTs for active matrix LCD and OLED displays. This will mean that the OTFTs will have to switch faster than they do now, but the latest work on single-crystal organic transistors show that huge leaps in performance are quite likely. The OTFT backplane market is expected to reach $3.3 billion by 2015.
- In the recent past, the development of organic memory has languished compared to that of OTFTs. But it is now catching up rapidly. By 2015, $16.1 billion in electronic products are expected to contain organic memories.
- There are major opportunities to find new "inks" that will enable solution processing of OTFTs and organic memories at full production levels. According to NanoMarkets' report by 2015 as much as $4.0 billion in materials may be sold for the production of OTFTs and organic memories.

The report also includes detailed eight-year forecasts of these markets and of the underlying materials markets as well as strategic profiles of 30 commercial firms manufacturing or developing OTFTs/organic memories and 59 university and research groups making leading edge contribution to increasing performance, using new materials and improving architectures for these devices. The full report may be purchased from NanoMarkets.

This "High Frequency Applications" column presents research results, technology developments and business news related to the use of high frequency technology. We welcome news releases and other information from companies and institutions to be considered for publication. Send them by e-mail to: editor@highfrequencyelectronics.com

Predicting Probable Cavity Resonance with a 3D EM Tool

By Yeap Yean Wei, Nanyang Technological University
Frank Demming-Janssen and Linus Lau Ngie Ung, Computer Simulation Technology (CST)

Electromagnetic analysis can be used to predict resonances inside microwave modules, allowing the designer to implement measures to avoid poor performance and instability

Cavity resonance is commonly encountered when the PCBs and RF components are placed in an enclosure. Due to the module height and the housing structure, the standing wave with characteristic such that the E and H fields are 90° out of phase with each other. The impedance will therefore fluctuate wildly across the cavity causing unknown effects on circuitry, including the introduction of instability to active devices [1].

A few practical approaches have been demonstrated by Yeap, et al. [2] to suppress the cavity resonances within a high power amplifier (HPA) module by using an isolation block and tantalum capacitors at the DC bias network. To further understand the behavior of electromagnetic (EM) propagation within this HPA module, we extend that earlier work to predict the possible cavity resonances scenario via EM field analysis and Eigen-mode computation using the Eigen-mode solver in CST MICROWAVE STUDIO® [3]. By adopting this approach, we show the likely phenomenon that can be observed with and without the existence of an isolation block.

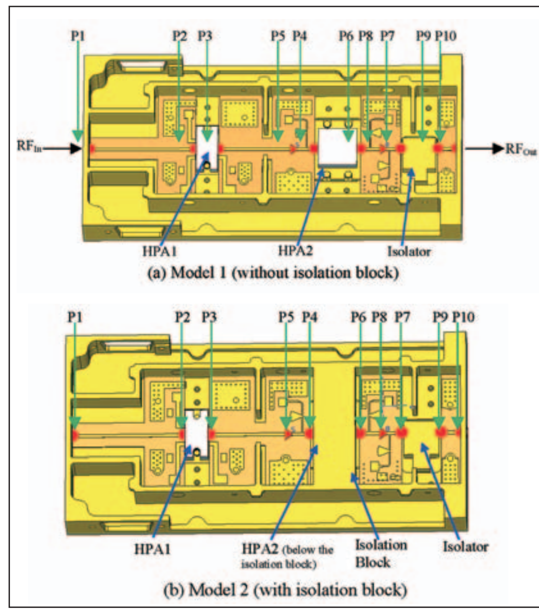

Figure 1 · Models imported to CST Microwave Studio for resonance analysis.

Model Description of HPA Module

The PCB layout of the HPA was initially designed in Agilent Advance Design System (ADS), and the module enclosure was designed in AutoCAD. PCB layers were exported as 2D DXF to CST MWS and further extruded in the z-axis to form the 3D object. The module enclosure was exported in IGES format from AutoCAD to CST MWS environment. Two different HPA modules were used in this study. The main difference between the models is that there is an "isolation block" extended over the HPA2 in Model 2, as shown in Figure 1(b). The effects of adding the isolation block is then demonstrated by the visualization of EM field distribution and cavity resonant frequencies between the two models. Model 1 is identical to the hardware developed in [2], however the lumped components, solder and connectors are not included in the simulation. The heights of the components (HPA1 = FMM5057VF [4], HPA2 = FLM7785-12F [5], Isolator = 2RI119 [6]) were modeled according to the units specified in the data sheet. The

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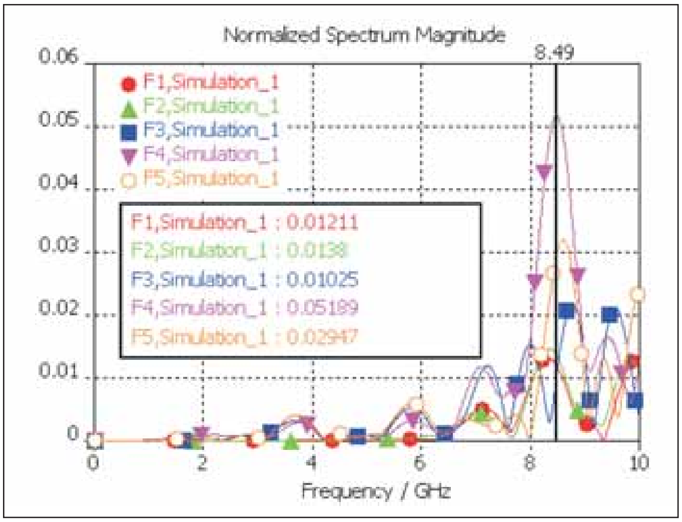

Figure 2 · Normalized spectrum magnitude captured by ports P1-P5 of Model 1.

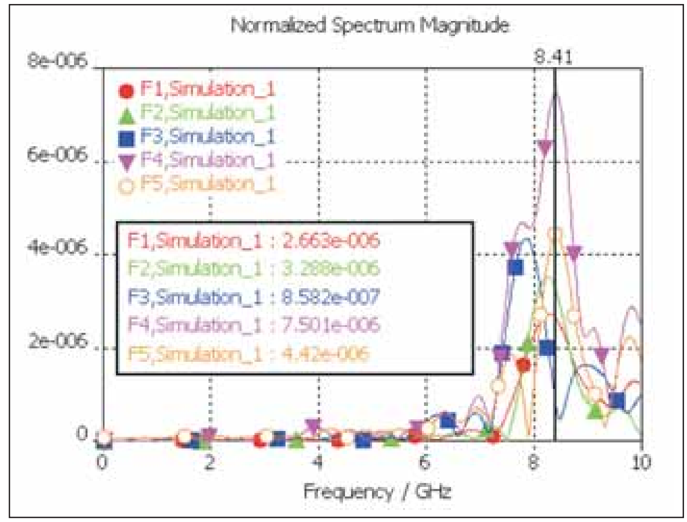

Figure 3 · Normalized spectrum magnitude captured by ports P1-P5 of Model 2.

substrate is defined based on the properties of RO4003 [7]. The "red dots" in Figure 1 are the discrete ports defined in CST MWS, which are used to excite signal to the RF traces as well as to receive EM fields. There are a total of ten discrete ports, denoted as P1 to P10 in each model.

Part 1: EM Fields Analysis in CST MWS

Both models were simulated with "Time Domain Solver (T Solver)" in CST MWS. Only P6-P10 (P6, P7, P8, P9 and P10) were activated for simultaneous port excitation. P1-P5 (P1, P2, P3, P4 and P5) act as "EM field receiver." If the EM field does not loop back to the input of the module, P1-P5 will receive very low EM field energy. Figure 2 and Figure 3 show the normalized spectrum magnitude captured by P1-P5 in Model 1 and Model 2 respectively. It is shown that Model 1, which has no isolation block, has a normalized spectrum magnitude of 6900 times (or 38 dB) greater than that of Model 2. This implies that there is strong coupling from P6-P10 to P1-P5 in Model 1, potentially creating a positive feedback within the module.

To visualize the EM field distribution in these modules, we will observe the electric and magnetic fields at 2 GHz (an arbitrary frequency selected for comparison purpose) and 8.3 GHz (operating frequency of the HPA). In

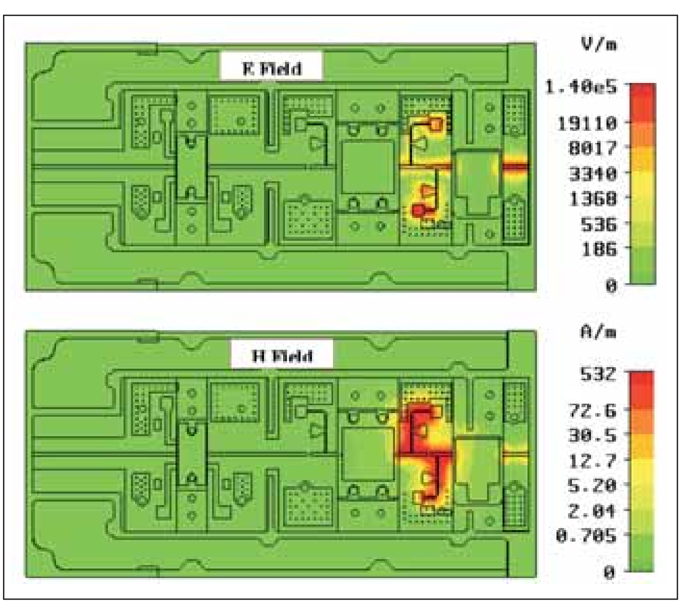

Figure 4 · Absolute E and H field strength of Model 1 at 2 GHz.

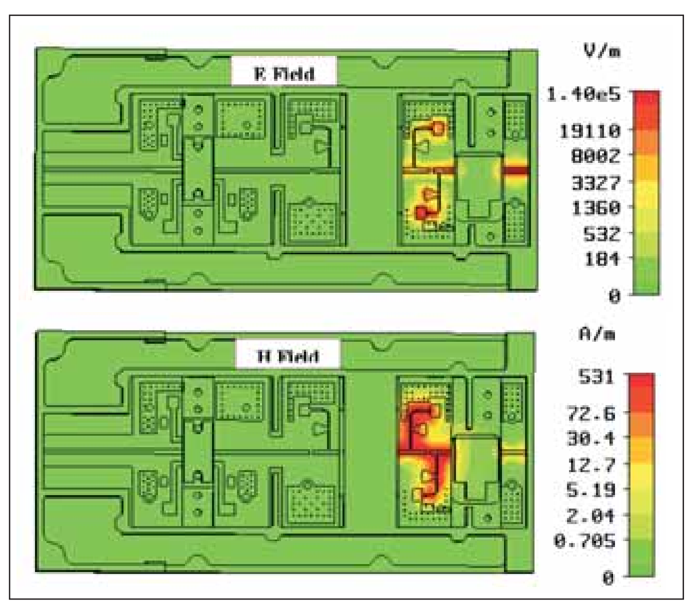

Figure 5 · Absolute E and H field strength of Model 2 at 2 GHz.

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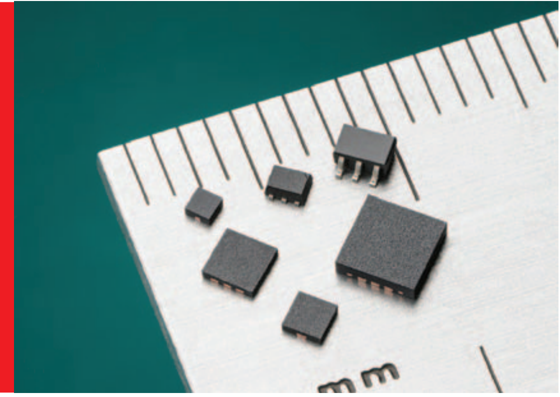

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	UPG2158T5K	1 Watt, high performance, ultra-miniature package	●	●	●		
	UPG2163T5N	2 – 6 GHz, industry's best insertion loss, chip-scale pkg		●	●		
	UPG2179TB	1.5 Watt, high performance, industry-standard pin-out	●	●	●		
	UPG2214TB/TK	Low cost, 1/2 Watt, 1.8 and 3 Volt guaranteed specs	●	●		●	
	SINGLE CONTROL SPDT						
	UPG2010TB	2 Watt, high power, high isolation, low insertion loss	●	●	●		
	UPG2012TB/TK	1/4 Watt, industry standard TB or miniature TK package	●	●		●	
	UPG2015TB	1 Watt, great performance	●	●	●		
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	UPD5713TK	Low cost CMOS, miniature package	●	●			
	MULTI-THROW SWITCHES						
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	UPG2162T5N	**DPDT**, 2.4 – 6 GHz dual-band, miniature, low insertion loss	●	●	●		
	UPG2164T5N	**DPDT**, 2.4 – 6 GHz dual-band, miniature, low insertion loss	●	●	●		
	UPG2227T5F	**SP3T**, ideal for CDMA and GPS, QFN package	●	●	●	●	

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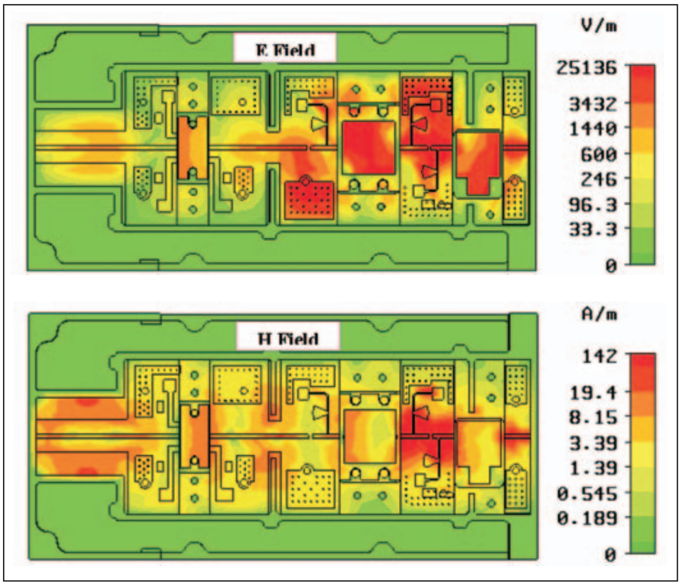

Figure 6 · Absolute E and H field strength of Model 1 at 8.3 GHz.

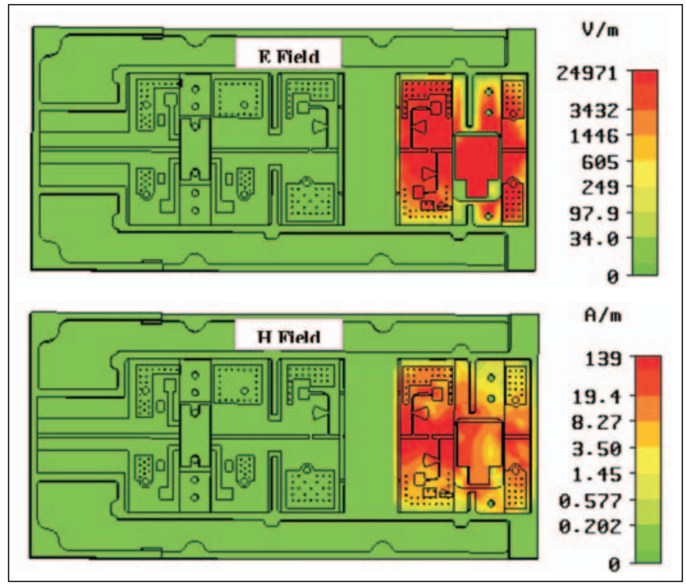

Figure 7 · Absolute E and H field strength of Model 2 at 8.3 GHz.

both models, Figure 4 and Figure 5 show that the E and H field only gathers around the RF traces. However, it is shown in Figure 6 that the E and H fields in Model 1 have spread around the whole module without the presence of isolation block. This phenomenon could lead to a loop-back, causing the amplifier to oscillate.

