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MARCH 2013

HIGH FREQUENCY ELECTRONICS

Small Cell Amplifier and System Design Considerations

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Feasibility of Microstrip Wilkinson Power Dividers on FR4 Substrates for L-Band Applications

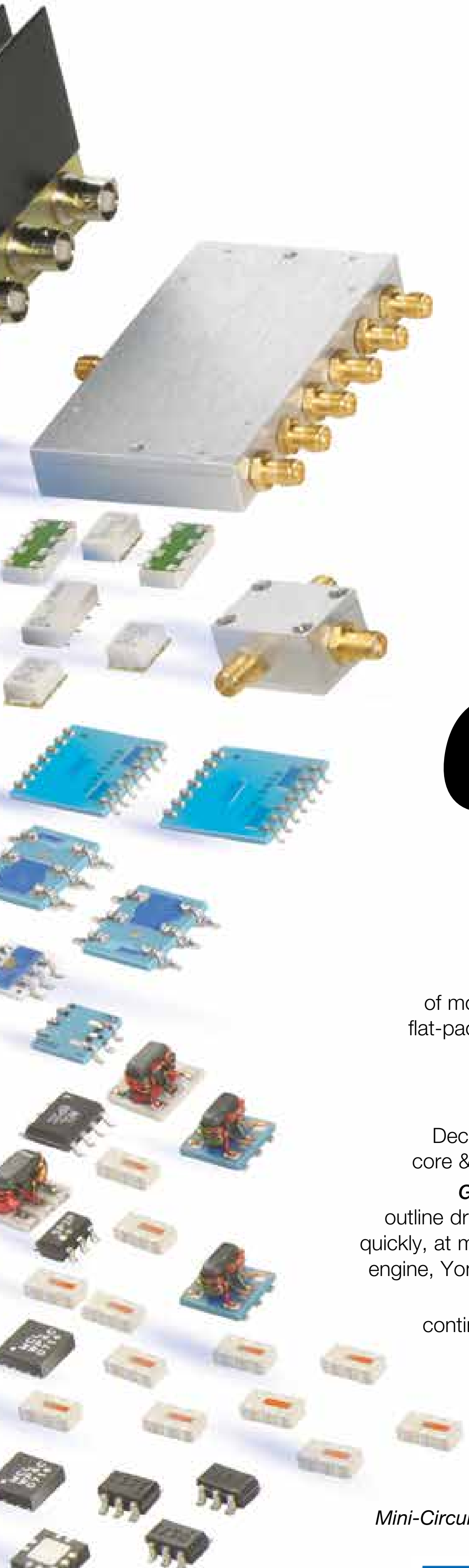
Featured Products

New Products

Market Reports

Ideas for today's engineers: Analog · Digital · RF · Microwave · mm-wave · Lightwave


MCL B 744
ADP-2-10



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Moore's Law Running Strong Nearly 50 Years Later

Scott L. Spencer
Publisher

The International Solid-State Circuits Conference (ISSCC) is a leading global forum for the presentation of advances in solid-state circuits and systems-on-a-chip. ISSCC 2013, held last month in San Francisco, was the 60th annual Conference. In 1954, seven years after the transistor was invented by William Shockley, John Bardeen, and Walter Brattain, the first "Conference on Transistor Circuits" was held in Philadelphia by the IRE, a predecessor of the IEEE—and the first wave of electronic miniaturization was under way.

Soon transistor circuit design evolved into integrated-circuit design, and along came Gordon Moore's 1965 observation that the number of components in integrated circuits had doubled at regular intervals from the invention of the integrated circuit in 1958 until 1965. His observation was published in a magazine article, *"Cramming More Components onto Integrated Circuits."* Along with this he predicted that the trend would continue for at least another 10 years. At the time Dr. Moore had no idea how accurate his prediction might be. In fact, years later he remarked, *"I never expected it to be precise. I was trying to get the message across that this was going to be the cheap way to make electronics putting a lot of it on a chip rather than building it up from individual components soldered together."* Nevertheless, his vision and the accuracy with which he was able to predict the future of integration remain uncanny.

Based on published reports, the presentations made at this year's ISSCC2013 reaffirmed the essence of Moore's Law, as higher levels of integration remain the trend. Increasingly we are seeing more functionality, often with a single die containing the front-end, a synthesizer, and baseband in complex millimeter-wave designs, coupled with efforts to radically improve receiver designs to eliminate unnecessary and bulky duplexers and SAW filters.

Nanotubes to Replace Silicon? Not so Fast

But could advances in material technology ultimately signal an end to the microelectronic era defined by Moore's Law? In the next decade or so, circuits etched on silicon will likely become as small as they can physically become, ushering in an era of new advanced materials like carbon nanotubes to take their place. At ISSCC 2013, researchers from Stanford University demonstrated a simple microelectronic circuit composed of 44 transistors fabricated entirely from carbon nanotubes. It is believed that the

Stanford demonstration is the first time a complete working circuit has been created and shown publicly.

In oscillators, millimeter-wave amplifiers, and PAs, the papers presented at ISSCC indicate a clear trend in the continuing push for higher frequency in CMOS and BiCMOS. Due to high spatial resolution and the use of micro-miniature antennas, an emerging trend is the increasing complexity of systems operating in the 60-to-200 GHz range. With much of the frequency spectrum already crowded, researchers are continuing to target frequencies above 60 GHz, particularly for applications in imaging and radar. Another movement is the integration of millimeter-wave antennas onto silicon substrates.

Case in point: at ISSCC Frankfurt based Silicon Radar, in conjunction with the University of Karlsruhe and partner Bosch, demonstrated a functional radar sensor with integrated antenna that transmits and receives signals at 120 GHz. Taking advantage of Silicon-Germanium BiCMOS technology, designers envision extremely fast bipolar transistors with transmit frequencies up to 300 GHz and Metal Oxide Semiconductors on the same chip. The result could be fully functional radar systems with dimensions of just a few millimeters.

NAB Just Around the Corner

In a few weeks *HFE* will be in Las Vegas for the National Association of Broadcasters (NAB) show. The annual meeting attracts over 90,000 visitors and 1,500 exhibitors from 150 countries together on nearly 1 million square feet of exhibit space. Although NAB is highly diverse in scope, covering all forms of media in every stage of life from content to consumption, a primary element of the exhibition is “content distribution” including broadcast, fiber, mobile, broadband video, streaming and more. For this reason several of the advertisers and companies frequently mentioned on the pages of *HFE* are attending NAB to strengthen their position in addressing emerging opportunities in the broadcast arena.

Start Planning for IMS 2013

The Exhibition Managers for IMS 2013 have confirmed that *High Frequency Electronics* will again be the exclusive sponsor for this year’s Opening Reception in Seattle. As the sponsor of last year’s Opening Reception, we were pleased with the large turnout of conference delegates and IMS staff and volunteers. For those unable to attend last year, I encourage you to attend in Seattle in order to renew old acquaintances and make new ones, as well.

