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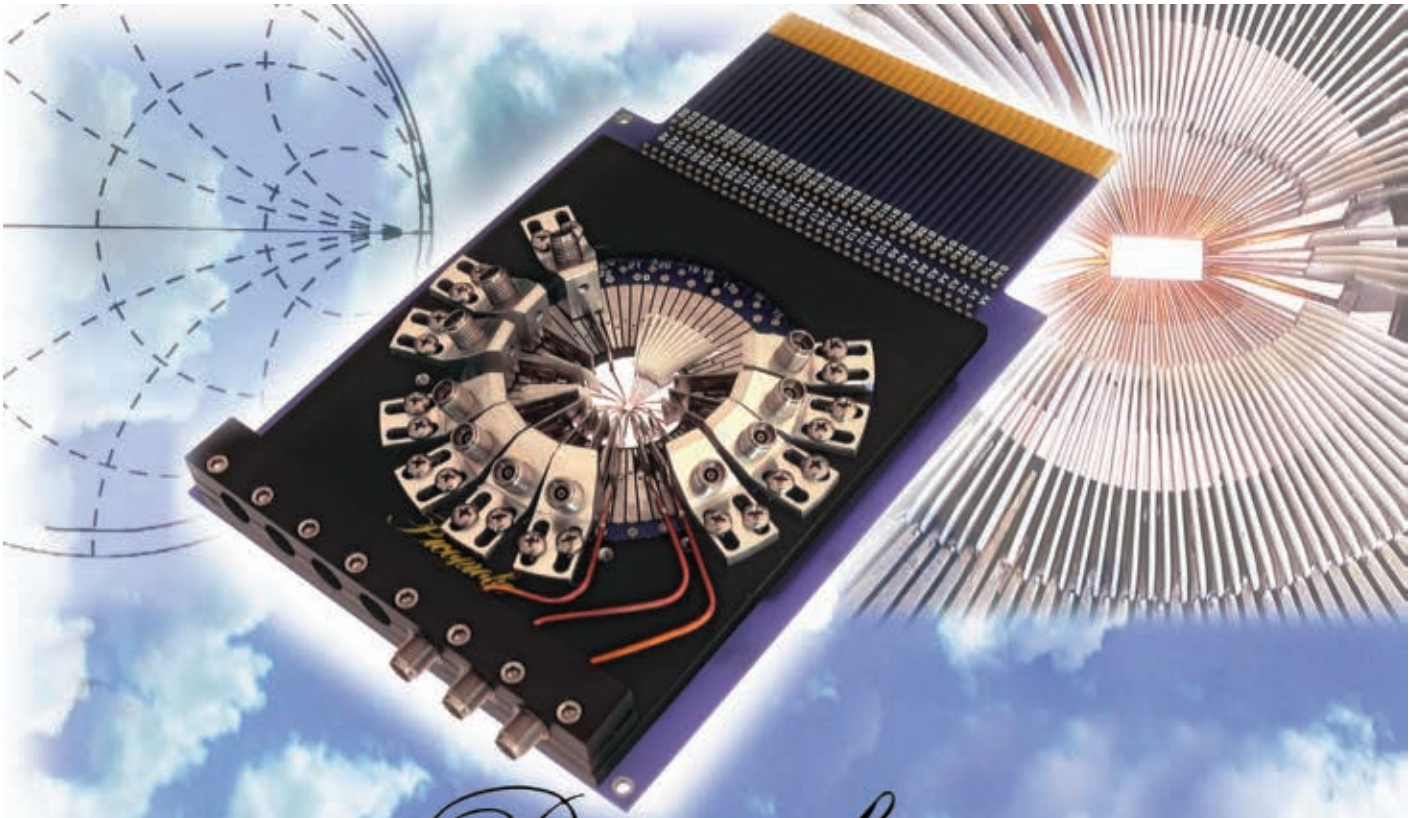

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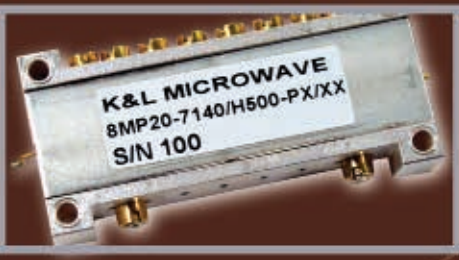

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150-70-1	dc-18.0	0-70/10	
151-11	dc-4.0	0-11/1	
152-90-3	dc-26.5	0-90/10	
150T-11	dc-18.0	0-11/1	◆
150T-15	dc-18.0	0-15/1	◆
150T-31	dc-18.0	0-31/1	◆
150T-62	dc-18.0	0-62/2	◆
150T-70	dc-18.0	0-70/10	◆
150T-75	dc-18.0	0-75/5	◆
150T-110	dc-18.0	0-110/10	◆
151T-110	dc-4.0	0-110/10	◆
152T-55	dc-26.5	0-55/5	◆
153-70	dc-40	0-70/10	*New*
153-110	dc-40	0-110/10	*New*

Model	Frequency Range (GHz)	Attenuation Range (dB)	Notes
3200-1	dc-2.0	0-127/1	
3200-2	dc-2.0	0-63.75/.25	
3200-1E-2	dc-3.0	0-127/1	
3200-2E-2	dc-3.0	0-63.75/.25	
3201-1	dc-2.0	0-31/1	
3201-2	dc-2.0	0-120/10	
3206-1	dc-2.0	0-63/1	
3200T-1	dc-2.0	0-127/1	◆
3206T-1	dc-2.0	0-63/1	◆
3250T-63	dc-1.0	0-63/1	◆ X
3406-55	dc-6.0	0-55/1	*New*
3408-55.75	dc-6.0	0-55.75/0.25	*New*
3408-103	dc-6.0	0-103/1	*New*
4216-63	0.8-3.0	0-63/1	
4218-127	0.8-3.0	0-127/1	
4238-103	.01-2.5	0-103/1	

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Microwave Journal

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Expert Advice Feedback: "Optimizing 4 and 5 GHz Antenna Systems" by Andy Singer, Radio Waves

To make antennas larger is not possible due to the lack of space or maximum dimension specifications. So is there any other method to minimize the radome interference on the antenna? Are your antennas simulated with the radome integrated?
Posted by: Esther | 10/21/2009 at 01:04 AM

Hi Andy, are there any current plans to adopt an industry standardization of antenna performance specifications?
Posted by: Gary Filak | 10/22/2009 at 01:31 PM

Very good and simple article, with accessible information for all levels of experience. Interesting points when you mentioned the point-to-multipoint hub configuration, worth note taking!
Posted by: Gus | 10/23/2009 at 10:23 AM

Andy, I wonder how much design consideration is given to the ubiquitous WiFi antennas appearing in public places and on personal laptops? Nodes appear to use simple verticals, but most adaptors seem to have patch antennas under radomes. Polarization matching would seem to be an important consideration, but only a few adaptors offer flexible orientation. Are WiFi antennas less important for good communication than other system components?
Posted by: Mike Swaney | 10/28/2009 at 10:21 AM

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Technological highlights: network analysis

- Easy-to-use modular solutions up to 325 GHz
- Pulse profile measurements with high resolution
- Precise group delay measurements on frequency converters without LO access
- Absolute phase measurements on mixers

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Online Technical Papers

Data Communication Path Utilizing Wireless ZigBee Modules
Application Brief, CEL

LTE Wireless Standard Demands New Testing Approaches and Instrumentation
Mark Elo Director, RF Products, Keithley Instruments Inc.

Broadband Leadership in the Licensed Microwave Sector
Solution Paper, Motorola

CoMPA™: An Innovation in Satellite Antenna Technology
Jacob Keret, Starling Advanced Communications

Executive Interview

Dr. Samuel Cho, Founder and CTO of Korea's **RFHIC,** explains the company's global activity, how strategic partnerships have shaped its success and the company's commitment to GaN technology.

Expert Advice

Ferenc Marki, President and Founder of **Marki Microwave**, is one of the world's foremost experts in microwave mixers. After nearly four decades of experience in the industry as both a technologist and entrepreneur, Marki shares his thoughts about the future role of small businesses in this rapidly evolving field.

Read the advice from this industry expert, respond with your comments and win a complimentary copy of *Electrical Engineering: A Pocket Reference* from Artech House (see www.mwjournal.com for details).

EDAFocus

Synopsys Inc. has pushed into the custom IC market with product releases that offer the design environment, circuit simulation, parasitic extraction and verification capabilities required by RFIC designers. This area has been dominated by Cadence's Virtuoso for many years. Will the new tools, built on an OpenAccess platform, shake up the market? See this month's EDAFocus to learn more.

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THE YEAR THAT WAS

DAVID VYE, *MICROWAVE JOURNAL* EDITOR

"We're just trying to get through the end of the year." For many, this was the mantra of 2009. Well, good news—the "Entering 2010" sign is now visible on the horizon. As we head towards that mile marker, let's take a quick glance in the rear view mirror. Here's what I see.

This past year, a new administration entered the White House and our editorial perspective deliberately considered "the world in transition". Each month, our lead article covered the changes in that issue's technology or market related theme. Over the course of the year, we looked at the changing state-of-the-art in antenna technology as reflected in the papers presented at the Allerton Antenna Symposium (January); we reported on the evolution in nano-scale system-in-package technology (February), the on-going battles between GaAs and Silicon devices in the PA arena (April) and the competition between high voltage RF transistor technologies (June). In test and measurement equipment, the *Journal* covered instrument advances for the emerging 4G market (March) and we took a historical look at the impact of RF design software on hardware development (July).

Where government and commerce intersect, we reported on the need for greater bandwidth capacity via satellite links for US armed forces (August) and unserved/underserved rural communities via microwave backhaul and middle-mile infrastructure (October). Our IMS and EuMW show issues moved away from listing conference schedules, in favor of reporting on the products and companies at the exhibition itself. The industry needs this watchful eye on both the technology and business of high frequency electronics and so we deliberately steered our editorial in that direction.

In 2009, electronic media was embraced by our audience in greater numbers than ever before. The MWJ/Besser webinar series attracted nearly 10,000 engineers and managers. The positive response to these events, based on feedback, attendance and the quality of the Q&A sessions has convinced me that expert-based webinars will play a significant role in disseminating information for years to come.

This past year, we launched several social media initiatives and discovered that LinkedIn, Facebook and Twitter not only compliment our traditional print and electronic content distribution channels, but also create a platform for our audience to communicate directly with us and each other. The RF and Microwave community on LinkedIn is quickly approaching 2,000 members, each with access to insider information on jobs, business opportunities and vital industry-related discussions.

The *Microwave Journal* website doubled as a community message board by hosting multiple Twitter feeds. At IMS and EuMW, our website facilitated twittering exhibitors as they provided show updates on product releases, demos and promotional activity. A sizable number of tweets from many sources proved that the marketing arm of the microwave industry is ready to adopt these new forms of communication. It is all part of the world in transition.

Looking at 2009 in the rear view mirror, I see a year like no other; an industry that met and in some cases exceeded the modest goal of "getting through it". With lots of belt-tightening and budget cut-backs, the vast majority of companies survived. Quantifying the health of our industry through this recession, I offer the following observation:

The number of pages in a trade magazine often reflects the health of the industry it serves. Page counts are dictated by the number of placed advertisements, which in turn reflects the level of investment companies are willing and able to make in marketing their own products (setting aside advertising shifts from print toward the Internet). Based on this metric and from the *Journal*'s perspective, while it was a tough year, the microwave industry fared far better than the Dow Jones. Similar trends, but the plunge was not as deep, the recovery more robust. Of course, this is a broad observation; individual results may vary.

Looking at the road ahead, I see many recession-fueled changes: A renewed interest in engineering, science, education and taking on big challenges such as green energy, transportation, and technology's role in lowering the cost of health care. The *Journal* will keep an eye on these changes as we investigate and report next year's editorial theme—the microwave supply chain. As for 2009, stick a fork in it. It's done. ■

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RFID READER ARCHITECTURES AND APPLICATIONS

In order to use radio frequency identification (RFID) for wireless communication and real world applications such as supply chain management, asset tracking systems, security and privacy systems, healthcare and commercial applications, library management systems, geographic surface location identification and industrial tracking systems, the study of the nature and characteristics of the reader is an important factor. The purpose of this article is to review and discuss various methodologies aimed at developing the reader's components and remove its interference. It further focuses on the review of future implementation methodologies and performance comparison along with their applications.

Radio frequency identification, or RFID, is a generic term for technologies that use radio waves to automatically identify people or objects. The purpose of an RFID system is to obtain data programmed in devices, which is then read by an RFID reader and processed for the particular application. The data can provide identification or location information about the product, such as date of purchase or price.

RFID consists of three basic components: A transponder (tag), an interrogator (reader) and an antenna. RFID has a number of standards such as The International Organization for Standardization (ISO), in conjunction with the International Electro-technical Vommission (IEC), Electronic Product Code (EPC) global and the European Telecommunications Standard Institute (ETSI). Moreover, RFID follows some standard frequency ranges that are low frequency (120 to 135 KHz), high frequency (10 to 15 MHz), ultra high frequency (UHF) (850 to 950 MHz) and microwave frequency (2.45 GHz).

In recent years, RFID readers have supported applications that use UHF and microwave frequencies (such as supply chain, asset tracking, etc.). Moreover, an RFID reader provides geographic surface location identification. This location and identification system has been proposed for various applications including locating large and tract boundaries, and identifying pipelines and power lines for industrial construction. An RFID reader has also been used in the medical field. It can improve the accuracy of patient identification as well as other commercial applications. It can

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The printed version of this article gives a brief explanation of RFID and a short historical background of RFID reader systems. In the full length version, found on the Web at www.mwjournal.com/RFIDdec09, this is followed by highlighting the architectural infrastructure of an RFID reader. Furthermore, the RFID reader's circuit design perspective based on the frequency range and the different methods on mobile devices is explained. Finally, some recommendations for future work are discussed.

RFID READER: A BRIEF HISTORY

In very early times, electro-magnetism and electricity were limited to observation of electrostatic discharge and the magnetic properties of loadstones. Early applications probably included making light with fire, use of mirrors for signaling and use of loadstone for navigation. Scientific understanding progressed very slowly until the 1600s. In 1846, Michel Faraday proposed that light and radio waves are a form of electromagnetic energy. In 1864, the Scottish physicist James Clerk Maxwell published his theory on electro-magnetism. In 1887, the German physicist Heinrich Rudolf Hertz confirmed Maxwell's electromagnetic theory and discovered electro-magnetic waves (radio waves).[1] In 1906, Alexanderson presented the first continuous waves (CW) generation and transmission of radio signals. The birth of radar occurred in the early 20th century. The first use of radar was during World War II and its development was mostly done in the Radiation Laboratory at MIT. Radar uses radio waves to determine the position and speed of an object.

According to Jeremy Landt's (Transcore's chief scientist) inspection,[2] the commercial activities of RFID began in the 1960s and 1970s, where developers, inventors, companies, academic institutions and government laboratories were actively working on RFID. A number of companies were also developing RFID technology. Among them, Raytheon's Retag in 1973 and Richard Clench of RCA's development of an electronic identification system in 1975 were major advances. The 1980s became the decade for full implementation of RFID technology, though interest developed somewhat differently in various parts of the world. The world's first open highway electronic tolling system opened in Oklahoma in 1991. It was the first system installed on the Kansas turnpike, using RFID readers that could operate with a different protocol as well as existing tags. Research and development was very fast from the 1990s with new technological developments expanding the functionality of the RFID reader. For the first time, useful microwave Shottky diodes were fabricated on regular CMOS integrated circuits. This development permitted the construction of microwave RFID readers that contained only a single integrated circuit.[1] In the late 1990s, RFID readers were used in supply chain management and article tracking applications that grew rapidly. Now RFID readers are using receiver design, transceiver design, integrated circuit design, network engineering and many more technologies. Increasing numbers of engineers are involved in the development and application of RFID readers.

The following section shows the RFID reader's timeline, where they are classified into four generations and including a new portable reader for the next generation. According to its generation, an RFID reader follows a number of standards, such as class 0, 0+, 1, 2, EPC, ISO 18000-6A, ISO18000-6B and ISO18000-6C protocols. These standards were improved by various ongoing industries such as Intermec Technology, Marks and Spencer, Metro, WalMart, Tesco, Alien Technology, WJ Communication, Impinj Corp., Awed Group, Skytel, Symbol Technology and many more.

FIRST GENERATION RFID READERS

First generation RFID readers serve as a gateway between the physical world of tags on packages and the online world. RFID readers have a number of reading modes such as single, multi and dense modes to accommodate various operating environments. For most hardware parts, readers are operating in one of two ways, either autonomously or as directed/undirected devices.

In 2005, Intermec Technologies and Genets introduced multi-protocol RFID handheld readers. They supported Gen1, class 0, 0+, 1.[3] They were convenient for flexibility and exceptional handling capabilities for a handheld device. A multi-protocol handheld reader is based on the highly successful IP3 portable reader. This reader provides a robust mobile platform for wireless connectivity, which complements the current EPC Gen1 infrastructure. It is a complete handheld solution that can address today's barcode and RFID platform for future growth.

By the end of 2005, the market research firm Venture Development Corp. offered the electronic product code (EPC) Gen1 reader.[3] It is a new feature of the EPC standard that allowed readers to work in the same area without interfering with each other. It can operate with up to 50 readers located within one square kilometer.

By October 2006, Thomas S. Heydt-Benjamin, et al. presented the first generation RFID-enabled credit card reader.[4] The convenience of this reader leads to risks for security and privacy. RFID-enabled credit cards are susceptible in various degrees to a range of particularly traditional reader attacks, such as skimming and relaying, but the problem of this reader is to require a large investment for their manufacture, personalization and distribution.

In December 2006, WJ Communication announced the WJ Communication reader (WJR) version 7000.[5] It supports EPC global, Gen1, class 1 and 0+ protocol standards. It is a small personal computer memory card international association (PCMCIA) that is used as a business card. It makes the WJR-7000 especially appropriate for use in mobile readers. It can perform all dense reader mode functions described in the EPC standard. Transmitting readers that are used in dense-reader mode allow interrogators to avoid RF interferences and better performance.

By the end of 2006, Alien Corp. presented Alien reader version ALR-9780 fixed RFID reader for first generation, as shown in ***Figure 1***.[6] The Alien ALR-9780 fixed reader is ideal for industrial and warehouse applications. It is fully featured, and Federal Communications Commission (FCC)-certified. The industrial reader

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Fig. 1 Alien ALR-9780 fixed reader.[6]

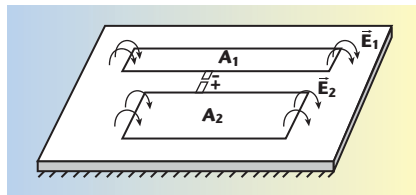

Fig. 2 Samsys MP9320 first fabricated RFID antenna chip.

can be easily mounted where reader objects are inbound or outbound in a logistics supply chain. The proposed reader has the ability to read a population of tags at high rates in real-world situations.

SECOND GENERATION RFID READERS

Second generation RFID readers have a number of features that meet local regulations, networking capability, power, operating frequency, control interface and so forth. The Gen2 protocol takes the best features of the Gen1 Class 1, Gen1 Class 2 and ISO standard. The Gen2 standard promises a number of much more sophisticated features (faster read rate, size, global standard, etc.) than the Gen 1 protocols.

At the beginning of 2005 (February), Samsys upgraded its Multi-port (MP) version 9320 RFID reader.[7] The Multi-port RFID reader (MP9320) is normally a hardware-based application. It is supported by the MP9310 embedded ultra high frequency (UHF) reader module. It also supports the existing EPC tag protocols class 0, 0+, and 1 standards. ***Figure 2*** shows the Samsys MP9320 Multi-port reader antenna chip. The proposed reader offers increment improvements over its predecessor, including better performance, faster reading, writing, and regulation compliance for use especially in Asia.

In 2006, WJ Communication presented the multi-port reader (MPR) series PCMCIA type2 RFID card reader.[8] The MPR series is designed for UHF second generation and updated FCC standard. This version features a complete class 1, Gen2 reader, which is significantly faster and supports non-EPC compliant reader IDs for class 1.

In October 2006, Alien Technology Corp. presented a global deployment of Gen2 RFID with unified Alien Gen2 readers.[9] Alien Gen2 readers enable organizations to implement a single unified RFID infrastructure worldwide and reduce the costs, risks and complexities of international RFID deployment.

By the end of 2006, WJ Communication presented a RFID UHF Silicon (Si) reader chipset WJC200,[10] as shown in ***Figure 3***. WJC200 is the industry's first RFID reader chipset that introduced the EPC global Gen2 ISO 18000-63 and ISO 18000-6B international standards. The WJC200 simplifies UHF reader designs with transmit preamble, data encoding, modulation, frequency-agile carrier generation, down conversion and decoding, all incorporated into a single chip. The on-chip protocol engine is supported by ISO18000-6B and ISO18000-6C (large rigid tag). The on-chip synthesizer supports operation within the 902 to 928 MHz US industrial, scientific and medical band (ISM). The frequency range is extended from 860

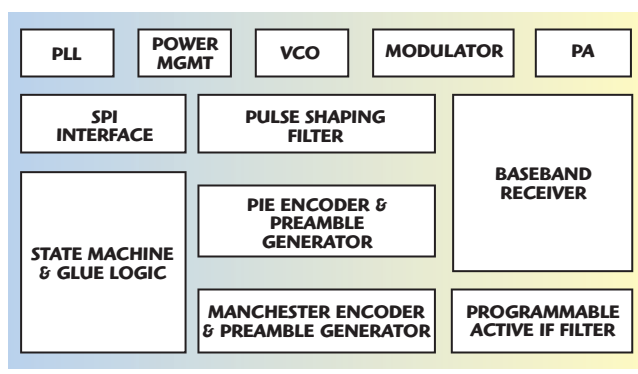

Fig. 3 WJ Communication's WJC200 RFID chipset.

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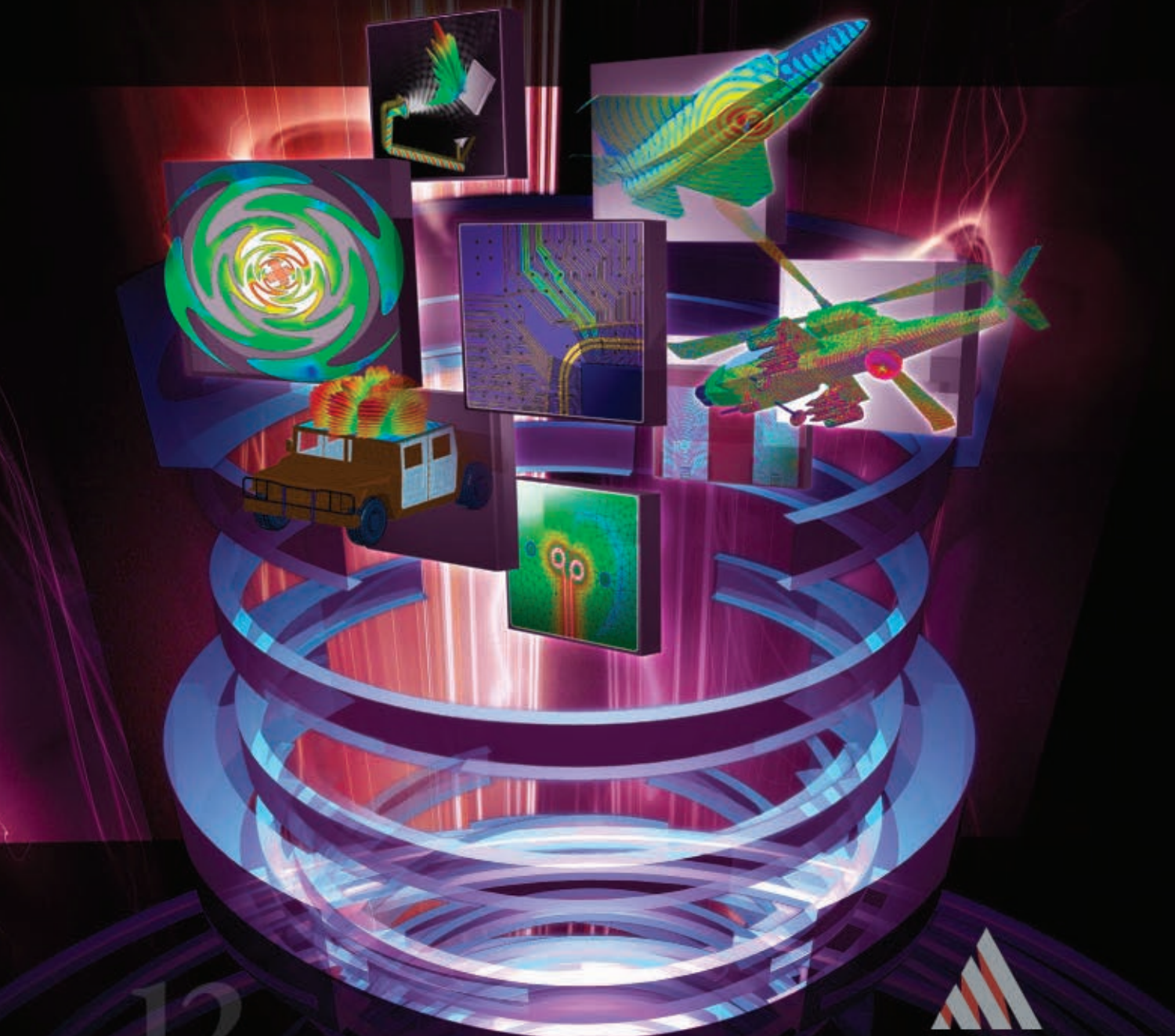

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THIRD GENERATION RFID READERS

High volume, general availability of Gen3 readers are better (price, performance) than Gen1 and Gen2. The new standard changes the RFID control system and provides data security and user privacy. In 2006, Anadigm Corp. presented a third generation chipset for a high frequency (HF) and ultra high frequency (UHF) RFID reader.[11] It proposed that the reader can be customized to read different radio frequency identification tag types, with different modulation types and frequencies. It supports current HF standards as well as the EPC standard. It accepts class 0, 1, 2 and ISO18000-6 standards. This reader operates at 3.3 V, while providing increased read range and sensitivity optimization with variable gain. It is ideally suited for portable readers, as well as fixed-based readers.

FOURTH GENERATION RFID READERS

Fourth generation RFID reader products are available from many companies, such as ThingMagic, AbeTech, Accu-Sort, Acsis, ADT/Sensormatic, BuyRFID, CIT, IconNicholson, Omron Corp., RFID Global Solutions, Rush Tracking Systems, SONTEC, Ubi-Tech, Venture Research and Zebra Technologies. They have better performance and options than third generation readers.

In 2004, ThingMagic introduced the leading proponent of the smart Mercury4 RFID reader,[12,13] which is shown ***Figure 4***. Mercury4 is supported by the Generation4 RFID reader. The reader reads UHF tags that are based on EPC class 1 and class 0, ISO 18000-6B. It upgrades remotely as new protocols become available. This reader also supports a module for reading high frequency (13.56 MHz) tags.[12] A year later, in 2005, ThingMagic upgraded the flagship reader,[13] which reads the tag on an object moving at 600 feet per minute in 12 milliseconds. It is now upgraded for very high performance and fast moving supply chain applications. It supports all of the metrics of class 0+ capabilities.

In 2005, National Instrument Corp. (NI) presented peripheral component interconnects (PCI) express in a chipset for RFID readers.[14] It supports the fourth generation. By the end of 2006, ThingMagic announced the Mercury4 RFID reader.[15] The Mercury4 RFID reader can read all EPC Gen4 tags. It is remotely upgradeable to read future protocols. Mercury4 is supported among a variety of applications in different sectors such as government, retail, aerospace and manufacturing.

Fig. 4 ThingMagic Mercury4 reader.

NEXT GENERATION RFID READERS

The next generation of RFID readers is highly qualitative and competitive for current markets as generation 5 readers are available. Even though this generation RFID reader is using modern technologies, it is still being improved and updated in the global market.

In 2004, Near-Field Communication (NFC) presented an input/output (IO) reader for the next generation.[16] It is the world's smallest and lowest-cost

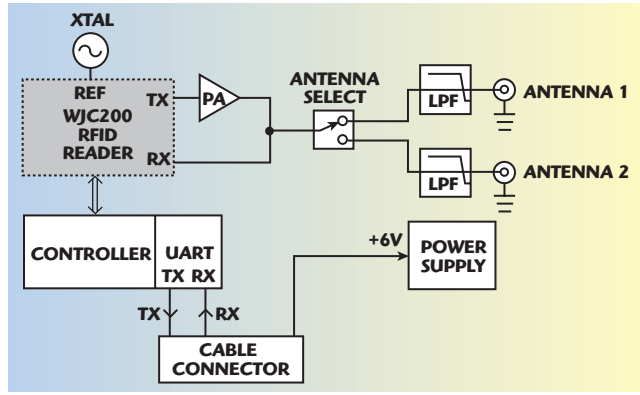

Fig. 5 WSM series WJM300 RFID reader block diagram.

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AMF-4D-00100100-30-30P	0.1-1	44	1	3	2.2:1	30	850
AMF-3B-00500100-13-33P	0.5-1	43	1.5	1.3	2:1	33	1700
AMF-4D-00500200-25-33P	0.5-2	40	2	2.5	2:1/2.3:1	33	1400
AMF-4B-00800250-50-34P	0.8-2.5	40	3	5	2:1/2.3:1	34	2700
AMF-3B-01000200-35-30P	1-2	30	1	3.5	1.8:1	30	900
AMF-3B-01000200-20-33P	1-2	35	1	2	1.5:1	33	1200
AMF-5D-01000200-15-33P	1-2	50	1.5	1.5	2:1/2.3:1	33	1500
AMF-3B-01000200-50-40P	1-2	35	3	5	2.2:1/3:1	40	4100
AMF-3D-01000400-45-30P	1-4	28	1.5	4.5	2:1/2.3:1	30	800
AMF-4D-01000400-35-30P	1-4	39	1.5	3.5	2:1/2.3:1	30	900
AMF-4D-01000800-85-30P	1-8	28	2	8.5	2.2:1	30	1100
AMF-4D-00400600-50-30P	0.4-6	34	2	5	2:1/2.3:1	30	650
AMF-3B-02000400-20-30P	2-4	35	1	2	2:1	30	950
AMF-4B-02000400-15-33P	2-4	50	1.5	1.5	2:1	33	1600
AMF-5B-02000600-70-33P	2-6	34	2	7	2:1	33	2200
AMF-4B-02000600-70-37P	2-6	35	2	7	2:1/2.8:1	37	4800
AMF-4B-02000800-80-36P	2-8	40	2.5	8	2:1/2.8:1	36	4800
AMF-3B-02001800-30-30P	2-18	35	2	3	2.2:1	30	2000
AMF-3B-02001800-60-32P	2-18	35	2.5	6	2:1/2.3:1	32	4500
AMF-3B-02002000-60-30P	2-20	40	2.5	6	2:1/2.5:1	30	4500
AMF-5B-04000800-60-30P	4-8	33	1.5	6	2:1	30	1400
AMF-4B-04000800-50-33P	4-8	36	1	5	2:1	33	1500
AMF-6B-06001800-80-33P	6-18	35	2.5	8	2.1:1/2.2:1	33	3500
AMF-2B-06001800-65-35P	6-18	45	3	6.5	2.1:1/2.2:1	35	6500
AMF-6B-06001800-120-40P	6-18	43	5	12	2:1/2.3:1	40	12,500

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13.56 MHz RFID reader. The reader's small size and 2.8 V power consumption make it ideal for small-footprint devices such as small, battery-powered handheld devices. By 2006, Symbol Technologies Inc. introduced Symbol extended release XR480.[17] It is the industrial-class RFID reader that supports current RFID standards. It builds on the next generation architecture of the XR RFID reader series. It provides control of input or output and USB interfaces to manage devices ranging from motion sensors and lights to memory sticks and display screens.

By 2007, WJ Communication presented the WJ module WJM3000 reader chipset for the next generation,[18] which is shown in ***Figure 5***. It embodies best in class performance for its size and price target, while exceeding industry module in benchmarks. It supports 1 W (+30 dBm) RF output power, and dense reader mode (DRM) capability.

In 2005, WJ Communication presented WJ reader WJR 7000 multiprotocol UHF RFID reader.[19] The next generation WJR 7000 reader supports full 1 W dense reader spectrum. It enables a fast data rate of 240 KHz, and worldwide operation capability. It is supported by UHF frequency band (902 to 928 MHz). It includes the RF, digital circuitry and embedded firmware required for Class 1, ISO18000-6C and ISO 18000-6B international standards.

A list of RFID readers is given in ***Appendix A***, which shows the manufacturer company who developed the model of RFID reader in the current market.

CONCLUSION

This article gives a brief historical background and describes the various generations of readers as they appeared over time. The various components of RFID reader's architecture—antenna, attenuator, filter, power amplifier, power splitter, PLL, transducer design, oscillator—are discussed along with their advantages and disadvantages in the expanded Web article. ■

The full version of this article is available online at www.mwjournal.com/RFIDdec09.