On the other hand, Figure 7 shows that, with an isolation block used in Model 2, most of the E and H field are blocked from spreading all around and bounded within the compartment.

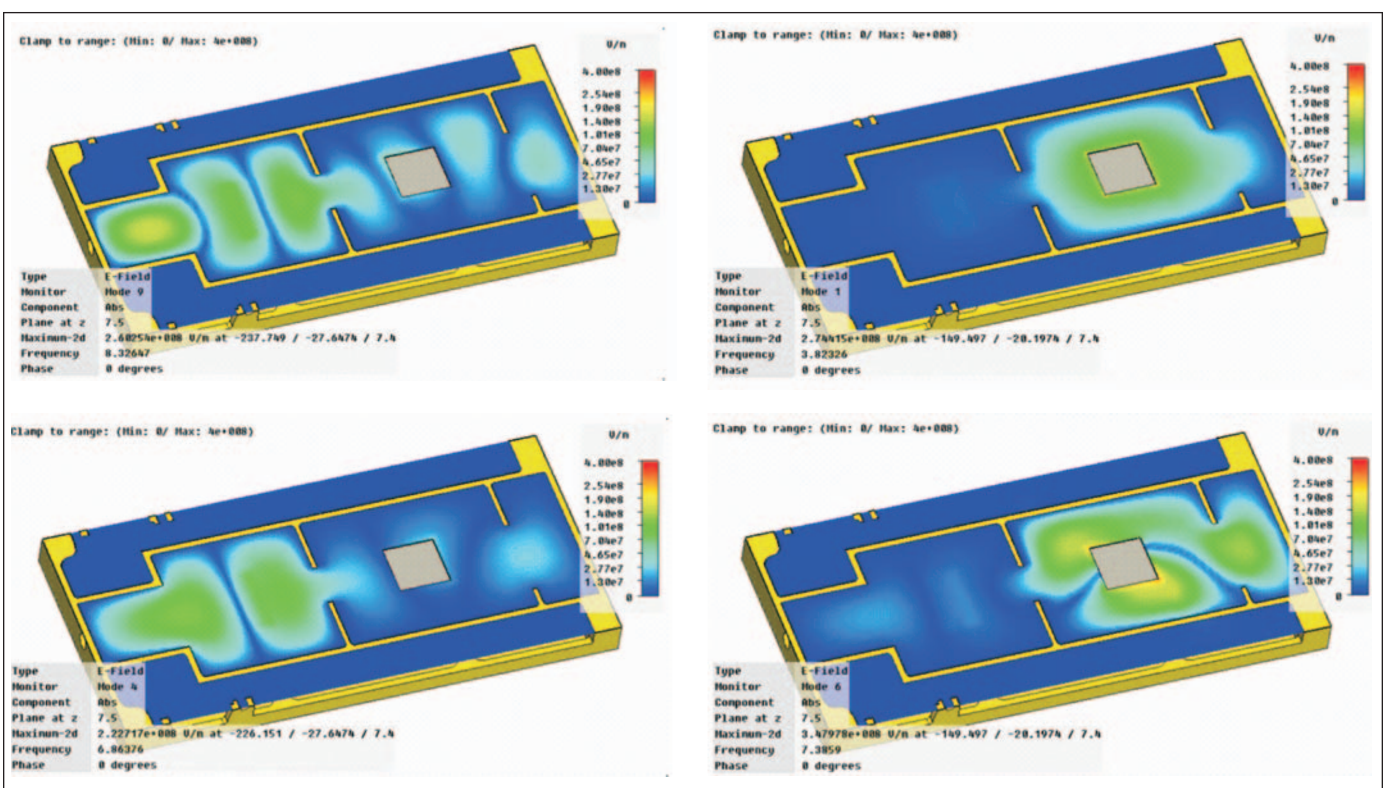

Figure 8 · Four Eigen-modes of the HPA cavity.

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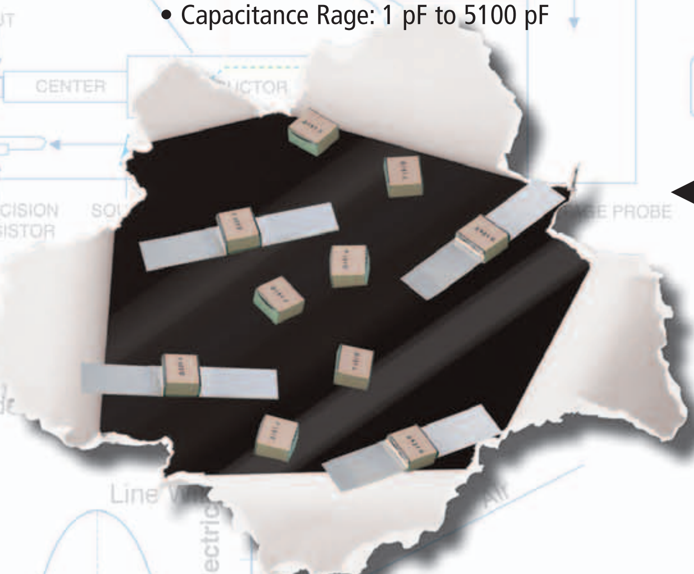

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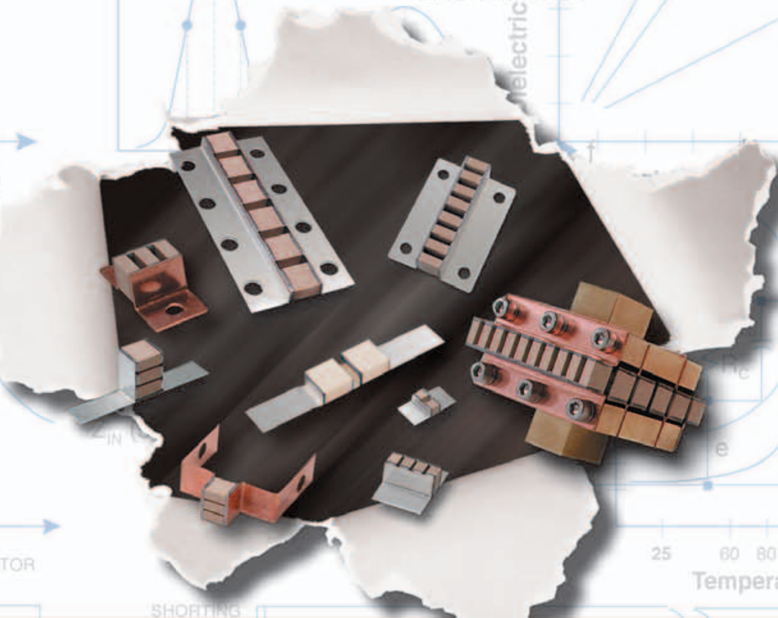

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Part 2: Resonances Prediction with Eigen-mode Solver

From the previous section, we have shown that the cavity resonance might cause coupling between the input and output stage of the amplifier in Model 1. These Eigen-modes reflect the potential frequency for HPA oscillations as a result of positive feedback in the enclosure. To investigate this problem in greater detail and to find these resonant frequencies, the CST MWS Eigen-mode Solver (E Solver) can be used. Figure 8a-d shows four different Eigen-modes of the cavity.

If these resonance frequencies are compared to the amplitude spectrums in Fig. 2, it can be noticed that each mode corresponds to a coupling peak in the spectrum. By analyzing the field distribution of these modes, the best position for absorbing and isolation blocks as well as shorting vias can be revealed. While the transient simulation as described in the first section of these paper includes all structure details (e.g. all PCB traces terminated with ports), the Eigen-mode simulation is performed on a simplified model excluding some of the traces. Since the Eigen-mode simulation (by definition) does not included any ports, all "free floating" traces have either been shorted to GND or been removed. This is done to eliminate "static" modes in the simulation. It is expected, that the presence of the traces only has a minor effect on the Eigen-modes and the results of the simplified Eigen-mode simulation and the transient simulation of the full model agree very well.

Conclusion

The cavity resonances excitation within a high power amplifier (HPA) module is demonstrated here using a commercial 3D EM simulator. The simulated normalized spectrum magnitude captured at various positions in different compartment indicates a strong signal coupling occurs inside the cavity. This result is confirmed by the visualization of both the predicted EM fields and cavity Eigen-modes at the operating frequency of the HPA.

The modeling of a RF circuit enclosure for natural resonances is always a good practice and should be included in the development flow. The simulation and visualization of 3D EM fields distribution within a metallic enclosure is useful for preventing cavity resonance during the design stage and, hence, avoiding all the troubleshooting effort in the much later stage of prototyping work.

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Author Information

Yeap Yean Wei received First Class BEng (Hons) Degree in Communication & Electronics Engineering from Northumbria University (UK) in Jul. 2002 and M.Eng Degree in Electrical & Electronics Engineering from Nanyang Technological University (NTU), Singapore in Jun. 2007. From Dec. 2002 to Sep. 2004, he was a Project Officer in Satellite Engineering Centre of NTU, developing S-band and X-band microwave transceivers for the X-Sat. From Oct. 2004 until Aug. 2006, he was an Associate Consultant in the Network Technologies Group of Infocomm Development Authority of Singapore. He is currently a Senior R&D Engineer in Fujitsu Media Devices Singapore, involving in the research and development of RF front-end modules for mobile communication.

Frank Demming-Janssen Received his Diplom Ingenieur (FH) in Engineering Physics in Oct. 1995 from the University of Applied Science in Münster. From August 1994 to May 1995 he was studying as a Fulbright Scholar at the Institute of Optics at the University of Rochester, N.Y., USA. In Sep. 2001 he received his Ph.D. in Physics from the Technical University of Chemnitz/Germany. He joined Computer Simulation Technology (CST) in Jan. 2001 and is currently working as a Senior Sales and Application engineer supporting customers in South East Asia and Australia.

Linus Lau obtained First Class honors BEng in Mechatronics engineering, Master of research in Mechanical Engineering and PhD in Microwave Engineering from University of Manchester Institute of Science and Technology (UMIST) in between 1995-2003. He then returned to Malaysia, joining Intel Penang as a Senior Test module Development Engineer (2004-2005). He was working in the area of test module development for Intel Centrino Wi-Fi Transceiver chipset; conducting performance study of an RF test module using 3D EM simulation tool and setting up measurement verification studies on test-related challenges, i.e signal integrity, EMC, thermal and mechanical test. He is now attached to Computer Simulation Technology (CST) as the main technical consultant for South East Asia region. He is responsible for both business development and technical support for customers in this region and is currently based in Kuala Lumpur, Malaysia.

Development is Ramping up for ZigBee®, IEEE 802.15.4 and Related Systems

Ultra-low power, short-range wireless systems with modest data rates meet the requirements for many sensor and control networks. Such networks can replace wired networks, allow the placement of nodes where wiring is difficult, or simply make it possible to reconfigure networks quickly and easily.

The primary transmission standard for these systems is IEEE 802.15.4. A specialized applications superset of the 802.15.4 specification, ZigBee®, is a voluntary industry standard that is intended to assure interoprability among various manufacturers of system hardware. Where interoperability is not essential, such as a turnkey system from a single vendor, the basic 802.15.14 standard, or a customized variant, may be used.

Significant deployment of these types of systems is now underway, with many moderate-scale and demonstration systems in operation. Large scale systems are just beginning to come on line, both commercial and residential.

ZigBee Developments

The ZigBee Alliance (www.zigbee.org) is the industry organization for the promotion of that standard and coordination of compliance among users (similar to Wi-Fi).

The organization reports that a diverse ZigBee powered Home Area Network (HAN) is on display at CenterPoint Energy Houston Electric's Technology Center. The display features ZigBee-enabled electric and gas meters from Itron, ZigBee-enabled programmable controllable thermostats (PCT) from Computime, Control4, Hunter Fan Company, Golden Power Manufacturing/Radio Thermostat Company of America and Trane, along with an energy management web portal from Tendril Networks. The system demonstrates the capabilities of smart power management, and also shows how products from different manufacturers can all operate in a networked environment.

The ZigBee Alliance is also promoting the standard for multi-purpose home networking, not just power management. The home automation (HA) profile for ZigBee allows reliable and interoperable home automation applications to be developed by product manufacturers for consumers. The Alliance is making publicly available its ZigBee Cluster Library (ZCL), which provides engineers with the building blocks for applications with common needs, reducing development effort.

HA provides standard interfaces for the control of lighting, HVAC, power outlets, motorization, security, audio/video and other devices. It maximizes the technical strengths of ZigBee including the use of the globally available 2.4 GHz band, self-organizing and self-healing mesh networks, and operational co-existence with Wi-Fi, Bluetooth and other systems.

IEEE 802.15.4 Applications

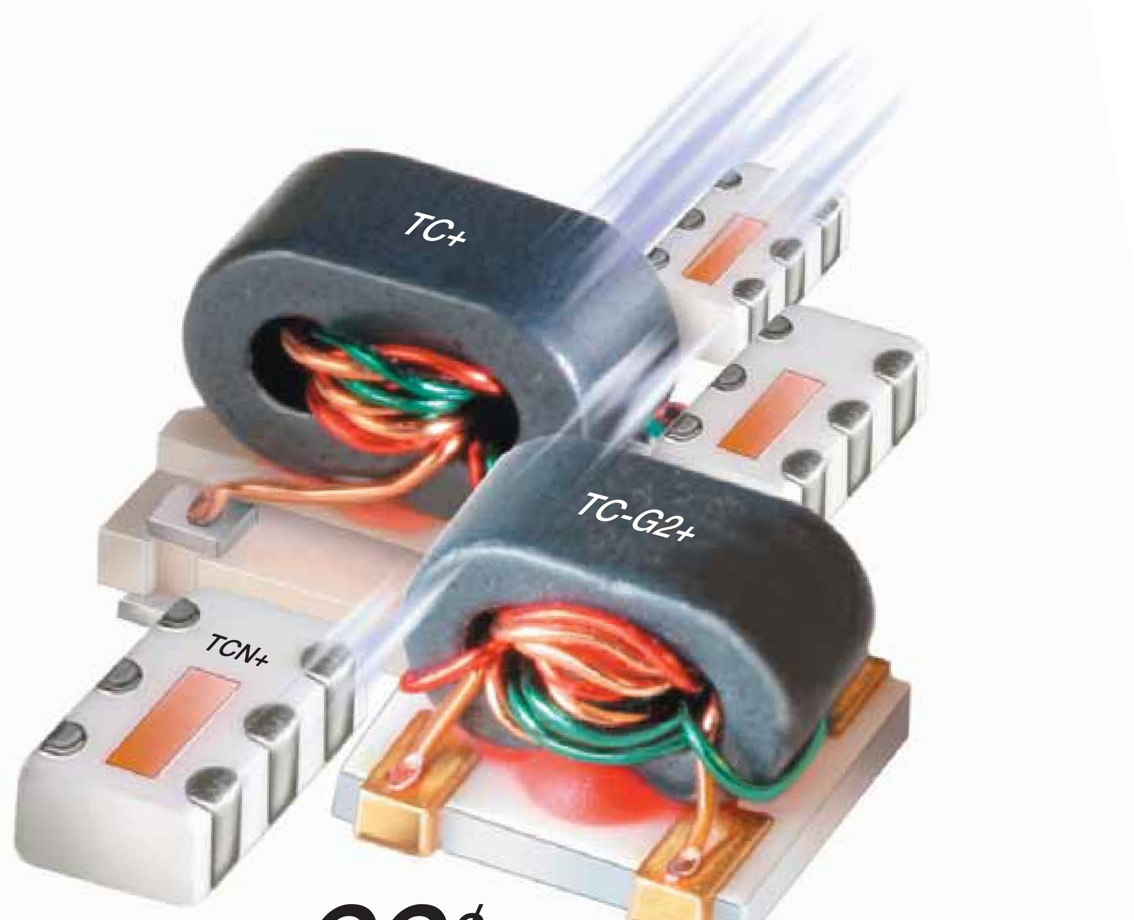
Many applications do not need the certified interoperability of a standard like ZigBee. A company may wish to develop a proprietary application for either performance or competitive reasons. The IEEE 802.15.4 standard offers a baseline that can be expanded for use with different messaging protocols. Turnkey systems for commercial HVAC and lighting are a key application type for proprietary networks, as are personnel access and security systems.