HFE

Conferences

March 19 – 21, 2013
AeroDef Manufacturing Exposition and Conference
Long Beach, Calif.
aerodefevent.com

April 10 – 11, 2013
Microwave & RF
Paris
microwave-rf.com

June 2 – 7, 2013
IMS 2013
Seattle, Wash.
http://www.ims2013.org/

June 2 – 4, 2013
IEEE RFIC 2013
Seattle, Wash.
http://www.rfic-ieee.org

October 15 – 18, 2013
IEEE International Symposium on Phased Array Systems & Technology
Waltham, Mass.
www.array2013.org

Short Courses

Besser Associates
besserassociates.com
Tel: 650-949-3300

New Courses
Course 227: Wireless LANs
Course 226: Wireless/Computer/Telecom Network Security
Course 228: GaN Power Amplifier Design
Course 223: Fundamentals of LTE, HSPA, & WCDMA
Course 221: BER, EVM, & Digital Modulation Testing for Test & Product Engineers

Company-Sponsored Training & Tools

Analog Devices
Training, tutorials and seminars.
http://www.analog.com/en/training-tutorials-seminars/resources/index.html

AWR
On-site and online training, and open training courses on design software.
http://web.awrcorp.com/Usa/News--Events/Events/Training/

Linear Technology
LTSpice IV
LTpowerCAD
LTpowerPlay
Amplifier Simulation & Design
Filter Simulation & Design
Timing Simulation & Design
Data Converter Evaluation Software
http://www.linear.com/designtools/software/

National Instruments
LabVIEW Core 1
Online
http://sine.ni.com/tacs/app/fp/p/ap/ov/pg/1/
LabVIEW Core 2
Online
http://sine.ni.com/tacs/app/fp/p/ap/ov/pg/1/
Object-Oriented Design and Programming in LabVIEW
Online
http://sine.ni.com/tacs/app/fp/p/ap/ov/pg/1/
Free, online LabVIEW training for students and teachers.
http://sine.ni.com/nievents/app/results/p/country/us/type/webcasts/
Webcasts on demand.
http://search.ni.com/nisearch/app/main/p/bot/no/ap/tech/lang/en/pg/1/sn/catnav:mm,n15:WebcastsOnDemand,ssnav:dzn/
LabVIEW user groups.
https://decibel.ni.com/content/community/zone/labviewusergroups

Call for Papers

2013 IEEE Wireless Power Transfer (WPT)
May 15 – 16, 2013, Perugia, Italy
Abstract Deadline: March 12, 2013
Final Paper Deadline: March 23, 2013
http://www.ieee.org/conferences_events/conferences/conferencedetails/index.html?Conf_ID=30420

2013 IEEE International Topical Meeting on Microwave Photonics (MWP 2013)
October 28 – 31, 2013, Annapolis, Md.
Abstract Deadline: May 1, 2013
www.mwp2013.org

2013 IEEE International Symposium on Phased Array Systems
October 15 – 18, 2013, Waltham, Mass.
Summary Deadline: December 15, 2012
Final Paper Deadline: June 1, 2013
www.array2013.org

2013 38th International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz)
September 1 – 6, 2013, Mainz, Germany
Abstract Deadline: April 15, 2013
Final Paper Deadline: July 1, 2013
www.irmmw-thz.org

Size Does Matter

The MLTO and MLTM-Series TO-8 YIG-Tuned oscillators from Micro Lambda Wireless provide designers a small compact and easy to use alternative for tuneable oscillator applications. These miniature oscillators provide wide tuning ranges covering 2 to 9 GHz, excellent phase noise performance of -125 dBc/Hz at 100 kHz offset in a TO-8 sized package. Both electromagnetic and permanent magnet designs operate off +8 Vdc and -5 Vdc and do not require a heater.

If PC board space is a premium, then these miniature oscillators are just what you are looking for.

Same great performance as standard oscillators at less than one third the size!

For more information about the MLTO & MLTM Series or other products, please contact Micro Lambda Wireless.

See our complete line of YIG-Tuned Oscillators

Mini-Oscillators
.5 to 10 GHZ

1" cube Oscillators
.5 to 18 GHZ

Low Noise Oscillators
2 to 20 GHZ

Millimeterwave Oscillators
18 to 40 GHZ

www.microlambdawireless.com

MICRO LAMBDA WIRELESS, INC.

"Look to the leader in YIG-Technology"

46515 Landing Parkway, Fremont CA 94538 • (510) 770-9221 • sales@microlambdawireless.com

3G/4G Diameter Routing to Reach $500M by 2016

4G network crashes are extraordinarily painful and costly events for any mobile network operator. Much of the problem is attributed to a "signaling storm" and Diameter Routing is pitched as a cure-all for almost any 4G network instability. "A network outage at a top tier operator could put $300M of revenue at risk," says Joe Hoffman, principal analyst at ABI Research. "Most of the problems to date are growing pains of 4G, and Diameter Routing mitigates a lot of risk."

ABI's research report "Control Plane Signaling, Scalability, and Diameter Challenges" finds "Signaling Storms" are caused by one-off events, where an element node is presented with an unexpected condition and may lurch into a chaotic state of retry and resend. Diameter is the language of the 3GPP 4G control plane, and even an ordinary perturbation can get out of control and cascade into a network crash because of Diameter signals flooding the network.

"Diameter Signal Routers serve as the traffic cop of the 4G control plane," continues Hoffman, "and disorderly conduct is quickly squelched." But there are other network engineering practices to consider in addition to Diameter Routing. Since Diameter Signaling is critical for the entire network, operators will do well to make it bulletproof as each incrementally evolves its networks to 4G.

Leading independent vendors have captured initial market share, as Diameter Signaling has been under the radar of the major RAN/EPC vendors. As operators step up efforts to monetize 4G investments, Diameter usage spreads to policy and charging. Diameter Signaling is recognized as a critical control point, and the big iron vendors are now heating up the race.

—ABI Research
abiresearch.com

Middle East: Opportunity for Defense Suppliers

While political storms of protest and change continue to rage throughout the Middle East, one aspect of the region remains steady amidst the choppy waters: military spending. Against the backdrop of a flattening global market, the Middle East stands out as an area of opportunity for global defense suppliers. For weapons-exporting nations, the market is a crucial buttress protecting their domestic defense industries from diminishing home orders.

A look at the region's defense spending over the past two five-year periods serves as a testament to the Middle East's persistent growth. According to Forecast International figures, from 2004 through 2008, combined military expenditures for the region grew by 37 percent, from $61 billion to $98 billion. From 2008 through 2012, the same expenditures rose by 24 percent up to $129 billion.

14 Percent Rise

In its latest analysis of the Middle East military market, FI projects a rise of nearly 14 percent across the coming five years, largely spearheaded by four countries: Saudi Arabia, Israel, Iraq, and the United Arab Emirates. These four nations will combine to make up over two-thirds of all regional spending by 2017, according to FI's Middle East Military Market analyst, Dan Darling.