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APPENDIX A

RFID READER MARKET SURVEY

Manufacturer	Model	Frequency	Standard	Remark
Symbol Technologies	RD5000	902-928 MHz	EPC global, Class 0	General purpose forklift and clamp trucks on mobile carts, portable stake wheel conveyors
Alien Technologies	ALR-9640	902-928 MHz	EPC global, class 1	General purpose item tracking, suitable in metric environment
Omron Inc.	V750	866-953 MHz	EPC Gen2	General purpose with low installation cost and high performance line speed
SAMsys Technologies	MP320 multi-port reader	UHF protocol	EPC Gen2, class 0, 0+, 1	General purpose with improved multi regional performance
Skyetek Technologies	H1 handheld reader	13.56 MHz	ISO-15693 and ISO-14443	Uses include point of sale, shop floor data collection and ticketing or validation
Intermac Technologies	RFID handle reader	UHF (915 MHz-2.45 GHz)	Class 1	General purpose for quality control process (WIP)
Intellident Corp.	Multi-scanner reader	13.56 MHz	ISO-15693	General purpose for time consuming data reading and can be connected to LAN
ThingMagic	Mercury5	UHF protocol	EPC global, Gen2	General purpose for filtering RF interference from non-RFID reader source, such as cordless phones, wireless networks
Range-master2	Programmable analog signal processor	902-928 MHz	EPC Gen1 and Gen2 (class 0, 1, 2), and ISO 18000-6	General purpose to enable fixed and portable "Universal" RFID reader application
WJ Communication	MPR7050	920-925 MHz	EPC class 0, EPC class 1, Gen1	General purpose RF solutions for wireless infrastructure, low cost, easy to integrate RFID reader devices

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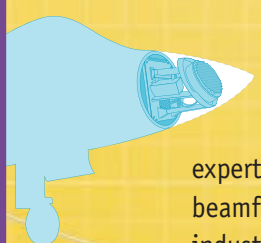

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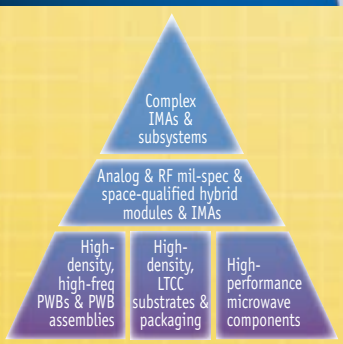

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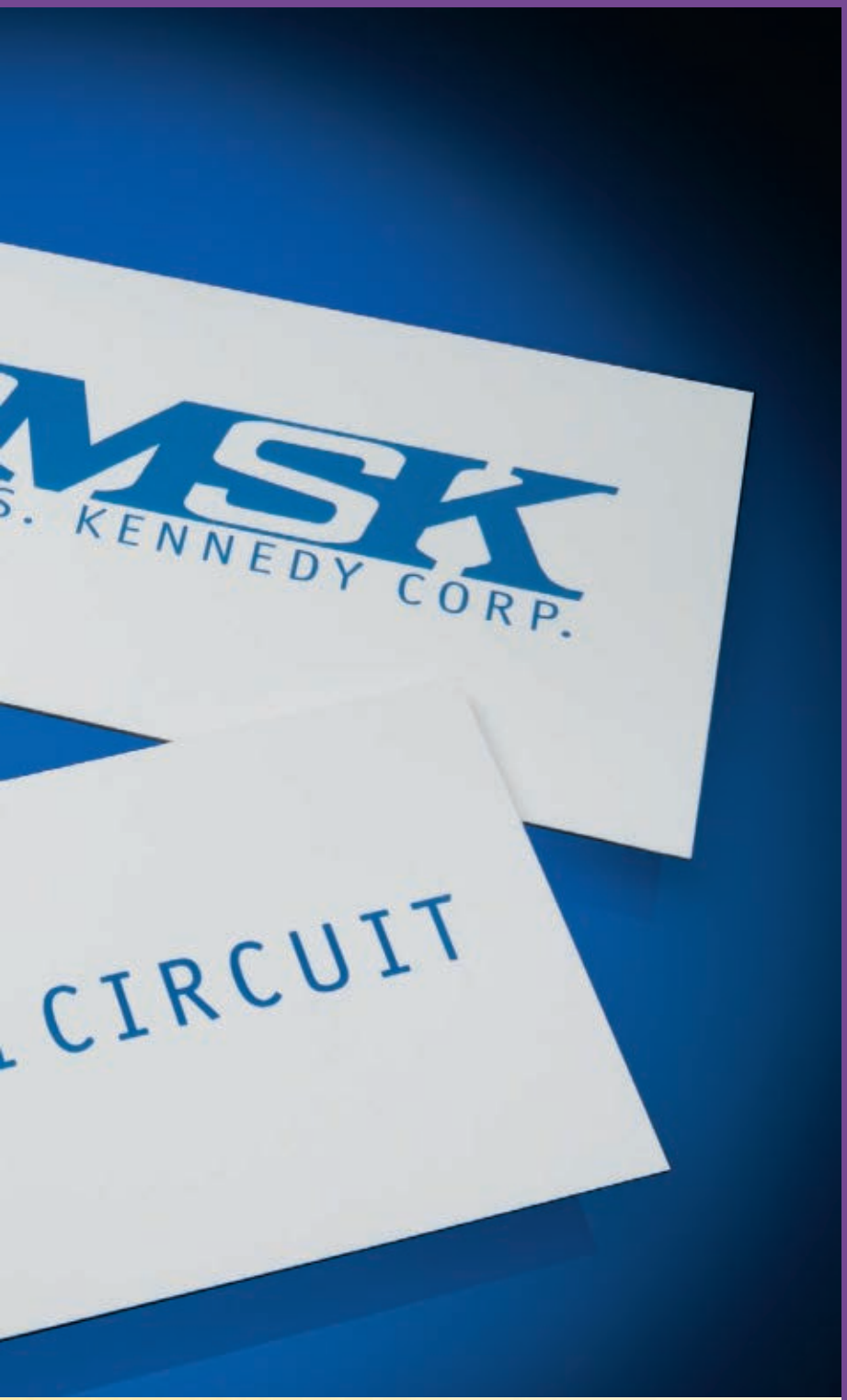

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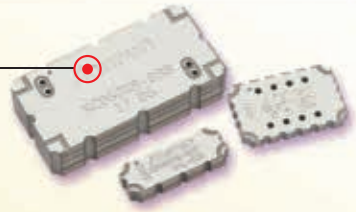

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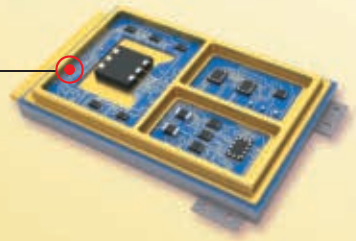

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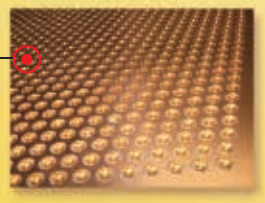

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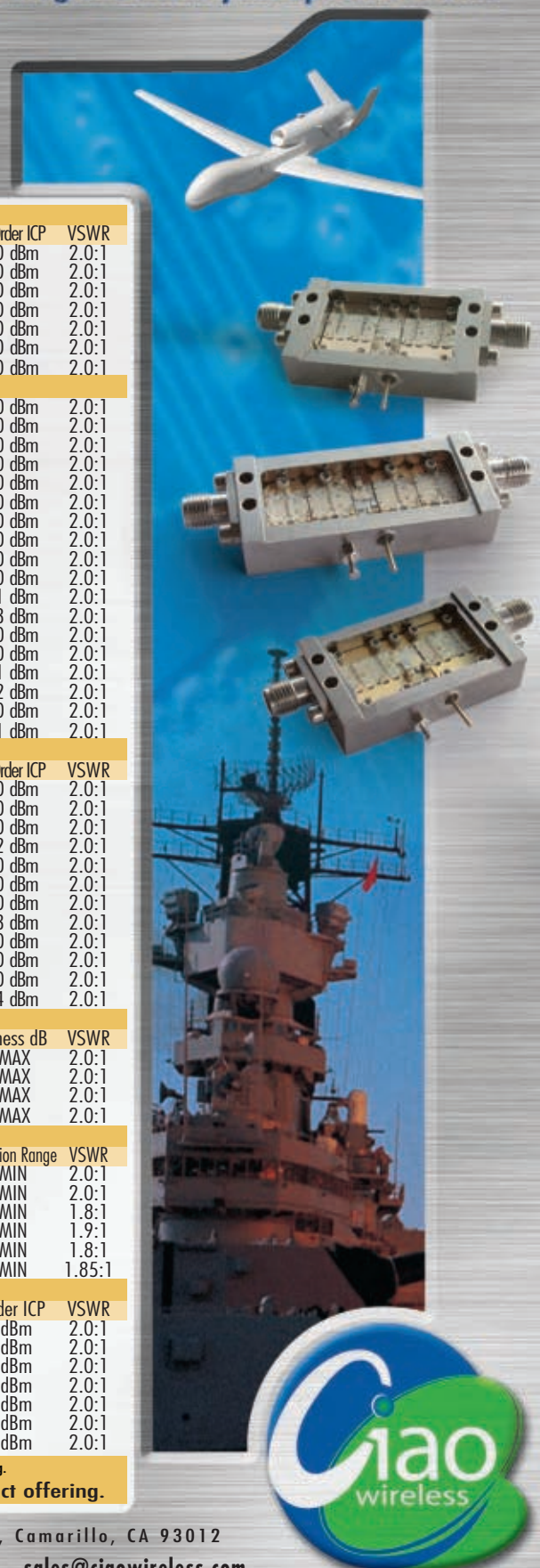

OCTAVE BAND LOW NOISE AMPLIFIERS

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

NARROW BAND LOW NOISE AND MEDIUM POWER AMPLIFIERS

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

ULTRA-BROADBAND & MULTI-OCTAVE BAND AMPLIFIERS

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

LIMITING AMPLIFIERS

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

AMPLIFIERS WITH INTEGRATED GAIN ATTENUATION

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

LOW FREQUENCY AMPLIFIERS

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

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Lockheed Martin's Guided MLRS Reaches New Distance Record

Lockheed Martin successfully fired a US Army Guided Multiple Launch Rocket System (GMLRS) rocket 92 km in a recent test at White Sands Missile Range, NM. The successful test highlighted recent product improvements of this battle-proven system to give it a longer reach, maintaining its accuracy and effectiveness while minimizing potential collateral damage.

Firing crews for the launch were from the 5th Battalion, 3rd Field Artillery from Fort Lewis, WA. This test firing of a unitary GMLRS met all mission objectives, which included:

- Verify production of GMLRS and HIMARS production lines;
- Validate rocket and launcher reliability;
- Provide performance of system software; and
- Obtain performance, technical and reliability data.

GMLRS is a combat-proven evolutionary family of rockets that also scored numerous successes again in Operation Iraqi Freedom and Operation Enduring Freedom, where more than 1,200 have been fired by the US Army and Marine Corps, and British Army artillery in Afghanistan and Iraq. The GMLRS system, in combat, has maintained a reliability rating of over 98 percent.

GMLRS is a premier long-range rocket artillery round designed specifically for destroying high-priority targets at ranges of 70 km and beyond. Successfully employed in both urban and non-urban environments, it is able to operate in all climate and light conditions while remaining beyond the range of most conventional weapons. Each GMLRS is packaged in a MLRS launch pod and is fired from the MLRS Family of Launchers.

The GMLRS rocket used in this test was fired from a High Mobility Artillery Rocket System (HIMARS) launcher, the newest member of the MLRS launcher family. HIMARS can accommodate the entire family of MLRS munitions, including all variants of the Guided MLRS rocket and Army Tactical Missile System (ATACMS) missiles. Designed to enable troops to engage and defeat artillery, air defense concentrations, trucks, light armor and personnel carriers, as well as support troop and supply concentrations, HIMARS can launch its missiles and move away from the launch area before enemy forces locate the launch site. HIMARS can be transported by C-130 "Hercules" aircraft, which allows HIMARS to be deployed into areas inaccessible to heavier launchers, and is a force multiplier to the units it supports.

GMLRS is an international cooperative program among the United States, France, Germany, Italy and the United Kingdom. Other international customers include the United Arab Emirates and Singapore.

Raytheon Awarded More than $100 M for New Missile Defense System

Raytheon Co. was awarded two contracts worth in excess of $100 M by Rafael Advanced Defense Systems Ltd. to design and develop the David's Sling Weapon System. The DSWS is a joint program between the Missile Defense Agency and the Israel Missile Defense Organization. The system will defeat short-range ballistic missiles, large-caliber rockets and cruise missiles in their terminal phase of flight.

The first contract was awarded to co-develop the Stunner Interceptor, the missile component of the DSWS. Stunner is an advanced hit-to-kill interceptor designed for insertion into the DSWS and allied integrated air and missile defense systems. The second contract was awarded for the development, production and integrated logistics support of the missile firing unit, the launcher component of the DSWS. The MFU will provide the DSWS with vertical interceptor launch capability for 360° extended air and missile defense.

"Large-caliber rockets and short-range ballistic missile threats are inexpensive, plentiful, easily concealed and largely exempt from international arms control accords," said Mike Booen, Raytheon's Vice President of Advanced Security and Directed Energy Systems. Employable in a variety of engagement scenarios that combine ground-, sea- and air-based sensors, Stunner offers substantial operational and deployment flexibility. "Rafael and Raytheon are responding to the worldwide demand for affordable missile defense by co-developing a next-generation hit-to-kill interceptor," said David Stemer, Rafael's Missile Division General Manager. "The Stunner interceptor redefines the performance-cost value equation for terminal missile defense and provides all-weather hit-to-kill performance at a tactical missile price."

Northrop Grumman Continues Pursuit of Electronic Warfare

Northrop Grumman Corp. has submitted its proposal for the Technology Maturation phase in the US Navy's competition to develop and field the Next Generation Jammer (NGJ). The jammer will complete the Navy's fielding of a flexible, adaptable weapon that will help defeat enemies on the electronic battlefield, whose weapons can range from those developed in defense laboratories to weapons procured from the corner store. The company estimates that the eventual NGJ production program value could be hundreds of millions of dollars or more to the winning competitor.

NGJ will function as the "shooting end" for the new Northrop Grumman-built airborne electronic attack weap-

DEFENSE NEWS

on system on board the EA-18G Growler. It is a critical replacement for the pre-digital ALQ-99 jamming system that, though still effective, faces diminishing availability of components and capabilities in the face of digital threats that improve and adapt almost daily.

"The first shot fired in a conflict is no longer a bullet. It's an electron," said Stephen Hogan, Vice President of Northrop Grumman Information Operations and Electronic Attack. "We saw how the Russians used electronic attack in Georgia, and we see every day how terrorists operate, using store-bought electronics to harm our soldiers and innocent bystanders.

"Northrop Grumman essentially invented airborne electronic attack five decades ago to protect our military, and we recently won awards for our new system for the Growlers. We understand this kind of warfare and have the new ideas to deliver the Next Generation Jammer on time and within budget," said Hogan.

The Navy is expected to select up to four competing teams for NGJ Technology Maturation contracts in the first quarter of 2010. These teams would refine their system concepts and components in preparation for a down select in 2011, when the Navy is expected to award two Technology Demonstration contracts that will incorporate the best of all the proposed technologies. The Navy plans to award an Engineering and Manufacturing Development contract to a single supplier in the fourth quarter of 2012.

Harris Awarded Technical Support Contract for US Air Force

Harris Corp. has been awarded a potential three-year, $7.5 M contract to provide technical and support services—including information assurance, development testing, configuration management and training—for the US Air Force Air Mobility Command's (AMC) command and control systems.

Systems and programs within the command and control structure include the Advanced Computer Flight Plan, L-band Satcom, Commercial Operations Integrated System, Consolidated Air Mobility Planning System, Global Air Transportation Execution System, Worldwide Port System, Global Command and Control System, and Global Decision Support. Harris is one of three subcontractors to Computer Sciences Corp. (CSC) on the Applications Infrastructure and Systems Support (AISS) contract.

The AISS contract has a three-month base period with three, one-year options. Harris will lead architecture planning and design, information assurance, and network support. Prior to this award, Harris provided information systems and development support for several command and control, and business systems for AMC.

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20 - 45 MHz, minimum	≥ 40 dB @ 60 MHz & ≥ 50 dB @ 90 - 600 MHz
20 - 75 MHz, minimum	≥ 40 dB @ 90 MHz & ≥ 50 dB @ 135 - 600 MHz
20 - 115 MHz, minimum	≥ 40 dB @ 150 MHz & ≥ 50 dB @ 250 - 600 MHz
20 - 150 MHz, minimum	≥ 40 dB @ 200 MHz & ≥ 50 dB @ 300 - 600 MHz
20 - 220 MHz, minimum	≥ 40 dB @ 300 MHz & ≥ 50 dB @ 450 - 900 MHz
20 - 335 MHz, minimum	≥ 40 dB @ 440 MHz & ≥ 50 dB @ 660 - 1400 MHz
20 - 500 MHz, minimum	≥ 35 dB @ 670 MHz & ≥ 50 dB @ 1005 - 2000 MHz
20 - 700 MHz, minimum	≥ 40 dB @ 980 MHz & ≥ 50 dB @ 1470 - 2000 MHz
20 - 1010 MHz, minimum	≥ 35 dB @ 1400 MHz & ≥ 50 dB @ 2100 - 3000 MHz
20 - 1400 MHz, minimum	≥ 40 dB @ 2000 MHz & ≥ 50 dB @ 3000 - 4200 MHz
20 - 2000 MHz, minimum	≥ 40 dB @ 2800 MHz & ≥ 50 dB @ 4200 - 5000 MHz
20 - 3000 MHz, minimum	≥ 40 dB @ 3940 MHz & ≥ 50 dB @ 5910 - 6000 MHz

Common Specifications

- IL: ≤ 0.3 dB @ PB
- VSWR: ≤ 1.25:1 @ Passband
- Power: 2000 W CW
- Connectors: SC or Type N

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Europe-China Standards Platform Launched

The new Europe-China Standards Information Platform (CESIP) designed by the Sustainable Development Association (SDA) with the support of the European Commission and the European Free Trade Association (EFTA) has been launched.

Aimed particularly at SMEs, the portal—http://eu-china-standards.eu—is a valuable source of information regarding the relevant regulatory regime, standards and standardization systems in Europe and in China. Businesses have free access to this powerful search engine to easily and quickly find the standard references needed for their products. The information and the searches can be carried out in English and Chinese and the tool aims to facilitate trade between both regions.

Considerable added value of this portal for European Industry is that the search on Chinese standards is not only limited to national standards (voluntary and mandatory), but also to the relevant industry (sector) standards. Normally, these are more difficult to obtain for foreign companies wanting to do business with China.

The platform currently includes information on four sectors (Electrical Appliances, Machinery, Medical Devices and Environmental Protection). The portal will be complemented by other sectors once the Standardization Administration of China (SAC) and the European Standardization Organizations CEN, CENELEC and ETSI in Europe take over the platform with the support of the European Commission and EFTA.

ETSI Begins Standardization of Reconfigurable Radio

Following the completion of a phase of feasibility studies, standardization of Reconfigurable Radio Systems (RRS) is underway. The initial phase of the work, carried out by ETSI's RRS Technical Committee, has resulted in a series of ETSI Technical Reports that examine the standardization needs and opportunities. They include architectural and implementation aspects of RRS, as well as specific user requirements in the context of public safety communications. The principal Technical Report in this series summarizes the feasibility studies carried out by the committee and presents its recommended topics for standardization.

Reconfigurable Radio Systems are based on technologies such as Software Defined Radio (SDR) and Cognitive Radio whose systems exploit the capabilities of reconfigurable radio and networks for self-adaptation to a dynamically-changing environment with the aim of ensuring end-to-end connectivity.

Faced with increasing global data traffic volumes, regulators have started to consider allowing wireless data devices to operate as secondary users on spectrum bands. Thus, network operators are building composite wireless networks to provide access to multiple services. Typical user devices may contain several radios and it is becoming increasingly vital to coordinate the operation of these different radios and systems to minimize cost and make efficient energy use of the overall radio communications capacity. Therefore, creating effective, standardized RRS solutions is essential.

As part of its work, the ETSI committee is addressing the critical area of public safety communications, which are currently characterized by patchworks of separate, often incompatible systems with widely varying capabilities. The application of dynamic spectrum management, cognitive radio and SDR can provide solutions for the required interoperability of such systems, which often operate in uncertain and changing operational scenarios, and maximize the use of the very limited radio spectrum usually assigned to these services. Apart from bringing improved operational capabilities, these techniques also offer increased system flexibility and the ability to adapt to evolving technologies.

Major Investment in BioP@ss European Research Project

Chip manufacturers Infineon Technologies AG and NXP Semiconductors Germany GmbH and chip card maker Giesecke & Devrient GmbH are among the 11 companies from six European Union countries participating in the European research project BioP@ss to develop a high-security chip card platform. BioP@ss is the biggest chip card research project in the EU. Its goal is to do the technical spadework for the introduction of an electronic ID card in chip card format valid throughout the entire EU.

The BioP@ss research project entails the further development of the security chips, the card operating system and the security software for the Internet PCs used by citizens and public authorities alike. The aim is to ensure that the chips, operating systems and software conform to the various national ID document standards already developed by EU member states.

In their contribution to the BioP@ss project, the two semiconductor companies Infineon and NXP are working on refining encryption technologies for chips. Another main focus is to enhance the data transfer rates between chip card and reader. G&D is developing an innovative chip card operating system that will allow the chip cards to be used with Internet PCs without the need to install additional software components.

The BioP@ss research project has a total budget of some €13 M, half of which is being provided by the participating partners from business and industry.

Bell Labs and SK Telecom Take Next Technological Step

SK Telecom and Bell Labs, the research arm of Alcatel-Lucent, have signed a Memorandum of Understanding that provides a framework for research projects in next generation communications networking. In the area of wireless technology, one potential project involves the two companies working toward defining what the shape of wireless networks, in particular the applications running on those networks, will look like beyond the 4G networks that network operators are intending to launch over the next few years.

Through this cooperative relationship, both SK Telecom and Bell Labs can realize their complementary interests. The former expects to collaborate in core technologies such as interference control, network automation and virtualization in a multi-network environment, which will contribute to optimizing network transmission as well as reducing network maintenance costs. The project will also serve as a platform for Bell Labs to deepen its capabilities in emerging technology areas and broaden the scope of its research programme in Korea.

CNRS Establishes CINTRA Research in Asia

The French National Centre for Scientific Research (CNRS), Singapore's Nanyang Technological University (NTU) and Thales have established a joint international research unit (Unité Mixte Internationale) called the CNRS International – NTU – Thales Research Alliance (CINTRA). Based in Singapore, the new unit will conduct research into nanotechnologies for electronics, photonics and related applications.

The new research unit illustrates to the partners' ongoing efforts to promote cooperation between academic and industry researchers in France and Singapore, and will make a significant contribution to strengthening pathways between technological breakthroughs and innovation in industry.

The partners will focus their research on nanocomponents and the new circuit architectures needed to overcome current limitations. They will work together to develop new technologies supporting co-integration of electronic and photonic components on a single substrate to leverage the properties of both and meet future requirements in the field of communications, computing and sensors.

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CBL-1.5FT-SMSM+	SMA	1.5	0.7	27	68.95
CBL-2FT-SMSM+	SMA	2	1.1	27	69.95
CBL-3FT-SMSM+	SMA	3	1.5	27	72.95
CBL-4FT-SMSM+	SMA	4	1.9	27	75.95
CBL-5FT-SMSM+	SMA	5	2.5	27	77.95
CBL-6FT-SMSM+	SMA	6	3.0	27	79.95
CBL-10FT-SMSM+	SMA	10	4.8	27	87.95
CBL-12FT-SMSM+	SMA	12	5.9	27	91.95
CBL-15FT-SMSM+	SMA	15	7.3	27	100.95
CBL-25FT-SMSM+	SMA	25	11.7	27	139.95
CBL-2FT-SMNM+	SMA to N-Type	2	1.1	27	99.95
CBL-3FT-SMNM+	SMA to N-Type	3	1.5	27	104.95
CBL-4FT-SMNM+	SMA to N-Type	4	1.9	27	112.95
CBL-6FT-SMNM+	SMA to N-Type	6	3.0	27	114.95
CBL-15FT-SMNM+	SMA to N-Type	15	7.3	27	156.95
CBL-2FT-NMNM+	N-Type	2	1.1	27	102.95
CBL-3FT-NMNM+	N-Type	3	1.5	27	105.95
CBL-6FT-NMNM+	N-Type	6	3.0	27	112.95
CBL-10FT-NMNM+	N-Type	10	4.7	27	156.95
CBL-15FT-NMNM+	N-Type	15	7.3	27	164.95
CBL-20FT-NMNM+	N-Type	20	9.4	27	178.95
CBL-25FT-NMNM+	N-Type	25	11.7	27	199.95
		Female to Male			
CBL-3FT-SFSM+	SMA-F to SMA-M	3	1.5	27	93.95
CBL-2FT-SFNM+	SMA-F to N-M	2	1.1	27	119.95
CBL-3FT-SFNM+	SMA-F to N-M	3	1.5	27	124.95
CBL-6FT-SFNM+	SMA-F to N-M	6	3.0	27	146.95
ARMORED CABLES		Male to Male			
APC-6FT-NM-NM+	N-Type	6	3.0	27	181.95
APC-10FT-NM-NM+	N-Type	10	4.8	27	208.95
APC-15FT-NM-NM+	N-Type	15	7.3	27	243.95

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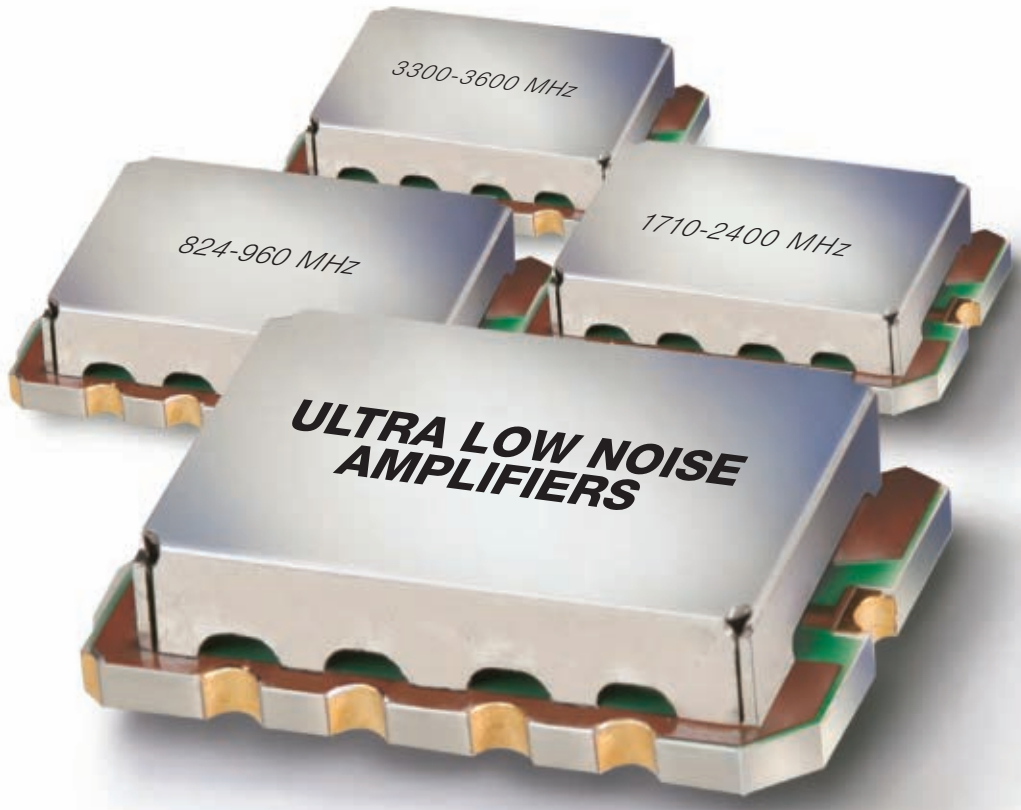

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The TAMPs do not require any external elements, are unconditionally stable, and are matched to 50Ω input/output. They're the ideal mix of flexibility, efficiency, and price and come in a single, integrated component ready to drop-in to your assembly board.

TAMP Typical Specifications

MODEL	Frequency, GHz	NF dB	Gain dB	Max Output dBm	Price $ (5-49)
TAMP-960LN+	.82-.96	0.55	18.0	16.5	9.95
TAMP-242LN+	1.7-2.4	0.65	13.0	17.0	9.95
TAMP-242GLN+	1.7-2.4	0.85	30.0	20.0	13.95
TAMP-272LN+	2.3-2.7	0.90	14.0	18.0	9.95
TAMP-362LN+	3.3-3.6	0.90	12.0	11.0	10.95
TAMP-362GLN+	3.3-3.6	0.90	20.0	16.0	14.95
TAMP-Custom	Customer to specify				

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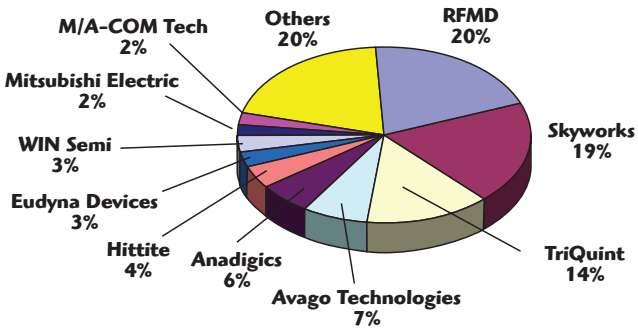
Avago, Eudyna and WIN Shake Up GaAs Rankings

Avago Technologies, Eudyna Devices and Taiwan's WIN Semiconductor made impressive gains in GaAs market share in 2008, ascending the top-ten list in the annual Strategy Analytics ranking of the world's leading GaAs companies. RF Micro Devices remains the leading GaAs vendor by revenue, but its closest rivals—Skyworks Solutions and TriQuint Semiconductor—are pushing this market leader hard. Lower down the ranks:

- Avago Technologies overtook Anadigics as the fourth-ranked supplier in 2008;
- Eudyna stole Mitsubishi Electric's position as the leading Japanese GaAs vendor;
- Fast-growing WIN Semiconductor is neck-and-neck with TriQuint as the largest supplier of GaAs foundry services.

GaAs Device Market Share 2008 (courtesy of Strategy Analytics)



"Despite the onset of the global financial crisis, the GaAs industry grew 8 percent to reach a total value of $4 B," said Asif Anwar, Director of the Strategy Analytics GaAs service. "Although the end of the year saw production slump to a near-standstill, Strategy Analytics believes that the GaAs industry hit bottom during the first half of 2009, and has since recovered its former momentum, with no major casualties resulting from the global recession."

Other findings from "GaAs Device Vendor Market Share 2008: North America" and "GaAs Device Vendor Market Share 2008: Asia Pacific and Europe," include:

- M/A-COM will benefit from its ownership change, and this will help the company challenge competitors moving forwards;
- Revenues at Japanese GaAs device manufacturers increased sharply; and
- UMS cemented its position as the leading European source of GaAs devices.

A-GPS Update

Assisted GPS (A-GPS) improves location determination by obtaining "assistance" data from a network over the wireless communication channel. The result? Higher position accuracy, quicker location fixes, and improved coverage of service in difficult locations, such as urban and in-building environments. Also, in some cases, position calculations may be offloaded to a remote server, freeing the device's processor to service more critical functions.

Until recently, all industry-defined GPS test methodologies focused on testing the performance of a device over a cabled RF connection, bypassing the GPS antenna and associated circuitry. Consequently, devices that pass all tests in the existing conformance standards may perform poorly in the real world. To determine real world performance of mobile devices with A-GPS, testing needs to include all relevant components.

CTIA – The Wireless Association® recently released Version 3.0 of its Test Plan for Mobile Station Over the Air (OTA) Performance. OTA testing is performed in a controlled radiated environment, called an anechoic chamber, using specialized equipment to provide a known signal to the device under test. A key aspect of this testing is that all signals are transmitted and received wirelessly, as they are in the real world. The arrival of A-GPS OTA testing is a very significant event for the cellular industry and users of mobile devices and will, ultimately, ensure the consumer of a superior end-user experience when using location tracking technology.

To learn more about A-GPS and the wireless OTA test solutions offered by ETS-Lindgren and Spirent Communications, read the white paper available at www.ets-lindgren.com/resources titled "A-GPS Over-The-Air Test Method: Business and Technology Implications" by Michael D. Foegelle of ETS-Lindgren and Ron Borsato of Spirent Communications. For more: www.mwjournal.com/testbench_12010.

Power Amplifier Market on Track for $2.8 B at Four Billion Units

The Strategy Analytics RF & Wireless Component market research service predicts that the market for power amplifiers (PA) in cellphones and related mobile devices will grow to $2.8 B over the next five years, in the report, "Cellular PA Forecast 2009 to 2014."

Demand for cellular PAs declined in the first half of '09 with a slowdown in handset shipments; however, cellular will continue to spread beyond conventional handsets into notebook and netbook computers, and machine-to-machine systems such as automatic meter readers. At the same time, the number of bands used by the typical cellular terminal will continue to increase. Together, these trends promise continued growth in shipments

of cellular terminals and PAs, even as the conventional cellphone market matures and growth slows.