Component Availability

The manufacturers of ZigBee and other IEEE 802.15.4 systems have a wide range of products to choose from. Chip sets are offered by Atmel, Freescale, Texas Instruments, Chipcon and others.

OEM modules provide system designers with complete ZigBee/802.15.4 radios and digital interfaces. They are offered by California Eastern Laboratories, AeroComm, Radiocrafts, Cirronet, Digi International (Maxstream), and numerous other manufacturers.

Control and monitoring systems using this standard are actively being designed and deployed. These systems are expected to become commonplace in both commercial and residential settings. There are only a few concerns that full-scale wireless control systems will experience unforseen problems, since issues such as operation in the presence of potential interferers have been well-studied.



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Productivity by Design: ADS 2008 Reduces Steps to Simulation and Verification

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The latest update to this well-known EDA system includes usability enhancements that can greatly reduce the time and effort required to create and analyze new designs

In today's challenging environment for RF, high-speed communications product design, development cycles must shrink if profits are to grow. Circuit designs that meet the latest specifications must get to the marketplace ahead of the competition to ensure the success of the design group creating them, and margin for error is slight or non-existent.

Agilent EEsof EDA, the electronic design automation division of Agilent Technologies, has a more than two-decade history working with key customers to develop advanced RF-mixed signal simulation technologies for optimal performance and yield in RF-mixed signal and high speed products. The latest release of its Advanced Design System (ADS) is the first in a series of four releases in 2008 designed specifically to double productivity for common design tasks over previous ADS versions.

ADS 2008 adds easier access to the powerful simulators the software is known for, largely through enhancing the graphical user interface (GUI). With this new release, the underlying ADS 2008 user interface uses the same advanced GUI development platform for the latest internet applications, such as Google™ Earth, to enable quick implementation of capabilities for enhancing user productivity and development speed throughout the design flow.

This article discusses the considerations for using ADS 2008 to double designer productivity when performing common design and development tasks.

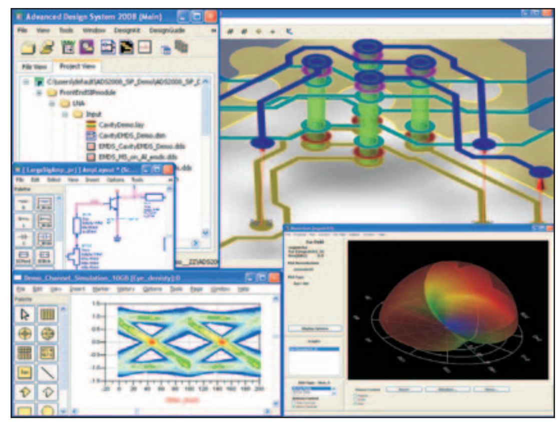


Figure 1 · Advanced Design System 2008 doubles productivity by adding easier access to powerful RF-mixed signal and 3D EM simulators.

Productivity improvements are measured in terms of reducing the following:

- Activities needed to accomplish a particular design task
- Number of mouse clicks
- Simulation time

A sample listing of these improvements is available through the following link: http://eesof.tm.agilent.com/products/ads2008_productivity.html.

Design Navigation

By far the most routine design tasks include navigation and steps to:

- Prepare schematics for simulation
- Lay out the design to prepare it for electromagnetic simulation and fabrication

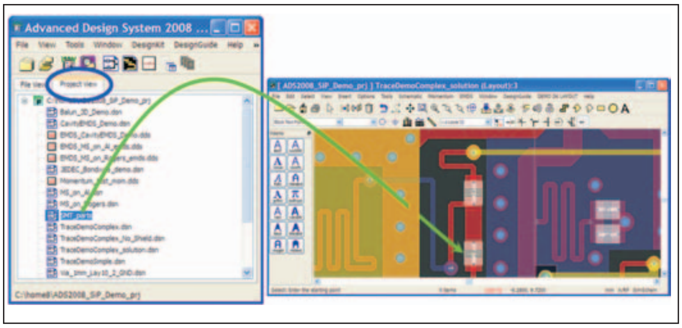


Figure 2 · Existing designs can be reused by single step drag-and-drop action without needing menu picks.

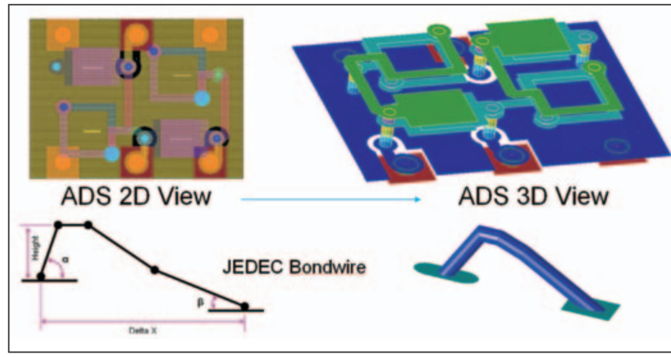


Figure 3a · 3D viewer allows easier visualization of multi-layer layout and bond wires than 2D views.

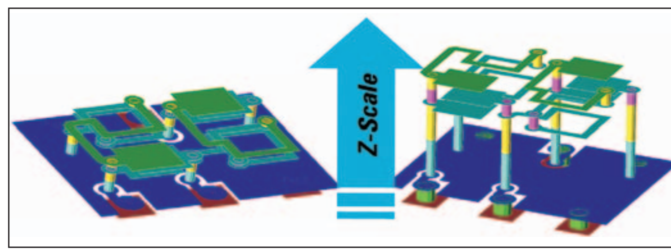


Figure 3b · Vertical stretching allows via connections to be inspected interactively.

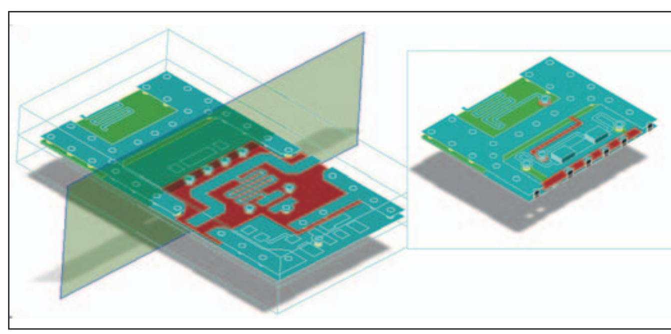


Figure 3c · Sliding 3D cut-planes through a complex multilayer design provide interactive cross sectional views to inspect proper interconnections.

Reducing the number, or simplifying navigation of menu picks and mouse clicks can save significant time, which is better spent in design creation and assessment.

For example, zooming in and out is now accomplished by scrolling the mouse wheel instead of taking the eye off the design to pick the zoom menu. Panning across the design also does not require the user to take the eye off the design to drag the horizontal or vertical window edge pan bars. It is done simply by holding down the right mouse button to pan in any direction instantly.

Project Management

Reusing designs from multiple exiting projects is a common task that involves:

- Copying and renaming new versions of the design to start work on
- Collecting and organizing the designs into intuitive folders and hierarchies
- Inserting and combining existing designs into the current one

ADS2008 now accomplishes these tasks through single-step copy and automatic renaming of hierarchical designs into intuitive, user-defined project view folders. Existing designs can be dragged and dropped into new ones, without the need for menu picks.

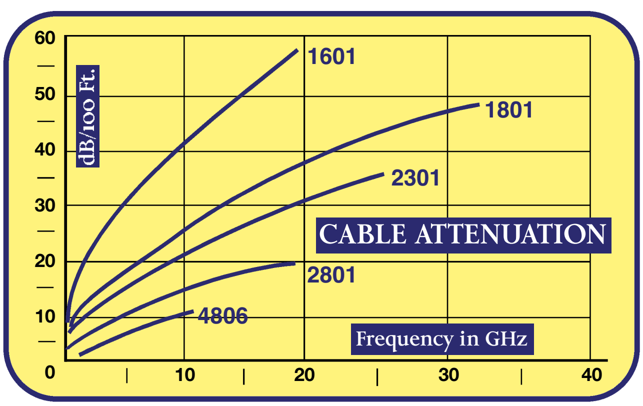
Multi-Layer High-Frequency Physical Design

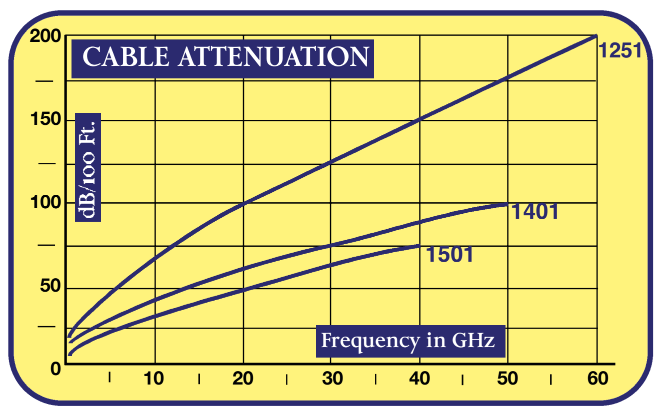
High frequency physical designs are increasingly multi-layer for RF modules, System-In-Package (SIP), RF boards and MMIC. Drawing these structures correctly for electromagnetic (EM) simulation or hardware fabrication is a significant part of the design and contains many subtasks, including:

- Drawing, alignment, and connection of vias, traces, interconnects and bond wires across multiple layers.
- Verifying layout against schematic design.
- Verifying layout against design rules.
- Verifying layout manufacturing output against original layout design.

ADS2008 now enables automatic via insertion during multi-layer trace routing with hot-key traversal through layers. This allows a complete multi-layer interconnect to be inserted in a smooth, continuous sequence without multiple distracting menu picks of layers, traces, and vias. JEDEC-compliant profile of bond wires can be directly drawn in layout to connect traces to packages for subsequent EM simulation.

All layers can be simultaneously viewed either through 2D-translucency or 3D interactive viewing to verify cor-





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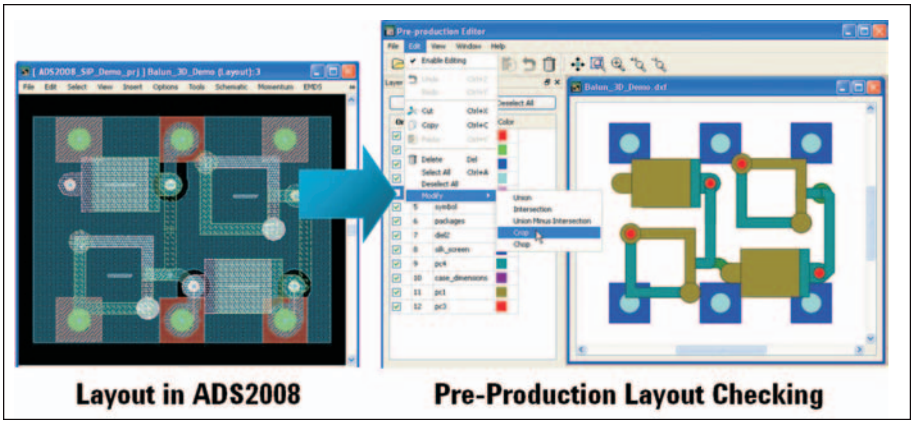


Figure 4 · Pre-Production editor verifies manufacturing layout file output against original layout design in ADS2008.

rectness. The 3D viewer also enables interactive vertical stretching and sliding cut planes to examine the proper interconnection of vias, traces, and bond wires within multilayer structures.

Design synchronization between layout and schematic provides interactive layout-versus-schematic (LVS) verification as the layout design progresses. The designer has full control over the layout process by switching between auto or manual design synchronization as needed for achieving speed with precision placement.

Design rule checking (DRC) reports all violations in a scrollable list with auto-zooming of the selected error on the layout to quickly guide the user to fix the error location.

The layout output file such as DXF or Gerber for manufacturing is verified for correctness against the original layout design via a pre-production editor, which also allows additional manufacturing required adjustments such as cropping or union of layer information.

Simulation Integration Productivity

EDA tools allow quick exploration of multiple design possibilities through simulation. However, multiple simulation technologies are needed to provide more complete answers to make the best design decisions. For example, full 3D and planar 3D EM simulation are needed to examine the impact of bond wires, packaging, finite dielectrics, and ground planes on circuit performance. Considerable time is saved when system, circuit, and EM simulators are integrated into the design environment to use the same set of design data input for separate simulations or combined co-simulation and co-optimization. This eliminates unproductive, error-prone manual design data translation and re-entry with standalone EM simulators.

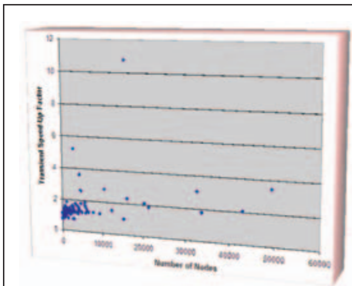
ADS 2008 integrates full 3D EM using finite element method (FEM) analysis with the convenience of re-using the same physical design data input from its layout environment and planar 3D Momentum EM simulator without manual design re-entry. This makes the full power of system-circuit-EM co-simulation or co-optimization available to the designer for thorough design exploration without leaving the design environment

Speeding Up Simulation

As designs become larger due to increased integration complexity, the capabilities of simulation algorithms to accommodate capacity with convergence and speed must keep pace. The quality of available simulation engines can vary significantly when compared with one another. Therefore, designers cannot assume that all harmonic balance simulators are equal simply because they share the same analysis technique.

Another current trend is the affordable availability of powerful 64-bit multi-core and multi-node parallel computing resources that simulators can take advantage of. Particularly, EM simulations that traditionally consume the most computing time and power can now benefit from parallel computing to return design exploration data fast enough for EM to become increasingly a design tool instead of a sign-off verification tool.

ADS 2008 has improved simulation speed, capacity and convergence in multiple areas to make faster computations available to the designer. In DC, AC, and transient simulation, the algorithm has been refined to increase simulation speed by an average of 6x for large designs containing over 10,000 nodes. In addition, 64-bit data structure enables much larger design simulation data to be collected, processed and viewed. Multiple convergence techniques are employed



Size (# nodes)	Average Speed-up	Median Speed-up	Maximum Speed-up
10k-100k	6 X	2.2 X	40 X
1k-10k	1.5X	1.3X	5X
< 1k	1.1X	1.1x	1.6x

Figure 5 · ADS 2008 improves DC, AC and Transient simulation speed for large designs by over 6x.