"In large part, the Middle East military market can be broken down by strategic alignment. Those countries aligned with U.S. and European interests are generally atop the defense acquisition food-chain," Darling says. "Those shut off from U.S. or European suppliers, such as Iran and Syria, face a much more restrictive menu from which to choose."

"Another layer of the market pertains to countries that suffer from internal fissures or civil conflict, as in the cases of Lebanon and Yemen," says Darling. "Because of the intrinsic combustibility of these countries, weapons sales to these nations remain limited, with most hardware transfers coming in the form of donated redundant material."

U.S. Assistance

Naturally, much depends on the scale and ambitions of the prospective buyer nation. Financial resources and U.S. military financing assistance often prove to be decisive factors. For instance, the U.S. provides Israel with $3.1 billion in annual financing – all *gratis* – in order to help fund major Israeli defense acquisitions. Iraq, too, has been the beneficiary of U.S. largesse, receiving some $21 billion in appropriations since 2005, earmarked for the rebuilding and modernization of the Iraqi Security Forces.

In regard to the Saudi and UAE markets, the common denominator is access to a broad array of military platforms underpinned by large reserves of petro-dollars. Both Saudi Arabia and the UAE seek to build advanced, integrated air-defense networks capable of protecting strategic infrastructure from potential missile attacks by Iran, while also ensuring air superiority and maritime protection in the event of an outbreak of hostilities. Internal security concerns will propel future purchases of unmanned surveillance and reconnaissance drones and other electronics intelligence-gathering systems.

—Forecast International
forecastinternational.com

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

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

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

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

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

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

Here are some high Q tips

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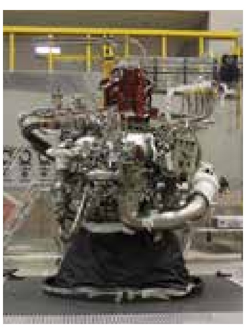
General Dynamics, Bath Iron Works, Bath, Maine, is being awarded a $6,875,016 cost-plus award fee modification under a previous awarded basic ordering agreement (N00024-09-G-2301) to provide engineering and management services for advance planning and design in support of the post shakedown availability for the **Littoral Combat Ship Independence (LCS 2)**. Bath Iron Works will provide design, planning and material support services for the vessel. Efforts will include program management, advance planning, engineering, design, material kitting, liaison and scheduling. Work will be performed in Bath, Maine, (90 percent) and Pittsfield, Mass., (10 percent), and is expected to be completed by April 2013. Fiscal 2013 research, development, testing and evaluation funding in the amount of $6,875,016 will be obligated at time of award, and will not expire at the end of the current fiscal year. The Supervisor of Shipbuilding, Conversion, and Repair, Bath, Maine, is the contracting activity.



NASA Image

NASA's progress toward a return to deep space missions continues with a new round of upcoming tests on the next-generation **J-2X rocket engine**, which will help power the agency's Space Launch System (SLS) to new destinations in the solar system. Engineers will conduct a series of tests on the second J-2X development engine, designated number 10002, on the A-2 Test Stand at **NASA's Stennis Space Center** in Mississippi. Once the series is completed, the engine will be transferred to the A-1 Test Stand to undergo a series of gimbal, or pivot, tests for the first time. The first objective of the testing is to verify and demonstrate the engine's capability. Data from what is known as hot-fire engine tests will be compared to the performance of the first engine. Engineers also will vary liquid hydrogen and liquid oxygen inlet pressures and subject the engine nozzle to higher temperatures than in previous tests to see what effect they have on performance.

Lockheed Martin Image

Lockheed Martin Space Systems Co., Sunnyvale, Calif., is being awarded a $58,408,979 contract modification for the **Space Based Infrared Systems** Follow-on Production Program. The location of the performance is Sunnyvale, Calif. Work is expected to be completed by April 28, 2016. The contracting activity is SMC/ISK, Los Angeles Air Force Base, Calif. Type of appropriation is fiscal 2013.

RF solutions supplier **TriQuint Semiconductor**, Inc. announced its **financial results** for the quarter and year ended December 31, 2012, including the following highlights: Revenue for the quarter was $233.6 million, up 16% from Q3 2012; Mobile Devices market revenue grew 19% sequentially from Q3 2012; Strong demand for 5 GHz WLAN drove 66% sequential growth in connectivity in smartphones; Ramping high-performance LTE filters for Samsung, LG, HTC and Motorola Mobility smartphones; Record Optical sales in 2012 fueled by industry leading 40/100G modulator drivers; VSAT revenue up 40% sequentially with production launch of major Ka band program; Set industry record for gallium nitride (GaN) reliability performance. Commenting on the company's financial results, **Ralph Quinsey**, President and Chief Executive Officer, stated "TriQuint's revenue for Q4 was $233.6 million and non-GAAP earnings per share was $0.04, both above our guidance. We are continuing to expand capacity for high performance filters in anticipation of stronger demand in the second half of 2013 and beyond. I believe these investments will lead to improved financial results for the company."

The United States Agency for International Development **(USAID)** Partnerships for Enhanced Engagement Research (PEER) Science program and **National Instruments** announced a unique public-private partnership. The organizations are partnering to bring cutting-edge scientific equipment, training and support to approximately 100 research projects with commercial promise and demonstrated long-term development impact in more than 80 countries over the next five years. This partnership is the first step in USAID's effort to leverage the private sector in support of scientists in developing countries. At the signing of the partnership agreement, **Dr. Alex Dehgan**, science and technology adviser to USAID administrator Rajiv Shah, said, "The lack of access to scientific equipment is a major impediment to research in the developing world. This partnership will help give scientists all over the developing world access to the tools that can help them unlock their potential to solve the great development challenges of our time."

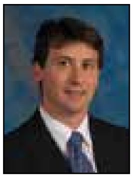
Teseq Inc., a provider of instrumentation and systems for EMC emission and immunity testing, has announced its **calibration laboratory** in Edison, NJ has gained renewed accreditation to the international standard **ISO/**

IEC 17025 in an assessment by the American Association for Laboratory Accreditation (A2LA). In addition to its accredited calibration renewal, Teseq has added several RF parameters to its scope of accreditation and is now accredited to calibrate CDNs, ISNs and compact immunity generators.

Computer Simulation Technology AG (CST) and **Delcross Technologies** (Delcross) signed a distribution agreement to make CST the authorized reseller of EMIT and Savant. CST and Delcross are pleased to announce that Delcross Technologies' EMIT (Electromagnetic Interference Toolkit) and Savant are now available worldwide through all CST sales channels.

Laird Technologies, Inc., supplier of customized performance-critical components and systems for advanced electronics and wireless products, announced the acquisition of **Nextreme Thermal Solutions**, Inc., a developer of thin-film thermoelectric technologies.