"We estimate that the PA market will reach almost four billion units per year in 2014, even as dual-mode PAs begin to reduce the power amplifier count per cellular terminal," said Chris Taylor, Director of the RF & Wireless Components market research service.

Asif Anwar, Director of the Gallium Arsenide and Compound Semiconductor market research service, added, "Shipments of CMOS PAs will increase over the next five years, but GaAs-based PA modules will continue to dominate the market as cellular moves beyond W-CDMA to LTE."

Personal Navigation Devices Battle GPS-enabled Handset Challenge

The personal navigation device (PND) market is showing signs of maturity as price points decline sharply, consolidation occurs and shipment growth slows, reports In-Stat. In addition, the increasing competition from GPS-enabled mobile phones represents the most significant threat the PND market will face. Nevertheless, stand-alone PND sales will continue to grow over the next five years, albeit at an anemic rate.

"Drivers for continued PND market growth include average selling price declines, automobile manufacturers' desire to offer more affordable navigation options, and the potential growth anticipated from connected PNDs," says Stephanie Ethier, In-Stat analyst. "Connected PNDs, like the recently announced Garmin nuvi 1690, can connect to the Internet and receive dynamic information such as flight updates, gas prices and local weather. These expensive models may be a tough sell in the current struggling economy, however."

Recent research by In-Stat found the following:

- Worldwide unit shipments for PNDs will reach approximately 56 million units in 2012.
- The total silicon opportunity for PNDs will pass $1 B in 2010, before starting to decline. Processors will be the largest semiconductor segment, followed by DRAM and NAND memory.
- Among the semiconductor competitors in this market are Broadcom, Cambridge Silicon Radio (CSR) & SiRF Technology Inc., GloNav/NXP/STMicroelectronics/Ericsson, Infineon, Qualcomm, Samsung Electronics and STMicroelectronics.
- GPS-enabled mobile phone shipments will nearly triple by 2013, compared with 2009.

The research, "Personal Navigation Devices: Worldwide Shipment Growth Continues Despite Increasing Competition from GPS-enabled Handsets," covers the worldwide market for personal navigation devices.

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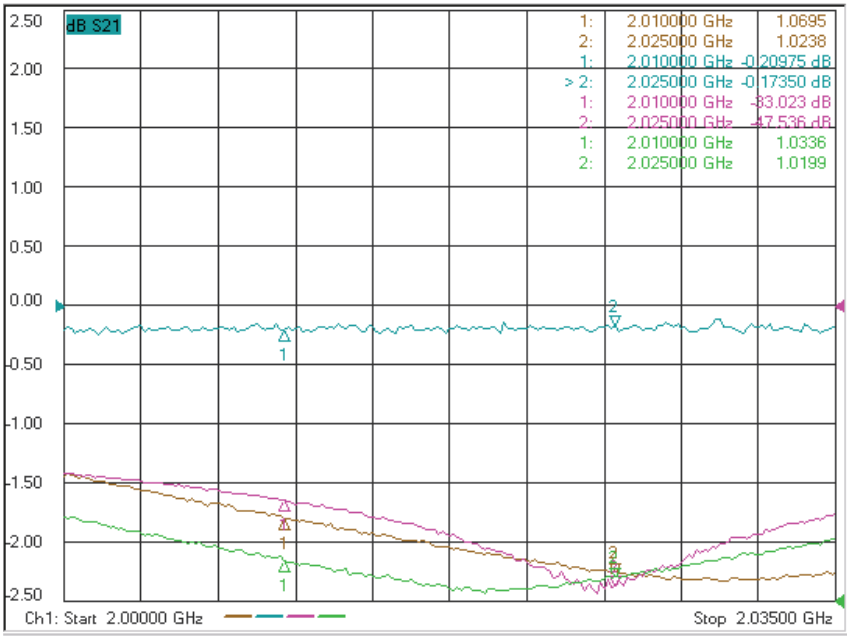

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INDUSTRY NEWS

■ **Raytheon Co.** announced that it has completed its acquisition of **BBN Technologies**, a leader in research and development, and provider of critical solutions for national defense and security missions. The purchase price is approximately $350 M, subject to post-closing adjustments. The transaction will not materially impact Raytheon's sales or earnings per share for the fourth quarter of 2009, and is expected to be accretive in 2010.

■ **Sypris Solutions Inc.** announced that it has completed the sale of its Test & Measurement business to **Tektronix**. Sale of Sypris Test & Measurement Inc. was completed for $39 M of cash on October 26, 2009. Proceeds will be used by Sypris Solutions to support growth of its Aerospace & Defense segment and the retirement debt, among other uses.

■ **Channel Microwave** announced that it has been acquired by **Smiths Group plc**, and will now operate as an independent division of **Lorch Microwave Inc.**

■ **ANADIGICS Inc.** and **WIN Semiconductors Corp.** announced a strategic agreement for the design and manufacture of GaAs microwave monolithic integrated circuits (MMIC). GaAs ICs are used in wireless handsets and data devices that allow people to connect and communicate anywhere, anytime. This relationship forms the cornerstone of ANADIGICS' hybrid manufacturing strategy that provides for a mix of internal and external manufacturing capability to ensure customer demand can be met at all times. WIN has agreed to provide ANADIGICS with GaAs foundry processing services to meet customer demand for its high-performance, radio frequency integrated circuits (IC).

■ **NXP Semiconductors** and **Virage Logic Corp.** announced a strategic agreement that accelerates NXP's move to high performance mixed signal leadership and further broadens Virage Logic's extensive semiconductor IP portfolio. The agreement calls for the transfer of a part of NXP's advanced CMOS intellectual property rights and certain engineering talent and equipment to Virage Logic. Virage Logic will establish an R&D center in Eindhoven providing on-going support to NXP and developing new products based on the acquired advanced CMOS I/O, analog mixed signal and System-on-Chip (SoC) infrastructure IP. These new products are expected to be commercially available in early 2011.

■ **Cascade Microtech Inc.** announced King Abdullah University of Science and Technology's selection of multiple probe stations to support measurements in the area of materials analysis, nano-technologies and semiconductor research. Proven performance capability in multiple microwave and DC applications combined with the flexibility to address diverse applications led this new university to choose Cascade Microtech as a partner in providing the most technologically advanced wafer-probing equipment.

■ **Exalt Communications** announced that **Teton Communications Inc.**, a network operator and two-way radio systems integrator in Eastern Idaho, has standardized on Exalt microwave radio systems to support its backbone network over a 20,000 square-mile service area stretching from Pocatello to Yellowstone. The company has deployed Exalt licensed 6 GHz radio systems on several 20-mile links to date, and intends to replace the legacy gear on its remaining links over time. Teton Communications is also recommending Exalt radio systems to its customers, including public safety organizations and utilities, for their own private network upgrades and expansions.

■ **MFG Galileo Composites**, a specialist in the design and manufacturing of composite radomes and reflectors, announced that manufacturing operations for the company have been relocated from Sparks, NV to Opp, AL. The new built-to-spec facility adds manufacturing capacity and processing capabilities to accommodate increased demand, as well as improving accessibility to a significant percentage of their customer base. The company will maintain a satellite office in Reno, NV, where key engineering and administrative team members will continue to operate from.

■ **Skyworks Solutions Inc.**, an innovator of high reliability analog and mixed signal semiconductors enabling a broad range of end markets, announced that it is powering several of **LG Electronics'** newest multimedia handsets. In particular, Skyworks' front-end solutions are at the heart of LG's GM200, GR500 and KP500, innovative platforms with enhanced touchscreen, audio, camera and messaging functionality.

■ **WIN Semiconductors** announced the availability of a new MMIC tool bar personality for ten Advanced Design System (ADS) process design kits (PDK) for its popular Enhancement/Depletion-Mode PHEMT and HBT process technologies. The new add-on WIN PDKs, developed for use with current and future releases of **Agilent Technologies'** ADS 2009, enable high-frequency RF and microwave designers to create compact integrated circuits comprised of power amplifiers, switches, low noise amplifiers, mixers and logic circuitry. The add-on PDKs are available now from WIN Semiconductors.

■ **The ZigBee® Alliance**, a global ecosystem of companies creating wireless solutions for use in energy management, commercial and consumer applications, congratulates its members who were selected to receive funding for their Smart Grid efforts as part of the United States American Reinvestment and Recovery Act. ZigBee Alliance members received a total of $478,823,415, representing a total investment of more than $1.2 B in smart grid programs with ZigBee Smart Energy as the standard for home area networks.

■ **Lockheed Martin** has elevated preferred supplier **Evans Capacitor Co.** to the Platinum level of Lockheed

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DCO7075-3	**700 - 750**	**0.5 - 3**	**+3 @ 10 mA**	**-108**	
DCO80100-5	**800 - 1000**	**0.5 - 8**	**+5 @ 21 mA**	**-111**	**0.3 x 0.3 x**
DCO100200-5	**1000 - 2000**	**0.5 - 24**	**+5 @ 30 mA**	**-95**	**0.3 x 0.3 x 0.1**
DCO1198-8	**1195 - 1205**	**0.5 - 8**	**+8 @ 24 mA**	**-115**	**0.3 x 0.3 x 0.1**
DCO170340-5	**1700 - 3400**	**0.5 - 24**	**+5 @ 24 mA**	**-90**	**0.3 x 0.3 x 0.1**
DCO200400-5 DCO200400-3	2000 - 4000	0.5 - 18	+5 @ 35 mA +3 @ 35 mA	-90 -89	0.3 x 0.3 x 0.1
DCO300600-5 DCO300600-3	3000 - 6000	0.5 - 18	+5 @ 35 mA +3 @ 35 mA	-80 -78	0.3 x 0.3 x 0.1
DCO400800-5 DCO400800-3	4000 - 8000	0.5 - 18	+5 @ 35 mA +3 @ 35 mA	-78 -76	0.3 x 0.3 x 0.1
DCO432493-5 DCO432493-3	4325 - 4950	0.5 - 11	+5 @ 17 mA +3 @ 17 mA	-88 -86	0.3 x 0.3 x 0.1
DCO473542-5 DCO473542-3	4730 - 5420	0.5 - 22	+5 @ 20 mA +3 @ 20 mA	-88 -86	0.3 x 0.3 x 0.1
DCO490517-5 DCO490517-3	4900 - 5175	0.5 - 5	+5 @ 22 mA +3 @ 22 mA	-88 -86	0.3 x 0.3 x 0.1
DCO495550-5 DCO495550-3	4950 - 5500	0.5 - 12	+5 @ 22 mA +3 @ 22 mA	-87 -85	0.3 x 0.3 x 0.1
DCO608634-5 DCO608634-3	6080 - 6340	0.5 - 5	+5 @ 22 mA +3 @ 22 mA	-86 -84	0.3 x 0.3 x 0.1
DCO615712-5 DCO615712-3	6150 - 7120	0.5 - 18	+5 @ 22 mA +3 @ 22 mA	-85 -83	0.3 x 0.3 x 0.1

Model	Frequency Range (GHz)	Tuning Voltage (VDC)	DC Bias VDC @ I [Typ.]	Phase Noise @ 10 kHz (dBc/Hz) [Typ.]	Size (Inch)
DXO Series					
DXO810900-5 **DXO810900-3**	8.1 - 8.925	0.5 - 15	+5 @ 26 mA +3 @ 26 mA	-82 -80	0.3 x 0.3 x 0.1
DXO900965-5 **DXO900965-3**	9.0 - 9.65	0.5 - 12	+5 @ 22 mA +3 @ 22 mA	-80 -78	0.3 x
DXO10701095-5	10.70 - 10.95	0.5 - 15	+5 @ 21 mA	-82	0.3 x
DXO11441200-5	11.44 - 12.0	0.5 - 15	+5 @ 23 mA	-82	0.3 x
DXO11751220-5	11.75 - 12.2	0.5 - 15	+5 @ 24 mA	-80	0.3 x 0.3 x 0.1

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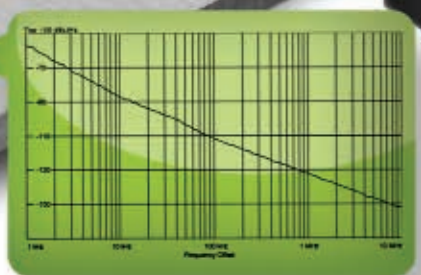
- Patented Technology



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■ **Mimix Broadband Inc.**, a fabless semiconductor company, announced that the company has successfully completed re-certification to ISO 9001:2008. This certificate recognizes all operations in the Houston (US), Belfast (Northern Ireland) and North Sydney (Australia) facilities. Mimix Broadband's subsidiary, Mimix Asia Inc. (Hsinchu, Taiwan), passed its re-certification audit by SGS for ISO 9001:2008 in March of 2009.

■ **Renaissance Electronics Corp.** announced that its Harvard, MA facility has been awarded the AS9100 Aerospace Standard Certification. The AS9100 is the aerospace industry's quality system standard developed by the International Aerospace Quality Group for quality assurance in design, new product introduction (NPI), manufacturing and servicing.

■ **ENS Microwave LLC** announced that it has achieved ISO 9001:2008 certification. ENS is a small, woman-owned manufacturer of high performance flexible and semi-flexible microwave cable assemblies that offers a wide range of cable and connector combinations from DC to 60 GHz with typical lead times of less than four weeks. ENS can also design special connectors to be used within any particular application and can utilize almost any cable type commercially available. All cables are built to customers' specifications and are found in the telecommunication and aerospace industries, while addressing the stringent reliability, environmental, and performance requirements of the RF industry. Visit www.ensmicro.com for more information.

■ **Microtech Inc.**, as part of the company's ongoing continuous quality improvement program, announced it has achieved the AS9100 Aerospace Quality Standard System Certification. Microtech's team received a rating of 92.5 and is now certified to AS9100 and ISO9001: 2000.

■ **Elcom Technologies Inc.** announced the first shipments of its Ka-band up and down SATCOM converters bringing the total number of FlxGen™ SIGINT and SATCOM receivers and converters to over 550. The FlxGen architecture provides high performance RF/MW performance up to 40 GHz in converters and receivers through proprietary RF chain topologies that produce exceptional spurious free dynamic range and signal sensitivity.

CONTRACTS

■ **Cobham plc** announced that its Defence Systems Division has received two delivery order releases valued at $40 M from **Northrop Grumman** for the ongoing supply of its ROVIS (AN/VIC-3) digital vehicular intercom systems for the US Army. All deliveries of the intercom system, which provides enhanced communication and situational awareness to users of armoured and light tactical vehicles including MRAPs, will be made by the end of first quarter 2010.

■ **Comtech Telecommunications Corp.** announced that its Maryland-based subsidiary, Comtech Mobile Datacom Corp., received orders totaling $7.6 M under its Movement Tracking System, or MTS contract, with the US Army. Total orders received to date against the $605.1 M MTS contract increased to $589.8 M.

■ **TriQuint Semiconductor**, an RF products manufacturer and foundry services provider, announced that it has been awarded a $16.2 M Defense Advanced Research Projects Agency (DARPA) multi-year Gallium Nitride (GaN) R&D contract to create complex, high dynamic range circuits for future defense and aerospace applications. TriQuint received its DARPA contract to advance GaN research and develop new generations of compound semiconductor circuits through the Nitride Electronic NeXt-Generation Technology (NEXT) program.

■ **Orbit Technologies**, a leader in the development of advanced solutions for stabilized mobile satellite communication and tracking systems, has announced record orders for its satellite communication products. The company reports second quarter additional orders in excess of $5 M of its marine VSAT systems. According to Orbit, total worldwide VSAT systems orders are expected to exceed $100 M this year.

■ **Comtech Telecommunications Corp.** announced that its Santa Clara, CA-based subsidiary, **Comtech Xicom Technology Inc.**, received orders totaling $1.8 M for ruggedized, high-power, solid-state power amplifiers (SSPA) that will be incorporated into transportable flyaway satellite terminals used by US soldiers stationed overseas in remote areas.

■ **RF Micro Devices Inc.** (RFMD) announced **ZTE** has selected two of RFMD's dual-band transmit modules to support ZTE's S305 GSM handset. The ZTE S305 is a stylish dual-band (GSM 900/1800 MHz or 850/1900 MHz) mobile handset designed for emerging markets.

■ **Orbit Technologies**, a supplier of tracking systems for Israel's defense industry and a leader in satellite communications technology, announced a $3 M order to supply two Israeli defense companies with a range of tracking solutions over the coming year. The deal includes tactical systems for tracking UAVs, systems designed for radar installation integration, and large systems for tracking airborne manned platforms.

■ **AWR** announced that its Simulation Technology and Applied Research (STAAR) division, which develops Analyst™ 3D finite element method (FEM) software, has been awarded three grants for US government-sponsored research projects through the Small Business Innovation Research (SBIR) program. Two of the grants for FEM EM software development are from the US Department of

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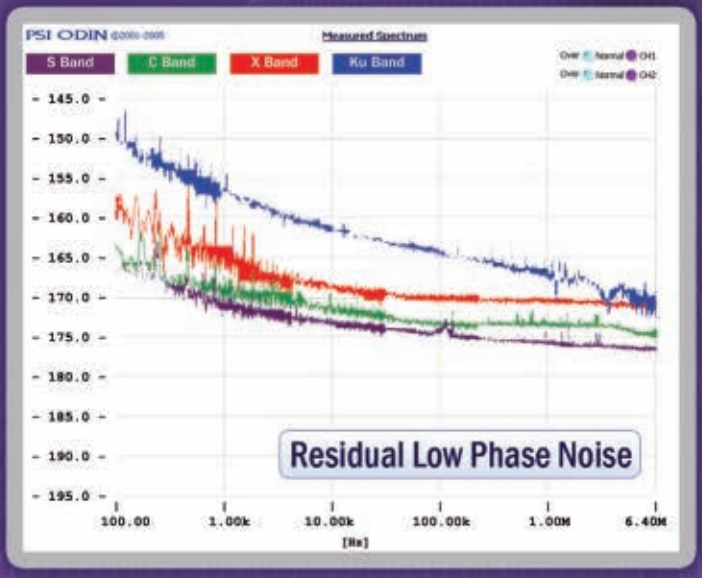

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Energy. One is focused on RF cavity design and the other on current modeling to enable more rapid evaluation and design iteration of next-generation light sources and particle colliders. The third, awarded by the US Navy, focuses on improving emission/ionization algorithms of 3D FEM technology in the 80 to 300 GHz range.

■ **Ducommun Inc.** announced that its Ducommun AeroStructures Inc. (DAS) subsidiary has definitized a follow-on contract with **The Boeing Co.** to provide fuselage skins for the C-17 Globemaster III military transport aircraft through the fourth quarter of 2010.

■ **RFaxis** announced that **Jorjin Technologies** has selected RFaxis' RF Front-end Integrated Circuits (RFeIC) and embedded antennas for integration into its family of wireless module system-in-package (SiP) soloutions. In related news, RFaxis announced that it has selected **IBM Microelectronics** to manufacture its fully integrated, single-chip, single-die RFeICs. The RFeICs will be manufactured using IBM Microelectronics' BiCMOS process technology at its semiconductor facility in Burlington, VT.

■ **AMC** recently contracted with **ARA** to provide the newly-developed Remote Automated Portable Intrusion Detection (RAPID) system, providing a wide area surveillance and perimeter security capability for AMC bases. Three RAPID systems will be deployed to Grand Forks Air Force Base in North Dakota, home of the 319th Air Refueling Wing, and one system will be located to Scott Air Force Base in Illinois, home of the 375th Air Mobility Wing. The systems will be used for wide area intrusion and assessment around the bases' flight lines.

■ **AR Modular RF** recently announced the completion of a new 50 W auto-tuning, multi-band tactical booster amplifier, designed to make it easy for troops to maintain constant, reliable communications in even the worst environments. The new AR-50 booster amplifier boosts tactical radio signals from handheld and back-pack transceivers operating in the 30 to 512 MHz band.

PERSONNEL

■ Endwave Corp. announced that **Ed Keible** will step down as Vice Chairman, Chief Executive Officer and Director effective November 30, 2009. The Board of Directors named John Mikulsky as President and Chief Executive Officer succeeding Keible. The board also elected Mikulsky to the Board of Directors effective December 1, 2009. Mikulsky is currently Endwave's President and Chief Operating Officer. Mikulsky began his Endwave career in 1996 holding key positions in marketing, business development and product development. In July of this year, Mikulsky was appointed President and Chief Operating Officer responsible for the company's operations and technology.

■ M/A-COM Technology Solutions Inc. (M/A-COM Tech) announced that **Michael (Mike) Murphy** has joined the company as Vice President of Engineering reporting to

▲ *Mike Murphy*

Chief Executive Officer Joseph G. Thomas. He will lead new technology and product development efforts for the company. Murphy will have the lead in setting policy in many areas as well as R&D project tracking and reporting. Working with M/A-COM's global technical community, he will play a key role in developing and executing on the company's new product growth strategy. Most recently he served as Vice President of Engineering of TriQuint Semiconductor's Networks and Standard Products Business Unit. Prior to that Murphy led TriQuint's New England Design Center, which he initially launched for Infineon Technologies in 1999.

■ **Gary Tilley** has joined ZTEC Instruments as Vice President of Sales and Marketing. Tilley will help establish a larger market presence for ZTEC Instruments globally and grow into adjacent markets. Previously, Tilley was responsible for managing one of the largest global accounts at Teradyne Inc. Prior to joining Teradyne, he was a Senior Director at Novellus Systems and a Vice President at LTX Corp. (now LTX-Credence).

■ Lime Microsystems has appointed **Dan Rabinovitsj** as Non-executive Director. He brings 20 years of experience in general management and marketing of mixed-signal and analog communications ICs, having held management positions at companies such as ST-Ericsson, NXP, AMD and Silicon Laboratories, where he was a founding member of the wireless products business unit in 1998 and went on to lead the development of the AeroFone single-chip product.

▲ *Dan Rabinovitsj*

■ M/A-COM Technology Solutions recently announced the addition of **Phillip (Phil) Stathas** to its leadership team as Director of Information Technology (IT). Stathas is responsible for directing all IT activities throughout the company's global organization. He has more than 27 years of experience in the semiconductor, components and high volume manufacturing industry. Nine of those years were spent with M/A-COM, where he directed the company's management information systems activities.

■ Microtech announced that **Matthew Underhay** has joined Microtech Inc.'s team as Sales and Marketing Manager. Underhay has over 12 years in the telecommunications industry with leaders such as Andrew Corp., Alcatel-Lucent and Com Dev International. Underhay is tasked with strengthening Microtech's product catalog, market position and establishing a long-term sales strategy. Additionally, he will focus on strengthening day-to-day operations within the Sales Department team, streamlining current contact management tools to minimize redundancies and enrich customer service.

REP APPOINTMENTS

■ **Richardson Electronics Ltd.**, an electronics components distributor with strong local support and a key pres-

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ence in all major markets worldwide, announced that it is stocking and delivering **Vincotech**'s newest complete GPS receiver system solutions, the A1084-A and A1084-B receiver modules and the A1035-H receiver/antenna module.

■ **International Manufacturing Services Inc.** (IMS), a manufacturer and supplier of high quality thick and thin film resistors, terminations, attenuators, planar dividers, planar filters and thermal management devices to the electronics industry, announced the appointment of **TX Sales** as its Midwestern representative. TX Sales, located in Fort Wayne, IN, has nearly 40 years of sales and marketing experience in the electronics industry. TX Sales will be representing IMS products in the states of Indiana, Ohio, Michigan, Kentucky and Western Pennsylvania. More information about TX Sales may be found at www.txsales.com.

■ **Duplex CSA Ltd.**, a supplier of industry standard and custom-made RF connector solutions, shielding products and cable assemblies for the telecommunications, cable/satellite and related industries, announced the appointment of **Connector Specialists Inc.** as the company's authorized sales representative for the southwestern US region, including the states of Texas, Oklahoma, Arkansas, Louisiana, New Mexico and Mexico territory. Connector Specialists has over 20 years of direct sales and engineering experience specializing in connectors, cable, antennas, switches, relays and related electromechanical/packaging products. Contact Rick Prindle at (972) 396-0066 or via e-mail at RPrin81855@aol.com.

■ **ZeroG Wireless Inc.**, an innovator in low-power embedded Wi-Fi design, announced that it has signed a distribution agreement with **Avnet Express**, part of Avnet Electronics Marketing, an operating group of Avnet Inc. Under the terms of the agreement, Avnet will distribute ZeroG Wireless' embedded Wi-Fi products through the Avnet Express Web-based distribution service. The ZeroG Wireless products are available for order and shipment today.

■ **Reactel Inc.**, a manufacturer of RF and microwave filters, multiplexers, switched filter banks, and multi-function assemblies to the commercial, military, industrial and medical industries, announced the appointment of REL as the company's exclusive representative in the Czech Republic. For more information about REL, please contact Frantisek Remta at remta@volny.cz.

■ **Linx Technologies Inc.** recently announced the appointment of **World Micro Inc.** as a stocking distributor.

WEB SITE

■ **RF Micro Devices Inc.** (RFMD) announced the launch of a new online store offering new features and functionality that significantly enhance the e-commerce experience and streamline the selection and ordering of samples and volume shipments. The new online store is directly accessible via RFMD's home page at www.rfmd.com and is available immediately for ordering samples, evaluation boards, prototypes and volume production.

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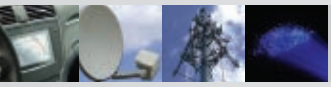

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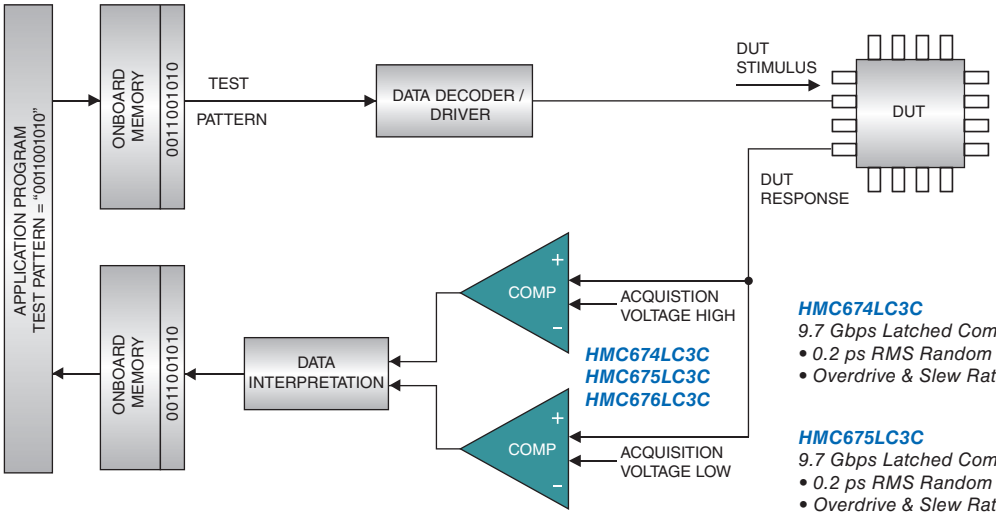
IN-STOCK HIGH SPEED COMPARATORS

	Analog Input B/W (GHz) / Clock Rate (Gpbs)	Function	Deterministic Jitter (ps)	Propagation Delay (ps)	Output Voltage Swing (Vdc)	DC Power Consumption (mW)	Vcco / Vterm [2] Power Supply (Vdc)	Package	Part Number
NEW!	10 / 20	Clocked Comparator - RSPECL	<3	120	0.4	150	+3.3 / +1.3	LC3C	**HMC874LC3C**
NEW!	10 / 20	Clocked Comparator - RSCML	<3	120	0.4	130	0 / 0	LC3C	**HMC875LC3C**
NEW!	10 / 20	Clocked Comparator - RSECL	<3	120	0.4	150	0 / -2.0	LC3C	**HMC876LC3C**
	9.7 / [1]	Latched Comparator - RSPECL	2	85	0.4	140	+3.3 / +1.3	LC3C	**HMC674LC3C**
	9.7 / [1]	Latched Comparator - RSCML	2	100	0.4	100	0 / 0	LC3C	**HMC675LC3C**
	9.7 / [1]	Latched Comparator - RSECL	2	100	0.35	120	0 / -2.0	LC3C	**HMC676LC3C**

[1] Note that HMC674/675/676LC3C is a family of Level Latched Comparators
[2] Vee = -3.0V & Vcci = +3.3V

Automatic Test Equipment (ATE)



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9.7 Gbps Latched Comparator - RSPECL
- *0.2 ps RMS Random Jitter*
- *Overdrive & Slew Rate Dispersion: 10 ps*

HMC675LC3C
9.7 Gbps Latched Comparator - RSCML
- *0.2 ps RMS Random Jitter*
- *Overdrive & Slew Rate Dispersion: 10 ps*

HMC676LC3C
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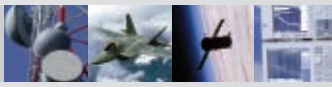

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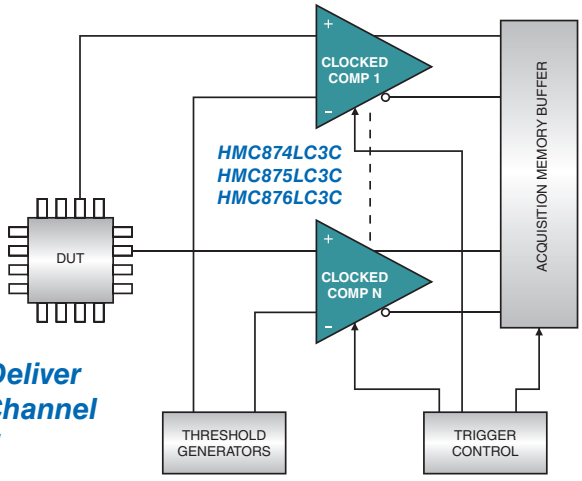

HMC874LC3C
20 Gbps Clocked Comparator - RSPECL
- *0.2 ps RMS Random Jitter*
- *Overdrive & Slew Rate Dispersion: 10 ps*

HMC875LC3C
20 Gbps Clocked Comparator - RSCML
- *0.2 ps RMS Random Jitter*
- *Overdrive & Slew Rate Dispersion: 10 ps*

HMC876LC3C
20 Gbps Clocked Comparator - RSECL
- *0.2 ps RMS Random Jitter*
- *Overdrive & Slew Rate Dispersion: 10 ps*

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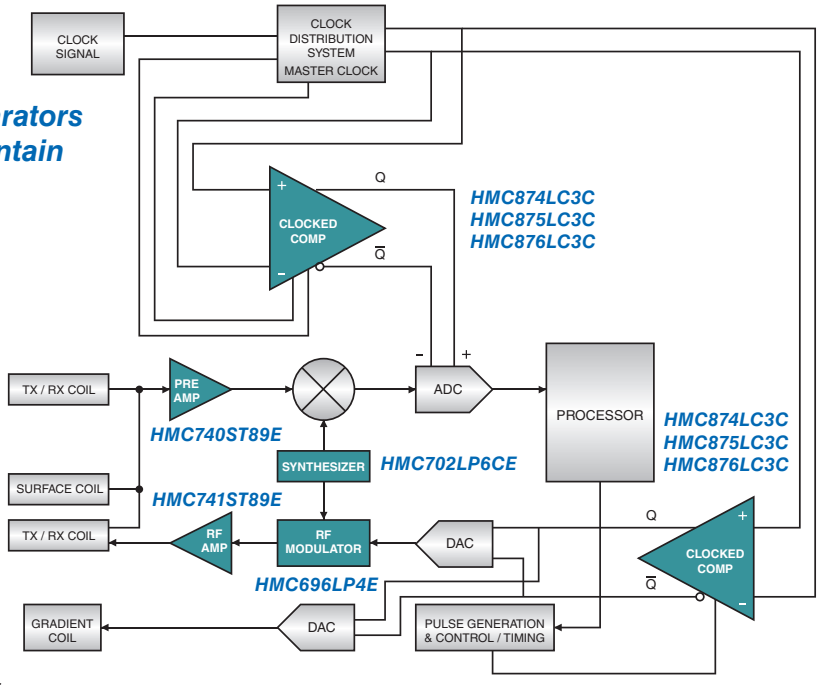
Magnetic Resonance Imaging (MRI)



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TECHNIQUES TO DEMONSTRATE MRI SAFETY OF MEDICAL IMPLANTS

Magnetic resonance imaging (MRI) scans may cause harmful tissue heating in patients with active and passive implants,[1] such as pacemakers, deep brain stimulators, stents and prosthetic implants, as a result of the applied RF magnetic field (B1) of 64 MHz at 1.5T and 128 MHz at 3T. Consequently, patients with implants are preventively excluded from receiving diagnostically valuable MRI scans.

MECHANISM OF RF HEATING IN MR

The two primary mechanisms for coupling the RF energy to the implant are 1) the B1 orthogonal to the implants forms a conductive loop and 2) the induced E-field components in the tissues are tangential to the implant path (without implant present) as a result of the B1 exposure of the patient. The collected RF power over the entire length of the implant may be deposited very locally, e.g. at the tip of implants.