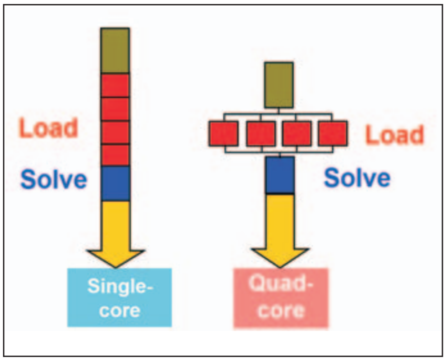


Figure 6 · By taking advantage of multi-core processors, 3D planar EM simulation is now sped up by 100% for larger problems by parallelizing the matrix load solution process across the processor cores.

in unison such as using transient simulation to find starting conditions for highly non-linear harmonic balance or circuit envelope simulations

Momentum, the planar 3D simulator in ADS 2008, now takes advantage of multi-core processors for parallel matrix-loading. This technique improves simulation speeds by more than 100 percent for large designs.

A new optimization technique, called simulated annealing, improves optimization convergence in problems where the optimized variables vary over a very wide range where multiple local minima exist to trap more traditional gradient, random or hybrid optimizers.

ADS 2008 also is HSPICE netlist compatible, meaning that external designs captured as an unencrypted HSPICE netlist can be simulated directly in ADS without time-consuming manual translation. This is especially useful for high-speed serial link signal integrity designers who get the models of their input and output buffers in HSPICE format from digital IC suppliers.

Instant Productivity Assistance

Designers often have little time to learn how to use the new capabilities of the latest EDA tools even though the benefits of significant productivity gains exist. Since this is a common trait among designers, the EDA tool provider is faced with opposing requirements—to make more powerful simulations available while also making them easier to access, learn, and use.

ADS 2008 has completely redesigned its Help rendering system to enable quick access through a single click from any Help page. The Help menu contains hyperlinks to:

- Instructional videos of common design tasks
- The Agilent EEsof EDA knowledge center
- Design examples
- Documentation

Designers who are accustomed to using previous versions of ADS can still continue to operate ADS 2008 in the same way while they learn the new productivity enhancing capabilities described in this article

Summary

Advanced Design System 2008 from Agilent EEsof EDA represents significant enhancements to deliver 100% productivity improvements over previous versions of ADS through improvements in user interface, simulation algorithms, and integration and support for parallel computing resources. Planned update releases this year will further deliver on productivity by design.

Author Information

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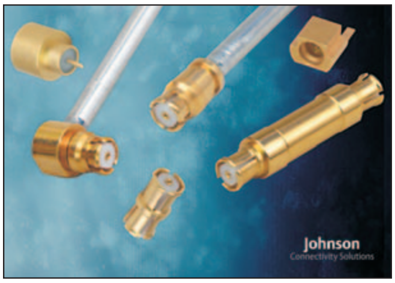
Agilent EEsof EDA
http://eesof.tm.agilent.com/products/ads2008_productivity.html
Find the link at www.HFeLink.com

Connectors



SMP Blind-Mate Connectors

Johnson®, a wholly-owned subsidiary of Emerson Network Power Connectivity Solutions, has introduced a new line of SMP Blind-Mate Connectors that can handle frequencies up to 40 GHz. This new precision connection interface is a micro-miniature, slide-on/snap-on interconnect system that's ideal for high-density packaging. The system provides unmatched flexibility since it can correct axial and radial misalignment and is compatible with all SMP and GPO® connectors. To achieve optimum performance, Johnson's new line of SMP Blind-Mate Connectors includes 26 different connectors, adapters and mounts and nine new assembly tools. The company is also providing detailed assembly instructions and makes use of industry standard tooling whenever possible for customer convenience and compatibility.

Johnson
Tel: 800-247-8256
Emerson Network Power
www.emersonnetworkpower.com

Snap-On Connectors

the Coaxicom SSMB and SCMS series of micro miniature snap-on connectors and slide-on have an upper frequency limit of 12.4 GHz consistent with the cable used. All the SSMB and SCMS series connectors are gold plated brass and meet applicable paragraphs of MIL-STD-202. The lineup of both of these series include straight and right angle cable plugs and jacks for appropriately sized flexible and semi-rigid cables including bulkhead mounted configurations. Because the sub miniature size of these connectors lend themselves to compact designs, Coaxicom also offers a broad selection of PCB mounted connectors including male and female straight-in, right angle, surface mount, edge mount and bulkhead configurations in both series.

Coaxicom
Tel: 1-866-COAXICOM
www.coaxicom.com

M12 Feed-Through Connectors

Binder-USA recently has made an addition to its M12, 713 series connectors with a newly-designed threaded feed-through connector. This new design allows for a secure, sealed connection through a panel allowing M12 connectors to be connected on either end. The M12 feed-through adapter is constructed with a rugged metal design including an M12×1 thread locking termination. The connector is available in 4, 5 and 8 gold plated contacts with A-coding. The diameter of the mounting hole is 20 mm with an anti-rotation flats. When properly mated the feed-through adapter maintains an environmental protection rating of IP67 at both the panel and mating area on each side of the adapter.

Binder-USA
Tel: 805-437-9925
www.binder-usa.com

Premier Technology Brochure

ITT Interconnect Solutions has produced a Premier Technology brochure detailing seven of its leading technologies. The brochure contains pull sheets, white papers and animation files for the company's Pogo-Pin, Break-Away, Chip-on-Flex,Stacking Interconnect, Quadrax and PHD Fiber Optic connector products and technologies. The brochure can be ordered online at http://www.ittcannon.com/LiteratureRequest.aspx.

ITT Interconnect Solutions
www.ittcannon.com

High Speed Assemblies

Samtec has expanded its high speed cable assembly offering with a new 75-ohm single-ended 38 AWG micro ribbon coax cable system (EQSD Series). This new assembly is available with vertical mount or edge mount sockets or terminals and mates with high speed Q Series® connectors on .8mm (.0315") pitch. Application specific designs can be developed for mating with Q Series connectors on other pitches. This new 75-ohm system broadens Samtec's existing line of 50-ohm single-ended and 100-ohm differential pair data rate cable assemblies to three off-the-shelf impedance matched systems. They mate to Q Series connectors on .5mm (.0197"), .635mm (.025"), and .8mm (.0315") pitches and Q2 Series connectors on .635mm (.025") pitch. Samtec's line of data rate cables includes 100-ohm twinax edge card and high density DataBank™ assemblies, PCI Express® jumpers, combination Signal/QuietPower™ assemblies, and a variety of specific application test probes. Pricing varies by cable length, number of pins, and termination options.

Samtec, Inc.
Tel: 1-800-SAMTEC-9
www.samtec.com

Find New Product links online at www.HFeLink.com

75-Ohm SMB Connectors

RF Connectors' 75-ohm SMB connectors are available in a wide range of configurations including plugs, right-angle plugs, and PCB jacks and are suitable for use in applications with a frequency range up to 4 GHz. The 75-ohm SMB connector series provides consistent low mating and un-mating force in positive lock mating as well as snap-on mating faces. Constructed in accordance with the requirements of MIL-PRF-39012, their interface is in compliance with MIL-STD-348. This series has broadband performance with low reflection and is ideally suited for circuit miniaturization and mate with any standard 75-Ohm snap-on jack or plug.

RF Connectors
www.rfindustries.com

QSL RF Connector Series

Tyco Electronics Corporation introduces the QSL (Quick Stripline) RF connector series. This new connector interface is designed to support the increasing demands for WiFi (802.11) and WiMax (802.16) enabled products and applications. The coaxial cable displacement interface is a cost effective alternative to standard screw machine connectors for most cable-to-cable and cable-to-PC board applications. The developing family of connectors includes both single and multi-port versions, with a wide range of configuration options including PCB and cable mount receptacles, cable plugs terminated to RG 174 and RG 316 cable types, and cable assemblies terminated in IP 67 weatherproof housings. The QSL interface exhibits excellent performance through 6 GHz, has a temperature range of –40 to +85°C, and durability of 250 cycles for single port and 500 cycles minimum for 3 port QSL connectors. The QSL is suitable for 50-ohm applications, such as PCI/PCI Express cards and antennas for desktop PCs, mobile antennas, and satellite radio. Features such as polarization and keying, jackscrews, and squeeze-to-release versions, are readily accommodated. Designs are RoHS compliant.

Tyco Electronics
Tel: 800-522-6752
www.tycoelectronics.com

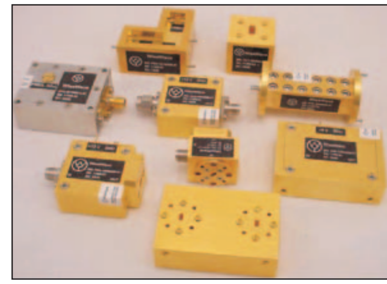
Electromagnetic EDA Tools

Foundry Model Libraries

Semiconductor Manufacturing International Corporation has announced that it will be using Ansoft Corporation's HFSS™ simulation technology for *S*-parameter extraction, frequency-dependent SPICE model extraction and EMI prediction. SMIC will use HFSS to provide a unique library of complex, high-speed and high-frequency passive structures for accurate, next-generation designs traceable to the foundry. In addition, SMIC is investigating new design flows that link process-accurate models of critical, multi-port structures with advanced circuit and system simulation. SMIC's adoption of HFSS extends its RF CMOS design capabilities with traceable on-chip model libraries.

Semiconductor Manufacturing International Corporation
www.smics.com
Ansoft Corporation
www.ansoft.com

mm-Wave Components



E-Band Component Family

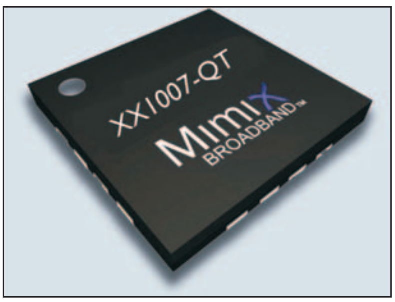
WiseWave's newly developed E Band (WR-12 waveguide band) component family enables the rapid development of short-haul communication links operating license-free from 71 to 86 GHz. The component family includes oscillators, multipliers, low noise and power amplifiers, sub-harmonically pumped mixers and up-converters, filters and diplexers. All products are available as separate components or combined as integrated assemblies.

Ducommun Technologies, Inc.
Tel: 310-513-7200
www.dt-usa.com

High-Power Amplifiers

MITEQ introduces a new addition to its family of broadband high-power amplifiers. AMF-4B-26003100-100-36P is a connectorized high-power amplifier/module, covering 26-31 GHz and delivering approximately 5W of power. The Female K-type connectorized aluminum housing is 10 × 25 × 34 mm. It is intended for bolting to a flat cooling surface or fins. Housing is environmentally sealed and EMI shielded. Hermetic sealing option is also available. Nominal small-signal gain is near 18 dB. Current draw is nominally 7A at P_{1dB} from 6-6.5 VDC of supply and –1.25 VDC.

MITEQ, Inc.
www.miteq.com



Self-Biased Doubler

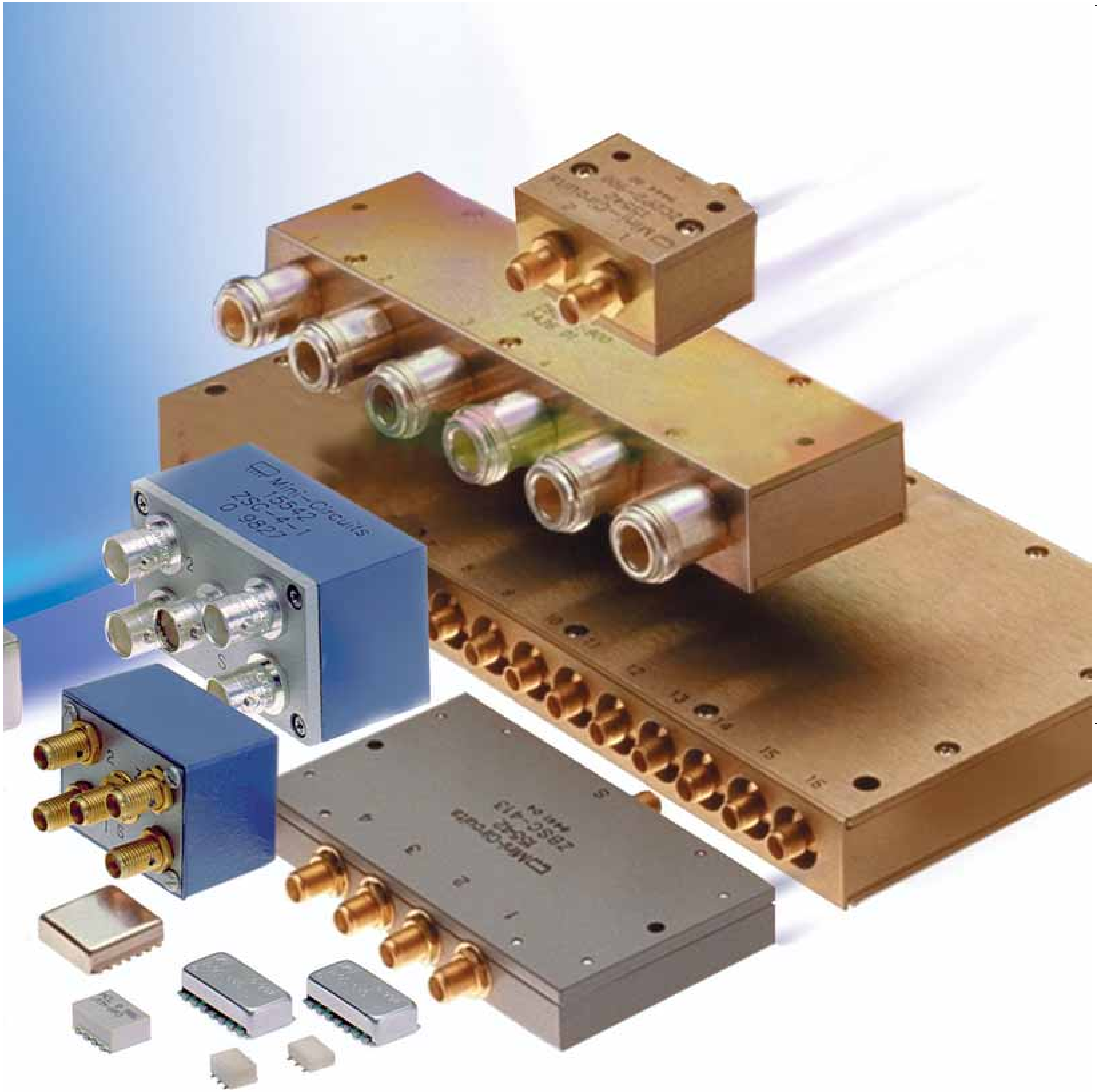
Mimix Broadband, Inc. introduces an active doubler in an RoHS compliant 3 × 3 mm plastic QFN package that delivers +20 dBm output saturated power (P_{out}) and 35 dBc fundamental suppression. Using 0.15 micron gate length GaAs pHEMT device model technology, the doubler covers the 13.5-17.0 / 27.0-34.0 GHz frequency bands and integrates a gain stage, passive doubler and driver amplifier onto a single device. Identified as XX1007-QT, this device is well suited for VSAT, millimeter-wave Point-to-Point Radio, LMDS or SATCOM applications. The XX1007-QT includes on-chip ESD protection and an integrated bypassing capacitor, eliminating the need for any external components. The device has a self-bias configuration, requiring only a positive 5V supply. Mimix performs 100% RF testing on the XX1007-QT. Production quantities are available today from stock.