SpotterRF was one of 15 industry partners selected to participate in a Department of Defense demonstration seeking cutting edge technologies with high potential of improving the warfighter's mission effectiveness and survivability. The **Stiletto Maritime Demonstration Program** conducted its first capability demonstration in January for the Navy Expeditionary Combat Command (NECC) off the coast of Virginia Beach, Va. During the course of the demonstration several scenarios were run in which vessels ranging from a jet ski to an 11-meter RHIB traveled different paths into and around the harbor. The Spotter M600C was set up remotely on a tripod at the mouth of the harbor and communicated back to the Stiletto vessel one mile away via Silvias Radio. "The M600C was very effective at detecting all vessels coming in and out of the harbor," said **Brock Josephson**, SpotterRF's team lead for the demonstration. "The system even detected and tracked a drifting jet ski."



NYU WIRELESS professor Theodore (Ted) Rappaport has been named a 2013 Distinguished Engineering Alumnus of **Purdue University**. Rappaport is the founding director of NYU WIRELESS, a research center that combines engineering, computer science and medical applications. He previously founded two international research centers in the wireless field, at **Virginia Tech** and **The University of Texas at Austin**. He is also co-principal investigator of a collaboration that will significantly accelerate cellular service beyond today's fourth generation (4G) wireless technologies.

LadyBug Technologies announced the appointment of **Orwill Hawkins** as the company's Vice President of **Marketing.** He will hold responsibility for all of LadyBug's marketing and business development strategies worldwide. "Today, LadyBug's products are industry-leading performers in the USB power sensor industry. Along with VP Sales Paul Schmitz, I look forward to working with our customers, distributors and sales organization to build a solid marketing platform for LadyBug's next generation of advanced Power Sensors for tomorrow's demanding applications," said Hawkins. He brings over three decades of management, marketing, engineering and manufacturing experience to his new position.

FEATURED PRODUCTS

Relay

RelComm Technologies, Inc. complemented its product line by offering a low cost, high-performance 1P12T relay configured with 'SMA' type connectors providing exceptional RF performance to 18 GHz. The relay measures 2.25" square and is less than 2" tall. It is fitted with standard DA15P header for ease of installation. The relay is available in both latching and fail-safe configurations with 12 & 24 volts DC operation. Options include TTL control input.

RelComm Technologies
relcommtech.com

Chipset

Hittite Microwave Corp. launched a highly integrated HMC6000LP711E/HMC6001LP711E Antenna-in-Package (AiP) Silicon Transceiver Chipset Solution, fabricated with silicon germanium (SiGe) BiCMOS semiconductor process technology and targets 60 GHz applications such as short range Gbps data links, wireless sensors and test applications. The HMC6000LP711E combines a 60 GHz antenna with the HMC6000 transmitter IC while the HMC6001LP711E combines a 60 GHz antenna with the HMC6001 receiver IC. Both are available in 7 x 11 mm QFN plastic packages.

Hittite Microwave Corp.
hittite.com

Phase Shifter

PMI Model No. PS-500M2G-8B-SFF is a State-Of-The-Art, 8-Bit Digitally Controlled Phase Shifter that operates over the 500 MHz to 2.0 GHz frequency range. This model has a typical insertion loss of 10 dB and offers 360 degrees of phase shift via 8-Bit TTL control. The phase shift error is less than ±10 degrees and the amplitude error is less than ±1 dB. The switching speed is 500 nsec maximum. This unit operates on ±15 VDC and supplied in a housing measuring 4.95" x 3.38" x 1.00."

Planar Monolithics Industries
pmi-rf.com

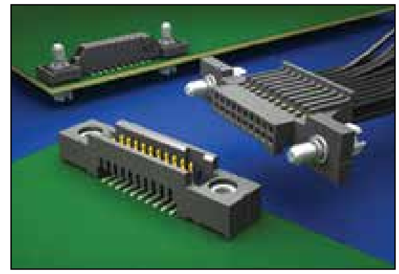
ADC

Touchstone Semiconductor announced the immediate availability of the TS7001, its newest 12-bit 187.5-ksps analog-to-digital converter (ADC) that can be used as a 1.5x faster/50% lower INL drop-in upgrade to the Analog Devices AD7887A. The TS7001 is a 50% smaller footprint and is also 1.5x faster versus the high-grade AD7887B in an SOIC-8.

Touchstone Semiconductor
touchstonesemi.com

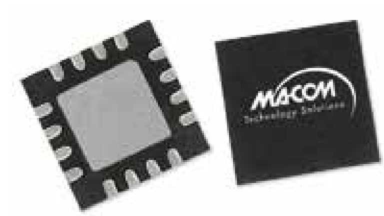
Connectors

Samtec's line of Tiger Eye™ interconnect solutions has been expanded to include screw-down options for both board-to-board and cable-to-board system on .050" (1,27 mm) and 2,00 mm (.0787") pitch. These connector systems feature rugged



Beryllium Copper contacts for high reliability and high mating cycles.

Samtec
samtec.com



LNA

M/A-COM Technology Solutions Inc. announced an X-Band extension to its low noise amplifier (LNA) family. The MAAL-010528 is designed for customers who need a quick LNA solution for V-Sat, radar and microwave applications. This LNA delivers higher gain and linearity performance over the 8.0 - 12.0 GHz frequency band than many competing parts, providing customers with system advantages for their LNA requirements. Packaged in a small 3 x 3 mm PQFN surface mount and having a single, positive bias supply, the device allows customers a simple and elegant LNA solution.

M/A-COM Technology Solutions
macomtech.com

Switch

This RLC Electronics' Terminated Single Pole, Two Position Coaxial Switch provides proven reliability, long life and excellent electrical performance. It features extremely low insertion loss and VSWR over


AWR
A National Instruments Company™
Achieve hyper speed simulations on complex multi-tone circuits.
Stop waiting and waiting and waiting for your complex multi-tone designs to simulate. AWR users don't wait. They simulate at turbo speeds thanks to multi-rate harmonic balance (MRHB) technology. With simulation times that are typically 10x faster, designs with 2, 3, 4 or even more tones converge quickly — and nail the performance, too! Fewer mouse clicks and novel MRHB technology mean shorter process times, right-the-first-time designs, and less stress for you. Don't you deserve that? Grab a test copy at awrcorp.com/MWO.
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the entire DC-50 GHz range while maintaining high isolation. Standard RF power rating is 2 watts CW limited by the termination. Terminations can be provided in either an internal or external configuration, or can be replaced by SMA "2.92 mm" or "2.4 mm" connectors for special applications.

RLC Electronics
rlcelectronics.com

Oscillator

RFMW, Ltd. provides design and sales support for a new Double Oven Crystal Controlled Oscillator (DOCXO) from Bliley Technologies, Inc. Developed for critical applications were exceptional Frequency vs. Temperature performance is required, the N6B series stability is rated at ± 0.4 ppb over an operating temperature range of -20 to +70 deg C. Two variations of the N6B series, the N6B-ABA-D1A-10M and N6B-ABA-D1B-10M, provide a sine wave output of +5dBm (typ.) into 50 ohms.