The heating depends on the following parameters:

- B1 rms
- body coil design
- position and posture of the patient in the MR scanner
- outer and inner anatomy of the patient
- implant trajectory
- implant length
- RF properties of the implant
- implant geometry at the location of maximum energy deposition
- 3-D distribution of the energy deposition
- thermal properties (heat capacity, conduction, perfusion, etc.) at the location of energy deposition

This list illustrates the complexity of analyzing worst-case heating even in a defined patient group independent of the scanner.

OBJECTIVES

Patients with active and passive implants will only be able to benefit from MRI diagnostics if the devices are inherently safe under worst-case conditions. This paper describes the possible methods and the available tools to demonstrate with known uncertainty that the induced heating under worst-case conditions is below the threshold of harmful thermal effects.

ANATOMICAL HUMAN MODELS

Since the exposure of the implant is a strong function of the anatomical features, the evaluation must include the anatomies of the entire patient population with respect to age, body mass index (BMI) and height.[2] Small postural

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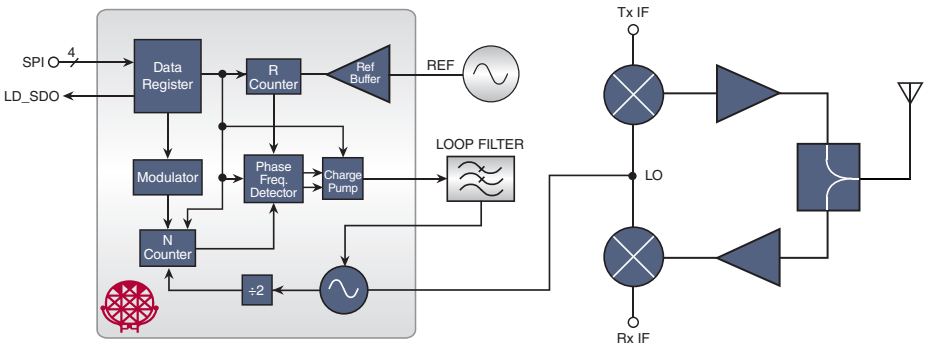

12 NEW IN-STOCK LOW PHASE NOISE PLLs w/ INTEGRATED VCOs

Frequency (GHz)	Closed Loop SSB Phase Noise @10kHz Offset	Open Loop VCO Phase Noise @1MHz Offset	Pout (dBm)	RMS Jitter Fractional Mode (fs)	Integrated PN Fractional Mode (deg rms)	Package	Part Number
0.78 - 0.87	-120 dBc/Hz	-147 dBc/Hz	+12	190	0.05	LP6C	**HMC824LP6CE**
0.99 - 1.105	-118 dBc/Hz	-145 dBc/Hz	+10	190	0.07	LP6C	**HMC826LP6CE**
1.285 - 1.415	-116 dBc/Hz	-142 dBc/Hz	+10	190	0.10	LP6C	**HMC828LP6CE**
1.33 - 1.56	-115 dBc/Hz	-142 dBc/Hz	+10	190	0.10	LP6C	**HMC822LP6CE**
1.72 - 2.08	-113 dBc/Hz	-140 dBc/Hz	+10	190	0.12	LP6C	**HMC821LP6CE**
1.815 - 2.01	-112 dBc/Hz	-141 dBc/Hz	+9	190	0.13	LP6C	**HMC831LP6CE**
2.19 - 2.55	-110 dBc/Hz	-139 dBc/Hz	+10	190	0.17	LP6C	**HMC820LP6CE**
3.365 - 3.705	-107 dBc/Hz	-135 dBc/Hz	0	190	0.25	LP6C	**HMC836LP6CE**
7.3 - 8.2	-102 dBc/Hz	-140 dBc/Hz	+15	196	0.55	LP6C	**HMC764LP6CE**
7.8 - 8.5	-102 dBc/Hz	-139 dBc/Hz	+13	193	0.58	LP6C	**HMC765LP6CE**
11.5 -12.5	-100 dBc/Hz	-134 dBc/Hz	+11	181	0.78	LP6C	**HMC783LP6CE**
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Fig. 1 The Virtual Family: Duke, Ella, Billie and Thelonius.

Fig. 2 The Virtual Classroom: Louis, Dizzy, Eartha and Roberta.

changes may also influence the exposure significantly (e.g. loops formed by arms and legs); therefore, manual manipulation may be necessary to accommodate these changes. If the entire implant inside the model requires evaluation, anatomically correct placement of the implant is also necessary.

The most advanced and suitable models for such investigations are The Virtual Family,[3,4] which was jointly developed by the IT'IS Foundation and the US Food and Drug Administration (FDA). It consists of four full anatomical 3-D surface models of an adult female, an adult male, an 11 year-old girl and a six year-old boy (see ***Figure 1***). The models were developed from high-resolution MR imaging data of four volunteers. All models were reconstructed from several hundred MR-images as three-dimensional surface meshes, thus overcoming the drawbacks of conventional voxel representation. This allows free positioning and rotation of the models in the computational domain. The models contain up to 84 different types of tissues and organs, and can be meshed at arbitrary resolutions without the loss of small features. The Virtual Family is now complemented by The Virtual Classroom (see ***Figure 2***). Another suitable model is the obese adult man (see ***Figure 3***) from Schmid & Partner Engineering AG (SPEAG)[5] that was developed using the same techniques. All models can be fully customized for resolution and posture using SEMCAD X.[6]

Fig. 3 The obese male phantom.

EM MODELING

Numerical modeling techniques such as the conformal finite-difference time domain[7,8] solver from SEMCAD X are commonly used when inhomogeneous, anatomical models require simulations of RF exposure. MRI safety investigations of implants may include detailed RF models of the implants, the complex anatomical models and the RF exposure system. Therefore, sub-millimeter resolution in a several cubic meter domain filled with hundreds of biological sub-domains must be numerically and efficiently solved. This can only be obtained within a reasonable time with innovative simulation techniques.

Figure 4 shows an example of a simulation of a pacemaker implant placed within an anatomical adult model from the Virtual Family inside a 64 MHz RF MRI birdcage coil. The overall simulation of the original 120 million cells can be performed within a few hours and with grid resolutions of much less than one millimeter using a two-step approach (Generalized Huygens Box Method).[7,9] A first simulation of the birdcage without the pacemaker lead is performed using a relatively coarse grid (15 to 20 million cells, graded mesh). The fields are recorded on the surface of a rectangular box, placed at a distance of a few centimeters around the lead wire and the mounting device, and are used to excite a second simulation with the lead present. This second simulation is restricted to the vicinity of the lead and has a graded mesh with maximum refinement at the implant.

TEMPERATURE MODELING

Electromagnetically induced effects in the lead are directly coupled to temperature elevation within the surrounding tissues. For implant safety investigations it is necessary not only to accurately calculate temperature distribution and heating effects at the implant-tissue interface, but also in the surrounding tissue. Blood pooling and various perfusion effects must be evaluated over a large parameter

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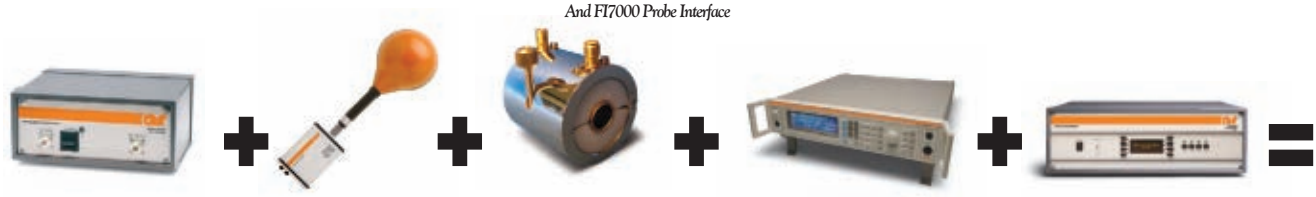

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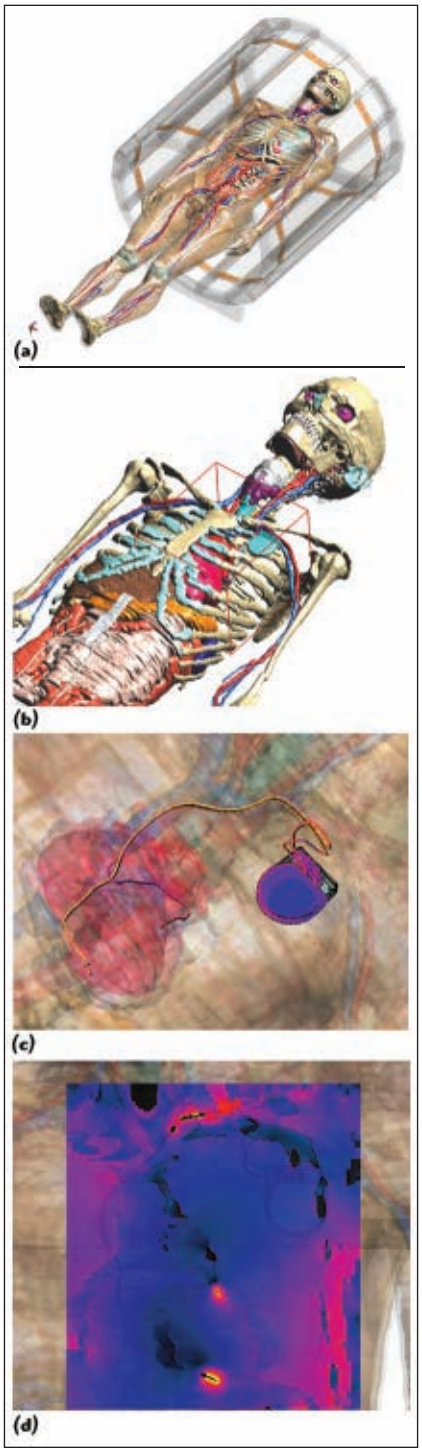
space. Tools like the Thermal Solver from SEMCAD X can generate tensorial perfusion tissue models as well as discrete networks of 1D vessels.

EXPERIMENTAL EVALUATIONS

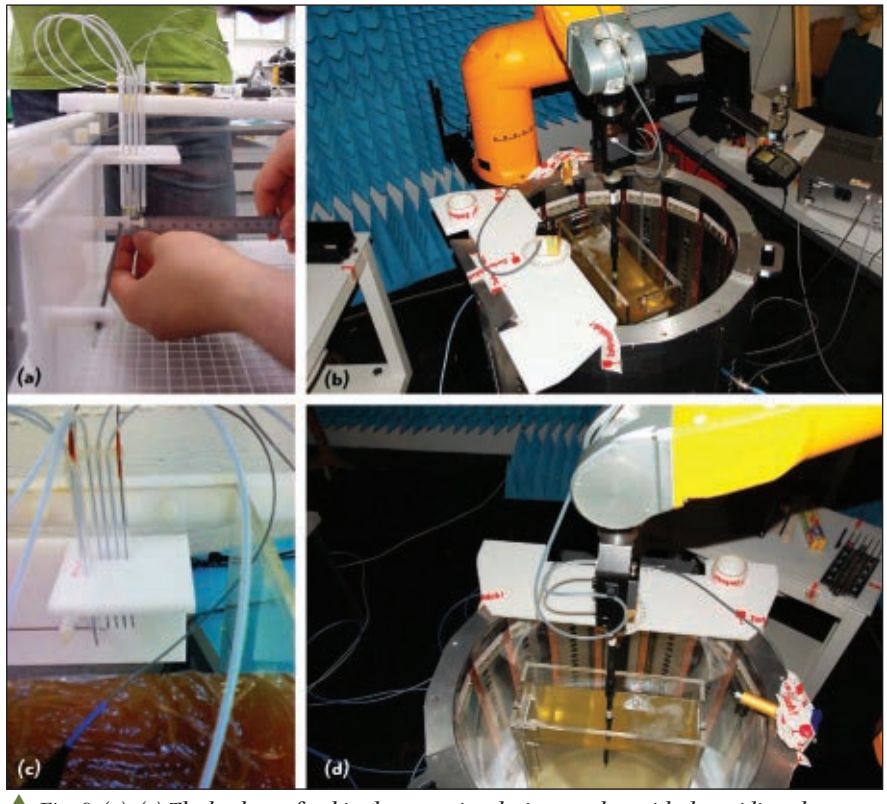
In silico evaluations are key to demonstrating MRI safety, but must be anchored to the real world by additional experimental evaluations, e.g. 1) combined numerical and experimental evaluations and 2) a full numerical evaluation. In the first approach, only the incident field as well as the transformation between energy deposition and in vivo temperature rise are determined by numerical means, whereas the energy deposition is determined experimentally under worst-case incident field conditions. In the second approach, the implant is modeled for the various configurations in all models representing the patient population. Since this approach also requires modeling of the device under test (DUT), the model must be validated experimentally under known exposure conditions.

Test suites such as the MITS 1.5 or the MITS 3.0 from ZMT Zurich MedTech[10] provide a solution to perform experiments under very well-defined field conditions for RF heating and EMC exposure (see ***Figure 5***). The magnitude and polarization are controlled independent of the load using isotopic H-field probes combined with EASY4MRI from SPEAG for MR applications. ASTM,[11] elliptical or cus-



▲ *Fig. 4 Duke (from The Virtual Family) with implanted pacemaker/leads, located inside a 64 MHz RF birdcage (a); Huygens Box (red) around pacemaker (b); induced surface current distribution (c); SAR distribution (d).*

▲ *Fig. 5 Picture of the medical implant test system (MITS 1.5/3.0 from ZMT Zurich MedTech); birdcage in horizontal operation, with ASTM phantom, probes and EASY4MRI measurement equipment (a); birdcage in vertical operation with DASY5NEO near-field-dosimetry scanner (b).*



▲ *Fig. 6 (a), (c) The leads are fixed in the mounting device together with the guiding glass tubes and temperature measurement probes. Some gel is visible in (c); (b) and (d) show the liquid filled phantom in the birdcage coil with the DASY5NEO robot scanning an E-field probe. A lead can be recognized in (d) at the left side of the ASTM phantom.[7]*

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tom-made phantoms filled with high or low conductive media can be positioned inside a 16-rung RF birdcage coil that represents a worst-case approximation of the coils used in available 1.5T and 3T MRI machines. ***Figures 6a*** and ***c*** show an example of an evaluation in an ASTM phantom utilizing a polyoxymethylen (POM) support for positioning temperature probes.[12]

These test suites have the advantage that measurements can be conducted with the birdcage in vertical orientation (see ***Figures 6b*** and ***d***). This permits the application of a dosimetric near-field scanner robot to perform measurements along a predefined path or within a defined volume around the implant during the RF field exposition. This configuration is the setting in which the modeling outcome and measurement results can be compared with highest accuracy and lowest achievable uncertainty. The setup can be used to perform E-field, H-field, specific absorption rate (SAR) and temperature measurements with a robot-scanned grid. ASTM phantoms for vertical use with only the small 'foot'-side open for access or the new oval phantom for implant testing from ZMT can be used in such a configuration. Scanned measurement phantoms should be filled with a liquid, since measurement probes do not have to be embedded at fixed locations. Liquids may follow the new IEC technical specification.[13]

UNCERTAINTY BUDGET

There are various testing and modeling approaches to accommodate the diversity of implant configurations and specific applications are possible. In order to obtain reliable results and consistent evaluations independent of the approach, the uncertainty budget should be determined for a certainty coverage factor of the patient population. Methodologies for determining uncertainty experiments involving quantities that cannot be assessed by statistical means have been developed in the past, e.g. ISO/IEC "Guide to the Expression of Uncertainty in Measurement."[14] It basically splits the total uncertainty into various uncertainty sources, which are independent or with limited interdependence, followed by the determination of the uncertainty from assumed statistical models.

STANDARDIZATION

Due to the limitations of existing ASTM standards and methodologies for compliance testing, a new ISO/IEC standard[13] on active implantable medical devices (AIMD) is currently being drafted to define the measurement and simulation techniques for demonstrating MRI safe implants. The standard will contain sections on exposure systems, measurement setups, probes, testing methodology, uncertainty assessment, and tissue simulating media and reporting.

CONCLUSION

The combined application of numerical modeling and experimental evaluation is the only methodology to demonstrate the MRI safety of implants. As significant progress has been achieved in recent years with

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respect to methodology and instrumentations, regulatory authorities will undoubtedly mandate minimal requirements based on this progress in the review process. ■

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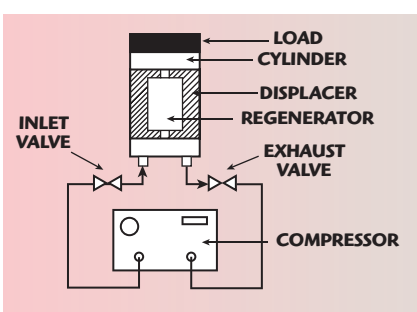
In the past few years, the development of In-based devices has enabled receiver systems with record noise temperatures and low power consumption. Incoming Sb-based devices promise to achieve their lowest noise at even lower power consumption. Both technologies, although not yet mature, are usually adequate for designers working with very low noise requirements and very low power consumption. Nevertheless, for some applications, these requirements are critical and a specific technology has to be applied to fulfill such conditions.

In radioastronomy, the lowest noise of the receiver system is always the cornerstone around which that system is designed, since the required integration time to reach a certain signal-to-noise ratio is proportional to the square of the receiver noise. Usually, the system noise requirements are below 20 K of equivalent noise temperature, T_e, which can only be achieved if the receiver is cooled down to cryogenic temperatures.[1,2]



▲ *Fig. 1 One stage closed-cycle refrigerator scheme.*

In order to design and test the different systems, the microwave engineers working in radioastronomy applications have to design and set-up a cryogenic facility in which to carry out reliable measurements. Therefore, these engineers have to gain knowledge in cryogenic related issues, which are far out of their professional training.

This article deals with practical issues related to designing and setting-up a small cryogenic facility that enables the ability to take reliable measurements. Calculations of the thermal load for designing the cryostat are presented, together with some advice regarding materials, cables and sensors. Finally, the cold-attenuator technique for measuring T_e of available low noise amplifiers (LNA), cooled down to cryogenic temperatures in the designed facility, is described.

CLOSED-CYCLE HELIUM REFRIGERATOR

Achieving such low temperatures is accomplished using commercially available closed-cycle helium refrigerators. These refrigerators are based in the Gifford-McMahon cooling cycle.[3,4] A source of compressed gas is connected to the cylinder through a regenerator and inlet valve (see ***Figure 1***). The regenerator extracts heat from the incoming gas, stores it, and then releases it to the exhaust gas. Another valve is in the exhaust way to the compressor. When

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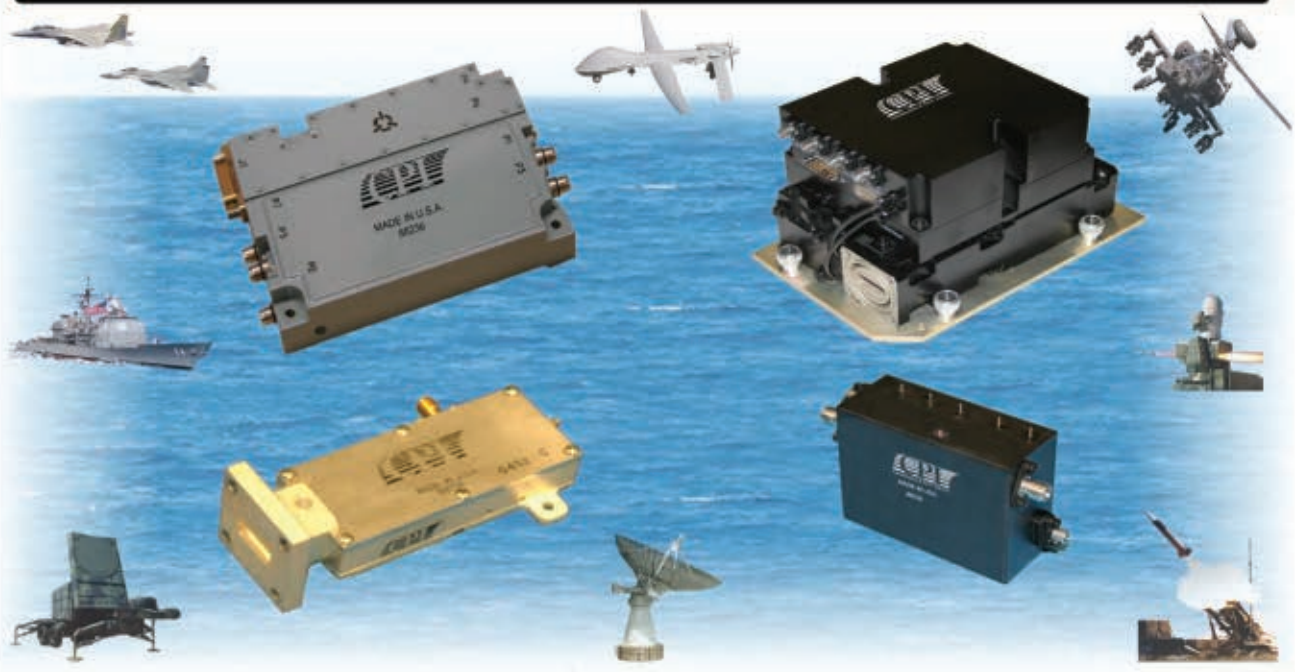

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TABLE I
CHARACTERISTICS OF ARS CRYOGENIC SYSTEMS

	Model	
	DE-202AF	DE-210AE
Minimum Temperature (K)	< 9	< 9
Cooling Power (2nd stage)	0.5W @ 10K 2.5W @ 20K	4W @ 10K 17W @ 20K
Cooling Power (1st stage)	4W @ 77K	60W @ 77K
Cooling Time down to 20K	45 min.	40 min.
Cooling Time down to min. temp.	80 min.	80 min.

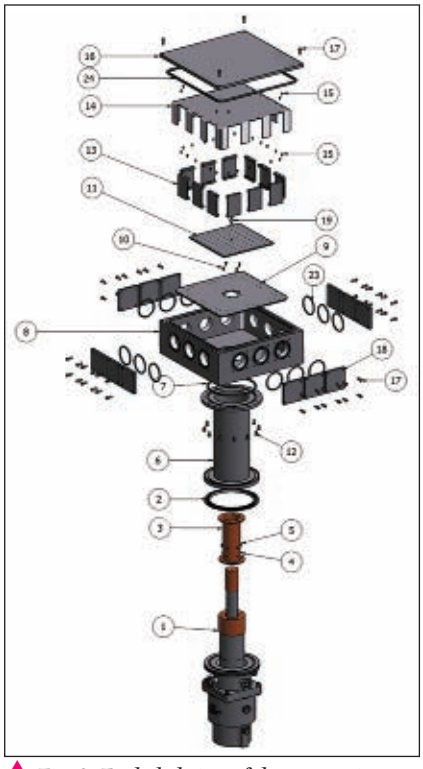

Fig. 2 Exploded view of the cryogenic system.

the inlet valve is open and the exhaust valve closed, the high-pressure gas goes through the regenerator, where it is cooled, then reaches the cylinder, where the displacer inside the cylinder moves to one end of the cylinder. When the inlet valve is closed and the exhaust valve is open, the gas expands and cools the load. The remaining low-pressure gas is pushed to the exhaust way by the displacer, going through the regenerator, from where the gas receives heat. The gas finally reaches the compressor where it is compressed to start the cycle again.

The first problem for the engineer arises when the refrigerator needs to be selected. There are many cryostats available, but all of them are characterized with the thermal load they can cool at the different stages and temperatures. These kinds of refrigerators have two stages. The first stage is usually cooled down to temperatures of approximately 77 K and the second stage, where the circuits are anchored for testing, reaches temperatures down to 10 K. The purpose of the first stage is to isolate the second stage from the hot refrigerator outer walls, which are at room temperature, approximately 296 K.

The selection of the cryostat is based on the cooling power needed by the user; therefore, the total thermal load has to be calculated prior to purchasing the refrigerator. On the other hand, the cryostat has to be known before designing the box (Dewar) where the measurements are going to be carried out. ***Table 1*** shows the main characteristics of two cryogenic systems from Advanced Research Systems (ARS) working at 60 Hz. The model DE-210AE has recently been purchased to overcome the cooling limitations of the former model DE-202AF in the laboratory.

THERMAL LOAD CALCULATION

The following calculations are based on the system shown in ***Figure 2***. This figure shows the refrigerator cold-head for the model DE-210AE together with the designed elements that complete the system: elements 6, 8, 17 and 18 make the Dewar; elements 3, 9, 13 and 14 form the radiation shield in the first stage; and element 11 is the second stage base where the circuits are attached.

To obtain the total thermal load in the system four different mechanisms have to be considered: heat conduction through the coaxial and DC-bias cables; heat radiation between surfaces at different temperatures; heat conduction by the residual gas inside the Dewar; and dissipation due to circuit power consumption.

CONDUCTION THERMAL LOAD CALCULATION

Cryogenic systems involve great temperature gradients. Since the thermal conductivity of materials is variable with temperature, the integral of the thermal conductivity over the temperature range has to be calculated. Equation 1 gives the thermal load due to conduction.[4,5] This equation has to be applied in each element going into the Dewar, generally coaxial and DC-bias cables

$$Q = \frac{A}{L}\left[\int_0^{T_2} K(T)dT - \int_0^{T_1} K(T)dT\right] \qquad (1)$$

where A is the conductor cross-section, L is the conductor length, K(T) is the temperature-dependent thermal conductivity of the material, and T_1 and T_2 are the temperatures at both ends. Plots of the thermal conductivity integrals for common materials are published in the literature.[4,6,7] Moreover, the National Institute of Standards and Technology (NIST) provides equations for the thermal conductivity of common materials.[8] According to Equation 1, small-section and long cables made with low thermal conductivity materials are preferable. For coaxial cables, stainless-steel outer and inner conductors are the best option. If losses are a concern, a BeCu inner conductor may be selected.

RADIATION THERMAL LOAD CALCULATION

Radiation is produced between two bodies within visual range of each other, separated by a medium that does not absorb this energy. The net rate of heat transfer from one surface at T_1 to another surface at T_2 can be calculated from Equation 2[6]

$$Q = \sigma \cdot A_1 \cdot F_A \cdot F_E (T_1^4 - T_2^4) \qquad (2)$$

where σ is the Stefan-Boltzmann constant, 5.67×10^{-8} $Wm^{-2}K^{-4}$, A_1 is the surface area of one of the bodies, F_A is a shape and orientation factor for the two bodies relative to area A_1, and F_E is the emission and absorption factor for the two bodies. If the surface of one body is small or enclosed by the surface of the other body, then $F_A = 1$. The parameter F_E is given by Equation 3

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$$F_E = \frac{\varepsilon_1 \cdot \varepsilon_2}{\varepsilon_2 + \frac{A_1}{A_2}(1-\varepsilon_2)\cdot\varepsilon_1} \quad (3)$$

where ε_1 and ε_2 are the emissivities of the inner and outer surfaces, respectively. These emissivities depend on the temperature and surface finish. ***Table 2*** gives some average values at room temperature for common materials. In general, aluminum and stainless-steel are chosen for Dewar manufacturing. Polished surfaces are preferable since the thermal load reduction, which has to be calculated both at the first and second stage, is noticeable.

CONDUCTION BY RESIDUAL GAS THERMAL LOAD CALCULATION

Once the temperature inside the cryostat is low enough to produce the condensation of the remaining gas, the cryogenic vacuum is reached. In such a situation, the heat exchanged by this kind of conduction is negligible. Therefore, in a well-designed system there is no need to calculate the thermal load due to conduction by residual gas.

On the other hand, if leaks are present in the system, the thermal load due to this process may be dominant over the other loads, making it impossible to reach the desired low temperature. Equation 4[9] gives a simplified way to calculate the heat exchanged between two parallel surfaces of area A at temperatures T_1 and T_2

$$Q = K_1 A \cdot a_0 \cdot P \cdot (T_1 - T_2) \quad (4)$$

where P is the pressure of the remaining gas (in Pascal), a_0 is a non-dimensional coefficient and K_1 is a gas dependent constant. For air, K_1 can be set to 1.2. The coefficient a_0 is always less than 1, so it can be set to 1 to consider a worst case scenario. Playing around with numbers, it can be seen that for pressures below 10^{-4} mbar the thermal load in this case is negligible in both stages. Therefore, when selecting the vacuum pump for the cryostat, a system that reaches pressures well below 10^{-4} mbar is advisable.

DISSIPATION THERMAL LOAD CALCULATION

Devices or circuits cooled in the cryostat are a source of heat since part of the energy they receive from bias lines is dissipated in the second stage, where the device under test is anchored. To obtain the thermal load in this case, the DC power dissipated by the circuit must be calculated.

SUMMARY OF THERMAL LOAD CALCULATIONS

Table 3 shows the calculated thermal loads at both stages for the designed cryogenic system, considering a remaining gas pressure of 10^{-5} mbar. According to the calculations in the table, it is clear that only the system DE-210AE considered previously fulfills the power requirements to achieve the desired temperatures. The thermal load in the first stage of model DE-202AF would be so high that this stage could not reach the temperature of 77 K, which would produce an increase in thermal load over the second stage, preventing this stage to be cooled below 20 K.

TABLE II

EMISSIVITY OF SOME COMMON MATERIALS

Material	Emissivity (ε)
Aluminum	0.01-0.06
Aluminum very polished	0.02-0.08
Aluminum oxidized	0.11-0.22
Aluminum very oxidized	0.20-0.31
Copper	0.22
Copper very polished	0.02
Copper oxidized	0.78
Gold polished	0.02-0.03
Nickel polished	0.072
Nickel oxidized	0.59-0.86
Stainless-steel polished	0.075
Stainless-steel oxidized	0.85
Brass polished	0.03
Brass oxidized	0.6
Glass	0.9

TABLE III

TOTAL THERMAL LOAD OF THE DESIGNED CRYOGENIC SYSTEM AT BOTH STAGES

P = 10^{-5} mbar	1st Stage	2nd Stage
Conduction	0	1.65
Radiation	6.11	0.02
Residual Gas	0.0658	0.0085
Dissipation	0	0.42
Total	6.166 W	2.01 W

OTHER ISSUES FOR DESIGNING CRYOGENIC SYSTEMS FOR MW APPLICATIONS

In previous calculations, some characteristics of materials such as thermal conductivity or emissivity have been taken into consideration, so the selection of materials is a concern when designing the system. For the Dewar, stainless-steel is commonly used since it shows some advantages over other materials. It does not suffer from oxidation and is easily electro-polished, which reduces the effective surface and therefore the gas absorbed by the surface is also reduced. Another advantage is that it can be easily soldered to obtain reliable high vacuum joints, which facilitates the fabrication of home-made designs. The main drawback of stainless-steel is its weight. When weight may be a problem, aluminum is the best alternative. Aluminum is more fragile, so it needs more thickness to get the same rigidity as stainless-steel; even so the weight reduction is noticeable. The drawback of aluminum is that it is more prone to leaks in the joints; that is the reason why polishing and gold-plating are advisable.

For the radiation shield attached to the first stage, materials with high thermal conductivity and low emissivity are needed, since they need to reduce the radiation absorbed and reemitted to the second stage. Aluminum and copper are usually used in this thermal shield. Once again, polishing and gold-plating is advisable in both materials.[5]

Cables, sensors and circuits need to be attached to the different stages

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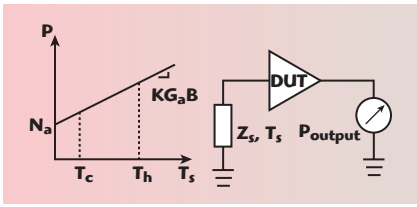

Fig. 3 Noise power at the linear system output N_a is the noise generated by the DUT.

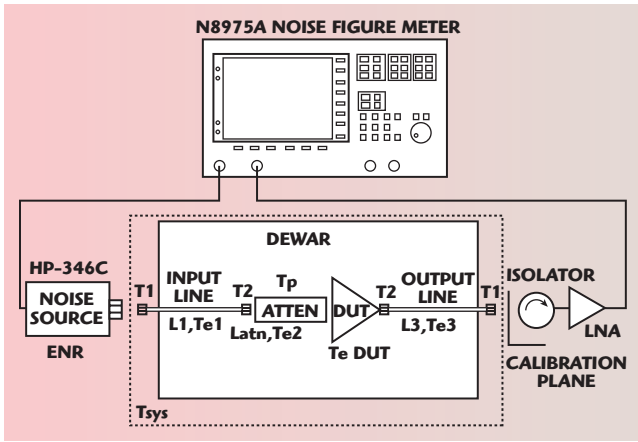

Fig. 4 Cold-attenuator technique set-up.

to be cooled down. When attached, a thermal resistance appears in the joints, which can produce a high temperature gradient between parts. This effect is because the contact is made only in some discrete points instead of the whole surface, even on the smoothest surfaces. One way to improve the thermal conductivity is to increase the applied force on the joint, but there are other options that give better results. The best way to improve thermal conductivity is to increase the total effective contact area by introducing or applying a soft material in the joint. Gold-plating the parts increases this effective area, but better results are found if an Indium foil is introduced in the joint. Nevertheless, the best results are obtained applying Apiezon® N[10] vacuum grease between parts.[4]

Temperature sensors are needed to characterize the experiment and to control the temperature inside the cryostat. There are many types of sensors that are suitable for these purposes, but Si-based diode sensors are commonly used since they offer some advantages: they cover the whole temperature range of interest; they follow a standard curve so they are easily interchangeable; they offer good accuracy without calibration; and they are not very expensive. Model DT-670 from LakeShore[11] is used in the designed system.