Mimix Broadband, Inc.
www.mimixbroadband.com

Ultra-Fast Transistor Reaches Terahertz Frequencies

Northrop Grumman Corporation has set a new world record for transistor speed with an ultra-fast device that will provide much higher frequency and bandwidth capabilities for future military communications, radar and intelligence applications. The company has produced and demonstrated an indium phosphide-based High Electron Mobility Transistor (InP HEMT) with a maximum frequency of operation of more than 1,000 Gigahertz, or greater than one Terahertz. The Terahertz transistor is the latest generation in a long line of compound semiconductor products that Northrop Grumman has produced by the millions for government and commercial uses, Streit noted. Tests conducted by NASA's Jet Propulsion Laboratory in Pasadena, Calif., validated the ultra-fast transistor by measuring a three-stage millimeter wave integrated circuit amplifier at 340 Gigahertz with greater than 15 dB gain.

Northrop Grumman Corporation
www.northropgrumman.com



Power Combiners, Impedance Transformers and Directional Couplers: Part II

By Andrei Grebennikov

This series of articles continues with an in-depth discussion of the classic Wilkinson divider, presenting typical methods of implementation, plus alternative methods that address specific problems

Wilkinson Power Dividers/Combiners

The in-phase power combiners and dividers are important components of the RF and microwave transmitters when it is necessary to deliver a high level of the output power to antenna, especially in phased-array systems. In this case, it is also required to provide a high degree of isolation between output ports over some frequency range for identical in-phase signals with equal amplitudes. Figure 19(a) shows a planar structure of the basic parallel beam N-way divider/combiner, which provides a combination of powers from the N signal sources. Here, the input impedance of the N transmission lines (connected in parallel) with the characteristic impedance of Z_0 each is equal to Z_0/N. Consequently, an additional quarterwave transmission line with the characteristic impedance

$$Z_0/\sqrt{N}$$

is required to convert the input impedance Z_0/N to standard impedance Z_0.

However, this N-way combiner cannot provide sufficient isolation between input ports. The impedances are matched only when all input signals have the same amplitudes and phases at any combiner input. The effect of any input on the remaining ones becomes smaller for combiners with greater number of inputs. For example, if the input signal is delivered into the input port 2, and all other (N–1) input ports plus output port 1 are matched, then the power dissipated at any load connected to the matched input ports will be decreased by $(1 - 1/N^2)/(2N - 1)$ times, and isolation between any two input ports expressed by S-parameters is obtained by

$$S_{ij} = -10\log_{10}\left(\frac{1}{N^2}\frac{N^2-1}{2N-1}\right) \quad (12)$$

where N is a number of the input ports and i, $j = 2, \ldots, N + 1$.

In most cases, better isolation is required than obtained by Eq. (12). The simplest way to

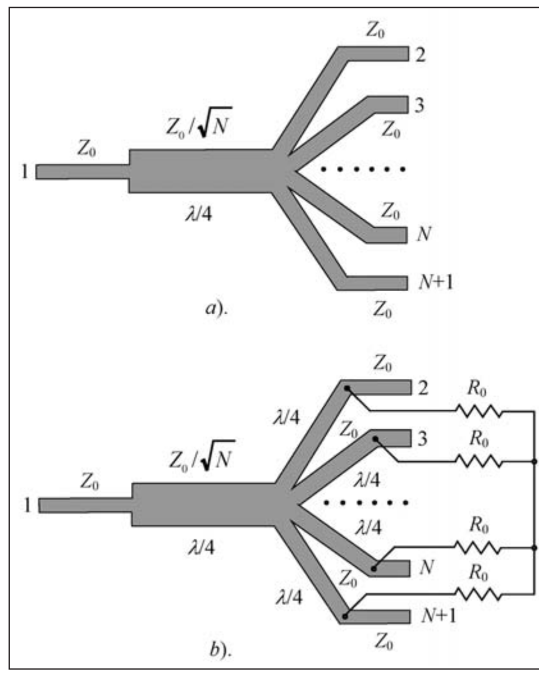


Figure 19 · Circuit topologies of N-way in-phase combiners/dividers.

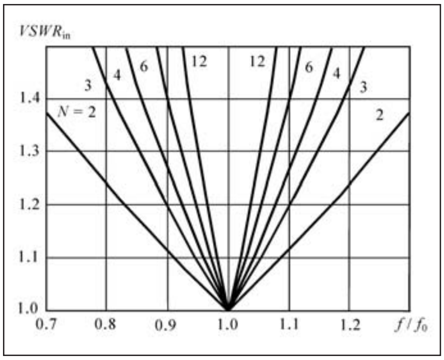


Figure 20 · Frequency performance of *N*-way Wilkinson combiner/divider (39).

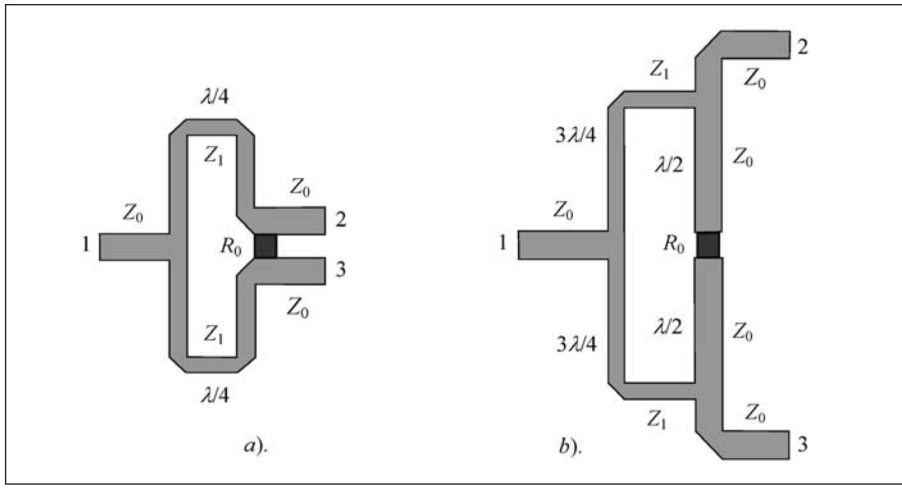


Figure 21 · Microstrip realization of two-way Wilkinson combiner/dividers.

provide full isolation between the input and output ports of the combiner is to connect the ferrite isolators (circulators) at the input ports 2, …, $N + 1$. In this case, the lengths of the transmission lines connected between each ferrite isolator and a quarterwave transmission line should be equal. Although the ferrite isolators increase the overall weight and dimensions of the combiner and contribute to additional insertion losses, nevertheless they provide a very simple combiner realization and protect the connected power amplifiers from the load variations. By using such a 12-way parallel beam combiner, the continuous output power of 1 kW for the *L*-band transmitter was obtained at the operating frequency of 1.25 GHz [34].

When one or more power amplifiers cease operating for any reason, the overall output power P_{out} and efficiency η_c of the combiner can be calculated, respectively, by

$$P_{out} = \frac{(N-M)^2}{N} P_1 \tag{13}$$

$$\eta_c = \frac{P_{out}}{P_{in}} = 1 - \frac{M}{N} \tag{14}$$

where $P_{in} = (N - M)P_1$, P_1 is the output power from a single power amplifier, N is the number of the input ports, and M is the number of the non-functioning power amplifiers. Part of the output power of the remaining power amplifiers will be dissipated within the ferrite isolators (in the ballast resistors of circulators). For each ferrite isolator connected to the operating power amplifier, the dissipated power P_{do} can be defined as

$$P_{do} = \left(\frac{M}{N}\right)^2 P_1 \tag{15}$$

whereas, for each isolator connected to the destroyed power amplifier, the dissipated power P_{dd} can be calculated from

$$P_{dd} = \left(\frac{N-M}{N}\right)^2 P_1 \tag{16}$$

In this case, by adding the ballast resistors $R_0 = Z_0$, the right-hand side terminals of which are combined together in a common junction as shown in Fig. 19(b), matching of all ports, low loss and high isolation between input and output ports can be provided. Such kind of a simple *N*-way hybrid power divider is known as a Wilkinson power divider [35]. However, it should be mentioned that, historically, this divider/combiner was reported a little bit earlier [36-38]. Originally, a Wilkinson power divider was composed of a coaxial line in which the hollow inner conductor has been split into *N* splines of length λ/4, with shorting plate connecting the splines at the input end and resistors connected in a radial manner between each spline at the output end and a common junction. The frequency response of the voltage standing wave ratio at the divider input port, $VSWR_{in}$, depending on the number of the output ports N, is shown in Fig. 20 [39].

The hybrid planar microstrip realization of the simplest two-way Wilkinson divider is shown in Fig. 21(a). It consists of the two quarterwave microstrip lines connected in parallel at the input end and the planar ballast resistor connected between the output ports of the microstrip lines. Despite its small dimensions and simple construction, such a divider provides a sufficient isolation between output ports over sufficiently wide frequency bandwidth when equal power division is provided due to a symmetrical configuration with

$$R_0 = 2Z_0$$

and

$$Z_1 = Z_0\sqrt{2}$$

However, in practice, it is neces-


contact

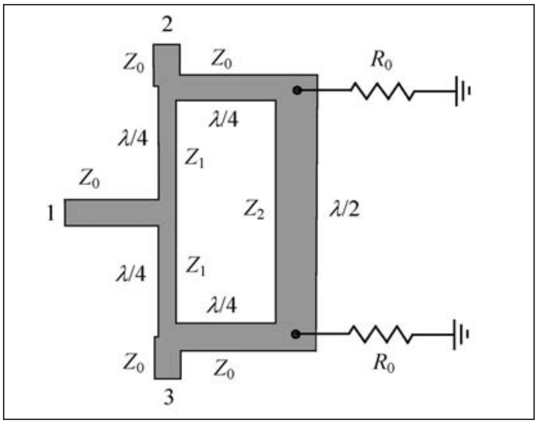


Figure 22 · Gysel high-power in-phase planar combiner/divider.

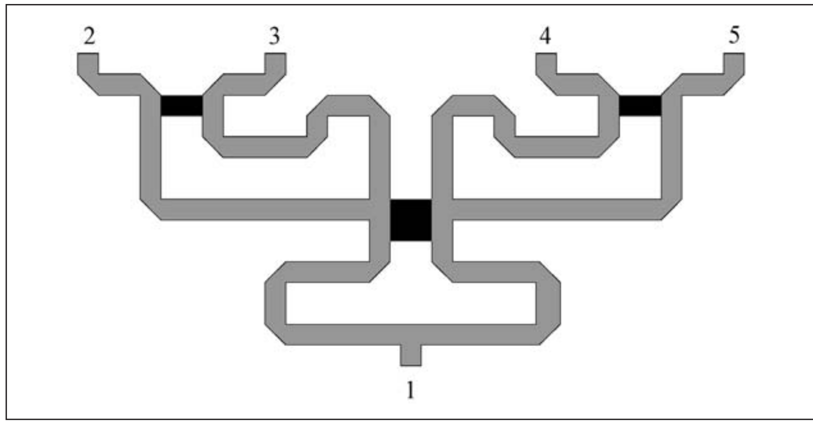


Figure 23 · A practical four-way microstrip Wilkinson power combiner/divider.

sary to take into account the distributed *RC* structure of the ballast resistor when its size is sufficiently large, as well as manufacturing tolerances and discontinuities. As a result, in a frequency bandwidth of 30% with $VSWR_{in} \leq 1.2$ at input port 1 and $VSWR_{out} \leq 1.03$ at output ports 2 and 3, the isolation between the divider outputs can be better than 20 dB [40].

In millimeter-wave integrated circuits, in order to increase a self-resonant frequency of the ballast chip resistor, the overall MMIC dimensions must be very small. This means that the two branches of the power divider are very close to each other, which leads to strong mutual coupling between the output microstrip lines and, as a result, upsets the desired power-split ratio. A possible solution is to use the branches with the electrical lengths of 3λ/4 instead of λ//4 and to include the two additional branches into a semi-circle, as shown in Fig. 21(b) [41]. These additional branches should be of the half-wave electrical lengths with the characteristic impedances equal to Z_0. In this case, isolation can be better than 17 dB between all ports with the insertion loss of about 1.3 dB at the operating frequency of 30.4 GHz.

However, the ballast resistors of the conventional *N*-way Wilkinson combiners/dividers cannot be designed to be a planar structure when it is necessary to minimize their physical lengths and connecting wires, which is required to provide sufficient isolation among output ports over the desired frequency range. For example, the radial and fork *N*-way hybrids have reasonably wide frequency bandwidth, of about 20% and higher, but their match and isolation are not perfect even at the center bandwidth frequency [42]. Besides, due to the small size of the ballast resistor compared to the wavelength and its balanced structure, it is difficult to heat-sink it in the case of high power combining. In order to provide higher output power capability, it is possible to modify the *N*-way Wilkinson combiner/divider by replacing the ballast resistor "star" with a combination of quarterwave transmission lines and shunt-connected resistors [43]. In this case, each ballast resistor is connected to a corresponding output port through a transmission line. At the same time, all ballast resistors are connected to a common floating starpoint by the transmission lines. Such a modification has an advantage of external isolation loads (high-power ballast resistors) and easy monitoring capability for imbalances at the output ports. For a two-way planar power combiner/divider, the circuit topology of which is shown in Fig. 22, the balanced 100Ω ballast resistor is replaced by a transmission-line network and two 50Ω resistors are connected to ground acting as the out-of-phase load [44], where

$$Z_1 = Z_0\sqrt{2}$$

$$Z_2 = Z_0\sqrt{2}$$

and

$$Z_0 = R_0 = 50\Omega$$

The cascade connection of two-way Wilkinson power combiners/dividers can provide a multi-way power division or power combining. The simplest practical realization is the binary power divider/combiner, composed of the *n* stages when each consecutive stage of which contains an increasing by 2^N number of two-way dividers/combiners. For a single destroyed power amplifier, the power dissipated in the ballast resistors is equal to

$$P_{db} = \left(1 - \frac{1}{N}\right)^2 P_1 \qquad (17)$$

The output power of $P_1/2$ is dissipated in the ballast resistor adjacent to the destroyed power amplifier; the output power of $P_1/4$ is dissipated in the ballast resistor of the next stage, and so on. It should be mentioned

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that the power divider with a number of outputs multiple to 4^N represents the convenient case when the characteristic impedance of the transmission line are of the same impedance. Figure 23 shows the four-way microstrip Wilkinson divider/combiner fabricated on alumina substrate with six 50Ω quarterwave microstrip lines and two 100Ω and one 50Ω thin-film resistors. This microstrip Wilkinson power divider/combiner can provide the insertion loss of less than 0.3 dB and isolation between any outputs of about 20 dB in a frequency bandwidth of ±10% in decimeter frequency band.

The frequency bandwidth property of a Wilkinson power divider/combiner can be improved with an increasing number of its sections [40]. Generally, a broadband two-way Wilkinson power divider can contain N pairs of equal-length transmission lines and N bridging resistors distributed from input port 1 to output ports 2 and 3. For example, for $N = 2$, the theoretical minimum isolation in an octave band between ports 2 and 3 can achieve 27.3 dB with VSWR at each port better than 1.1. In monolithic microwave integrated circuits, by using a two-metal layer GaAs HBT process when the bottom metal layer can realize a coplanar waveguide (CPW) transmission line and the top metal layer can realize a microstrip transmission line, the size of a two-section two-way power divider/combiner can be reduced. In this case, an isolation of 15 dB and a return loss of 15 dB can be achieved in a frequency bandwidth from 15 to 45 GHz [45].