RFMW
rfmw.com

Couplers

KRYTAR, Inc. announced the continued expansion of its line of directional couplers with the addition of two new models offering 20 dB nominal coupling over the ultra-broadband frequency range of 1.0 to 40.0 GHz, each in a single, compact and lightweight package. Models 101040020 and 101040020K are multi-purpose, stripline designs that exhibit excellent coupling over the 1.0 to 40.0 GHz frequency band. They target broadband electronic warfare (EW) systems and commercial wireless system applications, for example.

KRYTAR
krytar.com

Switch

Model SWJ-18-S1 is Ka Band instrumentation-grade motorized waveguide two-position switch to cover 26.5 to 40 GHz full waveguide bandwidth operation with 0.15 dB maximum insertion loss and 60 dB minimum isolation. This high RF performance is achieved by utilizing the H-plane rotor configuration. Typical switching time is about 500 milliseconds. Required power supply for the switch is +12 to +15 Vdc/50 mA and control logic is TTL low for position 1and TTL high is for position 2. The switch is equipped with standard WR-28 waveguide and UG599/U flange. The bias and control are via a sub-D, Jack 9 pin connector. The switches are also available in other frequency bands, such as U, V, E and W band.

SAGE Millimeter
sagemillimeter.com

Handheld VNAs

Anritsu Company introduced the MS2027C and MS2037C, two new members of its VNA Master handheld vector network analyzer series that bring the inherent advantages

of VNA Master to 15 GHz frequency applications. Providing best-in-class measurement speed and high accuracy in a compact design measuring as small as 8.3 x 12.4 x 3.1 in., the new MS2027C and MS2037C are ideal for demanding field use environments including aerospace and defense, SATCOM, commercial wireless backhaul, and research.

Anritsu Company
anritsu.com

VCO

Modco's Model LVC440-495VS tunes 440 MHz to 495 MHz and is used in handheld wireless RF applications. A bias voltage of 1.5 V delivers + 2.0 dBm power with only 5 ma current consumption.

Phase noise is -94 dBc @ 10 kHz offset. Package size is 0.175 inch square with height of .075 inch. Supplied on T&R and priced @ $4.95 ea for 10k quantity.

Modco
modcoinc.com

Clock Buffer

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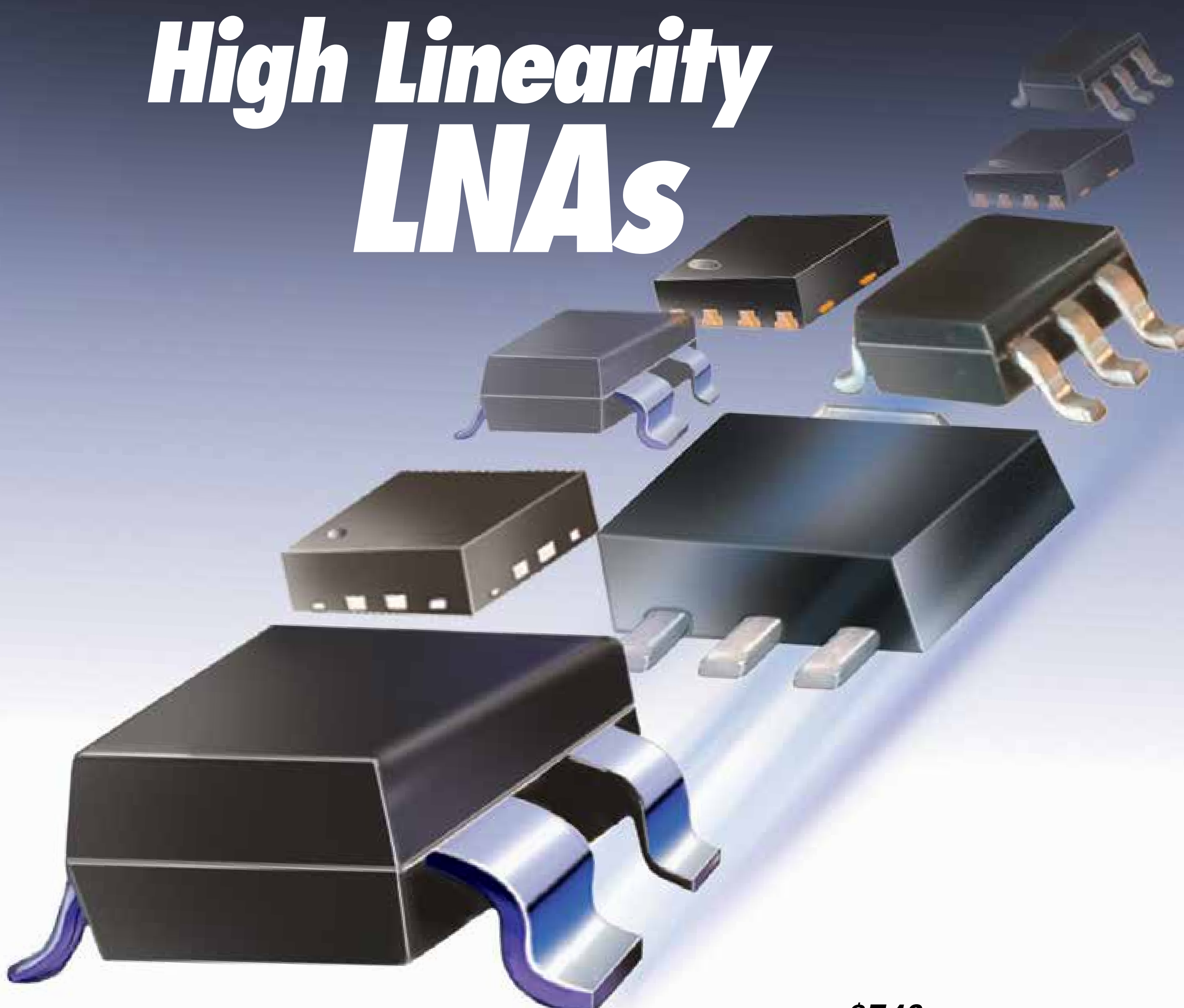

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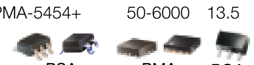
PMA-5452+	50-6000	14.0	**0.7**	**34**	18	40	1.49
PSA4-5043+	50-4000	18.4	**0.75**	**34**	19	33 (3V) 58 (5V)	2.50
PMA-5455+	50-6000	14.0	**0.8**	**33**	19	40	1.49
PMA-5451+	50-6000	13.7	**0.8**	**31**	17	30	1.49
PMA2-252LN+	1500-2500	15-19	**0.8**	**30**	18	25-55 (3V) 37-80 (4V)	2.87
PMA-545G3+	700-1000	31.3	**0.9**	**33**	22	158	4.95
PMA-5454+	50-6000	13.5	**0.9**	**28**	15	20	1.49