Finally, RF feedthroughs are an important issue, since they limit the bandwidth of measurements in the system. Feedthroughs installed in the Dewar window covers allow coaxial cables to connect to the circuit. Hermetic bulkhead adapters are preferable for these feedthroughs since they have to keep high vacuum in the chamber. The designed system is mounted with model 34_SMA-50-0-3/111_NE from Huber+Suhner,[12] which limit the bandwidth up to 18 GHz. There are some other options for measurements up to 40 GHz like model 25-925-2040-90 from SRI,[13] model 34_SK-50-0-54/199_NE from Huber+Suhner and model R127.753.000 from Radiall. These last two options are not available from their webpages, but they have been reported to show good performance in cryogenic Dewars.[14]

COLD-ATTENUATOR TECHNIQUE

Most of the noise measurement techniques, both at room and cryogenic temperatures, are based on the noise linearity of two-port linear circuits.

If a noise source capable of generating two different noise powers is available, then it is easy to calculate the noise generated by the device under test (DUT), when there is not a noise source connected to it, *Na*. This technique is known as Y-Factor (see ***Figure 3***).[15] In cryogenics the problem arises because the two noise powers generated by the source, T_{cold} and T_{hot}, are far from the DUT noise temperature and measurement error may be quite large. In the cold-attenuator technique, an attenuator is placed in front of the DUT and cooled inside the Dewar, which reduces the noise powers presented at the DUT input. The main advantages of this technique are the following:[16]

- There are no mechanical switches and neither noise source exchange: therefore, fast and broadband measurements are facilitated.
- The change of noise source output impedance from one state to another is minimized due to the cryogenic path to the DUT. With a 20 dB attenuator, the effect of impedance change is negligible.
- The insertion loss of the input coaxial line to the attenuator has negligible effect over the noise measurement error.

The cold-attenuator technique set-up is shown in ***Figure 4***. A noise source with high excess noise ratio (ENR), from Agilent Technologies, provides the noise power to the system. The parameters T_i mean physical temperatures, while T_{ei} mean equivalent noise temperatures and L_i are the insertion losses of the different elements. The purpose of the isolator is to match impedances, avoiding reflected waves that ruin the measurement; the LNA is for minimizing the influence of the noise figure meter, which usually has a big noise figure.

After calibrating at the calibration plane and if all the T_{ei} and L_i have been previously calculated, then the equivalent noise temperature of the DUT can be obtained through Equation 5.[17]

$$Te_{DUT} = \frac{Tsys - Te_1 - Te_2 \cdot L_1 - Te_3 \cdot \frac{L_1 \cdot L_{atn}}{G_{DUT}}}{L_1 \cdot L_{atn}} \quad (5)$$

LNA NOISE MEASUREMENT

Six units of LNA model CRYO10-4292-014 from Caltech (Pasadena, CA, USA) have been measured. One is shown in the photograph of ***Figure 5***. These LNAs have a 6 to 18 GHz bandwidth with over 30 dB gain and approximately 8 K equivalent noise temperature over the whole band,

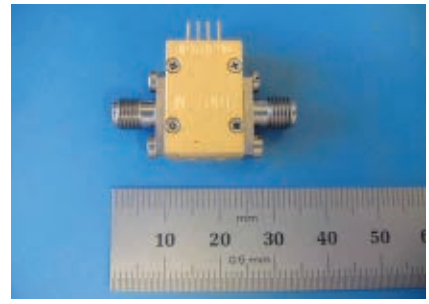

Fig. 5 Measured Caltech LNA.

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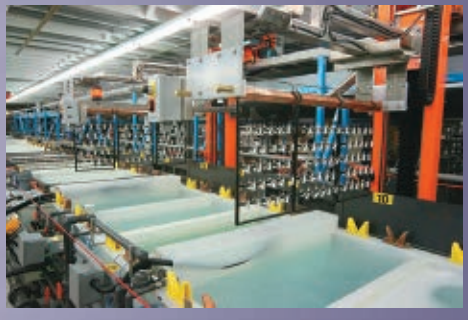

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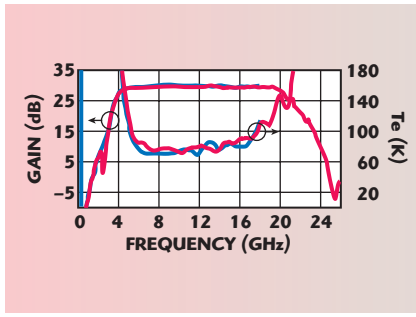

Fig. 6 Gain and noise results at 296 K from Caltech (blue) and the present system (red).

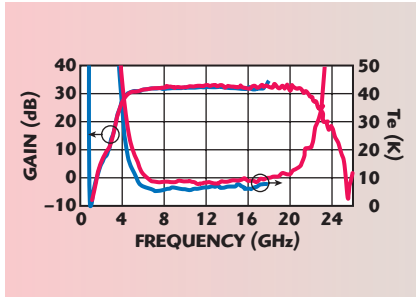

Fig. 7 Gain and noise results at cryogenic temperature for Caltech (blue) and the present system (red).

when cooled down to 18 K, according to the data provided by the manufacturer.

Figure 6 shows the gain and noise measured at room temperature, compared to the results from Caltech. For clarity, only the mean value of the six units is plotted. At cryogenics, the amplifiers have been measured in the Dewar presented in this article, together with the refrigerator model DE-202AF. That is the reason why the measured ambient temperature was only 24 K. The mean values obtained applying the cold-attenuator technique in all the units are plotted in ***Figure 7***, together with results from Caltech at 18 K. A photograph of the measurement set-up is shown in ***Figure 8***, with a detailed view of the cold-attenuator elements in ***Figure 9***. The cryogenic results are within 2 K of the data provided by the manufacturer; the difference may be produced by different ambient temperatures as well as measurement uncertainty.

Fig. 8 Measurement set-up in the designed system.

Taking into account all the error sources during the measurements and assuming that these errors are uncorrelated, then the resultant uncertainty can be calculated as the square root of all the uncertainties squared and summed. Typically, this gives a total uncertainty less than ±2 K.[17] If needed, an extensive approach to uncertainty calculation can be made using a Monte Carlo analysis.[18]

CONCLUSION

The main points to be considered when designing a cryogenic facility, from the microwave engineering point of view, have been presented in

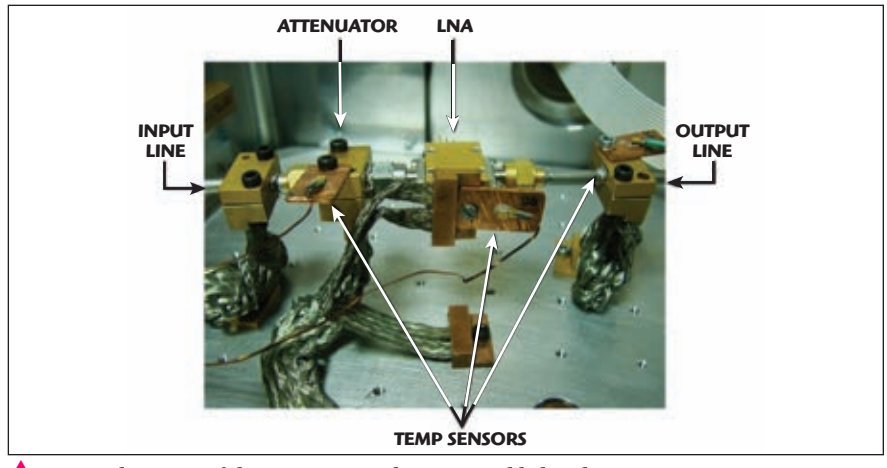

Fig. 9 Close view of the attenuator and LNA assembled in the Dewar.

this article. The thermal load calculation process is showed in detail as well as some valuable advice regarding materials, cables, sensors and adapters. All this knowledge has been applied to the design of a small system that permits reliable measurements. The performance of the designed facility has been tested with six LNAs manufactured by Caltech. The results show less than 2 K difference with the noise data provided by the manufacturer, which is within the measurement uncertainty. ■

ACKNOWLEDGMENTS

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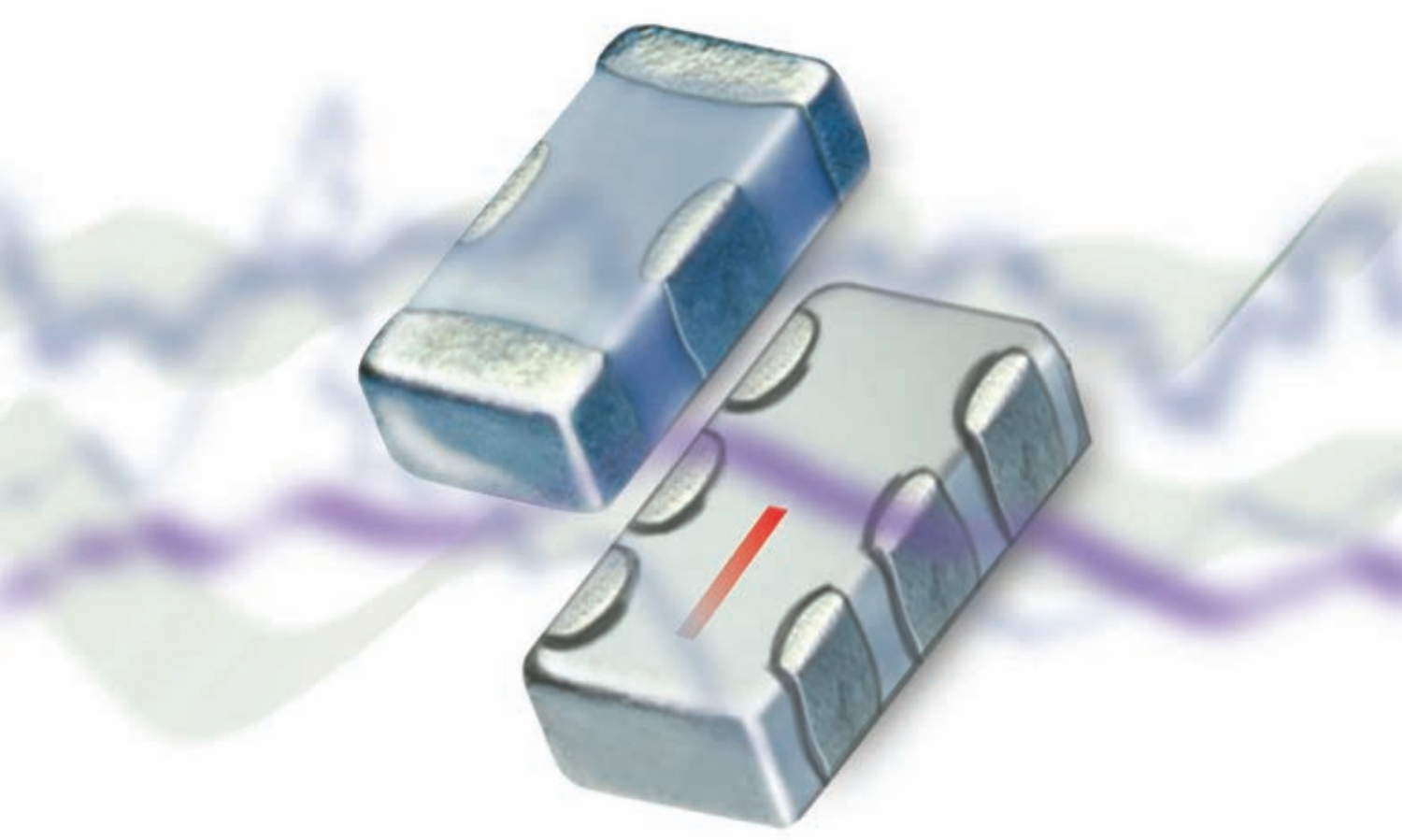

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MINIATURIZED BRANCH-LINE COUPLER EMPLOYING PERIODICALLY ARRAYED GROUNDED-STRIP STRUCTURE

In this work, a short guided-wavelength coplanar waveguide employing a periodically arrayed grounded-strip structure (PAGS) is proposed for the first time. Using a coplanar waveguide employing PAGS, a miniaturized branch-line coupler was realized in a silicon radio frequency integrated circuit (RFIC). The branch-line coupler exhibits good RF performance from 41.75 to 50 GHz and its size is 0.46 x 0.55 mm, which is 37 percent of a conventional one. This work is the first report of an on-chip coupler/divider employing transmission lines with a periodic structure on silicon substrate.

Recently, the demand for highly integrated and miniaturized radio frequency integrated circuits (RFIC) has increased in the wireless communication systems market. With the evolution of silicon CMOS device process technology, highly integrated silicon ICs, including RF and base-band block, have been developed.[1] However, passive components such as couplers, dividers and filters are fabricated outside the ICs due to their large sizes, which have been an obstacle in the realization of fully-integrated silicon front-ends. To solve this problem, a short wavelength transmission line, applicable to the development of miniaturized passive components on silicon substrate, must be developed. To date, using a photonic band gap (PBG) structure, a number of miniaturized passive components have been fabricated on GaAs and Teflon substrates.[2,3] However, short wavelength transmission lines and miniaturized passive components on silicon substrates have not yet been studied. The study of silicon passive components has instead been focused on the development of low loss structures, such as patterned ground shield (PGS), due to the high conductivity of silicon substrates.[4]

In this work, in order to realize highly miniaturized passive components on silicon RFICs, a coplanar waveguide employing a periodically arrayed grounded-strip structure (PAGS) is proposed for the first time. Using the coplanar waveguide employing PAGS, a

YOUNG YUN, YOUNG-BAE PARK, SUK-YOUB KANG, IN-HO KANG AND JI-WON JUNG
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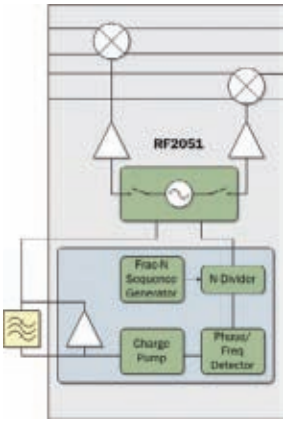
On-chip VCOs		Yes	Yes	No	Yes	Yes
RF mixers		2	1	1	2	2
DC Parameters						
Supply voltage	V	3.0	3.0	3.0	3.0	3.0
Supply current (low-current setting, mixer active)	mA	55	55	45	55	55
VCO and Synthesizer						
Input reference frequency	MHz			10 to 104		
LO frequency	**MHz**	**300 to 2400**	**300 to 2400**	—	**1900 to 2400**	**1550 to 2050**
Open loop VCO phase noise at 500 MHz LO frequency	dBc/Hz	-140	-140	—	-140	-140
RF Mixer						
RF and IF port frequency range	**MHz**			**50 to 2500**		
Noise figure (low-current setting)	dB	9.5	9.5	—	9.5	9.5
Input IP3 (high-linearity setting)	dBm	20	20	—	20	20



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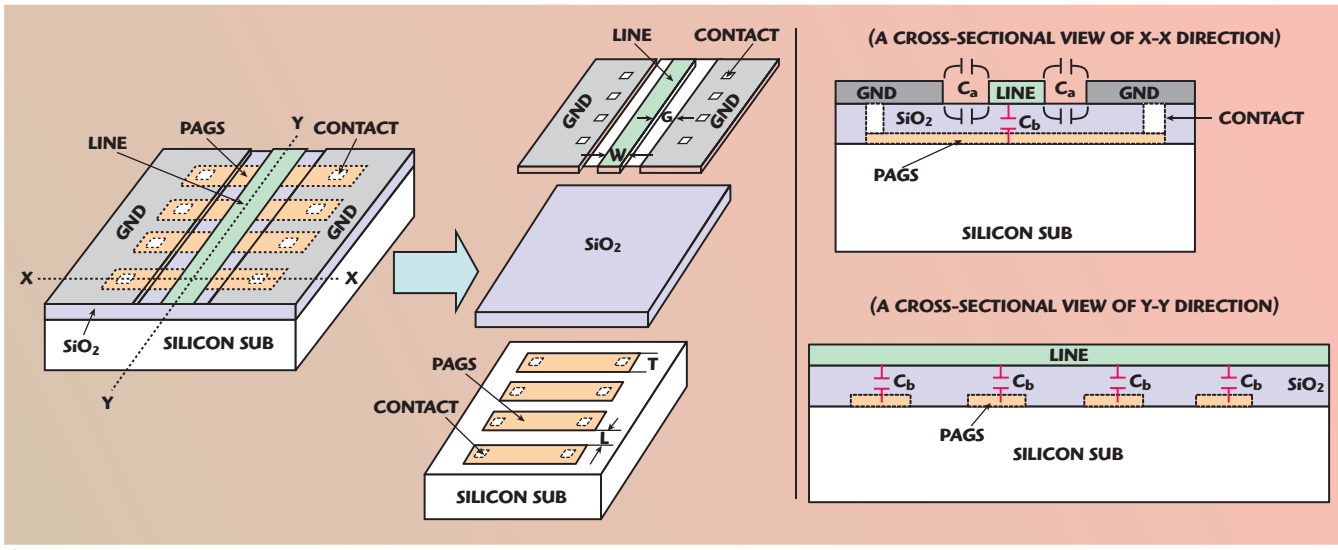


Fig. 1 Structure of the coplanar waveguide using PAGS.

highly miniaturized branch-line coupler was developed for U-band silicon RFIC applications. This work is the first report of an on-chip coupler/divider employing transmission lines with a periodic structure on silicon substrate.

A SHORT WAVELENGTH COPLANAR WAVEGUIDE EMPLOYING PAGS

Figure 1 shows the structure of the coplanar waveguide employing PAGS. As shown, the PAGS exists at the interface between the SiO_2 film and the silicon substrate, and is electrically connected to the top-side ground planes (GND planes) through via contacts. As is well known, a conventional coplanar waveguide, without PAGS, has only a periodical capacitance C_a per unit length, while the coplanar waveguide employing PAGS has an additional capacitance C_b as well as C_a due to PAGS. As shown, C_b is the capacitance between the line and PAGS. In other words, the total capacitance (per unit length) of the coplanar waveguide employing PAGS is $C_a + C_b$, but only C_a for a conventional coplanar waveguide without PAGS. Therefore, the coplanar waveguide employing PAGS exhibits a guided wavelength (λ_g) much shorter than a conventional one, because λ_g is inversely proportional to the periodic capacitance, i.e. $\lambda_g = 1/[f(LC)^{0.5}]$.

Figure 2 shows the measured wavelengths of the coplanar waveguide employing PAGS and the conventional one. The coplanar waveguides were fabricated on a silicon substrate with a height of 600 μm. L and W are both 20 μm, and the thickness of the SiO_2 film is 1 μm. The

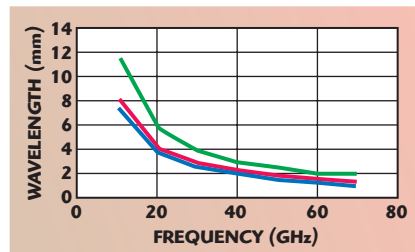
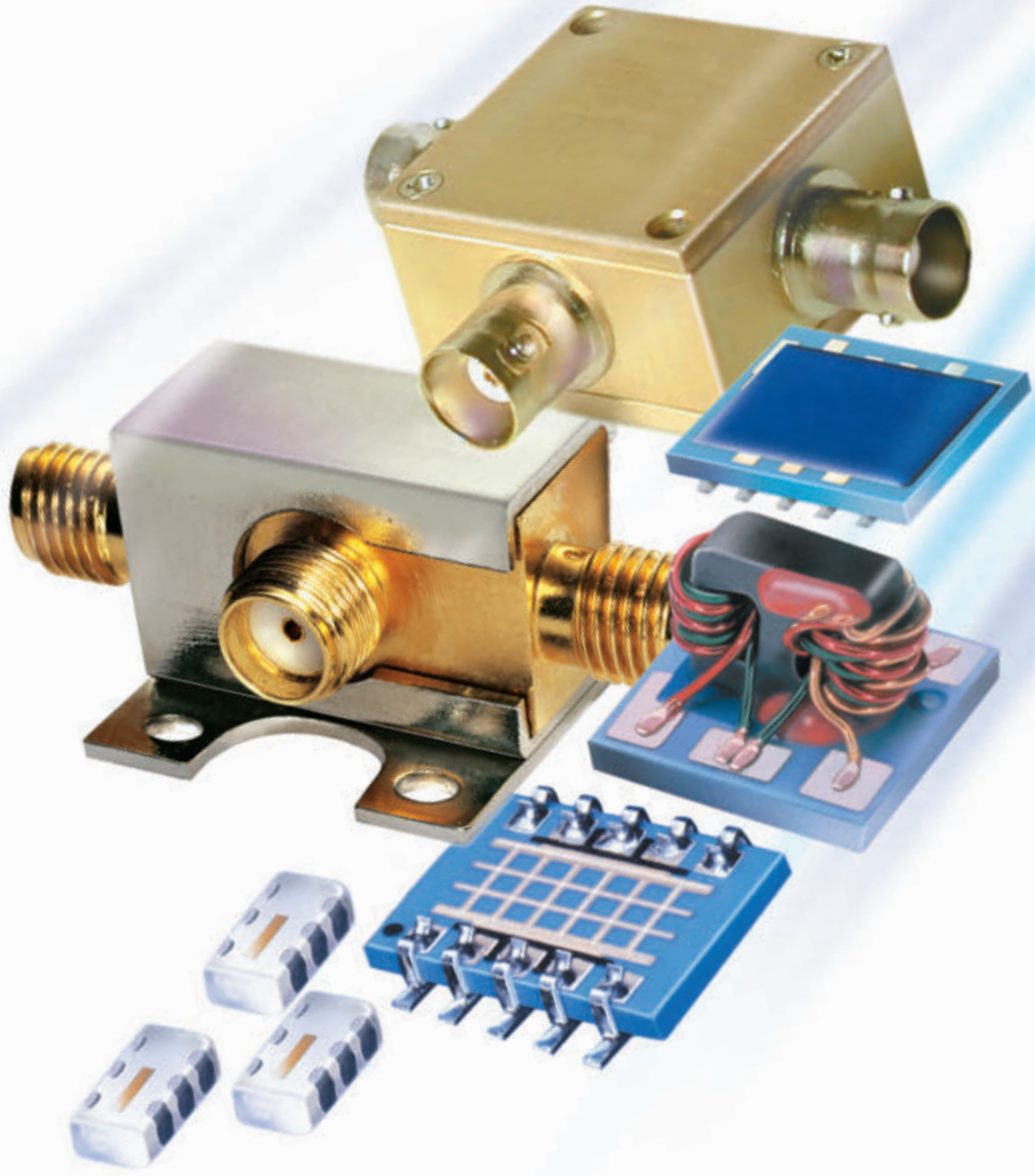


Fig. 2 Measured wavelength of CPWs using PAGS and a conventional one.



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red and blue lines correspond to the data of the PAGS with a T of 5 and 20 μm, respectively. The green line is for the conventional CPW. As shown, the wavelength of the coplanar waveguide was reduced from 60 to 65 percent of the conventional one by using PAGS. For example, the wavelength for the coplanar waveguide employing PAGS (with a T of 20 μm) is 3.7 mm at 20 GHz, while the wavelength for the conventional coplanar waveguide without PAGS is 5.9 mm at the same frequency. The above results indicate that highly miniaturized passive circuits can be realized by using the coplanar waveguide employing PAGS.

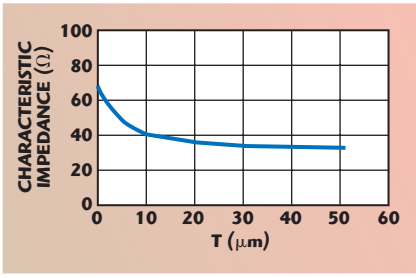

Fig. 3 Measured characteristic impedance of the coplanar waveguide using PAGS.

The measured characteristic impedance of the coplanar waveguide employing PAGS is shown in ***Figure 3***, where line width W was fixed to a value of 20 μm. As T becomes larger, the characteristic impedance becomes lower, because the characteristic impedance is inversely proportional to the periodical capacitance of the transmission line, i.e. $Z_0 = (L/C)^{0.5}$. An increase in T results in an enhancement of periodical capacitance C_b due to an increase in the capacitive area. For this reason, the characteristic impedance of the coplanar waveguide employing PAGS can be easily controlled by only changing T. Using PAGS, the characteristic impedance can be reduced to a value much lower than for a conventional coplanar waveguide. For example, the characteristic impedance shows a value of 67 to 32 Ω when T varies from 0 to 50 μm. This characteristic is very favorable to a reduction of size of passive components on RFIC, because a very low impedance line is required for impedance matching between active devices. In other words, the input/output impedance of FETs are much lower than 50 Ω (10 to 40 Ω) in the RF band,[5] and a very low impedance line should be used for impedance matching between FETs.

For example, the line width W of a conventional coplanar waveguide (having a G of 30 μm) with a characteristic impedance of 35 Ω is 130 μm, while the line width W of a coplanar waveguide using PAGS (having a T of 20 μm) with the same characteristic impedance is only 20 μm. Therefore, if a coplanar waveguide employing PAGS is used for impedance matching between active devices with low impedance, the line width W can be highly reduced (by only adjusting T), compared with a conventional coplanar waveguide.

HIGHLY MINIATURIZED BRANCH-LINE COUPLER EMPLOYING PAGS ON SI SUBSTRATE

Using the coplanar waveguide employing PAGS, a highly miniaturized branch-line coupler was developed for U-band RFIC applications. ***Figure 4*** shows the branch-line coupler fabricated on a silicon substrate. The GSG pads were connected to the input and output ports for on-wafer measurement; the branch-line coupler corresponds to the area surrounded by a dotted line. Three samples were prepared for the measurements of S_{21}, S_{31} and S_{41}. The unused ports were terminated with 50 Ω thin film resistors. Because the port impedance is 50 Ω, the characteristic impedances of the two lines comprising the branch-line coupler are 50 and 35 Ω, respectively. In order to realize the coplanar waveguide with 50 and 35 Ω, the value of T was set to 5 and 20 μm, respectively. The lengths of the λ/4 lines comprising the branch-line coupler were determined from the measured waveguide length, described before.

In the case of a center frequency of 46 GHz, the size of the branch-line coupler employing PAGS was 0.46 × 0.55 mm, which is 37 percent of the size of the one fabricated by a conventional coplanar waveguide. In other words, in the case where the branch-line coupler is fabricated with a conventional coplanar waveguide (having a G of 30 μm) on a silicon substrate with a height of 600 μm, the length

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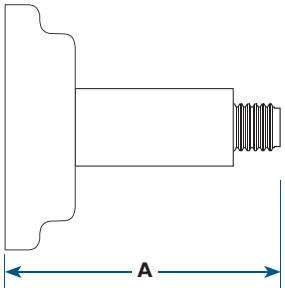

Freq. Range (GHz)	Model Number	VSWR Max.	"A" Max.	Female Connectors
26.5 -40.0	28AEL66	1.35	1.00	2.4mm
26.5 - 40.0	28AEL86	1.35	1.00	2.9mm
22.0 - 33.0	34AEL66	1.35	1.00	2.4mm
22.0 - 33.0	34AEL86	1.35	1.00	2.9mm
18.0 - 26.5	42AEL86	1.25	1.15	2.9mm
15.0 - 22.0	51AEL86	1.25	1.50	SMA
12.4 - 18.0	62AEL86	1.25	1.50	SMA
12.4 - 18.0	62AEL106	1.35	1.75	TNC
10.0 - 15.0	75AEL46	1.25	1.75	N
10.0 - 15.0	75AEL86	1.25	1.50	SMA
8.2 - 12.4	90AEL86	1.35	1.50	SMA

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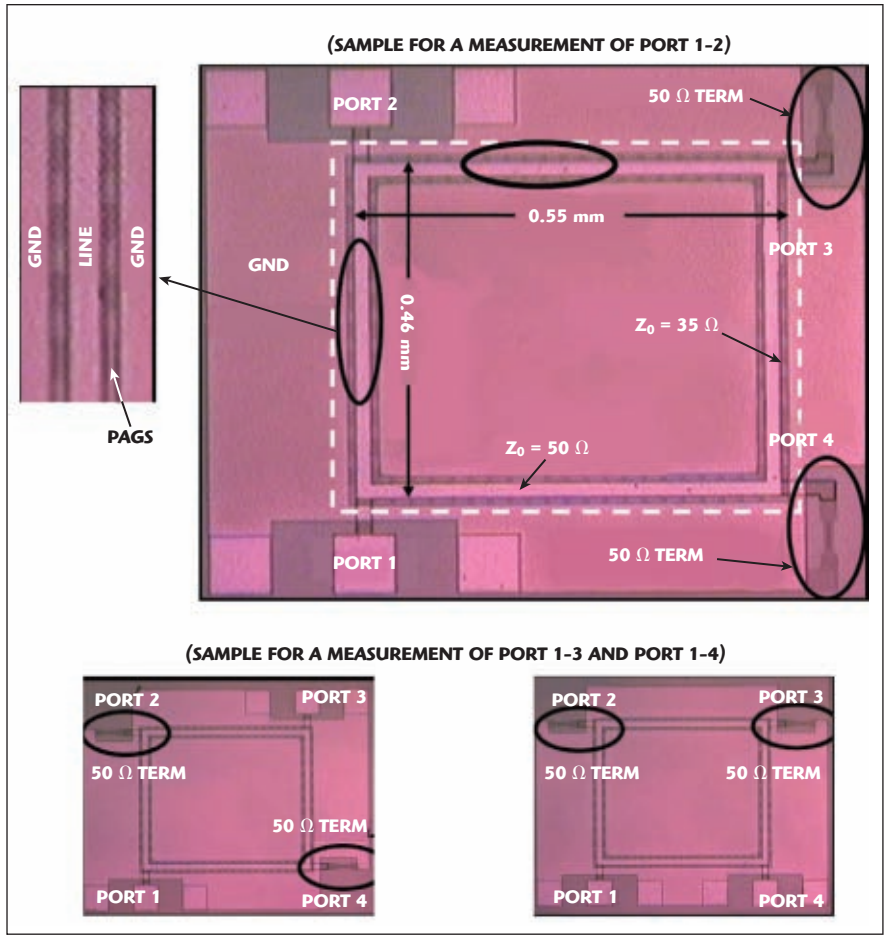

Fig. 4 Photograph of the branch-line coupler using PAGS on a silicon substrate.

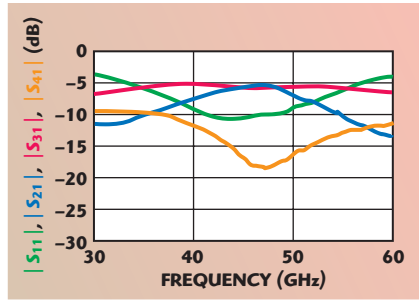

Fig. 5 Measured power division, isolation and return loss characteristics of the branch-line coupler using PAGS.

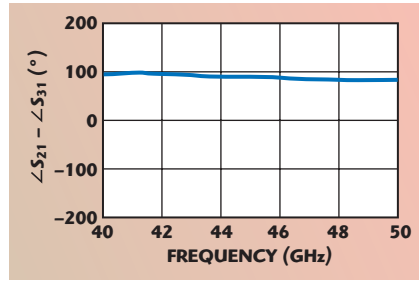

Fig. 6 Measured phase difference between S_{21} and S_{31} for the branch-line coupler using PAGS.

of the λ/4 line is 0.54 mm at a center frequency of 46 GHz, the widths W of the coplanar waveguide with a characteristic impedance of 50 and 35 Ω are 60 and 130 µm, respectively. Therefore, the size of the branch-line coupler employing a conventional coplanar waveguide is 0.9 × 0.76 mm.

Figure 5 shows the power division, the isolation and return loss characteristics of the branch-line coupler employing PAGS. A good power division characteristic can be observed from 41.75 to 50 GHz. Specifically, S_{21} and S_{31} exhibit a value of 5.7 dB at 46 GHz. In the frequency range from 41.75 to 50 GHz, S_{21} and S_{31} show a value of 5.9 ± 0.5 and 5.5 ± 0.5 dB, respectively. Actually, the power division value for a branch-line coupler fabricated on a Teflon substrate[6] is approximately 5 ± 0.5 dB, and the branch-line coupler employing PAGS shows a loss higher by 0.7 dB than for a conventional one, which originates from the high conductivity silicon substrate. The isolation characteristic (S_{41}) shows a value of 18.1 dB at 46 GHz, and a value of 13 to 18.1 dB in the frequency range from 41.75 to 50 GHz.