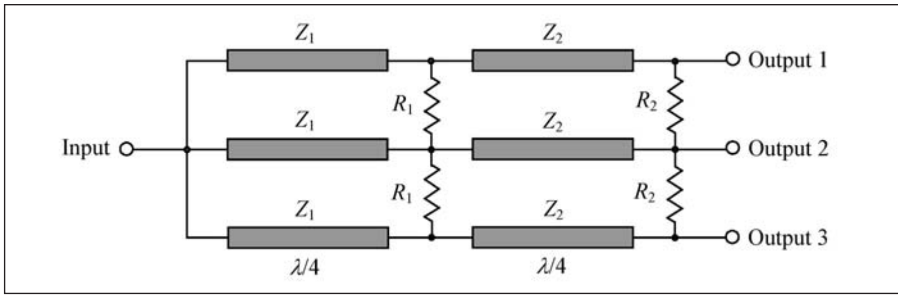


Figure 24 · Microstrip three-way divider with improved isolation.

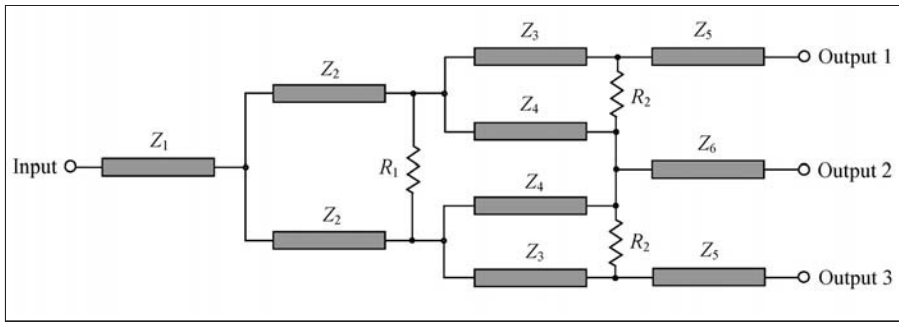


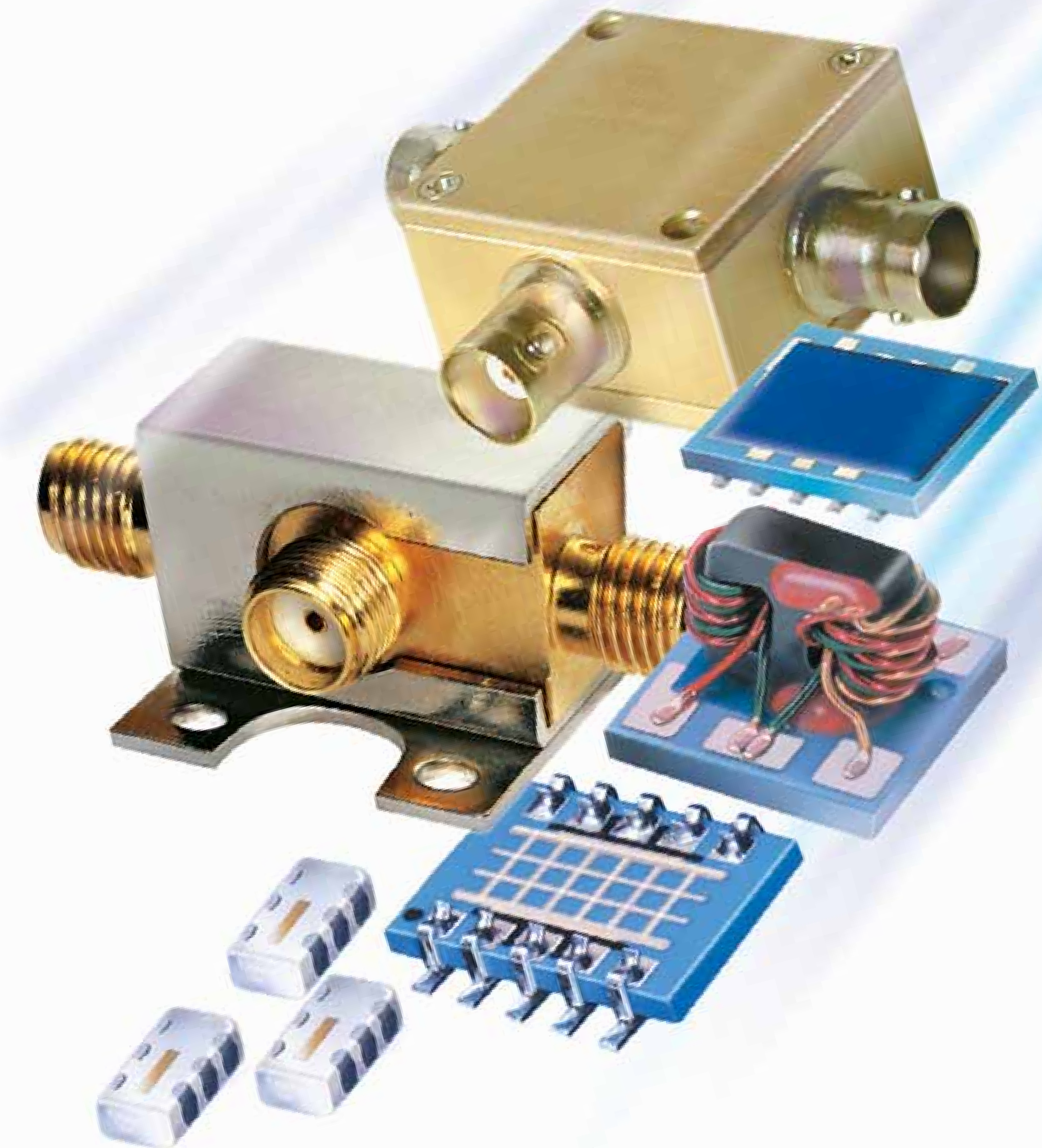
Figure 25 · Microstrip three-way recombinant divider topology with improved isolation.

Figure 24 shows the equivalent circuit representation of a three-way modified Wilkinson power divider/combiner [46]. Assuming all the impedances of the input and three output ports be 50Ω, the characteristic impedances of the quarterwave transmission lines are selected for a maximally flat performance as Z_1 = 114Ω and Z_2 = 65.8Ω. To match circuit at the center frequency, the values of the ballast planar resistors should be chosen as R_1 = 64.95Ω and R_2 = 200Ω. In this case, the isolation between output ports of such a three-way divider demonstrates more than 20 dB in an octave frequency bandwidth.

Generally, high characteristic impedance values (usually higher than 100Ω) for the transmission lines can create a problem in their practical microstrip implementation, since their narrow widths increase the insertion loss. In this case, using a recombinant power divider, which topology is shown in Figure 25, provides an isolation of 20 dB in a frequency range of 72% for a maximum line impedance of 80Ω and requires only three isolation resistors [47]. This three-way recombinant divider is characterized by the insertion loss of about 1 dB and return loss of more than 12 dB in a frequency range of 6 to 14 GHz, fabricated in 25-mil thick 99.6% alumina substrate. The design values for the quarterwave transmission lines were Z_1 = 36Ω, Z_2 = Z_3 = 40Ω, Z_4 = 80Ω, and Z_5 = Z_6 = 40Ω with the ballast resistors R_1 = 50Ω and R_2 = 100Ω, respectively. Over a 2:1 bandwidth, the center-to-side and side-to-side isolations exceed 20 dB.

The divider broadband properties can also be improved by using the more complicated phase-shifting circuit instead of a simple microstrip line. The phase shift between two output ports 2 and 3 will be close to 90° in an octave frequency range if a Schiffman element based on the coupled microstrip lines is connected to one output port [48]. At the same time, an additional microstrip line with the electrical length of 270° at the center bandwidth frequency should be connected to the second output port.

In the design of a microwave distributed network, a power divider providing two equal-phase outputs with unequal power division is often required. The split-tee power divider is a simple compact and broadband device. It provides two isolated equal-



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phase unequal-amplitude outputs with a good match at each port. Since a split-tee power divider is similar to the N-way equiphase equiamplitude power divider, it can be developed from this N-way divider as follows: connect M of the output ports together to form one port and the remaining $(N - M)$ output ports together to form the other port, connect quarterwave transformers to the resulting output ports to adjust their impedance level, and a power divider with two equiphase outputs and power ratio of $N/(N - M)$ is derived.

The basic schematic of a power divider with unequal output load impedances is shown in Figure 26(a) [49]. This power divider is designed so that, when fed from input port 1, the perfect match will be achieved at the center bandwidth frequency when the output power at port 3 is K^2 times the output power at port 2, and the voltage between port 2 and ground is equal to the voltage between port 3 and ground when measured at equal distances from port 1. To satisfy these conditions, the characteristic impedances Z_1 and Z_2 for unequal loads $R_2 = KZ_0$ and $R_3 = Z_0/K$ are calculated from

$$Z_1 = KZ_0\sqrt{K + \frac{1}{L}} \tag{18}$$

$$Z_2 = \frac{Z_0}{K}\sqrt{K + \frac{1}{K}} \tag{19}$$

where both transmission lines are of a quarter wavelength at the center bandwidth frequency. Since the voltages at port 2 and port 3 are equal with this design, a resistor may be placed between these two ports without causing any power dissipation. However, isolation between output ports and a good match seen looking in at any ports is obtainable because of this resistor. Finally, to transform the two unequal output impedances to output impedance Z_0 equal for each output port, the characteristic impedances of additional quarter-wave transformers Z_3 and Z_4 and ballast resistor R_0 shown in Figure 26(b) are determined from

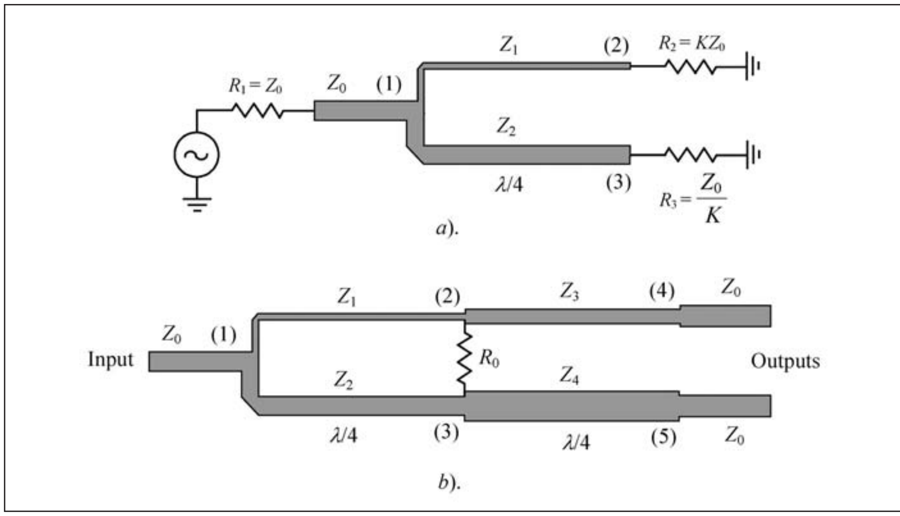

Figure 26 · Split-tee power divider.

$$Z_3 = Z_0\sqrt{K} \tag{20}$$

$$Z_4 = \frac{Z_0}{\sqrt{K}} \tag{21}$$

$$R_0 = Z_0\left(K + \frac{1}{K}\right) \tag{22}$$

The three-way power divider with various output power ratios, which represents a planar structure and can be easily realized using microstrip lines with reasonable characteristic impedances, is shown in Figure 27 [50]. When port 1 is an input port, the input power is divided by a ratio of M:N:K at corresponding output ports 2, 4, 6 with isolated ports 3 and 5. The electrical lengths of the transmission lines must be 90° except for the half-wave middle horizontal line. The characteristic impedances of the transmission lines can be calculated from

$$Z_1 = Z_0\sqrt{\frac{\Delta_1}{\Delta_2}} \tag{23}$$

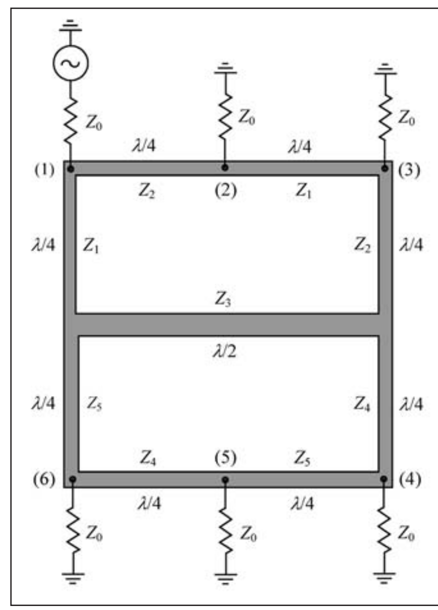

Figure 27 · New type of three-way power divider.

$$Z_2 = Z_0\sqrt{\frac{\Delta_1}{M}} \tag{24}$$

$$Z_3 = Z_0 \tag{25}$$

$$Z_4 = Z_0\sqrt{\frac{\Delta_2}{N}} \tag{26}$$

$$Z_5 = Z_0\sqrt{\frac{\Delta_2}{K}} \tag{27}$$

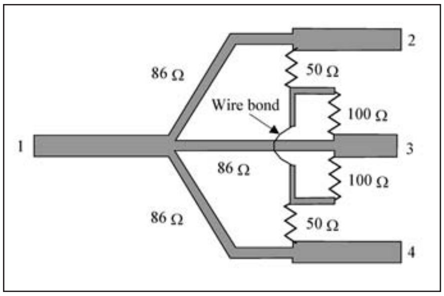

Figure 28 · Compact microstrip three-way Wilkinson power divider.

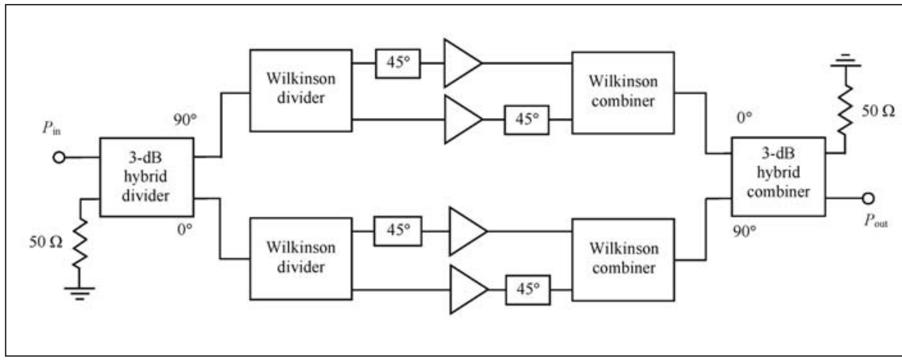

Figure 29 · Balanced power amplifier topology with two-way Wilkinson dividers/combiners.

where $\Delta_1 = M + N + K$ and $\Delta_2 = N + K$. For example, for a three-way divider with $M = 3$, $N = 2$ and $K = 1$, it follows that $Z_1 = Z_2 = 1.41Z_0$, $Z_4 = 1.22Z_0$ and $Z_5 = 1.73Z_0$. The same characteristic impedances are required for a 1:1:1 equal-power three-way divider, only the input port must be changed to port 4 in this case.