Model	Freq. (MHz)	Gain (dB)	NF (dB)	IP3 (dBm)	P_{out} (dBm)	Current (mA)	Price $ (qty. 20)
PGA-103+	50-4000	11.0	**0.9**	**43**	22	60 (3V) 97 (5V)	1.99
PMA-5453+	50-6000	14.3	**0.7**	**37**	20	60	1.49
PSA-5453+	50-4000	14.7	**1.0**	**37**	19	60	1.49
PMA-5456+	50-6000	14.4	**0.8**	**36**	22	60	1.49
PMA-545+	50-6000	14.2	**0.8**	**36**	20	80	1.49
PSA-545+	50-4000	14.9	**1.0**	**36**	20	80	1.49
PMA-545G1+	400-2200	31.3	**1.0**	**34**	22	158	4.95
PMA-545G2+	1100-1600	30.4	**1.0**	**34**	22	158	4.95
PSA-5455+	50-4000	14.4	**1.0**	**32**	19	40	1.49



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Feasibility of Microstrip Wilkinson Power Dividers on FR4 Substrates for L-Band (1-2 GHz) Applications

By Christos Kalialakis, EETT

The feasibility of using FR4 is investigated via the testing of Wilkinson power dividers operating in portions of the L-band (1-2 GHz).

1. Introduction

Microstrip structures are very popular choices both for circuits and antennas. Wilkinson power dividers in microstrip form are indispensable components for printed antenna array feeding networks. In principle, low loss specialized microwave substrates are used for best results. However, since substrate cost is the dominant factor for microstrip passive circuits [1], there is a need to use cheaper materials such as FR4 without compromising the performance.

In this paper, the feasibility of using FR4 is investigated via the testing of Wilkinson power dividers operating in portions of the L-band (1-2 GHz). The 1-2 GHz band serves significant wireless applications such as cellular mobile [2] and mobile satellite data [3].

The principles of the Wilkinson power divider operation, microstrip implementation and fabrication details are given in section 2. Results are given in section 3 using a divider built on Duroid as a performance benchmark.

A discussion on FR4 tolerances and potential consequences on amplitude and phase errors is also included in Section 4.

2. Principles of Wilkinson Power Divider Design

Wilkinson [4] proposed a power divider design that provides isolation between the output ports unlike the resistive divider or the T-junction. The design principles are included here for completeness, following Pozar [5]. The signal from the input port is split into two coupled lines quarter wavelength long that lead to the two output ports. The layout of Figure 1 assumes microstrip form i.e. a signal line printed on the top side of a fully metalized substrate, the bottom side serving as the ground plane.

There is no power lost in the divider. All the ports can be matched. The presence of resistor dissipates only the reflected power.

The most important performance metric is the 3 dB power split. Adopting the port convention of Figure 1 the power split is expressed via the S21 and S31 scattering parameters. The isolation between ports is measured by S23 and S32. The matching of each port is measured by S11, S22, S33. All scattering parameters can be readily measured via a vector network analyzer.

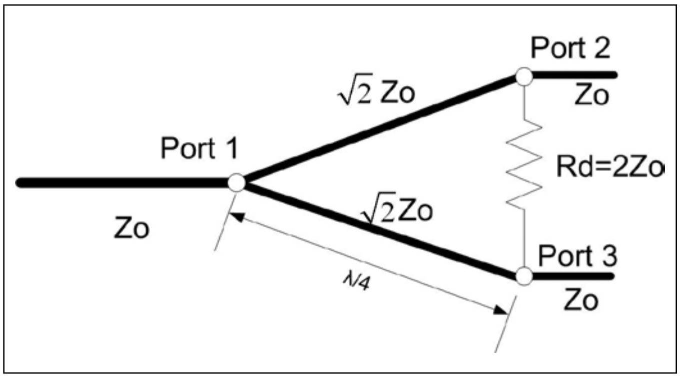

Figure 1 • Conceptual layout of a microstrip Wilkinson Power Divider.

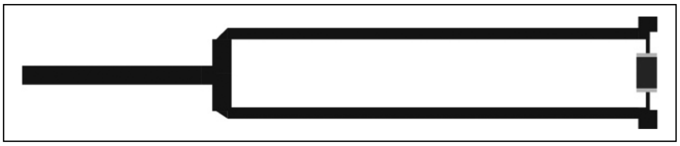

Figure 2 • Layout of a microstrip Wilkinson Power Divider (top layer) with a chip resistor.

Figure 2 shows the actual layout of the divider. Recall that the impedance for a given substrate dielectric constant and height is governed by the width of the line [6] (see Equation 1 below) whereas the length is equivalent to a delay expressed in wavelengths or degrees at the target design frequency. The resistance of Figure 1 is in reality a chip resistor of 100Ω.

It should be noted that there are many design variations extensions that achieve broadbanding or multiple band operation, see for example [7,8]. The focus of this note is on the substrate choice rather than optimal design.

3. Experimental Results

Substrates are characterized mostly by their dielectric constant and loss tangent. Usually for microwave applications low loss highly stable dielectric constant such as Duroid are used. On the other hand, PCB circuits are usually fabricated on FR4 which is cheap but on the expense of greater loss. Considering that substrates with varying thickness exhibit different loss and variations from the nominal dielectric constant, FR4 thin substrates with thickness h=0.5mm and h=1mm were tested. As benchmark substrate a Duroid microwave substrate with thickness 1.11 mm and dielectric constant ε_r=2.2 is used.

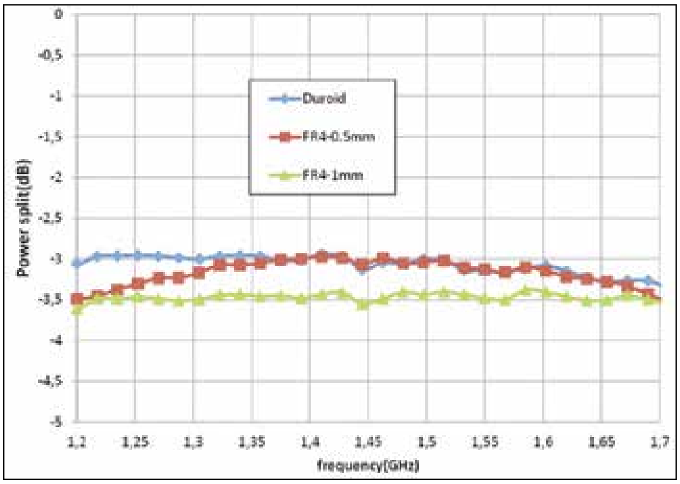

Figure 3 • Measured power split for Wilkinson dividers for FR4 substrates compared with Duroid.

Two dividers were built on FR4 and one on Duroid. Input matching was better than -10 dB for all three versions. The 3 dB power split is shown in Figure 3.

It can be seen (Figure 3) that the power split of the FR4-1mm substrate introduces about 0.5 dB loss whereas the FR4-05mm substrate, maintains a good split but for half the bandwidth of the Duroid one.