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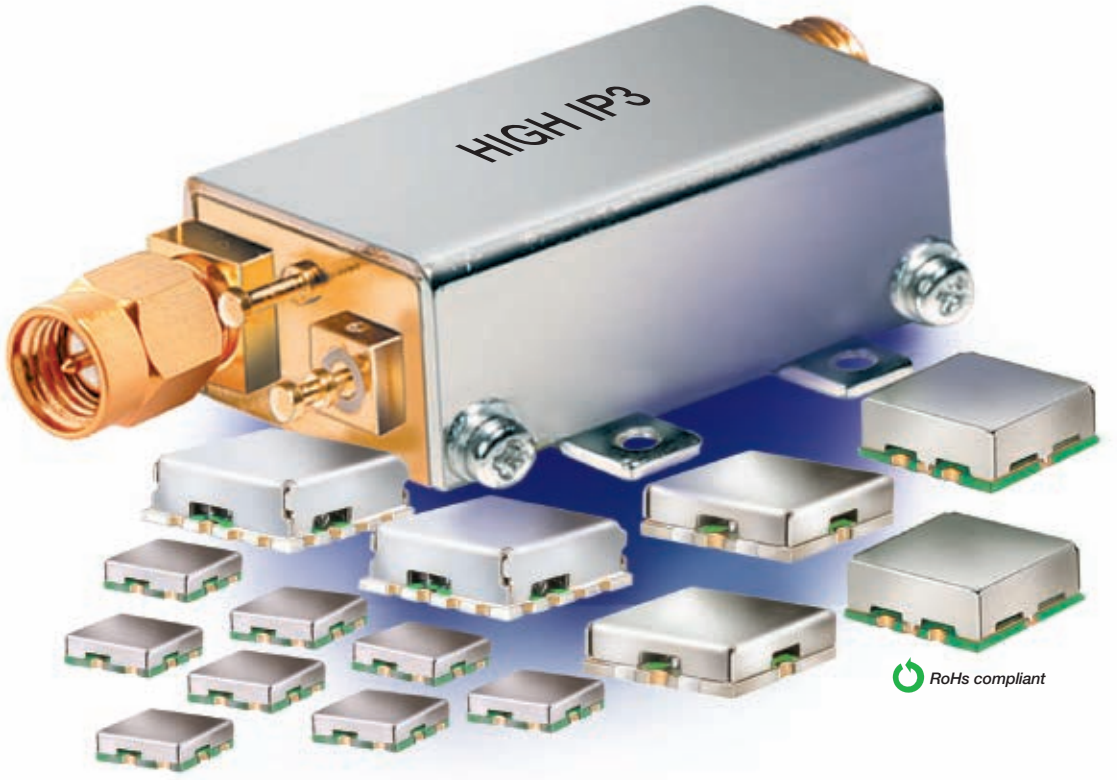

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All ports show the same return loss due to the symmetry of the structure, and only S_{11} was plotted in the figure. S_{11} shows a value of 11.1 dB at 46 GHz, and lower than 10 dB in the frequency range from 41.75 to 50 GHz. ***Figure 6*** shows the phase difference between S_{21} and S_{31} for the branch-line coupler employing PAGS. The phase difference shows a value of 90.1° at 46 GHz, and a value of 90 ± 4.8° in the frequency range from 41.75 to 50 GHz.

CONCLUSION

A coplanar waveguide employing PAGS exhibits a wavelength much shorter than a conventional one. Using the coplanar waveguide employing PAGS, a highly miniaturized branch-line coupler was fabricated on a silicon substrate for U-band RFIC applications. The branch-line coupler shows good RF performance from 41.75 to 50 GHz and its size is 0.46 × 0.55 mm, which is 37 percent of the size of the one fabricated by conventional coplanar waveguide. This work is the first report of an on-chip coupler/divider employing transmission lines with periodic structure on silicon substrate. ■

ACKNOWLEDGMENT

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S5W2	S5W5	N5W5	5	±0.40
S6W2	S6W5	N6W5	6	±0.40
S7W2	S7W5	N7W5	7	-0.4, +0.9
S8W2	S8W5	N8W5	8	±0.60
S9W2	S9W5	N9W5	9	-0.4, +0.8
S10W2	S10W5	N10W5	10	±0.60
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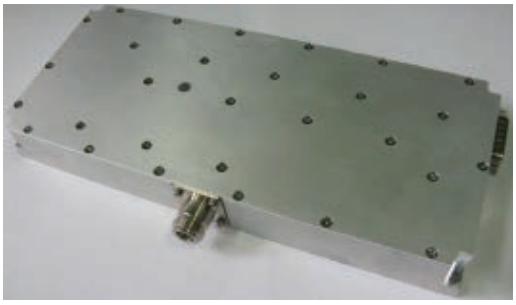


MEDICAL TREATMENT AMPLIFIERS FOR HYPERTHERMIA AND RF ABLATION

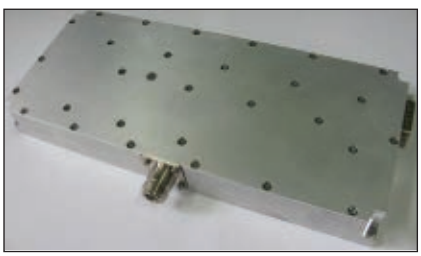
EXECUTIVE INTERVIEW SERIES

MWJ SPEAKS WITH DR. SAMUEL CHO, FOUNDER AND CTO, RFHIC.

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

There is a great deal of interest in using RF technology for cancer treatment. Research has offered hard evidence that this technology works and has advantages over traditional medical surgery. Recent research from major medical centers has prompted the observation that Radio Frequency Ablation (RFA) treatment has proven to be the most effective and safest approach to destroying inoperable early-stage cancer.

RFHIC, which is well known as a manufacturer of active RF and microwave components and hybrids for the wireless telecommunication and instrument markets, is also supporting the medical sector with high performance RF amplifiers. The company recently released the RFMA245 RF amplifier for hyperthermia treatment and RF ablation.



▲ *Fig. 1 RF amplifier module.*

AMPLIFIER CHARACTERISTICS

This highly efficient power amplifier uses a frequency of 2.3 to 2.5 GHz, has an output power of 100 W and a four-stage amplifier design producing 31 dB gain. These power amplifiers can be scaled by combining multiple amplifiers to achieve 1 kW. The final stage amplifier has 55 percent efficiency when operated at Class AB amplification. When using the power amplifier for Class E amplification, the efficiency reaches 90 percent.

The final amplifier product is provided in two form factors. One is the RF amplifier module, which is shown in ***Figure 1***. The size of the power amplifier module is 270 × 150 × 40 mm. The picture shows the amplifier with an isolator and low pass filter designed within the amplifier itself. For cancer treatment, the RFMA245 RF power amplifier can be built on a small system and is customizable to suit the specific treatment.

The other form factor is shown in ***Figure 2***. This option includes the heatsink and fan system to the amplifier; the size of the amplifier system is 270 × 150 × 100 mm. In both form factors the RFMA245 RF amplifier includes

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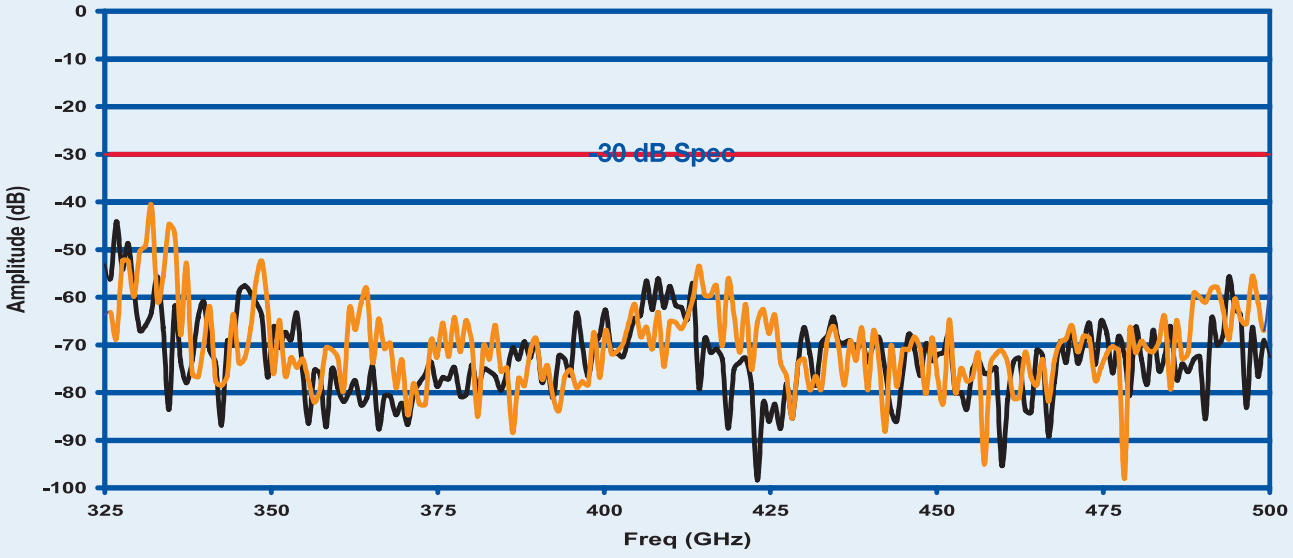
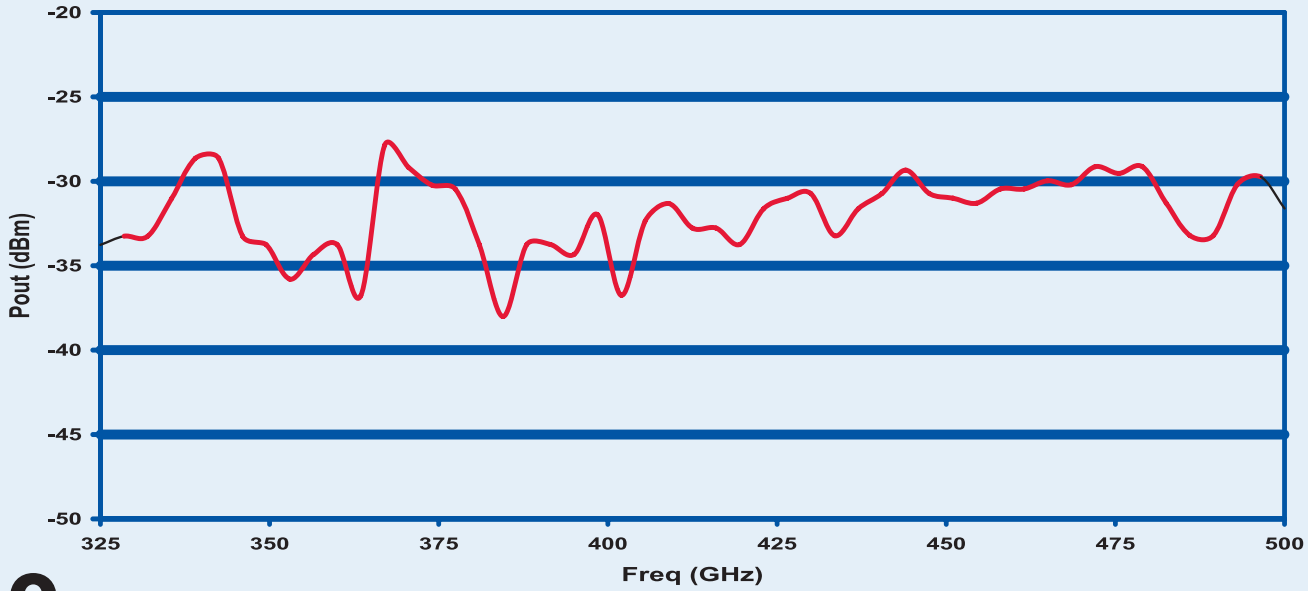
TYPICAL DYNAMIC RANGE PERFORMANCE



TYPICAL POWER OUTPUT



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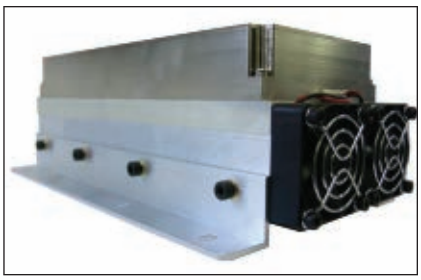

Fig. 2 RF amplifier with fan.

continuous wave (CW) and pulse signal generation Phase Lock Loop (PLL), so it does not need any additional RF input.

Multiple protection methodology, including a forward power detector, reflection power detector, a microcontroller unit (MCU) to control alarm features and an external fan control system for temperature control, remotely monitor and control the power amplifier. A 31.5 dB range, 0.5 dB step digital attenuator and linear high power gain compensation circuit for 0 to 100 W per 5 W steps are designed to control the gain and maintain the power of the amplifier. An additional RF on/off switch, isolator, low pass filter and temperature compensation circuits are incorporated within the amplifier. A block diagram of the RF amplifier is shown in ***Figure 3***.

FOUR-STAGE AMPLIFICATION

The key amplification is carried out via the four-stage power amplifier pallet. The size of this internal pallet amplifier is 207 × 61 × 22 mm and is shown in ***Figure 4***.

This pallet amplifier uses Gallium Nitride on Silicon Carbide (GaN-on-SiC) technology. The core design is dual push-pull in a symmetrical configuration that is very robust against back power or other hazards, which improves reliability significantly.

Patented packaging technology, eutectic bonding, wire-bonding, internal matching and multi-stage amplifier designs are utilized in the design to amplify the original signal 1,000 or 100,000 times (30 to 50 dBm) to get power of 200 W. RFHIC has also designed additional isolators, couplers and connectors to produce 100 W RF power from the output port. Higher power can be achieved by combining multiple pallet amplifiers.

GAN-ON-SIC TECHNOLOGY

GaN-on-SiC is the driving technology behind the amplifier. GaN has evolved from the laboratory to real RF and microwave power amplifiers and is gaining market share over other technologies. GaN device technology provides high efficiency, broad bandwidth coverage, good reliability, high operating voltage, high operating temperature and high in/output impedance, which all add benefits for the next generation of instruments.

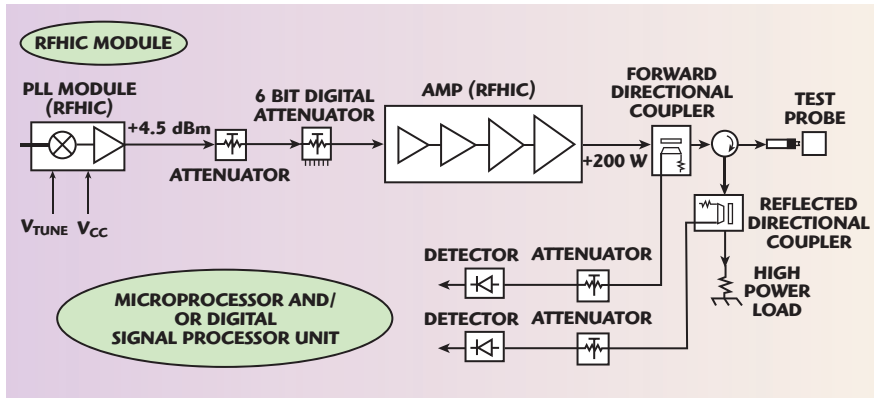

Fig. 3 Block diagram of the RFMA245 RF power amplifier.

Early stages of cancer treatment often use this effective RF technology to treat patients. Cancer cells will be destroyed at temperatures of 42°C or higher. Exposing the cancer cell to an RF power signal will increase the temperature and destroy the cancer cell without significantly affecting normal cells.

During the medical operation, the cancer cell may change its RF impedance by more than two orders of magnitude. It is critical to maintain and control the operation while a patient is exposed to RF ablation. By applying GaN-on-SiC technology to the medical amplifier, the variable output load, which in this case is the cancer tissue, can be continuously and stably destroyed. RF power can be applied for a length of time without any problem, due to the rugged characteristics of GaN, which is a significant safety factor.

MEDICAL RESEARCH

Numerous medical tests are currently being undertaken to study the implementation of RF technology and many medical institutes are applying it to treat patients. One of these institutions, the Samsung Medical Center, has demonstrated a significant success rate across 3,600 cases of liver cancer patients for the ten years from April 1999 to April 2009. Over that period the team performed RFA treatment 3,594 times on 2,600 patients. They screened 570 early-stage cancer patients and tracked how well they were doing after the treatment. As reported to the European Radiology Society, the one-year survival rate was 95 percent, the three-year survival rate 70 percent and the five-year survival rate 58 percent.

Fig. 4 Four-stage RF amplifier pallet.

FUTURE DEVELOPMENTS

Following the introduction of the RFMA245 RF amplifier, RFHIC considers the next stage of development to target various other medical instruments. Smaller equipment can be built using the higher power density characteristics of GaN. Higher polarization voltage gives lower current for the same power output and less Joule effect losses, which provides cost saving in thermal management.

The ability to withstand a higher junction temperature also results in more robust devices and improved lifetime and better mean-time-to-failure (MTTF) can be expected. Ultimately, less cooling will be necessary, which will bring down the size and cost of the system. Finally, other medical frequencies such as 5.8 GHz and existing ISM band products are being studied with key partners in Europe.

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With Heat Sink/Fan										
LZY-1+	20-512	43	+45.7	+47.0	8.6	+54	26	7.3	1995	1895
LZY-2+	500-1000	46	+45	+45.8	8.0	+54	28	8.0	1995	1895
ZHL-5W-2G+	800-2000	45	+37	+38	8.0	+44	24	2.0	995	945
ZHL-10W-2G+	800-2000	43	+40	+41	7.0	+50	24	5.0	1295	1220
ZHL-16W-43+	1800-4000	45	+41	+42	6.0	+47	28	4.3	1595	1545
• ZHL-20W-13	20-1000	50	+41	+43	3.5	+50	24	2.8	1395	1320
ZHL-30W-252+	700-2500	50	+44	+46	5.5	+52	28	6.3	2995	2920
• ZHL-50W-52	50-500	50	+46	+48	6.0	+55	24	9.3	1395	1320
• ZHL-100W-52	50-500	50	+47	+48.5	6.5	+57	24	10.5	1995	1920

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ZHL-30W-252X

ZHL-5W-2GX

LZY-1X+
LZY-2X+
ZHL-10W-2GX
ZHL-50W-52X
ZHL-100W-52X

ZHL-20W-13X

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LOOP TEST TRANSLATORS FOR SATCOM SYSTEMS

The loop test translator (LTT) is an extremely valuable tool for evaluating the performance of satellite earth stations. It allows the user to carry out analysis, alignment and testing without incurring satellite airtime costs and the risk of interfering with other satellite users. Thus, it has applications during equipment development, qualification, trouble-shooting and in-service routine monitoring.

A basic loop test translator comprises a mixer and local oscillator to translate the ground-to-space transmit frequency to the ground-from-space receive frequency in just the same way that the satellite does. In practice other features are provided to enhance usefulness and flexibility.

A BROAD RANGE

The ALT range of loop test translators from AtlanTecRF covers the satellite communication bands S, C, X, Ku, DBS and Ka. They are block converters, which means they convert the whole transmit band with a single frequency LO to the required receive band or directly to the first IF band (which is typically in L-band).

Table 1 shows the breadth that the standard ALT product range covers; non-standard bands and non-standard LO frequencies can also be provided.

The local oscillators leverage the company's expertise in low noise phase-locked oscillators. Standard products have internal 25, 50 or 100 MHz reference oscillators, according to model, but a range of options, including 10 MHz internal and/or external reference frequencies can be supplied for compatibility with station reference signals. Enhanced stability of internal references is available using OCXO and TCXO solutions. A reference frequency output is supplied together with a loss of phase lock alarm.

Double balanced mixers are used and the input path features a 30 dB variable attenuator, adjustable via a 10-turn control with dial. Optionally, a 69 dB range step attenuator can be provided. The purpose of the input attenuator is to set the input to the mixer so that it is operating at the correct level. The overall con-

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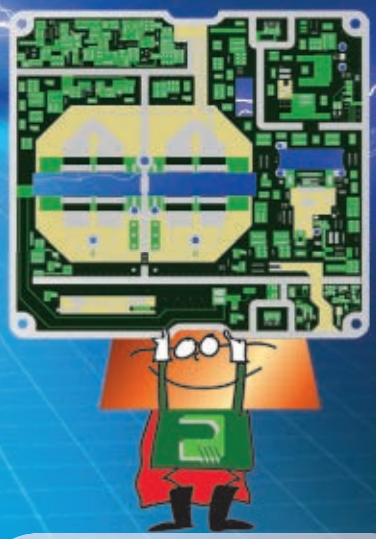

When amplifier designers asked, Rogers listened and developed RO4360™ high-frequency laminates. These thermoset materials feature a powerful balance of high performance, low cost and ease of processing in a laminate with a dielectric constant of 6.15.

RO4360 laminates deliver the low loss and high thermal conductivity sought by amplifier designers. Suitable for a variety of commercial and industrial applications, RO4360 laminates can be processed similar to FR-4 & support lead-free, RoHS-compliant manufacturing practices.

Features

- High dielectric constant
- Low loss
- High thermal conductivity
- Low Z-axis CTE (30 PPM/°C) for reliable PTHs

Total Cost Solution

- Priced better than alternatives
- Low fabrication cost

Ease of Fabrication

- Ideal for multilayer circuits
- Suitable for automated assembly lines
- Processes similar to FR-4
- Lead free, RoHS compliant

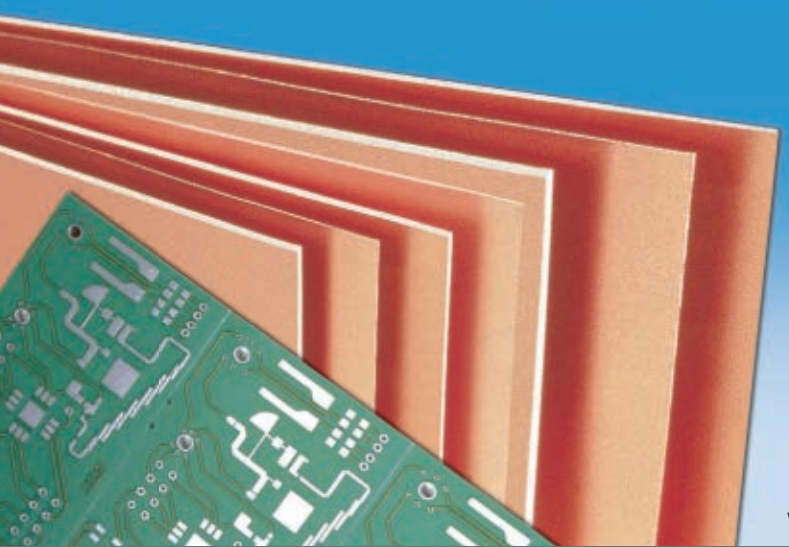

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TABLE I

THE ALT RANGE OF STANDARD LOOP TEST TRANSLATORS OFFERED BY AtlanTecRF

Model No.	Translation Bands	Input Freq. Range (MHz)	Output Freq. Range (MHz)	LO Frequency (MHz)
ALT-0175-S	S-S	2025-2125	2200-2300	175
ALT-1075-S	S-L	2025-2125	950-1050	1075
ALT-2225-C	C-C	5845-6425	3620-4200	2225
ALT-4975-C	C-L	5925-6425	950-1450	4975
ALT-7375-CI	C-L(inv)	5925-6425	1450-950	7375
ALT-0650-X	X-X	7900-8400	7250-7750	650
ALT-6950-X	X-L	7900-8400	950-1450	6950
ALT-1800-Ku	Ku-Ku	12750-13250	10950-11450	1800
ALT-2050-Ku	Ku-Ku	12750-13250	10700-11200	2050
ALT-11800-Ku	Ku-L	12750-13250	950-1450	11800
ALT-1750-KuE	KuE-Ku	13750-14500	12000-12750	1750
ALT-2300-KuE	KuE-Ku	13750-14500	11450-12200	2300
ALT-2800-KuE	KuE-Ku	13750-14500	10950-11700	2800
ALT-3050-KuE	KuE-Ku	13750-14500	10700-11450	3050
ALT-12800-KuE	KuE-L	13750-14500	950-1700	12800
ALT-1750-Ku	Ku-Ku	14000-14500	12250-12750	1750
ALT-2300-Ku	Ku-Ku	14000-14500	11700-12200	2300
ALT-2550-Ku	Ku-Ku	14000-14500	11450-11950	2550
ALT-3050-Ku	Ku-Ku	14000-14500	10950-11450	3050
ALT-13050-Ku	Ku-L	14000-14500	950-1450	13050
ALT-5100-DBS	DBS-DBS	17300-17800	12200-12700	5100
ALT-5178-DBS	DBS-DBS	17300-17800	12122-12622	5178
ALT-5600-DBS-A	DBS-DBS	17300-17800	11700-12200	5600
ALT-5600-DBS-B	DBS-DBS	17300-18100	11700-12500	5600
ALT-5600-DBS-C	DBS-DBS	17800-18100	12200-12500	5600
ALT-7400-DBS	DBS-DBS	18100-18400	10700-11000	7400
ALT-16350-DBS-A	DBS-L	17300-17800	950-1450	16350
ALT-16350-DBS-B	DBS-L	17300-18100	950-1750	16350
ALT-16350-DBS-F	DBS-L	17300-18400	950-2050	16350
ALT-16850-DBS	DBS-L	17800-18100	950-1250	16850
ALT-17150-DBS	DBS-L	18100-18400	950-1250	17150
ALT-9800-Ka	Ka-Ka	27500-31000	17700-21200	9800
ALT-10300-Ka	Ka-Ka	28000-31500	17700-21200	10300

version loss is 20 dB nominal, or 35 dB for Ka-band.

These LTTs are normally 'wide open', i.e. they contain no filtering and no additional gain. This provides the optimum conditions for the investigation of spurious signals. However, both filtering and additional gain to compensate for conversion loss can be provided if required.

The situation arises in Ku-band where a common transmit frequency range is associated with three differing receive bands. This can be addressed by a three-band model in which three local oscillators can be switched via a front panel control to allow a single unit to be used for all three receive bands. This is useful for testing mobile or fly-away systems, which may have to be field-configurable to suit the region in which they are deployed.

Figure 1 illustrates a three-band switched unit together with a custom-designed test translator. The same principle of combining several LOs in one product can be applied to provide a cost-effective combined C- and Ku-band unit. Custom translation frequencies can also be supplied.

▲ *Fig. 1 Three-band switched unit with custom-designed test translator.*

Industrial, Scientific and Medical RF Solutions

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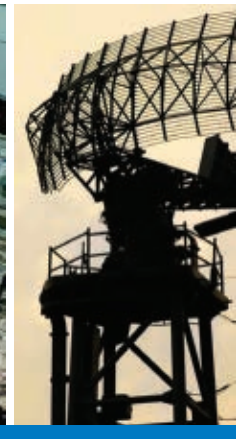

Freescale's Ultra-efficient RF Power Transistors

- **1 kWatt in industry standard air cavity ceramic package**
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- **Integrated ESD protection**

Using very high voltage VHV6 LDMOS technology combined with innovative and cost-effective over-molded plastic packaging, Freescale now offers a portfolio of transistors designed for the HF/VHF frequency range (to 600 MHz). Freescale also offers 28V LDMOS transistors in the 2.45 GHz ISM band.

Freescale's ISM portfolio of RF power transistors are designed for very high power applications, including:

- Plasma generators
- CO_2 laser exciters
- RF heating and lighting
- Magnetic Resonance Imaging (MRI)
- FM/VHF broadcast

To view Freescale products available from Richardson Electronics go to:
www.rell.com/Freescale.aspx

HF/VHF/UHF ISM – To 600 MHz Devices

Freescale's line of VHV ISM devices offer high gain and efficiency and can be used up to 600 MHz at 50V supply voltage. Superior gain in the harmonic frequencies makes them highly suitable for higher classes of amplifier operation.

Part Number	Test Frequency (MHz)	Voltage (V)	Rated Power (W)	Package	θ_{JC} °C/W	Typical Gain (dB)	Typical Efficiency (%)
MRF6V2010N	10-450	50	10	Over-molded	3(2)	23.9	62
MRF6V2150N	10-450	50	150	Over-molded	0.24(2)	25	68.3
MRF6V2300N	10-600	50	300	Over-molded	0.24(2)	25.5	68
MRF6V4300N	10-600	50	300	Over-molded	0.24(2)	22	60
MRF6VP2600H	10-250	50	600 CW	Air Cavity	0.20(2)	25/OFDM	28.5/OFDM
	88-108	50	600 CW	Air Cavity	—	26/CW*	72/CW*
MRF6VP11KH	10-150	50	1000(1)	Air Cavity	0.03(2)	26	71
MRF6VP21KH	10-235	50	1000(1)	Air Cavity	0.03(2)	24	67.5
MRF6VP41KH	10-450	50	1000(1)	Air Cavity	0.03(2)	20	64

ISM Band – 2.45 GHz Devices

Derived from Freescale's industry-leading cellular infrastructure portfolios, the MW6IC2420NB, MRF6S24140H and MRF6P24190H devices operate at 28V and achieve high levels of performance for 2.45 GHz applications.

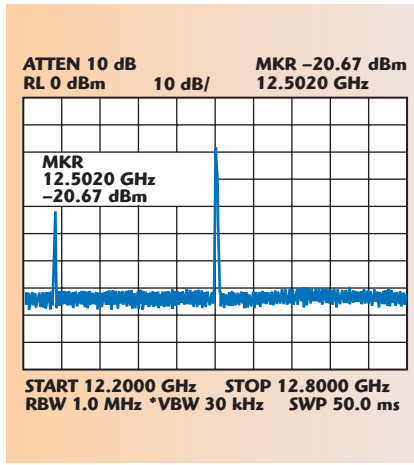
Part Number	Test Frequency (MHz)	Voltage (V)	Rated Power (W)	Package	θ_{JC} °C/W	Typical Gain (dB)	Typical Efficiency (%)
MW6IC2420NB	2450	28	20	Over-molded	1.8	19.5	27
MRF6S24140H	2450	28	140	Flanged Air Cavity	0.29	13.2	45
MRF6P24190H	2450	28	190	Flanged Air Cavity	0.22	13.2	46.2

(1) Peak power (2) See data sheet for test condition. *Preliminary Data

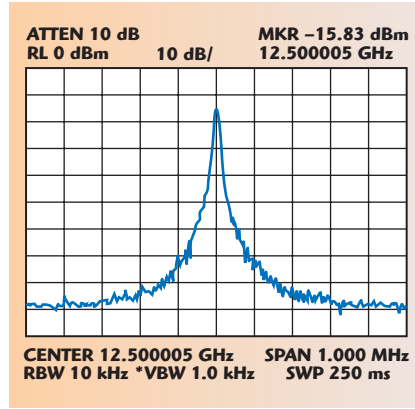
freescale™ semiconductor

Richardson Electronics

www.rell.com | rfpd@rell.com | 800.737.6937 | 630.208.2200



▲ *Fig. 2 ALT1750-KuE with 0 dBm input at 14.25 GHz.*



▲ *Fig. 3 Expanded centre portion of Fig. 2.*

The standard mechanical configuration is 19-inch rack mounting with a height of only 1U to minimize space in a crowded earth station rack, although other mechanical arrangements can be provided, including weatherproof enclosures designed for external mounting. Similarly, connector configurations can be changed to suit the application and waveguide interfaces can also be provided if necessary.

EXAMPLES

The ALT-1750-KuE LTT is an Extended Ku-band (13,750 to 14,500 MHz) unit translating to 12,000 to 12,750 MHz via a 1,750 MHz LO with internal reference. It has a nominal conversion loss of 20 dB. ***Figure 2*** shows a typical plot of the output with a transmitter input of 0 dBm at 14.25 GHz. This unit has an LO of 1,750 MHz and its seventh harmonic can be observed at 12,250 MHz.

Figure 3 is an expansion of the centre portion of the display. The local oscillator in this unit has a typical phase noise of -105 dBc/Hz at 1 kHz, extending to -140 dBc/Hz at 1 MHz offset. Frequency stability with a standard internal reference is ±5 ppm maximum over 0° to 50°C, with a typical stability of ±2 ppm over +10° to +40°C and ±2 ppm maximum per day.

The ALT-9800-Ka and ALT10300-Ka models cater for the increasingly popular Ka-bands. They cover transmit frequency bands of 27.5 to 31.0 GHz and 28.0 to 31.5 GHz, respectively, both models downconverting to 17.7 to 21.2 GHz.

APPLICATIONS

Most operational earth stations do not have the luxury of a continuously-available spectrum analyzer capable of observing waveforms at signal frequency, so the LTT provides a convenient and cost-effective way of down-converting the uplink signal to enable it to be seen in the receiver or with an IF spectrum analyzer. Typically this enables checks to be made on the modulation, power levels, spurious and noise. Used in conjunction with a baseband BER test set, BER can be measured. If group delay measurements are required, the LO in the LTT can be locked to the station reference to improve accuracy.

In the event of a hardware failure within a VSAT network it is common for the transceiver to be replaced in the field and returned to the service-provider's central workshop. The LTT is the ideal tool for verifying the perceived fault under controlled conditions before embarking on a costly repair process or returning the transceiver to the supplier. The availability of multiple translation frequencies in a single unit adds to flexibility at minimum cost.

CONCLUSION

This ALT range of loop test translators is suitable for off-air testing and monitoring of satellite earth station equipment, including the analysis of spurious, modulation and alignment of transmitter chains. Models are available for the satellite bands S to Ka and a wide range of options can be specified.

AtlanTecRF, Braintree, UK,
Tel: +44 1376 550220,
www.AtlanTecRF.com.