Figure 28 shows the compact microstrip three-way Wilkinson power divider designed to operate over a frequency range of 1.7 to 2.1 GHz, with minimum combining efficiency of 93.8 %, maximum amplitude imbalance of 0.35 dB, and isolation better than 15 dB [51]. To avoid any amplitude and phase imbalances between the divider 50Ω output ports, the ballast resistor connected to its middle branch should be split into two equal parallel resistors. To obtain an ideal floating node, these two resistors are connected together with narrow microstrip lines that are as short as possible. Finally, to connect the resistors from both sides of the middle branch, a copper wire of 7-mil diameter is used. The most critical parameter is the isolation between port 2 and port 4, which can be improved by shortening the bond-wire length.

Combination of the Wilkinson combiners/dividers and 45-degree phase shifters can improve the overall power amplifier characteristics which becomes more insensitive to variations of the load *VSWR*, unlike for conventional single-ended power amplifier configuration. The basic idea is to spread the different impedances seen by the device outputs when phase delay of the reflected signals varies between 0 and 180° with a step of 45°, thus creating different impedances along the corresponding load *VSWR* circle on the Smith chart. This means that only one of four devices can see the highest impedance which is mainly responsible for worsening of linear transfer response, because this device tends to operate in a voltage saturation mode. Figure 29 shows the block configuration of such a balanced power amplifier, combining two amplifier units in pairs by Wilkinson dividers/combiners and 45-degree delay lines and using 3-dB quadrature hybrids as the input and output divider and combiner, respectively. As a result, for a 3.5 V 29 dBm GaAs MESFET power amplifier designed to operate in a 900-MHz digital cellular phone system, the adjacent channel power ratio, *ACPR*, below –45 dBc with over 45-percent efficiency can be obtained for load $VSWR \leq 3$ [52].

This article will be continued in the next issue.

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Top-Down Design: An Introduction for New Engineers

By Gary Breed
Editorial Director

Engineers no longer begin their careers by working on individual pieces of the system; they now may be involved in developing the system architecture and performance specifications

About 20 years ago, I heard a young engineer lament, "I don't want to be stuck in a cubicle for the next five years designing one thing!" At that time, the most common engineering career path was, quite literally, starting at the bottom—the bottom of the flow chart of product development.

Things have changed, especially in the past five to ten years. Changes in types of products and company staffing are certainly a big part of the change. In addition, the nature of design has changed as well, with chipsets that replace discrete designs and modules that perform several functions that were previously designed from scratch.

As a result, new engineers may find themselves being asked, or expected, to make major contributions at the earliest and highest levels of design. Instead of a career that clearly works from the bottom up, today's engineers must know how to be involved in design and development from the top down (Figure 1).

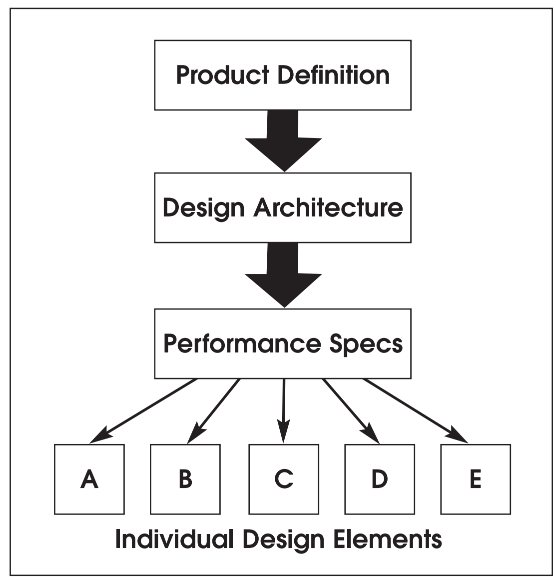

Figure 1 · A simplified product design flow. Past generations of engineers always started at the bottom and worked their way upward in the development process as they gained experience. But now, new engineers increasingly find themselves expected to contribute from the top-down.

This tutorial is intended to be an orientation to the typical way products are developed in many original equipment manufacturing (OEM) companies. Specifics of the process will vary among companies, but, in general, the flow from top to bottom will be similar to what is presented here.

The Process of Top-Down Design

Although the development of a new product may be a familiar working environment for a senior engineer or manager, new hires may not have a clear vision of the overall process. College courses establish fundamental technical concepts, and laboratory projects tend to represent the kind of individual pieces that previous generations of engineers began their careers working on. At best, an advanced project or a work internship will provide some insight into the "big picture."

Actually, a picture is the best way to show the process. Figure 2 presents a detailed version of the design work flow, noting the nature of each step, plus the feedback mechanisms that are part of that process.

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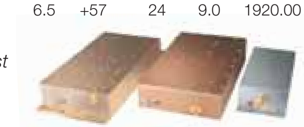

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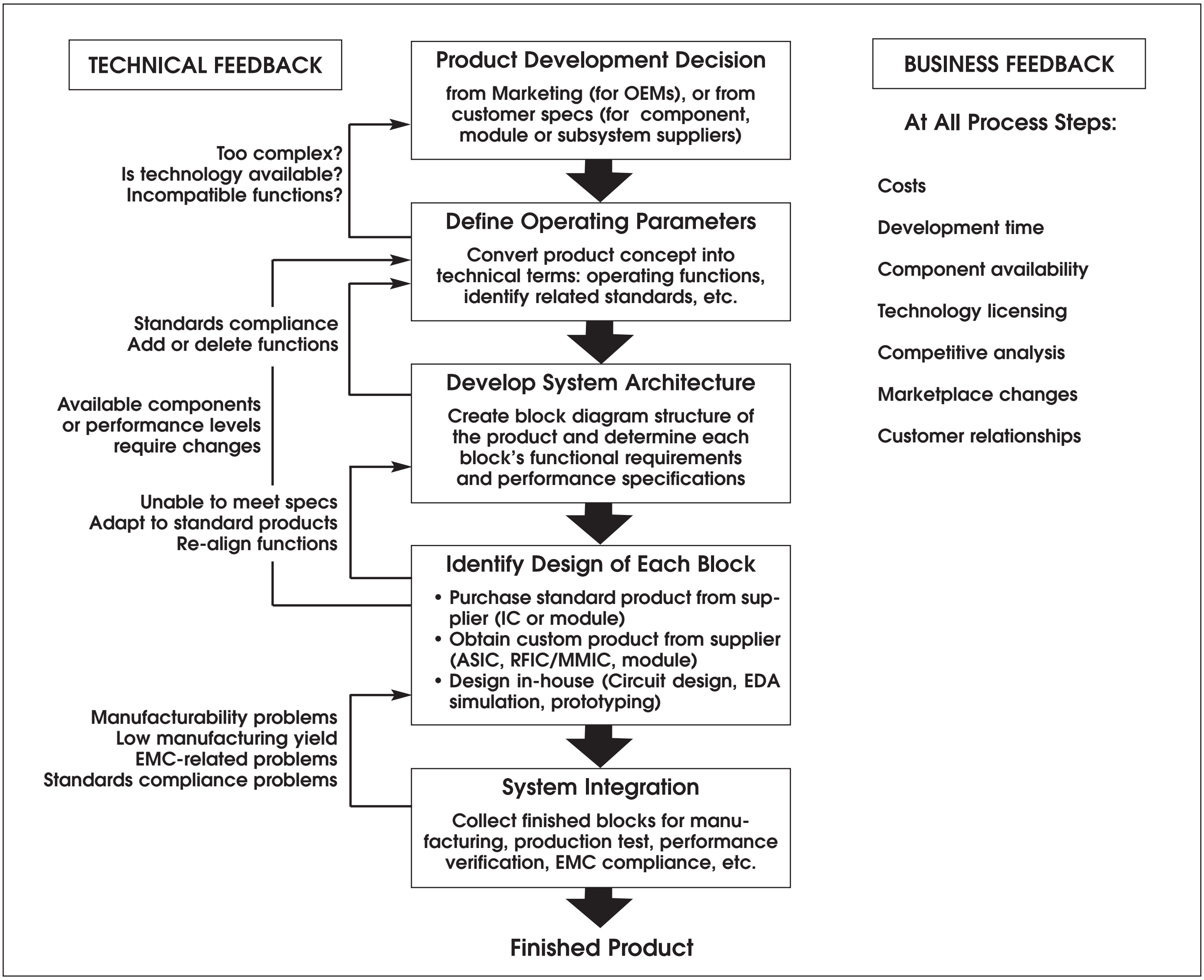

Figure 2 · Detailed product design flow, listing the typical design tasks for each step. "Feedback loops" formaking corrections to the process can be either technical or business related.

Some of the most significant issues that arise during the development process are business related, as noted in the feedback list on the right side. The often-quoted issues of cost and time-to-market can have a big effect in a consumer or commercial product. These may be less of a factor in some high-end applications where performance is paramount.

Some of the technical issues will not be accessible to a new engineer until a certain level of experience is acquired. These include design-for-manufacturability, design-for-test, and EMC compliance.

Working with vendors is also part of the process that is typically undertaken by more experienced engineers. However, this is an area where a beginner should pay close attention, because vendors play an ever-increasing role in product design and development. Not only are key components and modules obtained from specialized suppliers, but manufacturing and test services may be provided by a contract manufacturing company, possibly half-way around the world!

Summary

Growth in wireless and other high frequency technologies, along with changes in the structure of the component supply chain, has resulted in a new set of responsibilities (and employer expectations) for new engineers. With this brief introduction, we hope that new engineers can begin learning more about the overall process of product development. Understanding technology is essential, but so is understanding the development processes that bring that technology to the marketplace.

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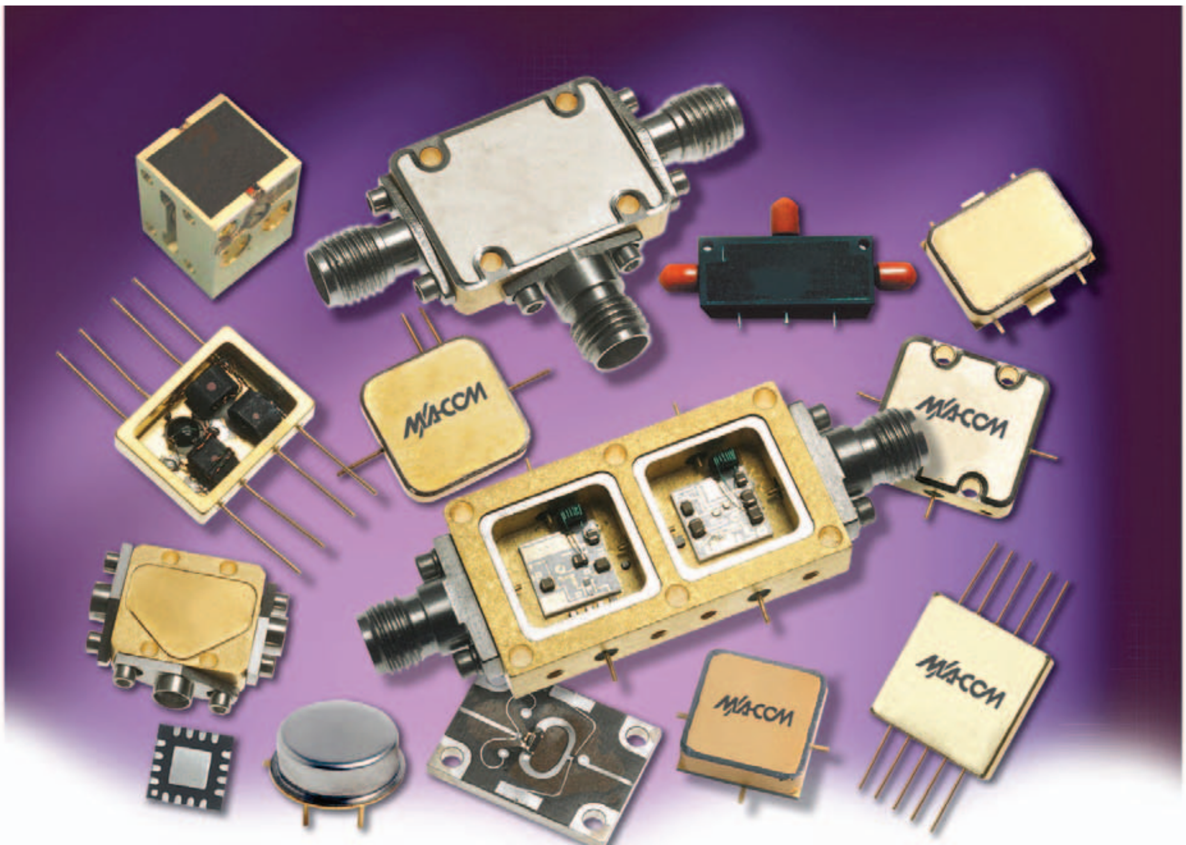

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Web Site: www.microwavecomponentsinc.com

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Broadband RF Power Divider

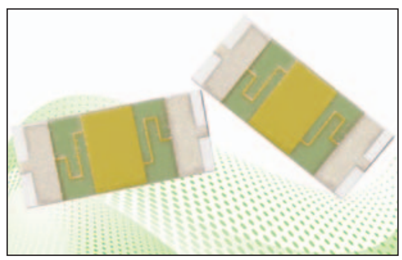
Narda, an L-3 Communications company, introduced the 4436 RF power divider that covers 500 MHz to 8 GHz and is available in two-way, three-way, four-way, and eight-way versions. The insertion loss of the 4436 ranges from 1.0 to 1.5 dB in the two-way version (depending on frequency), to 2.0 to 3.0 dB in the three-way version, 1.5 to 4.5 dB in the four-way version, and 2.0 to 8.0 dB in the eight-way version. Isolation is 12 to 20 dB in the two-way version, 12 to 18 dB in the three-way version, and 12 to 17 dB in the four-way and eight-way versions. Phase balance is of all versions ranges from 6 to 15 deg. The 4436 accepts a CW RF input power of 500 mW CW and 1.5 kW peak and operates over a temperature range of 0º C to +70º C with humidity up to 95% (non-condensing). It is housed in a rugged aluminum enclosure, weighs between 110 and 650 g depending on the level of power division, and has female SMA connectors. The 4436 power divider for commercial applications is available for immediate delivery.

Narda Microwave-East
www.nardamicrowave.com/east

Micro-OTDR

Anritsu Company introduces the Network Master MT9090A Fault Locator Series, a revolutionary micro-OTDR for installation and maintenance of FTTx and short-range optical networks. The MT9090A series combines the size of traditional handheld OTDRs and fault locators with the resolution and overall performance of mini-OTDRs to create the first truly compact, easy-to-use optical test instrument that addresses the specific test requirements of short fiber premise applications, such as FTTx drop cables, intra-building riser cables and cell towers. When equipped with the MU909011A Fault Locator Module, the new MT9090A provides all of the features and performance required for installation and maintenance of short fibers in a compact, modular test set. A high-performance instrument, the MT9090A can provide data sampling of 5 cm and dead zones of <1 m. The MT9090A Fault Locator Series is available for immediate delivery.