The measured return loss, for the frequency band of Figure 3, was better than 10 dB, i.e. VSWR<2 for all the dividers.

4. Tolerance Analysis and Error Effects

The substrate used was FR4 with a nominal dielectric constant of ε_r=4.2. FR4 is a mix of epoxy resin and glass. The glass additions can cause variations of the constant up to 4.6 especially for thicker substrates. The 4.2 value is more appropriate for thin substrates. The impedance of a microstrip line is given by [6].

$$Z_o = \frac{42.4}{\sqrt{\varepsilon_r + 1}} \ln\left\{1 + \frac{4h}{W}\left[\frac{14 + \frac{8}{\varepsilon_r}}{11}\frac{4h}{W} + \sqrt{\left(\frac{14 + \frac{8}{\varepsilon_r}}{11}\right)^2 \left(\frac{4h}{W}\right)^2 + \frac{\pi^2}{2}\left(1 + \frac{1}{\varepsilon_r}\right)}\right]\right\} \quad (1)$$

The tolerance in the dielectric constant could lead to a maximum impedance error of about 2 Ω .

The dielectric constant variations change the guided wavelength. Since the divider is using quarter wavelength sections (Figure 1), the tolerances can cause phase errors up to 4.4 degrees/ quarter wavelength.

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1.0 to 18.0 GHz
10 Watt, SPDT

8.0 to 18.0 GHz
20 Watt, SP8T

MODEL NUMBER	Style	Frequency Range (GHz)	Insertion Loss (dB)	Isolation (dB)	Switching Speed (nSec)	Operating Input Power (W)	DC Voltage & Current
P1T-0R310R0G-80-R-SFF-20W	SPST	0.3 – 18.0	2.5	60	250	20W Peak, 7W Ave.	+5vdc@100mA -12vdc@50mA
P1T-1R0G18R0G-80-R-SFF-75W	SPST	1.0 – 18.0	2.5	80	25	75W Peak 2W Ave.	+5vdc@65mA -12vdc@20mA
P1T-0R5G2R0G-80-R-SFF-LVT-10W	SPST	0.5 – 2.0	1.0	80	25	10W Peak 2W	+5vdc@50mA -5vdc@5mA
P1T-0R6G1R3G-70-SFF-4W	SPST	0.6 – 3.0	1.5	70	30	4W	+5vdc@100mA -5vdc@100mA
P2T-335M535M-30-R-SFF-20W	SPDT	0.335 – 0.535	0.9	45	100	20W	+5vdc@31mA
P2T-1G18G-10-R-528-SFF-HIP10W	SPDT	1.0 – 18.0	3.0	25	40	10W	+5vdc@5mA -28vdc@5mA
PEC-2D35G-100W-SFF	SPDT	2.2 – 2.5	2.4	40	150	100W	+12vdc@80mA -28vdc@30mA
P2T-17G18G-60-33DBM-5-SFF	SPDT	17.0 – 18.0	1.5	70	100	+33dBm	+5vdc@60mA -5vdc@60mA
P2T-0R1G2R0G-40-SFFF-100W	SPDT	1.0 – 2.0	1.5	40	<1µSec	100W	+5vdc@150mA -15vdc@70mA
PEC-9R510R7-100W-SFF-120W	SPDT	9.5 – 10.7	1.5	40	400	120W	+5vdc@160mA -28vdc@15mA
P2T-0R5G18G-60-SFF-10W	SPDT	0.5 – 18.0	1.5	60	150	10W	+5vdc@100mA -15vdc@75mA
P2T-14D415D4-15-SMT-20W Surface Mount, Driverless	SPDT	14.4 – 15.4	0.5	15	50	20W	Bias 50mA
P3T-0R1G2R0G-40-SFF-100W	SP3T	0.1 – 2.0	1.5	40	<1µSec	100W	+5vdc@150mA -15vdc@70mA
P3T-0R5G18G-70-SFF-200W	SP3T	0.5 – 18.0	3.75	70	100	200W Peak 12W	+5vdc@150mA -15vdc@100mA
P4T-2G18G-45-TFF-100W	SP4T	2.0 – 18.0	3.1	45	200	100W Peak 1W	+5vdc@105mA -15vdc@70mA
P4T-0R1G2R0G-40-SFF-100W	SP4T	1.0 – 2.0	1.5	40	<1µSec	100W	+5vdc@150mA -15vdc@70mA
P4T-0R1G18G-65-SFF-75W	SP4T	0.1 – 18.0	2.6	65	50	75W Peak 1W	+5vdc@150mA -15vdc@50mA
P4T-900M1300M-35-SFF-50W	SP4T	0.9 – 1.3	2.0	35	<1µSec	50W	28vdc
P8T-2R37G2R39G-60-SFF-10W	SP8T	2.37 – 2.39	2.5	60	<1µSec	10W	+5vdc@500mA -27vdc@10mA
P8T-8G18G-50-SFF-10W	SP8T	8.0 – 18.0	4.0	50	75	10W Peak 4W	+5vdc@450mA -15vdc@150mA

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These substrate tolerances can cause errors in the power splitters. The most direct consequence of that in an antenna array fed by such splitters is an increase in the minor sidelobes level.

5. Conclusions

It was found that the Wilkinson divider on the 0.5 mm thickness FR4 has comparable behavior to the specialized substrate divider and could be considered as a cheap and viable alternative for applications in the 1-2 GHz band.

About the Author:

Christos Kalialakis was born in Watrellos, France. He was awarded a Ph.D. in Electronic and Electrical Engineering from the University of Birmingham, UK in 1999. He received the B.Sc. in Physics and the Master in Telecommunications in 1993 and 1995, both from the Aristotle University of Thessaloniki, Greece (A.U.Th). He has industry experience working in the UK as an antenna designer and then in Greece as an RF Hardware Engineer working on RFIC testing and measurement. Since the end of 2002, he has been employed by EETT (National Regulatory Authority of Greece), first as an Expert on Wireless Communications and since 2004 as Deputy Head of the Thessaloniki Regional Office. He is also a lecturer adjunct at the Radiocommunications Laboratory, A.U.Th. Dr. Kalialakis is an IEEE Senior Member and a regular reviewer for several journals.

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Small Cell Amplifier and System Design Considerations

By Jean-Christophe Nanan and Barry Stern

Understanding small cell base station systems requires an understanding of how they differ from their larger counterparts.

Now that the wireless industry has delivered on its promise of truly high-speed data service in the form of LTE along with the tablets and smartphones to exploit it, the challenge for wireless carriers lies in ensuring that the requisite high data rates are available seamlessly within a geographic area. So-called “small cells” are the most broad-based solutions for this task and unlike their massive macrocell predecessors are small, light, inexpensive, and can easily be sited. They also provide a way to offload network and backhaul traffic.