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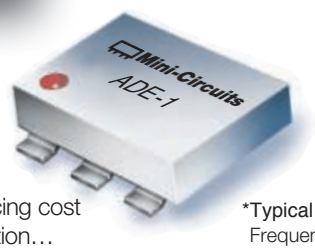

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actual size

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*Typical Specifications:	ADE-1	ADE-2	ADE-11X
Frequency LO/RF (MHz)	0.5-500	5-1000	10-2000
Frequency LO/IF (MHz)	DC-500	DC-1000	5-1000
LO Level (dBm)	7	7	7
IP3 (dBm)	15	20	9
Conv. Loss (dB)	5.0	6.67	7.1
L-R Isolation (dB)	55	47	36
L-I Isolation (dB)	40	45	37
Dimensions: L.310"xW.220"xH	.162"	.112"	.112"
Price $ea. (Qty. 25)	*2.49*	*2.49*	*2.49*

*Specified midband unless otherwise noted.

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VENDORVIEW

AKON is a supplier of microwave products for airborne, ground, shipboard and space applications. AKON has maintained its position by combining engineering design excellence with manufacturing capabilities. AKON-designed hardware can be found in almost every major EW program in the free world. Leading defense contractors such as Lockheed Martin, Northrop Grumman, BAE Systems, Raytheon, DRS Systems to name just a few have chosen AKON as their supplier of choice.

AKON Inc., 2135 Ringwood Avenue, San Jose, CA 95131

www.akoninc.com

Products and Investors

AML Communications announces the launch of its new website, located at www.amlj.com. This site features a robust investors and shareholders section. Images of products are included as well as full specifications. The redesigned product section enables the customer to view all products and technical content in one easy to navigate section. Engineers, investors and shareholders will find the improved site informative and user friendly.

AML Communications Inc., 1000 Avenida Acaso, Camarillo, CA 93012

www.amlj.com

Multimedia Web Resource

VENDORVIEW

AWR announced it has added a broad array of content related to electromagnetics (EM) to AWR.TV, its comprehensive multimedia Web resource for technical and product information. AWR.TV, which AWR launched in January, is designed to be a "one-stop" resource for product information, tutorial presentations, and application-specific discussions about EDA topics and AWR products.

AWR®, 1960 E. Grand Avenue, Suite 430, El Segundo, CA 90245

www.awr.tv

Connectivity Solutions

Emerson Network Power announced the newly redesigned website for the Connectivity Solutions business. EmersonConnectivity.com aims to extend the reach of all the Connectivity Solutions product lines by moving many divisional websites focused on one part of the business to one website encompassing all technologies and offering solutions to its customers.

Emerson Network Power Connectivity Solutions, 299 Johnson Avenue S.W., Suite 100, Waseca, MN 56093

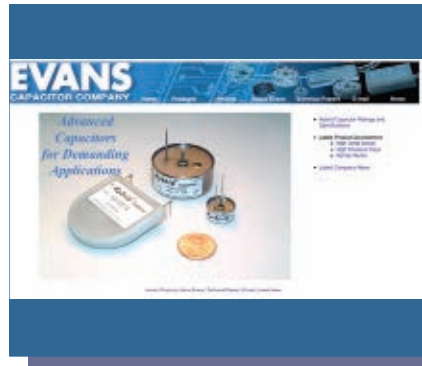
https://emersonconnectivity.com

TX/RX Devices and Subsystems

Endwave Corp. is sporting a new look. After an acquisition of its Defense and Security Division by Microsemi, the company has streamlined its offerings and is building a cornerstone for new products and capabilities. The site positions the company's leading edge millimeter-wave design innovations and custom MMIC capabilities as a force in solving high frequency challenges. Strand has designed and developed an entirely new graphic user interface and navigation scheme to represent Endwave's evolving brand position.

Endwave Corp., 130 Baytech Drive, San Jose, CA 95134

www.endwave.com



Advanced Capacitors

This website shares technical information, white papers, specs and pricing for the company's energy-dense Hybrid® capacitors and Hybrid capacitor banks. High performance aircraft, including the Joint Strike Fighter and the Apache helicopter, use Evans Hybrid Capacitors for laser targeting, communications modules, controls, cockpit displays, phased-array radars and fire control systems. Evans tantalum, hermetic hybrid capacitors have over 4× the energy density of any military-style capacitor.

Evans Capacitor Co., 72 Boyd Avenue, East Providence, RI 02914

www.evanscap.com

INTEGRATED ASSEMBLIES

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- IF frequency range 25 to 50 MHz
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Low Noise Block Downconverter

- RF input range 18 to 22 GHz
- Internal LO 17 GHz
- IF output 1 to 5 GHz
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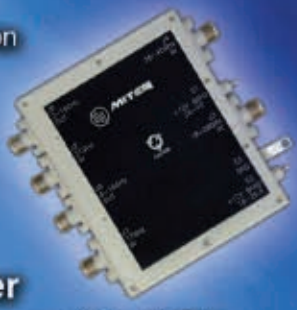
- 60 dB image rejection



Integrated Dual-Channel Block Converter

- RF input frequency range 18 to 40 GHz
- IF output frequency range 2 to 16 GHz
- Integrated LO multipliers and filters
- Integrated RF and IF filters

Sub-Harmonic Upconverter and Power Amplifier Module

- RF output range 36 to 37 GHz
- LO input frequency 17.5 GHz
- Output 1 dB compression point +24 dBm
- Conversion gain 20 dB
- Carrier suppression 40 dB
- High reliability miniature hermetic MIC construction

Low Noise Block Converter with Fiber Optic IF Output

- RF input frequency range 24 to 40 GHz
- IF output frequency range 2 to 18 GHz
- Instantaneous bandwidth 16 GHz
- Noise figure 4 dB typical
- Conversion gain 50 dB including fiber optic receiver

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www.miteq.com

ICs, Modules, Subsystems

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Hittite's redesigned website includes crisp webpage designs and a dynamic homepage featuring full specifications for over 775 products across 22 product lines, press releases and featured articles. Comprehensive Individual Product "Splash Pages" containing in-depth product information and technical content are located on one easy to navigate page. Engineers will find improved Product Support and streamlined Quality & Reliability pages containing invaluable reference materials.

Hittite Microwave Corp.,
20 Alpha Road, Chelmsford, MA 01824

www.hittite.com

Calibration, Measurement and Analysis

Pendulum Instruments, a company of the Orolia Group, a leader in time and frequency calibration, measurement and analysis, has launched a new website. The new website is part of Pendulum Instrument's efforts to facilitate customers and partners service through better and more robust information. Enhancements to the website include optimized and improved product information and a better view of the company's full range of leading system solutions and applications.

Pendulum Instruments,
Box 20020, SE-161 02 Bromma, Sweden

www.pendulum-instruments.com

Components and Subsystems

Planar Monolithics Industries (PMI) announced the redesign and refocus of the company's website (www.pmi-rf.com). The revised website features much more in-depth technical spec's on individual products and lines and is arranged in an easier to use and search manner. Also at PMI's new website, access and sign up for the company's monthly newsletter, a timely periodical addressing specific industry topics and looking at individual PMI products from an application and engineering standpoint.

Planar Monolithics Industries,
7311-F Grove Road,
Frederick, MD 21704

www.pmi-rf.com

Online Store

VENDORVIEW

RF Micro Devices Inc. (RFMD) announced the launch of a new online store offering new features and functionality that significantly enhance the e-commerce experience and streamline the selection and ordering of samples and volume shipments. The new online store is directly accessible via RFMD's homepage at www.rfmd.com and is available immediately for ordering samples, evaluation boards, prototypes and volume production.

RFMD,
7628 Thorndike Road,
Greensboro, NC 27409

www.rfmd.com

Engineer-focused Website

Richardson Electronics Ltd. announced the launch of its redesigned corporate website, www.rell.com, aimed at serving the global community of RF, microwave and power conversion engineers. In developing the new site, Richardson worked closely with the industry's leading suppliers for today's important applications to provide online resources designed to help engineers improve time to market for new products, locate alternative solutions, save development costs, reduce risk and improve design performance.

Richardson Electronics,
40W267 Keslinger Road,
LaFox, IL 60147

www.rell.com

Online Design Tool

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The High Performance Foams Division of Rogers Corp. has created an online design guide that helps designers select the proper Rogers BISCO® Silicones for use in railcar floating floor designs and systems. Use of the Floating Floor Online Design Guide will assist transportation engineers and designers in quickly evaluating options for materials that meet their specific design needs.

Rogers Corp.,
171 W. St. Charles Road,
Carol Stream, IL 60188-2081

www.rogerscorp.com/hpf/tools/floatingfloor

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American Microwave Corp. (AMC),
7311-G Grove Road,
Frederick, MD 21704

www.americanmic.com

Filters and Assemblies

Networks International Corp. has recently updated its website (www.nickc.com), making it more dynamic and user friendly. The updates include a new spotlight feature highlighting NIC's new products and capabilities and improved search for NIC products. Updates have also been made to NIC's product pages to include links to download PDF product catalogs and datasheets.

Networks International Corp.,
15237 Broadmoor,
Overland Park, KS 66223

www.nickc.com

VCOs and PLLs

Z-Communications Inc. announced a new company website with enhanced functionality and updated navigation. The new site features Z-COMM's entire line of VCO and PLL modules accessible through an easy-to-use product selector. Users can quickly search for parts by center frequency or model number and orders can be placed directly through the web store. Datasheets, mechanical drawings and application notes are provided for download. The company's short form product selection guide is also available.

Z-Communications Inc.,
9939 Via Pasar,
San Diego, CA 92126

www.zcomm.com

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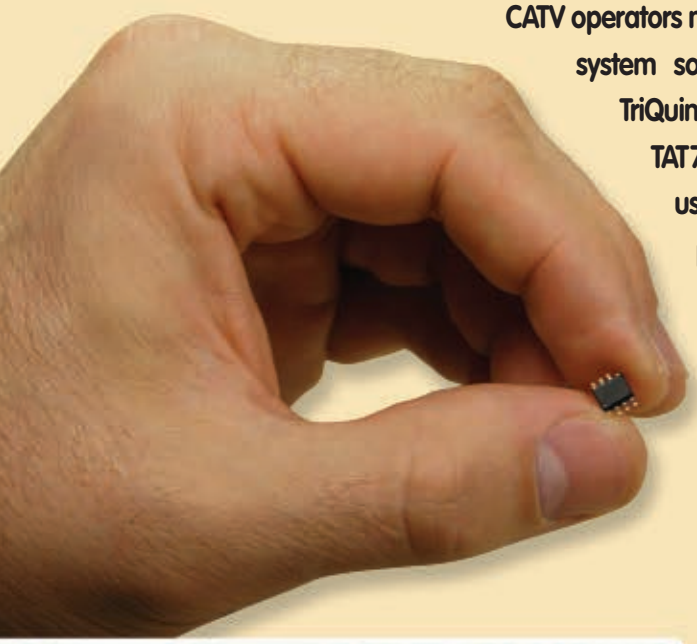

CATV operators need triple-play, multimedia advantages. The most compelling system solutions include 'green', high-efficiency RF amplifiers from TriQuint's new TriAccess™ portfolio. TriQuint Edge QAM amplifiers like TAT7467H deliver DOCSIS® 3.0 performance at half the power usage. FTTH amplifiers like TAT6254C offer superior low noise performance. Our new RFoG amplifier, TAT7457, operates with less than half the EIN of other solutions. TriAccess™ products deliver market-leading RF performance so cable operators can reduce costs and enhance services to win market share in a highly-competitive world.

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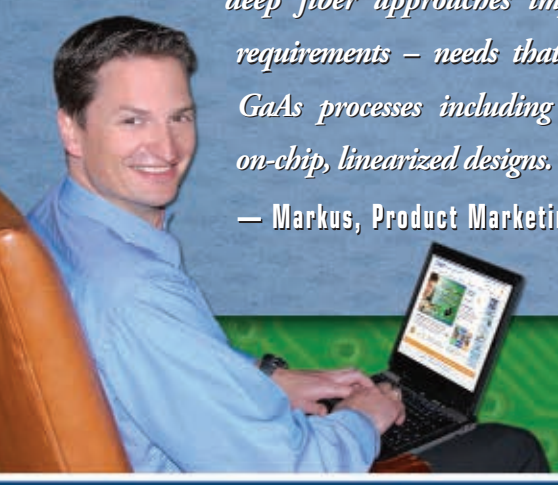
— Markus, Product Marketing Manager



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www.triquint.com/tech-connect/cable

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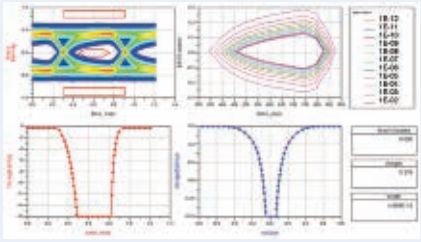


Agilent Technologies introduced a new statistical mode for its signal integrity Channel Simulator. The mode, offered as part of Agilent's Advanced Design System (ADS) 2009 Update 1, is well suited for design and verification of high-speed, chip-to-chip data links found in most consumer and enterprise digital products produced today, from laptop computers and data center servers, to telecommunication switching centers and Internet routers. By accelerating simulation, the new Channel Simulator mode allows manufacturers of such products to more quickly explore and arrive at an optimal design and eliminates the need for costly and time-consuming prototype iterations, dramatically improving time-to-market.

Agilent Technologies Inc.,
Santa Clara, CA
(800) 829-4444,
www.agilent.com.

RS No. 216

Analog-to-Digital Converters

ADI has expanded its low-power data converter portfolio with 26 analog-to-digital converters (ADC) for effective high-performance, power-efficient communications, portable device, instrumentation and healthcare applications. The offering includes three data converter technology industry firsts for 16-bit ADCs: ADI's AD9269, the industry's first 16-bit 80 MSPS low-power, dual ADC with quadrature-error correction (QEC); ADI's AD9265, the industry's first single-channel, 16-bit low-power ADC spanning 80 to 125 MSPS; and ADI's AD9266, the industry's smallest, single-channel 16-bit low-power ADC spanning 20 to 80 MSPS. These new ADC products provide designers a flexible, future-proof platform to differentiate their systems without changing the core design by migrating either resolution or bandwidth support by means of space efficient pin compatible families. In addition, the new ADCs' energy efficiencies provide significant power consumption improvement without impacting system-level performance.

Analog Devices Inc.,
Norwood, MA
(781) 329-4700,
www.analog.com.

RS No. 217

LTE Fading Simulator

VENDORVIEW

The MF6900A fading simulator is designed for use with its MD8430A Signalling Tester, which creates a single vendor solution for conducting simulation tests that have traditionally required more expensive, multi-vendor configurations. The integrated test solution allows developers and manufacturers of 3GPP LTE terminals and chipsets to perform highly accurate and repeatable 2×2 MIMO fading tests more efficiently. When connected to a MD8430A Signalling Tester, the MF6900A emulates the operation of a 3GPP LTE base station in a 2×2 MIMO fading environment. It tests and verifies the handover operation by simulating fading when a mobile terminal (UE) switches its connection between two base station cells. The MD8430A/MF6900A can perform all the necessary intra-LTE handover tests.

Anritsu Co.,
Richardson, TX
(972) 644-1777,
www.us.anritsu.com.

RS No. 218

PLL Synthesizer

Crystek's CPLL58-4240-4240 PLL Synthesizer operates at 4240 MHz with a typical step size of 2500 kHz. Engineered and manufactured in the USA, the model CPLL58-4240-4240 is housed in a compact 0.582" × 0.8" × 0.15" SMD package, which saves board space. Crystek's PLL Synthesizer construction essentially wraps a VCO around a PLL in a package that is only marginally larger than a VCO on its own, and significantly smaller than separate VCO/PLL modules. The CPLL58-4240-4240 is a complete PLL Synthesizer needing only an external frequency reference and supply voltages for the internal PLL and VCO.

Crystek Corp.,
Fort Myers, FL
(239) 561-3311,
www.crystek.com.

RS No. 219

Frequency Synthesizer

The SLS-2100 is a frequency synthesizer optimized for telemetry applications with extremely low phase noise (<-127 dBc/Hz at 100 kHz, typical). The serially-programmable synthesizer performs over the frequency range of 1900 to 2100 MHz with a step size of 100 kHz and fast switching speed (750 uSEC), and can be custom-designed to operate, fixed or programmable, at any L- or S-band frequency. The unit features an optional internal reference, operating temperature range of -30° to +70°C, output power of +8 dBm, low spurs (<-95 dBc) and operates on a supply voltage of +12 V at 155 mA, typical. The SLS-2100 is designed to improve interoperability of telemetry applications and is housed in a ruggedized, aluminum package of 1.5" × 1.5" × 0.6", with female SMA connectors.

EM Research Inc.
Reno, NV
(775) 345-2411,
www.emresearch.com.

RS No. 220

20 Gbps Clocked Comparators

VENDORVIEW

Hittite's new family of 20 Gbps Clocked Comparators offers a unique combination of low propagation delay for low input overdrive while minimizing propagation dispersion and power dissipation. The HMC874LC3C, HMC875LC3C and the HMC876LC3C are ideal for digital receivers, clock and data signal restoration, pulse spectroscopy, high speed instrumentation, medical imaging and diagnostics, and industrial systems where high speed, performance, and low power are critical requirements.

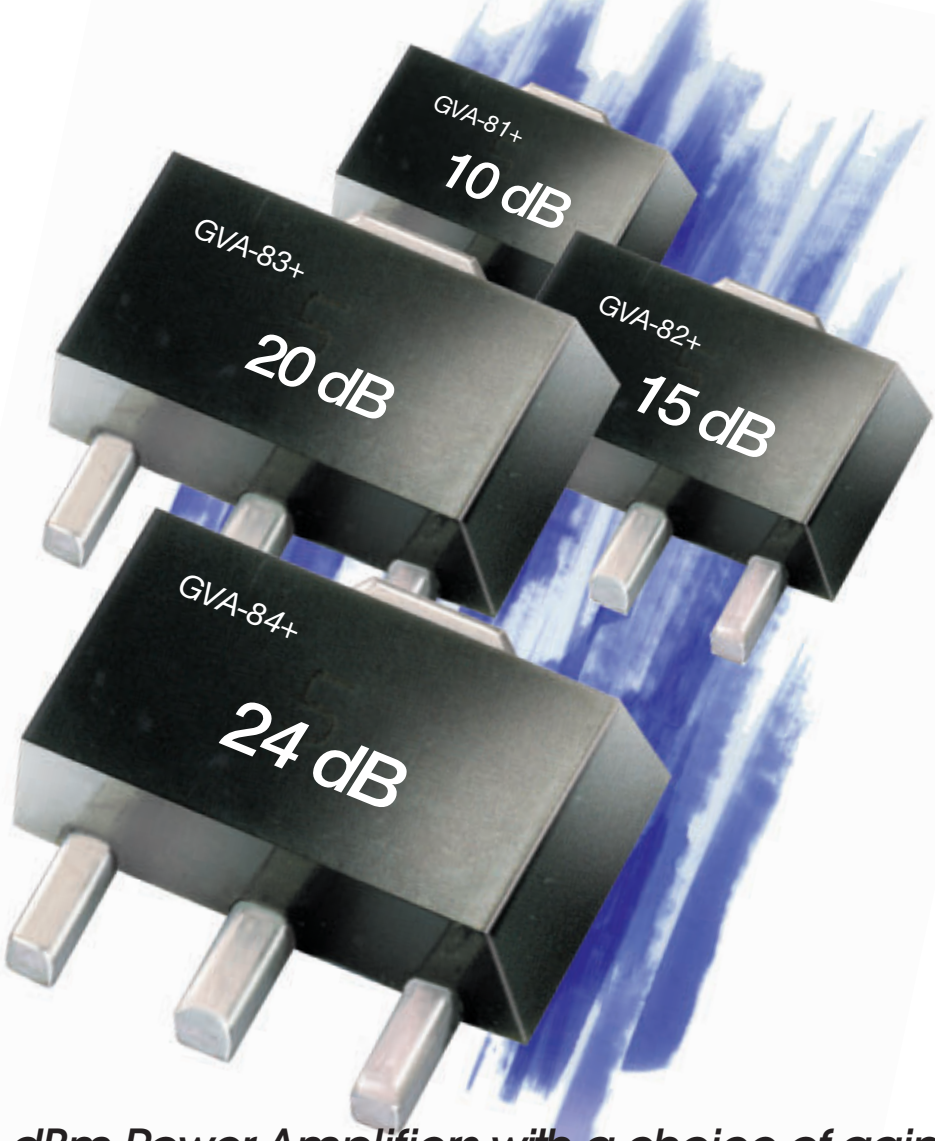
Hittite Microwave Corp.,
Chelmsford, MA
(978) 250-3343,
www.hittite.com.

RS No. 222

Hardware Extension Unit

VENDORVIEW

The R&S ZVAX24 hardware extension unit converts the vector network analyzers of the R&S ZVA family into space saving solutions to make intermodulation or pulse profile measurements easier – even applications up to +43 dBm. Due to its modularity, the R&S ZVAX24 can be tailored to individual applications and



+20 dBm Power Amplifiers with a choice of gain!

GVA AMPLIFIERS

DC to 7 GHz from $1.82 ea. (qty. 25)

Mini-Circuits' monolithic, surface-mount GVA amplifiers are extremely broadband, with wide dynamic range and the right gain to fit your application. Based on high-performance InGaP HBT technology, patented GVA amplifiers cover DC* to 7 GHz, with a selection of gain choices 10, 15, 20 or 24dB, (measured at 1 GHz). They provide better than +20 dBm typical output power, with typical IP3 performance as high as +41 dBm at 1 GHz. Supplied in RoHS-compliant, SOT-89 housings, low-cost GVA amplifiers feature excellent input/output return loss and high reverse isolation. With built-in ESD protection, GVA amplifiers are unconditionally stable and designed for a single 5-V supply. For more on broadband GVA amplifiers, visit the Mini-Circuits' web site at www.minicircuits.com.

US patent 6,943,629 **Low frequency determined by coupling cap.*

Mini-Circuits...Your partners for success since 1969

40TH ANNIVERSARY 1969-2009

Mini-Circuits®

ISO 9001 ISO 14001 AS9100 CERTIFIED

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661

YoniTM2 Patent Pending *The Design Engineers Search Engine finds the model you need, Instantly* • For detailed performance specs & shopping online see minicircuits.com

IF/RF MICROWAVE COMPONENTS

458 rev B

Visit http://mwj.hotims.com/23294-59 or use RS# 59 at www.mwjournal.com/info

New Waves

can be equipped with combiners, harmonic filters, pulse modulators and high power couplers. For connection, the extension unit is placed under the vector network analyzer and the RF ports are connected via semi-rigid coaxial cables. Control is performed via USB directly from the vector network analyzer, which displays a dialog box containing a block diagram of the extension unit. Depending on the test task, the required RF components can be connected.

Rohde & Schwarz,
Munich, Germany
+49 89 4129 13774,
www.rohde-schwarz.com.

RS No. 223

Mixed Signal Oscilloscope

The MSO70000 Series of Mixed Signal Oscilloscopes is a high-performance family of integrated MSOs. The instruments have up to 20 channels of measurement capture (4 analog and 16 digital) with analog bandwidth ranging from 4 to 20 GHz and 80 ps digital channel timing resolution. With the MSO70000 introduction, Tektronix now has a complete portfolio of Mixed Signal Oscilloscopes on the market; 17 MSO models are offered, which range from the value-priced portable MSO2000 all the way to the 20 GHz MSO72004. The MSO70000 Series combines the signal visibility and timing features of a high performance logic analyzer with the analog precision, probing and usability of a high performance real-time oscilloscope. This makes it the ideal debug and verification tool for such demanding high-speed design applications.

Tektronix Inc.,
Beaverton, OR
(800) 835-9433,
www.tek.com.

RS No. 224

MMIC Tool Bar

WIN Semiconductors announced the availability of a new MMIC tool bar personality for ten Advanced Design System (ADS) process design kits (PDK) for its popular Enhancement/Depletion-Mode PHEMT and HBT process technologies. The new add-on WIN PDKs, developed for use with current and future releases of Agilent Technologies' ADS 2009, enable high-frequency RF and microwave designers to create compact integrated circuits comprised of power amplifiers, switches, low-noise amplifiers, mixers and logic circuitry. The add-on PDKs are available now from WIN Semiconductors.

WIN Semiconductors,
Tao Yuan Shien, Taiwan
886-3-397-5999,
www.winfoundry.com.

RS No. 225

Components

Multi Position Switch

The SM Series features SMA connectors and a frequency range of DC to 18 GHz. The SME Series also features SMA connectors and has a frequency range of DC to 26.5 GHz. Both series are available with failsafe or normally open Actuator functions. Features include: weight of 5.0 oz; RF impedance of 50 ohms nominal; operating temperature of -55° to +85°C ambient; operating life of 2,000,000+ cycles minimum; switching time of 15 mSec maximum; and switching sequence of Break Before Make.

Ducommun Technologies,
Carson, CA
(310) 513-7214,
www.ducommun.com.

RS No. 226

Low Loss Cable Assemblies

VENDORVIEW

These low loss cable assemblies feature attenuation of 0.22 dB/ft. at 18 GHz. The extremely low loss, 0.335" (LL335), cable assemblies also achieve typical attenuation of 0.048 dB/ft. at 1 GHz, and 0.17 dB/ft. at 10 GHz. Additionally, these cable assemblies can handle 1800 W CW input power at 1 GHz and 600 W CW input power at 10 GHz. They offer shielding effectiveness of greater than 95 dB with low coefficient of expansion over a wide temperature range of -55° to +200°C to ensure that attenuation and phase performance remains stable over time and temperature. These low loss cable assemblies feature a minimum bend radius of 1.7".

Electronic Assembly Manufacturing Inc.,
Methuen, MA
(978) 374-6840,
www.eamcableassemblies.com.

RS No. 227

Isolators and Circulators

VENDORVIEW

JQL Electronics announced its new Thincore™ waveguide isolators and circulators. The new Thincore line is designed for point-to-point base station application with ultra compact size and reliable performance. Key models include WR 42 (17.6 to 19.7 GHz, 21.2 to 23.6 GHz) with 9.5 mm thick, WR 28 (37 to 40 GHz) with 12.7 mm thick and WR 62 (14.4 to 15.5 GHz) with 14 mm thick. Thincore also offers ultra competitive cost.

JQL Electronics Inc.,
Deerfield, IL (630) 930-9917,
www.jqlelectronics.com.

RS No. 228

i²S® INTELLIGENT INTERACTIVE SYNTHESIZERS

FEATURES: Over an octave bandwidth tuning, Small step size resolution, Outstanding spectral purity, High spurious rejection, Fast lock settling time

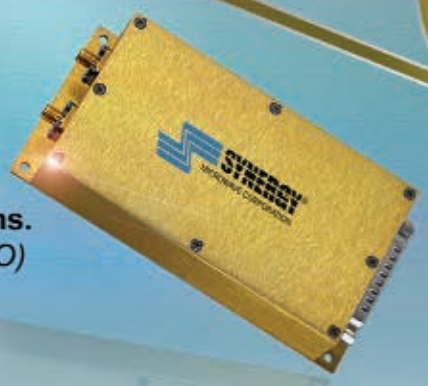
MTS2500-110250-10	
Output Frequency	1100 - 2500 MHz
Bandwidth	1400 MHz
External Reference	10 MHz
Step Size	Programmable to 1 Hz
Bias Voltage	+5 / +3.3 V
Output Power	+9 dBm (Min.)
Spurious Suppression	60 dB (Typ.)
Harmonic Suppression	15 dB (Typ.)
Typical Phase Noise	Offset / dBc/Hz. 1 kHz / -93 10 kHz / -95 100 kHz / -110
Settling Time	Within 1 kHz / <22 mSec Within 10 Hz / <36 mSec
Operating Temperature Range	-20 to +70 °C

MTS2500-200400-10	
Output Frequency	2000 - 4000 MHz
Bandwidth	2000 MHz
External Reference	10 MHz
Step Size	Programmable to 1 Hz
Bias Voltage	+5 / +3.3 V
Output Power	+5.5 dBm (Min.)
Spurious Suppression	60 dB (Typ.)
Harmonic Suppression	10 dB (Typ.)
Typical Phase Noise	Offset / dBc/Hz. 1 kHz / -88 10 kHz / -87 100 kHz / -100
Settling Time	Within 1 kHz / <10 mSec Within 10 Hz / <20 mSec
Operating Temperature Range	-20 to +70 °C

MTS2500-300600-10	
Output Frequency	3000 - 6000 MHz
Bandwidth	3000 MHz
External Reference	10 MHz
Step Size	Programmable to 1 Hz
Bias Voltage	+5 / +3.3 V
Output Power	+2 dBm (Min.)
Spurious Suppression	60 dB (Typ.)
Harmonic Suppression	20 dB (Typ.)
Typical Phase Noise	Offset / dBc/Hz. 1 kHz / -87 10 kHz / -83 100 kHz / -108
Settling Time	Within 1 kHz / <6 mSec Within 10 Hz / <12 mSec
Operating Temperature Range	-20 to +70 °C

Patented Technology

Programming Interface:
-- 3.3V SPI (Standard)
-- RS232



Also available in connectorized package with the following options.
-- Internal reference (TCXO & OCXO)
-- Divider output for lower bands
-- Low phase noise option

Available Frequencies Ranging Up To 8000 MHz

SYNERGY® MICROWAVE CORPORATION

For additional information, contact Synergy's sales and application team.
201 McLean Boulevard, Paterson, NJ 07504 | Phone: (973) 881-8800
Fax: (973) 881-8361 | E-mail: sales@synergymwave.com

Visit Our Website At WWW.SYNERGYMWAVE.COM

NEW PRODUCTS

Hybrid Ring Divider/Combiners

VENDORVIEW

MECA features two high power, hybrid ring divider/combiners designed to cover wireless bands from 0.810 to 0.960 GHz and 1.700 to 2.000 GHz with average RF power handling capability of 1,000 W (5 kW peak). Other high power, hybrid ring models are available in frequencies spanning from 0.810 to 6.000 GHz for narrowband applications. Available stock to four weeks ARO. Made in the USA with a 36-month warranty.

MECA Electronics Inc.,
Denville, NJ (973) 625-0661,
www.e-meca.com.

RS No. 230

High Power SPDT Switch

VENDORVIEW

This new wideband, high power SPDT switch exhibits optimum performance across the IFF band (1015 to 1105 MHz). The HPSW2-006016RN5NNF model measured loss is 0.33 dB and the VSWR is 1.07:1 across the IF band and degrades somewhat across the 600 to 1600 MHz range of operation. This switch operates over a –55° to +91°C temperature range and at 70,000 feet altitude. This model was designed and tested at 3.5 kW, 35 microsecond pulse width, 1.6 percent DF at high altitude and into a sliding 3:1 load.

MITEQ Inc.,
Hauppauge, NY (631) 436-7400,
www.miteq.com.

RS No. 231

Coaxial Terminations

VENDORVIEW

Model 368BNM and Model 369BNM coaxial terminations operate from 2 to 18 GHz and 700 MHz to 18 GHz, respectively, and are extremely rugged for use in applications ranging from instrumentation to transmitters in the field. The Model 368BNM handles an RF power input power up to 500 W average and 5 kW peak, has a maximum VSWR of 1.4:1 from 2 to 3 GHz, 1.3:1 from 3 to 12.4 GHz, and 1.45:1 from 12.4 to 18 GHz. It measures 11.9" × 3.88" including Type-N connector and heat sink, and weighs 6.5 lb (3 kg). The Model 369BNM handles an RF input power up to 175 W average and 10 kW peak, has a maximum VSWR of 1.2:1 from 700 MHz to 1 GHz, 1.1:1 from 1 to 9 GHz, and 1.2:1 from 9 to 18 GHz to 18 GHz. It measures 13.1" × 3.88" including Type-N connector and heat sink, and weighs 2.5 lbs (1.1 kg).

Narda,
Hauppauge, NY (631) 231-1700,
www.nardamicrowave.com/east.

RS No. 240

Single and Dual Directional Couplers

RLC Electronics' high power directional couplers offer accurate coupling, low insertion loss and high directivity in a compact package. The standard units are optimized for two octave bandwidths and are available with a choice of coupling values. These units are ideal for sampling forward and reflected power with a negligible effect on the transmission line and very low intermodulation products.

RLC Electronics Inc.,
Mount Kisco, NY (914) 241-1334,
www.rlcelectronics.com.

RS No. 232

Compact Filters

This series of compact LC BP filters is designed for the Iridium telephony band. This pole-placed bandpass filter passes the 1616.0 to 1626.5 MHz band with a maximum insertion loss of 2.6 dB while providing a minimum of 15 dB of isolation at GPS L1 and 70 dB minimum at GPS L2. It also provides 45 dB of isolation at 1710 to 1850 MHz band and 55 dB beyond that out to 10 GHz. Both connectorized and PCB mount versions are available.

Trilithic Inc.,
Indianapolis, IN (317) 895-3600,
www.trilithic.com.