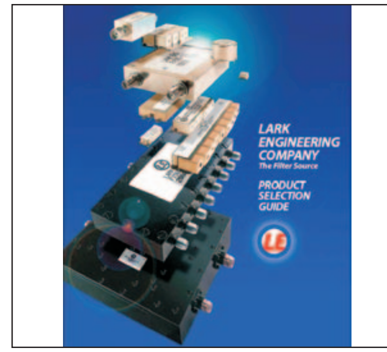
Anritsu Instruments Company
www.us.anritsu.com



S-Band Low Pass SMT Filter

IMS announces the introduction of its new IMF2293 “S” Band, planar, surface mountable low pass filter. This filter is low-profile, compact, and reliable, an ideal surface mountable solution for RF / Microwave circuit design engineers. Dimensions for this high-performing thick film filter are .442" × .184" × .030" thick. The passband is up to 2500 MHz with a passband ripple of .01 dB. Second and third harmonic rejection is a minimum of 25 dB with 0.4dB or better insertion loss. The VSWR for the filter is a ratio of 1.1:1. These filters have been successfully tested to input power levels exceeding 20W. Examples of applications include wireless local area networks, microwave communication links, radar systems, and wireless sensors and controls. The filter incorporates 5 sections with a 50-ohm input and output.

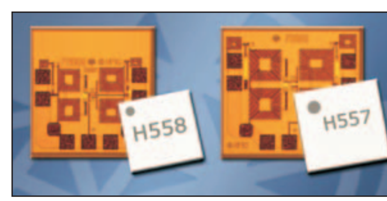
International Manufacturing Services
www.ims-resistors.com



New Catalog

Lark Engineering announces a new Product Selection Guide highlighting our wide range of filter products including our new Switch Filter Systems. The 8-page short form catalog features a user friendly, quick reference to filter specifications and capabilities that guides users to the filter ideally suited for the application. Specifications and performance simulations are instantly available using a filter design tool located on the company’s website.

Lark Engineering
www.larkengineering.com



Wideband Passive GaAs MMIC Mixers

Hittite Microwave Corporation announces the release of four double balanced GaAs MESFET mixers for use in test and measurement systems, military radios, commercial sensors and transceiver infrastructure including critical functions of fixed and mobile protocols such as WiMAX and VSAT applications. The HMC557LC4 is a versatile passive double balanced mixer that provides a LO to RF port isolation of 48 dB and an input IP3 of +22 dBm across the frequency range of 2.5 to 7 GHz. The HMC558LC4 is a passive double balanced mixer that provides an LO to RF port isolation of 45 dB

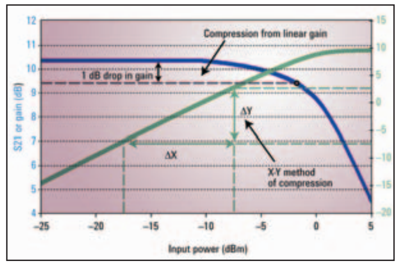
and an input IP3 of +24 dBm across the frequency range of 5.5 to 14 GHz. Both mixers are also offered in chip form as the HMC557 and the HMC558, and deliver a similar performance to their packaged counterparts. The HMC557LC4 and HMC558LC4 are conveniently housed in 4 × 4 mm RoHS compliant surface mount packages and specified for operation over –40°C to +85°C. For Hybrid MIC and MCM assembly, the HMC557 and HMC558 die are available and specified for operation from –55°C to +85°C. Die, SMT and evaluation PC boards are available from stock.

Hittite Microwave Corporation
www.hittite.com

Ceramic SMD Oscillators

MMD Components (Monitor & Quartztek) has introduced a new RoHS-compliant oscillator in a compact, hermetically sealed, surface-mount ceramic package. Ideal for use in devices such as mobile and cordless phones, digital cameras, PDAs and notebook computers, the new MXH series oscillators measure only 2 × 2.5 mm and are available in a wide frequency range of 1.54 MHz to 80 MHz. MXH series oscillators operate at supply voltages of 1.6 VDC minimum, with maximum power consumption during full operation as low as 8 milliamps. Operating temperature range is –40ºC to +85ºC; frequency stability is as tight as ±25 PPM; maximum start-up time is 10 milliseconds and rise/fall time 4 nanoseconds; and the aging rate is ±5 PPM for the first year. Availability is stock to 14 weeks. Prices start at $1.65 in 1K quantities.

MMD Components
www.mmdcomp.com



Gain Compression Application

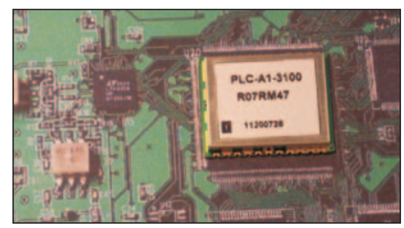
Agilent Technologies Inc. announced the availability of a new Gain Compression Application (GCA) for its premier-performance PNA-X network analyzer. Agilent's GCA measurement capability is an option for the PNA-X network analyzer for single-connection active-device measurements from 10 MHz to 26.5 GHz. Providing automated and simple gain compression over a wide power-sweep range, it enables engineers to measure many frequencies easily and with extreme speed and accuracy. Agilent's new GCA measurement option for the PNA-X eliminates the problems associated with lengthy test times and inconvenient setups by providing a single connection solution with a unique SMART Sweep capability that is easy-to-use, fast and accurate. The GCA also offers a 2-D sweep capability in which engineers can specify the frequency range, power range, and number of frequency and power points. Agilent's new Gain Compression Application, Option 086, for the premier-performance PNA-X network analyzer is available now.

Agilent Technologies Inc.
www.agilent.com

MLCC Model Library

AWR® has announced that Samsung Electro-Mechanics Co. Ltd. (SEMCO) has created and released a model library of its state-of-the-art, high-density, miniaturized, surface-mount multilayer ceramic chip capacitors (MLCCs) for use within AWR's Microwave Office® design suite. MLCCs are the most prevalent type of capacitor being utilized at present and their miniature size is well-suited for use in today's increasingly small electronic devices such as cell phones and notebook computers. The Samsung/AWR MLCC library consists of hundreds of capacitor models, including high-frequency, high-capacitance, high-voltage, low profile, super small, array and low inductance ceramic capacitors (LICCs). The Samsung MLCC library is free to AWR customers and the reference data is available from Samsung's Web site at http://www.sem.samsung.com.

Applied Wave Research, Inc.
www.appwave.com



Phase Lock Loop VCO

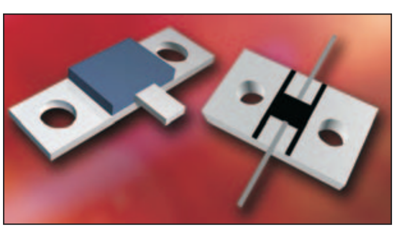
Raltron Electronics Corp. has just released their new PCC-A1-3100 PLL family of VCOs covering a frequency range of between 500 MHz and 3.5 GHz. Raltron's new product family will be particularly useful for base stations, point to point, point to multi-point transmissions, broadband wireless access, WiMax and RFID applications. The unit consists of a PLL IC loop filter and VCO. It uses an internal frequency reference that typically is 10 MHz but could also be specified at different values by the customer. Key specifications for a 3100 MHz unit show typical operating supply voltage at 5.0V at 70 mA. Phase noise at 1 kHz is –65 dBc/√Hz within a temperature range of from –30 to +70°C. Low phase noise in a compact package of only 25.4 × 31.75 × 5.08 mm makes these units an ideal choice for new design and retrofit needs. Quantity pricing is $23.00 each in lots of 1000 pieces with 6-8 week delivery ARO.

Raltron Electronics Corporation
www.raltron.com

Impedance Analyzer Withstands Strong Fields

The PowerAIM 120 from Array Solutions provides high resolution vector impedance measurements from 0.1 to 120 MHz. The unit is controlled by the user's computer via an RS-232 interface or optional USB adapter. To address applications such as broadcasting, the unit includes patent-pending filter technology to provide accurate measurement data when operated in in a high-intensity RF environment ($50V_{p-p}$). Operating software includes a wide range of capabilities, including de-embedding transmission lines, capturing and presenting data in various formats, including Smith chart display. The PowerAIM 120 includes an extremely rugged transport case that includes space for a laptop computer. Price is $2450.

Array Solutions
www.arraysolutions.com



Terminators and Attenuators

TT electronics IRC Advanced Film Division has developed a high power attenuator and surface mount transmission line terminator. Designated the PAT3060P Series attenuator and RFTF Series terminator, both devices feature low VSWRs at high frequencies. The high power attenuator features a frequency range from DC to 10 GHz with a VSWR of less than 1.3 at 10 GHz. Attenuation values include 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 16 and 20 dB. The high frequency terminator is available with power ratings to 250 W. Stray capacitance is <1.0 pF at 250 W and operating frequency ranges from DC to 3 GHz, with a VSWR of less than 1.1 at 3 GHz. Operating temperature ranges from –55°C to +155°C. Attenuators start at $10.50 each in quantities of 50 pieces. Terminators start at $8.75 in quantities of 100 pieces.

TT electronics IRC Advanced Film Division
www.irctt.com

Updated Software Models

Modelithics, Inc. has released an enhanced version of its powerful and feature-rich CLR Library™ of highly scalable passive surface mount component "Global Models" for Agilent-ADS. This upgrade adds several new models , including 01005, 0201, 0402 and 0603/0604 sized capacitors and inductors from vendors like AVX, Murata, Taiyo-Yuden, Coilcraft, Toko and TDK. In addition the 5.0 release includes a new feature with which the layout geometry for pad-scalable models will now be automatically updated to match user-specified values for the pad dimension parameters. It also adds pad scalability to five DLI capacitor models and includes enhanced effective series resistance (ESR) representations for a Johansson 0201 capacitor family.

Modelithics, Inc.
www.modelithics.com

Amplified Noise Source

NoiseWave announces the immediate availability of the NW3G-M amplified noise source. The NoiseWave NW3G-M features broadband frequency coverage from 10 MHz to 3 GHz. The NW3G-M offers 0 dBm output power with spectral flatness of ±2.0 dB. The NoiseWave NW3G-M comes standard with an SMA output connector. Utilizing low internal parts count, the unit is economically priced and delivery is typically from stock. Alternative voltages, output levels and frequencies are also available.

NoiseWave
www.noisewave.com

Family of RF Amplifiers

AR RF/Microwave Instrumentation has created a family of RF power amplifiers that can incorporate a variable output impedance. The A3 amplifiers feature an internal impedance transformer with selectable output impedance values of 12.5, 25, 50, 100, 200 and 400 ohms. An external impedance transformer is also available for applications requiring an extended range from 8-2,000 ohms. The A3 family presently includes three amplifiers: Model 800A3 (800 watts), Model 1500A3 (1500 watts), and Model 5000A3 (5000 watts). Each of the amplifiers covers the 10 kHz to 3 MHz frequency range.

AR RF/Microwave Instrumentation
www.ar-worldwide.com

New RF Products E-Store

JFW announces the launch of their totally redesigned e-commerce site, which offers competitive pricing and in-stock delivery of hundreds of the most popular models. The online inventory includes fixed attenuators, terminations, variable attenuators, RF switches, power dividers and impedance matching pads and transformers.

JFW Industries, Inc.
www.jfwindustries.com

Find New Product links online at www.HFeLink.com

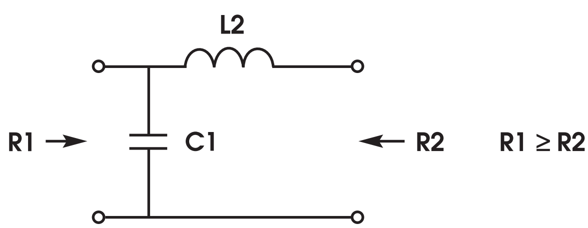
Advertiser Index

DESIGN NOTES

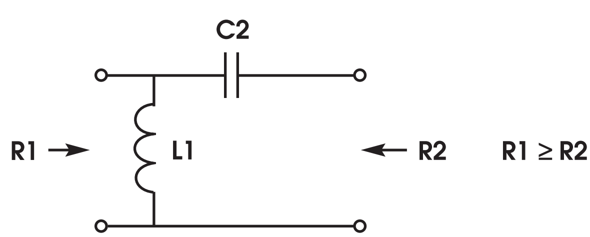
Impedance Matching With LC Networks

This month's columns includes more information on LCR circuits, provided by Ain Rehmann. The circuits described first are L-networks, consisting of one series and one shunt reactance. These networks are practical for matching a wide range of impedances in narrowband applications. They are commonly used for antenna matching, amplifier matching, and for matching to the inputs and/or outputs of passive circuits such as crystal and ceramic bandpass filters.

The two topologies detailed here include one inductor and one capacitor. Although not presented here, L-networks with two capacitors and two inductors are also legitimate choices.



$Q = \sqrt{(R1/R2 - 1)}$
$\omega C1 = Q/R1$
$\omega L2 = Q/R2$

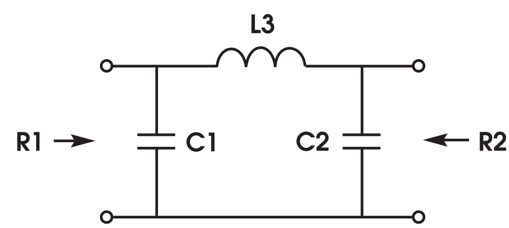


$Q = \sqrt{(R1/R2 - 1)}$
$\omega L1 = R1/Q$
$\omega C2 = 1/Q \cdot R2$

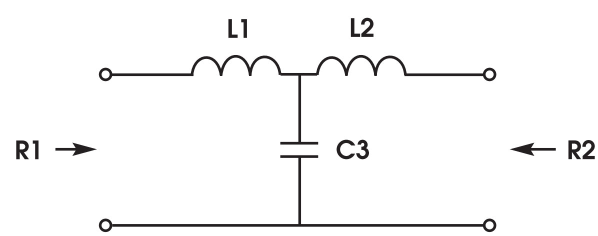
Note that the formulas are for resistive load matching only. Reactive loads are accommodated by incorporating them into the series reactance. For example, in the top configuration with a series inductance, the complex load is R2 ±jX. If the reactance is inductive, that inductance can be subtracted from the value of L2. Thus, $X_{L2new} = X_{L2old} - |X_{load}|$.

A capacitive reactance can be incorporated into the network by adding an equal value of inductive reactance to L2, so that $X_{L2new} = X_{L2old} + |X_{load}|$.

Three-element matching networks are also commonly used for impedance matching. With an additional degree of freedom in component value selection, these networks are more flexible when matching reactive loads. Below are two possible topologies, a "Pi" or "π" network, and a "Tee" or "T" network. Of course, they are named for the shapes of their circuit diagrams.



$\omega C1 = Q1/R1$
$\omega C2 = Q2/R2$
$\omega L3 = R1(Q1 + Q2)/(1 + Q1^2)$
$Q2 = \sqrt{(R2/R1)(1 + Q1^2) - 1}$
$Q1^2 > (R1/R2 - 1)$



$\omega L1 = Q1 \cdot R1$
$\omega L2 = Q2 \cdot R2$
$\omega C3 = (Q1 + Q2)/R2(1 + Q2^2)$
$Q1 = \sqrt{(R1/R2)(1 + Q2^2) - 1}$
$Q2^2 > R1/R2 - 1$

Additional topologies are possible, with inductors or capacitors in each position. These two are shown as examples. Readers are referred to texts on matching networks for additional information.

It should be noted that the Tee and Pi networks may be designed with phase shift as a parameter. Different design equations will apply. This approach is commonly used in broadcast transmitting arrays; a good source of information is any past edition of the *NAB Engineering Handbook*.

R/F Microwave Connectors

In addition to standard catalog configurations the R/F Microwave Connector Division manufactures all series and styles of RF connectors.

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