RS No. 233

Amplifiers

GaN Power Amplifier

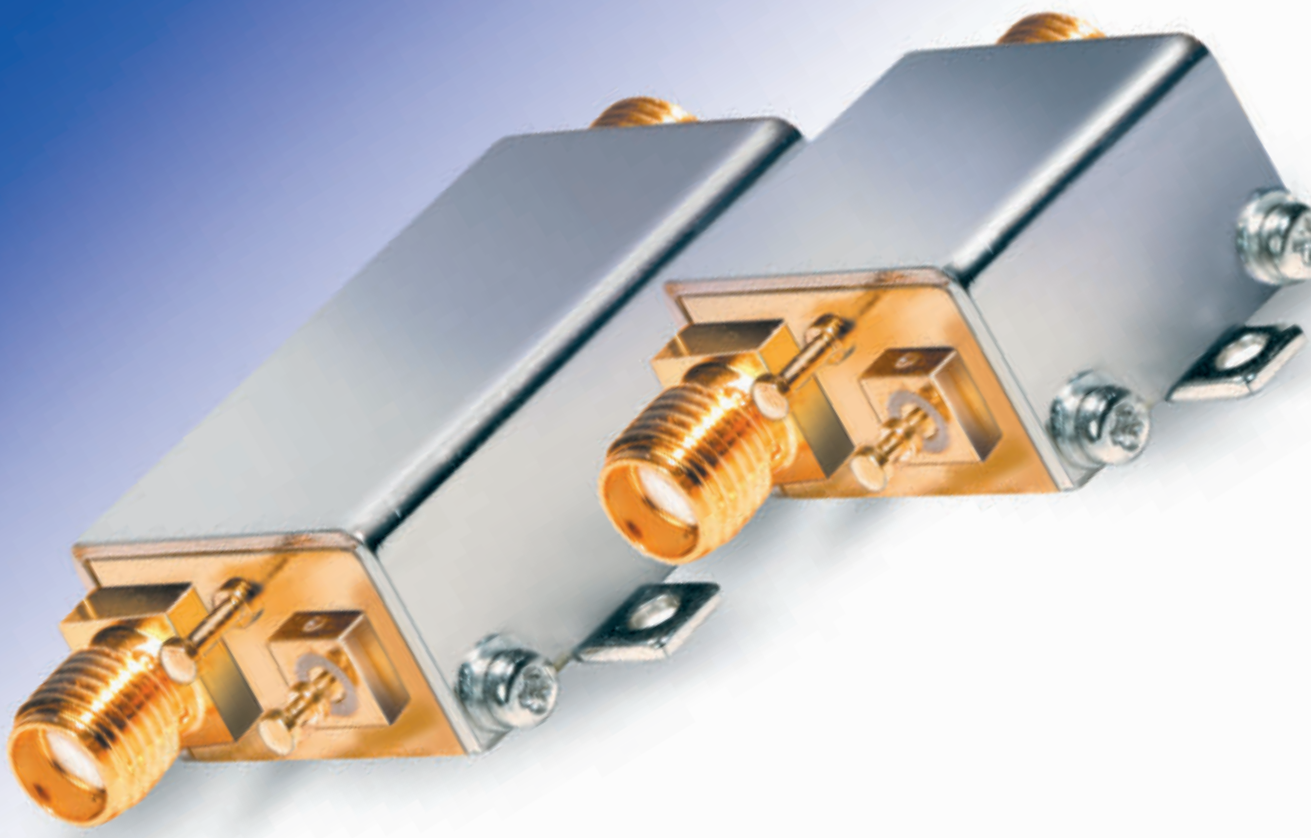
Model number SSPA 0.1-0.8-70 is a high power, Gallium Nitride (GaN) amplifier that operates from 100 to 800 MHz minimum and is packaged in a compact, high performance package. This amplifier is designed for operation in harsh environments. Typical output power is 80 W across the band at P3dB. Small-signal gain is 57 to 58 dB across the band typically. Power added efficiency in saturation is typically 45 to 60 percent across the band. Input and output VSWR is 2.0:1 maximum. This unit is equipped with DC switching circuitry that enables and disables the RF devices inside the amplifier in 4000 nSec typical for turn on and 1650 nSec typical for turn off time. Standard features include reverse polarity protection, output short and open circuit protection, and over/under voltage protection.

Aethercomm Inc.,
Carlsbad, CA (760) 208-6002,
www.aethercomm.com.

RS No. 234

300 kHz to 14 GHz

AMPLIFIERS



ZX SERIES

from $49.95 ea. qty. 1-9 IN STOCK

Mini-Circuits ZX60 family of compact coaxial amplifiers serve a broad range of applications from 300 kHz to 14 GHz. ZX60 models offer many combinations of gain (as high as 38 dB), noise figure, output power, and linearity (IP3 performance) over wide bandwidths, allowing designers, for example, to optimize system dynamic range through a wide choice of noise-figure performance levels (as low as 0.4 dB at 1.4 GHz) and high IP3 performance (as high as +45 dBm at 2.4 GHz). ZX60 amplifiers are small in size and low in cost, and still deliver excellent active directivity (isolation-gain) and outstanding unit-to-unit performance repeatability. All models feature Mini-Circuits exclusive Unibody housing (protected by US Patent No. 6,790,049) for reliability. And when these ready-to-ship standard models won't do, Mini-Circuits technical team is ready to quickly meet your most demanding requirements with effective custom solutions.

Mini-Circuits...Your partners for success since 1969

Model	Freq. (GHz)	Gain (dB) Typ.	NF (dB) Typ.	IP3 (dBm) Typ.	P_{out} @ 1dB Comp. (dBm) Typ.	DC Volts (V)	Current (mA) Max.	Price $ ea. (1-9)
Length: 0.74" x (W) 1.18" x (H) 0.46"								
ZX60-2510M	0.5-2.5	12.9	5.4	+28.8	17.1	5.0	95	59.95
ZX60-2514M	0.5-2.5	16.4	4.8	+30.3	16.5	5.0	90	59.95
ZX60-2522M	0.5-2.5	23.5	3.0	+30.6	18.0	5.0	95	59.95
ZX60-3011	0.4-3.0	12.5	1.7	+31.0	21.0	12.0	120	139.95
ZX60-3018G	0.02-3.0	20.0	2.7	+25.0	11.8	12.0	45	49.95
ZX60-4016E	0.02-4.0	18.0	3.9	+30.0	16.5	12.0	75	49.95
ZX60-5916M	1.5-5.9	17.0	6.4	+28.3	14.4	5.0	96	59.95
ZX60-6013E	0.02-6.0	14.0	3.3	+28.7	10.3	12.0	50	49.95
ZX60-8008E	0.02-8.0	9.0	4.1	+24.0	9.3	12.0	50	49.95
ZX60-14012L	0.0003-14.0	12.0	5.5	+20.0	11.0	12.0	68	172.95
ZX60-33LN	0.05-3.0	17.6	1.1	+30.0	17.5	5.0	80	79.95
Length: 1.20" x (W) 1.18" x (H) 0.46"								
ZX60-1215LN	0.8-1.4	15.5	0.4	+27.5	12.5	12.0	50	149.95
ZX60-1614LN	1.217-1.620	14.0	0.5	+30.0	13.5	12.0	50	149.95
ZX60-2411BM	0.8-2.4	11.5	3.5	45.0	24.0	5.0	360	119.95
ZX60-2531M	0.5-2.5	35.0	3.5	+26.1	16.1	5.0	130	64.95
ZX60-2534M	0.5-2.5	38.0	3.1	+30.0	17.2	5.0	185	64.95
ZX60-3800LN	3.3-3.8	23.0	0.9	+36.0	18.0	5.0	110	119.95

U.S.Patent # 6,790,049

40TH ANNIVERSARY 1969-2009

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IF/RF MICROWAVE COMPONENTS

411 rev F

Visit http://mwj.hotims.com/23294-60 or use RS# 60 at www.mwjournal.com/info

New Products

20 W Solid-state Amplifier

VENDORVIEW

AR's model 20S6G18, a 20 W solid-state amplifier covering 6 to 18 GHz provides high gain, low noise, good linearity and excellent mismatch capability. The amplifier also delivers superior error vector magnitude (EVM) performance. With a minimum of 43 dB gain and a typical noise figure of 6 dB, the 20S6G18 offers significant advantages over traveling wave tube amplifiers in this frequency range.
AR RF/Microwave Instrumentation, Souderton, PA (215) 723-8181, www.ar-worldwide.com.

RS No. 235

Wideband Amplifier

VENDORVIEW

The ZX60-V82+ is a compact wideband amplifier covering 20 to 6000 MHz with 14 dB gain (at 2 GHz). Housed in a rugged, cost-effective unibody chassis, this amplifier supports a wide variety of applications requiring moderate power output, low distortion and 50 ohm matched input/output ports. The ZX60-V82+ covers a wide spectrum of application frequencies from VHF through C-band. When combined with the output power and IP3, this amplifier supports a broad array of systems and test applications. With input VSWR typically 1.3:1 and output 1.5:1, the ZX60-V82+ can be used in cascade with many components and maintain minimal interaction or reflections. With small size, 0.75" × 0.75", the unique unibody construction enables the ZX60-V82+ to be used in compact designs. These amplifiers are unconditionally stable, and have no adverse effects due to loading of the input and output ports. Pricing: $69.95 (QTY 1-9).
Mini-Circuits, Brooklyn, NY (718) 934-4500, www.minicircuits.com.

RS No. 236

Low Noise Amplifiers

NIC successfully launched its new line of wideband low noise amplifiers (LNA) designed for C-band, Radar and SATCOM applications. This amplifier operates in the frequency range of 4 to 5 GHz, providing high gain of ~23 dB typical, low noise figure of ~0.9 dB typical and is built in an extremely small package size of 1.2" × 0.9" × 0.4". Custom designs are available.
Networks International Corp., Overland Park, KS (913) 685-3400, www.nickc.com.

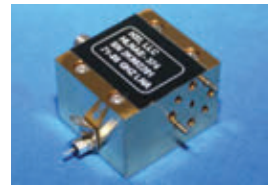
RS No. 237

High Power Pallet Amplifier

The PP470-860-1000 is a high power Linear Class AB pallet amplifier featuring the latest generation LDMOS transistors, covering the entire UHF TV band. The PP470-860-1000 can be used as an output PA at 250 W of DVB-T Average Digital Output Power, shoulder ≤ -33 dBc. This pallet is not designed for analog service. Please refer to PMT's UHFTV-600 for analog broadcast applications.
Power Module Technology Inc., Carson City, NV (775) 883-1122, www.pmtrf.com.

RS No. 238

Low Noise Amplifiers



The HLNA Series of low noise amplifiers covers the frequency ranges from 18 to 110 GHz. A wide variety of gain and bandwidth combinations are available to provide the designer with a solution for most applications. Custom designs are available and in most cases NRE is not required. MMIC technology is employed for high reliability and repeatability. The amplifiers can be used to lower system noise figure in communication and radar systems and also as gain blocks in LO chains and test equipment. Low noise amplifier stages can be combined with power amplifier stages for higher P1dB levels. LNAs can also be packaged with other components for custom configurations. Each LNA contains a voltage regulator and bias sequencing circuitry allowing the use of a single bias to power the amplifier.
Renaissance Electronics Corp./HXI, Harvard, MA (978) 521-7321, www.hxi.com.

RS No. 239

Material

PTFE Laminates

VENDORVIEW

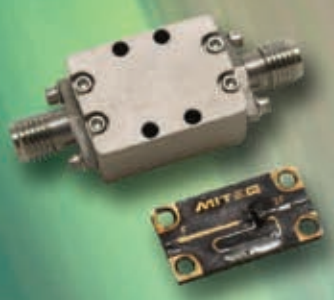
The RO3730™ laminates are tailored for the special needs of high-frequency antenna designers requiring cost-effective PTFE laminates. These ceramic-filled laminate materials are reinforced by woven fiber glass with optimized glass and filler loading for excellent structural stability and outstanding electrical performance. The optimized blend of filler materials results in consistent dielectric constant across even large laminate panels, with low dissipation factor (0.00159 at 10 GHz/ 0.00128 at 2.5 GHz) and high power-handling capabilities. The RO3730 laminates boast the low passive intermodulation (PIM) distortion valued by engineers developing antennas for complex digital communications formats, including in 3G and 4G base stations. These robust RO3730 laminate materials with a dielectric constant of 3.0 are

Delivery From Stock!

MIXERS

Model Number	RF/LO Frequency (GHz)	IF Frequency (GHz)	LO Power (dBm)	Conversion Loss (dB) Typ./Max.	LO-to-RF Isolation (dB) Min.
DOUBLE-BALANCED VERSIONS					
DM0052LA2	0.5 – 2	DC – 0.5	7 – 13	6.5/8.5	30
DM0104LA1	1 – 4	DC – 1	7 – 13	5.5/7	30
DM0208LW2	2 – 8	DC – 2	7 – 13	7/8	30
DM0408LW2	4 – 8	DC – 2	7 – 13	5/6	30
DM0812LW2	8 – 12	DC – 4	7 – 13	4.5/6	30
DM0416LW2	4 – 16	DC – 4	7 – 13	7/8	30
DB0218LW2	2 – 18	DC – 0.75	7 – 13	6.5/8.5	22
DB0226LA1	2 – 26	DC – 0.5	7 – 13	9/10	20
DB0440LW1	4 – 40	DC – 2	10 – 15	9/10	20
M2640W1	26 – 40	DC – 12	10 – 15	10/12	28
TRIPLE-BALANCED VERSIONS					
TB0218LW2	2 – 18	0.5 – 8	10 – 15	7.5/9.5	20
TB0426LW1	4 – 26	0.5 – 8	10 – 15	10/12	20
TB0440LW1	4 – 40	0.5 – 20	10 – 15	10/12	18

PASSIVE DOUBLERS



Model Number	Input Frequency (GHz)	Input Power (dBm)	Output Frequency (GHz)	Conversion Loss (dB) Typ./Max.	Rejection (dBc) Typ. Fund.	Rejection (dBc) Typ. Odd Harm.
DROP-IN VERSIONS						
SXS01M	0.5 – 3	8 – 12	1 – 6	13/16	-20	-25
SXS04M	2 – 9	8 – 12	4 – 18	13/15	-20	-25
SXS07M	3 – 13	8 – 12	6 – 26	13/18	-18	-25
CONNECTORIZED VERSIONS						
SXS2M010060	0.5 – 3	8 – 12	1 – 6	13/16	-20	-25
SXS2M040180	2 – 9	8 – 12	4 – 18	13/15	-20	-25
SXS2M060260	3 – 13	8 – 12	6 – 26	13/17	-18	-25
MX2M130260	6.5 – 13	8 – 12	13 – 26	11/13	-15	-15
MX2M004010	0.02 – 0.5	8 – 12	0.04 – 1	10.5/13	-25	-25

Additional models available with 60 day lead time, please contact MITEQ.
Above models also available with optional LO power ranges, please contact MITEQ.

Fastest Delivery Available! + 3 YEAR WARRANTY = MITEQ

For additional information or technical support, please contact our Sales Department at (631) 439-9220 or e-mail components@miteq.com

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www.miteq.com

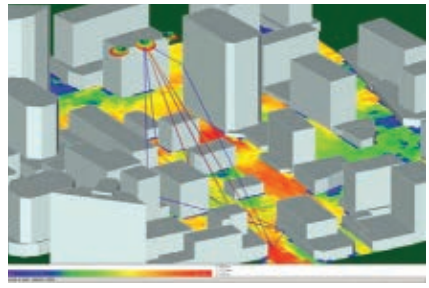
Visit http://mwj.hotims.com/23294-67 or use RS# 67 at www.mwjournal.com/info

ideal for high-frequency circuit boards in a wide range of communications antennas.
Rogers Corp.,
Chandler, AZ (480) 961-1382,
www.rogerscorp.com.

RS No. 241

Software

Radio Propagation Software

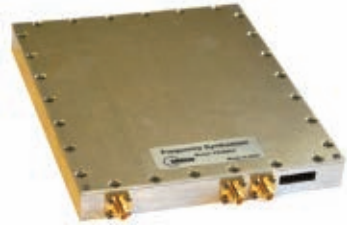


Remcom announces a new version of Wireless InSite®, enhanced to further improve customer productivity and efficiency with faster run times and the ability to handle more intricate wireless EM propagation problems. Wireless InSite is site-specific radio propagation software for the analysis and design of wireless communication systems. It provides efficient and accurate predictions of propagation and communication channel characteristics in complex urban, indoor, rural and mixed path environments, including high-fidelity and real time options. Applications range from military defense to commercial communications, helping RF engineers to design wireless communications links, optimize antenna coverage, and assess the effectiveness of jammers.
Remcom Inc.,
State College, PA (814) 861-1299,
www.remcom.com.

RS No. 242

Sources

Frequency Synthesizer



The FS3840A is an extremely wideband frequency synthesizer module featuring 1 Hz tuning resolution, very low spurious and excellent phase noise. The unit can be programmed by the user to operate from either the internal TCXO reference or an external source. The FS3840A can be used as a stand-alone frequency source conveniently controlled by a PC via its RS-232 serial port. Alternatively, the FS3840A can be programmed via a four-wire serial interface for embedded applications. The unit runs from a single +15 VDC supply. Its wide bandwidth, fine resolution, and a rich complement of programming commands makes the FS3840A ideal for a variety of applications.
Shireen Inc.,
Rockville, MD (301) 838-4380,
www.shireeninc.com.

RS No. 243

Voltage-controlled Oscillator

Z-Comm announced a RoHS compliant voltage-controlled oscillator (VCO) model V600ME14-LF in S-band. The V600ME14-LF operates at 2000 to 4000 MHz with a tuning voltage range of 0 to 24 VDC. This VCO features a typical phase noise of -89 dBc/Hz at 10 kHz offset and a typical tuning sensitivity of 110 MHz/V. The V600ME14-LF is designed to deliver a typical output power of 10 dBm at 5 VDC supply while drawing 35 mA (typical) over the temperature range of -40° to +85°C. This VCO features typical second harmonic suppression of -15 dBc and comes in Z-Comm's standard MINI-16-LOW package measuring 0.5" × 0.5" × 0.16".
Z-Communications Inc.,
San Diego, CA (858) 621-2700,
www.zcomm.com.

RS No. 244

Subsystem

Digital Receiver

The DRX-5571 is the latest addition to Cobham Sensor Systems M/A-COM SIGINT Products' line of high-performance microwave set-on receivers. The proven RF to IF performance of the SMR-5500 series receivers is combined with an FPGA-based demodulation and radio demultiplexing capability. This allows the receiver to fully process microwave signals having complex modulation and encoding schemes down to the underlying radio payload. The DRX-5571 provides a completely integrated system solution for capture, analysis, survey and collection of wideband digital radio RF signals. An intuitive and easy to use GUI with Ethernet control interface is provided, which combines control for the receiver, demodulator and radio processing in a single interface. All flexible processing can be quickly and easily configured using the user-friendly interface, and access to all status is provided including spectrum display, constellation plot and analysis results.
Cobham Sensor Systems,
Baltimore, MD (410) 542-1700,
www.cobham.com.

RS No. 245

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For RoHS compliant requirements, ADD + SUFFIX TO BASE MODEL No. *Example: VLF-80+*

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

Model	Passband (MHz)	fco, Nom. Loss 3 dB (MHz) Typ.	Stopband Loss >20 dB (MHz) Min.
VLF-80	DC-80	145	200
VLF-95	DC-95	165	220
VLF-105	DC-105	180	250
VLF-120	DC-120	195	280
VLF-160+	DC-160	230	330
VLF-180+	DC-180	270	370
VLF-190+	DC-190	280	400
VLF-225	DC-225	350	460
VLF-320	DC-320	460	560
VLF-400	DC-400	560	660
VLF-490	DC-490	650	800
VLF-530	DC-530	700	820
VLF-575	DC-575	770	900
VLF-630	DC-630	830	1000
VLF-800	DC-800	1075	1275
VLF-1000	DC-1000	1300	1550
VLF-1200	DC-1200	1530	1865
VLF-1400	DC-1400	1700	2015
VLF-1450	DC-1450	1825	2025
VLF-1500	DC-1500	1825	2100
VLF-1525	DC-1525	1750	2040
VLF-1575	DC-1575	1875	2175
VLF-1700	DC-1700	2050	2375
VLF-1800	DC-1800	2125	2425
VLF-2250	DC-2200	2575	2900
VLF-2500	DC-2500	3075	3675
VLF-2600	DC-2600	3125	3750
VLF-2750	DC-2750	3150	4000
VLF-2850	DC-2800	3300	4000
VLF-3000	DC-3000	3600	4550
VLF-3800+	DC-3900	4850	6000
VLF-4400+	DC-4400	5290	6700
VLF-5000	DC-5000	5580	6850
VLF-5500+	DC-5500	6200	7200
VLF-5850+	DC-5850	6540	7600
VLF-6000	DC-6000	6800	8500
VLF-6400+	DC-6400	7200	8300
VLF-6700	DC-6700	7600	9300
VLF-7200+	DC-7200	8150	9500

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

Model	Passband (MHz)	fco, Nom. Loss 3 dB (MHz) Typ.	Stopband Loss >20 dB (MHz) Min.
VHF-650	710-2490	650	480
VHF-740	780-2800	740	550
VHF-880	950-3200	880	640
VHF-1200	1220-4600	1180	940
VHF-1300	1400-5000	1300	930
VHF-1320	1400-5000	1320	1060
VHF-1500	1600-5500	1550	1250
VHF-1600	1650-5000	1600	1290
VHF-1760	1900-5500	1760	1230
VHF-1810	1900-4750	1810	1480
VHF-1910	2000-5200	1910	1400
VHF-2000	2260-6250	2000	1530
VHF-2100	2200-6000	2100	1530
VHF-2275	2450-7000	2275	1770
VHF-2700	2650-6500	2500	1800
VHF-2700A+	2900-8700	2700	2150
VHF-3100+	3400-9900	3100	2450
VHF-3500+	3900-9800	3500	2800
VHF-3800	4250-10000	3800	3200
VHF-4400+	5000-10100	4400	3500
VHF-4600+	5000-11000	4600	3800
VHF-5050+	5500-10000	5050	4200
VHF-5500	6000-11500	5500	4500
VHF-6010	6300-15000	6010	5200
VHF-7150+	7900-11000	7150	6150
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Wireless Positioning Technologies and Applications

Alan Bensk

In many wireless systems, distance measurement and position location capabilities have become necessary. A big thrust toward this was in 1995 when the FCC started requiring 911 caller location services for cellular phones. Other applications where position location has become important include RFID, WLAN and WPAN while GPS has been pervasive for several years.

Wireless Positioning Technologies and Applications covers the various wireless positioning technologies including the basic principles and applications plus the technology behind them. The first two chapters describe typical applications and give a basic description of positioning methods as well as definitions of important parameters and physical limitations of time measurement. The other chapters are organized in the three broad categories of technology, methods and application. They cover spread spectrum, time transfer, multicarrier phase measurement, received signal strength, time of arrival and time difference of arrival, and angle of arrival. Cellular networks, short-range wireless networks, RFID and UWB are also covered.

This book is primarily aimed at working engineers who are involved in projects with wireless distance measurement and location technologies or who want to expand their knowledge in the area. An understanding of basic engineering mathematics, including familiarity with Fourier analysis, matrix manipulation and probability are helpful for understanding some of the equations and examples. Along with theoretical information, this book also includes practical content on implementation. It discusses the challenges to achieving theoretical accuracy due to noise, multipath, and fading plus practical limitations of antenna directivity and time measurement precision.

Two examples are given in the final chapters for the ECMA-368 specification for high data rate personal area networks and IEEE 802.15.4a, which extends the capabilities of the physical layer of the ZigBee protocol for low-cost, low complexity sensor networks. The inclusion in this book of legacy navigation systems and the ranging features in the newest specification give a comprehensive review of distance measurement and location technologies. Typically, books only focus on one technology so this is a good resource covering the whole subject of wireless positioning.

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MCA1-24	7	300-2400	6.1	40	5.95
MCA1-42	7	1000-4200	6.1	35	6.95
MCA1-60	7	1600-6000	6.2	30	7.95
MCA1-85	7	2800-8500	5.6	38	8.95
MCA1-12G	7	3800-12000	6.2	38	10.95
MCA1-24LH	10	300-2400	6.5	40	6.45
MCA1-42LH	10	1000-4200	6.0	38	7.45
MCA1-60LH	10	1700-6000	6.3	30	8.45
MCA1-80LH	10	2800-8000	5.9	35	9.95
MCA1-24MH	13	300-2400	6.1	40	6.95
MCA1-42MH	13	1000-4200	6.2	35	7.95
MCA1-60MH	13	1600-6000	6.4	27	8.95
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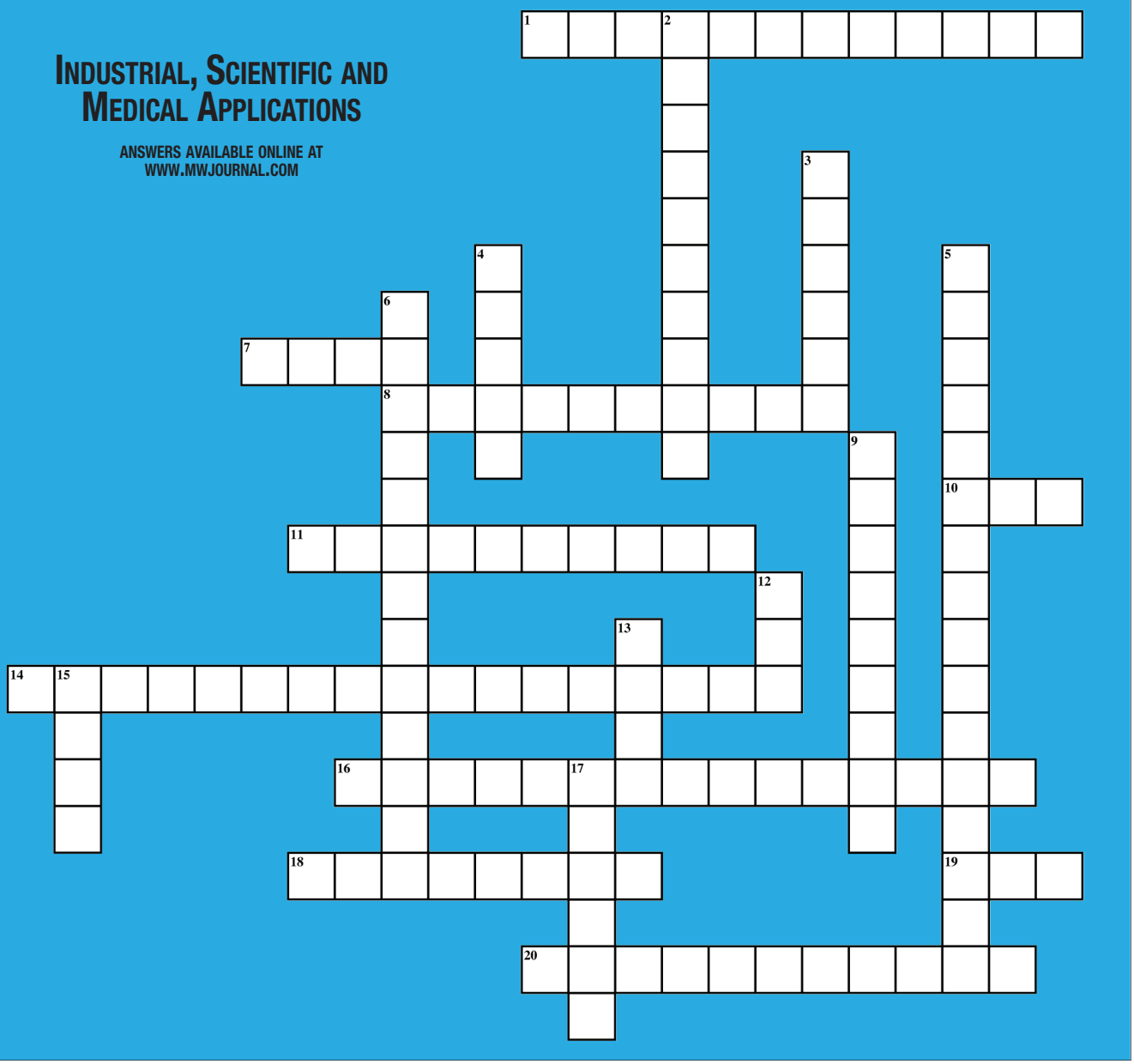

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1 BER (3 words)

7 Seeks to produce the telecommunications standards that will be used throughout Europe

8 Medical treatment found to be most effective for destroying inoperable early stage cancer (2 words)

10 RFID transponder attached to an item

11 Frequency domain representation of rapid, short-term, random fluctuations in the phase of a wave, caused by time domain instabilities (2 words)

14 LNA (3 words)

16 Closed cycle helium refrigerators for cryogenic use use this cooling cycle

18 A vessel, similar in construction to a vacuum flask, used to maintain cold cryogenic temperatures

19 RFID frequency band covering 850 to 950 MHz

20 RFID reader mode of operation that prevents readers from interfering with one another when many are used in close proximity to one another (2 words)

DOWN

2 The relative power of a materials surface to emit heat by radiation

3 Cryogenic temperatures are typically measured using this temperature scale

4 Vacuum-jacketed vessel used for the storage of liquid gases

5 Noise figure expressed in Kelvins typically used by radio astronomers (2 words)

6 Four full anatomical 3D surface models of a family used to investigate the effects of MRI fields on the body (2 words)

9 Organization leading the development standards for the Electronic Product Code to support RFID

12 Specific absorption rate

13 Radio frequency identification

15 Oven controlled crystal oscillator

17 RFID interrogator

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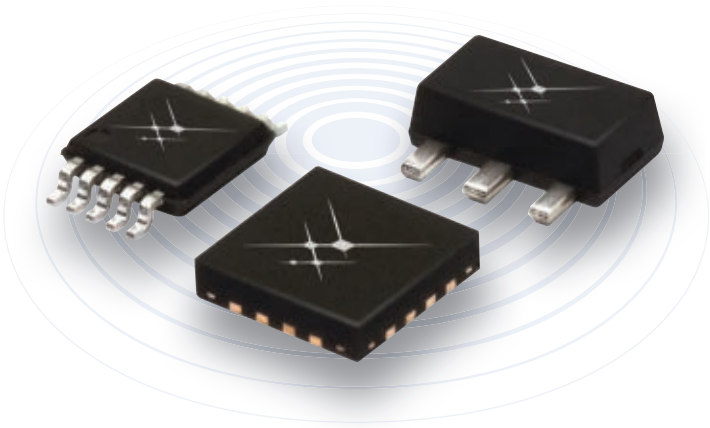

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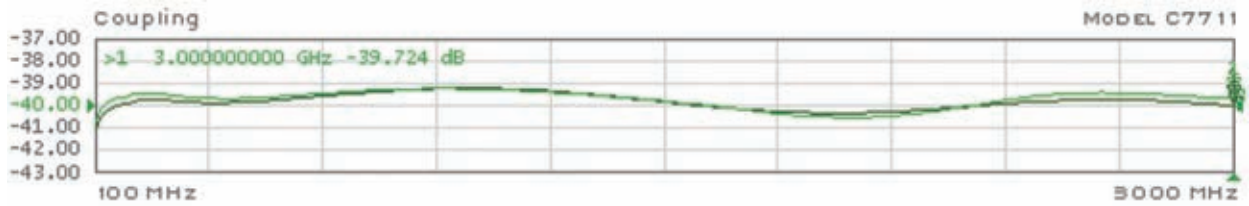
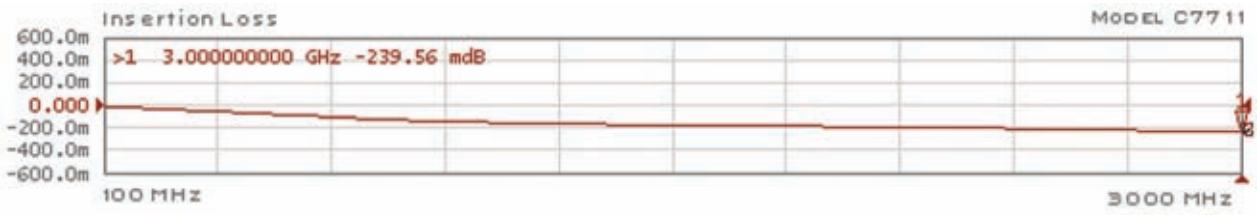
COUPLERS





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Model	Coupler Type	Frequency (MHz)	Power CW (Watts)	Coupling (dB)	Flatness (±dB)	Insertion Loss (dB)	VSWR (Mainline)	Directivity (dB)	Size (Inches)
C7734	Dual Directional	30-2500	100	43	±1.5	0.35	1.25:1	18	3.5 x 2.6 x 0.7
C7148	Bi Directional	60-600	200	10	±1.0	0.35	1.20:1	20	6.0 x 4.0 x 0.75
C7711	Dual Directional	100-3000	100	40	±1.0	0.35	1.25:1	18	3.0 x 2.2 x 0.7
C7783	Bi Directional	200-1000	200	20	±0.75	0.2	1.20:1	20	3.0 x 1.5 x 0.53
C6600	Bi Directional	200-2000	200	20	±1.2	0.25	1.25:1	18	4.0 x 2.0 x 0.72
C7152	Bi Directional	300-3000	100	20	±1.0	0.35	1.20:1	15	3.7 x 2.0 x 0.75
C7811	Dual Directional	500-2500	100	40	±0.5	0.2	1.25:1	20	3.0 x 2.0 x 0.6
C7753	Bi Directional	700-4200	100	20	±1.0	0.35	1.25:1	18	1.8 x 1.0 x 0.6