The Small Cell Defined

Like so many “high-tech” terms, these base stations in a box began their lives as femtocells, which were (and increasingly are) used in residences to boost coverage. However, with the introduction of high-end third- and fourth-generation standards such as HSPA+, CDFMA 2000 Rev. A, and LTE, carriers have realized that small cells could also be the answer for handling, in the uplink, downlink, and backhaul paths, the massive amounts of data traffic generated by these high-speed networks. This resurgence of interest spawned new terms, including metrocells, metro femtocells, public access femtocells, enterprise femtocells, super femtocells, Class 3 femtocells, picocells, and microcells.

Figuratively speaking, the most prudent approach is to lump all these cells together under the term “small cells” because, regardless of their size or coverage area, they are all designed to accomplish more or less the same thing: To increase signal strength to acceptable levels in areas where it is low, such as “urban canyons” in cities where buildings obscure the signal path, to residences and businesses in which signals are impeded by walls, ceilings, and many other areas. A comparison of these various base station constructs with a macrocell is shown in Table 1.

Their small size and comparative ease of installation allow small cells to be placed on

Cell type	Installation	Subscribers	Maximum cell radius	Maximum RF output power	Signal Bandwidth (MHz)	Wireless standard	Maximum sectors	MIMO support
Femto	Indoor	4 to 16	10 m	100 mW	10	3G/4G/ Wi-Fi	1	2x2
Pico	Indoor Outdoor	32 to 100	200 m	250 mW	20	3G/4G	1	2x2
Micro/ metro	Outdoor	200	2 km	6.3 W	20, 40	2G to 4G	2	4x4
Macro	Outdoor	200 to 1000	10 km	100 W	60 to 75	2G to 4G	3	4x4

Table 1 • Characteristics of Various Small Cell Types and Macrocell.

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Model	Freq. (GHz)	Gain (dB)	P_{OUT} (dBm)	IP3 (dBm)	NF (dB)	DC (V)	Price $ ea. (qty 20)
CMA-62+	0.01-6	15	19	33	5	5	4.95
CMA-63+	0.01-6	20	18	32	4	5	4.95
CMA-545+	0.05-6	15	20	37	1	3	4.95

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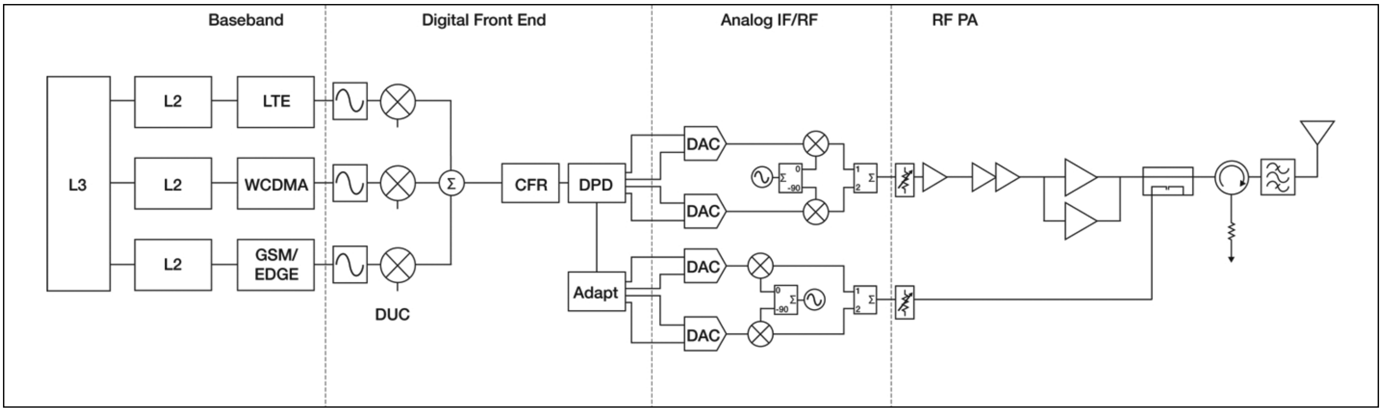

Figure 1 • A typical single-sector transmission link.

lamp posts, utility poles, rooftops -- basically anywhere they have access to a power source and a high-speed communications path back into the wired infrastructure. They can be used to provide good reception and transmission quality throughout office buildings, airports, convention centers, and dozens of other places where people need to communicate but are hampered by low signal strength. As small cells send their traffic into the wired network via hybrid fiber coax or all-fiber networks, they can also offload network traffic as a backhaul solution.

While small cells may be a fraction of the size of macrocells, they are nevertheless high-performance base stations that perform the same functions and often others such as managing inter-cell interference that macrocells themselves do not encounter. Small cells include signal capture, baseband digital signal processing, general-purpose processing, and RF and microwave receive and transmit capabilities (and other functions) in a densely-packed enclosure and operate in hostile environmental conditions. They may also need to accommodate second-generation legacy standards as well as CDMA 2000 Rev. A and R, TD-SCDMA, W-CDMA, WiMAX, HSPA+, and LTE in up to 15 different frequency bands.

Design Considerations

A major goal of small cell design is to efficiently integrate all functions from baseband through RF and microwave transceivers as tightly as possible while maintaining the ability to differentiate and scale products as technologies evolve. In addition to the small form factor of these base stations, they are often powered by a low-voltage source or even batteries, which makes high-level integration and efficiency essential tasks for the designer. A typical single-sector transmission link is illustrated in Figure 1 with its important interfaces identified.

Using LTE as the primary example, the baseband functions of the physical layer (Layer 1) in an LTE base station are implemented with DSP cores and baseband accelerators and radio front end logic in an ASIC or FPGA. Digital baseband processing for Layers 2 and 3 consists of medium access control (MAC), radio link control (RLC), and packet data convergence protocol (PDCP), all of which are typically implemented by a general-purpose processor.

In Layer 1, the 3GPP standards for third-generation W-CDMA and LTE, for example, employ different approaches for modulating and mapping data to the physical medium. W-CDMA requires that processing resources efficiently perform the spreading and despreading, scrambling and descrambling, and combining operations. In contrast, LTE uses Orthogonal Frequency Division Multiple Access (OFDMA) modulation for the downlink path and Single Carrier Frequency Division Multiple Access (SC-FDMA) modulation for the uplink path.

The primary operations in an OFDMA/SC-FDMA environment are Discrete Fourier Transforms (DFT) in the form of Fast Fourier Transforms (FFT) or DFT and multiply-accumulate operations. The data organization and subframe structure in LTE allow Layer 1 processing steps to be scheduled sequentially according to subframe user and allocation information. Latency has a major influence on both voice and data performance and it requires adherence to the tight latency requirements of physical layer processing so that time can be made available for MAC layer scheduler tasks. The LTE standard defines end-user round-trip latency as less than 5 ms, so latency in the base station must be significantly less (0.5 ms in the downlink and less than 1 ms in the uplink). MIMO equalization and detection and forward error correction are heavily used in LTE and MIMO equalizer and turbo coding error correction algorithms have a significant impact on base station throughput and latency. Freescale implements Layer 1 using StarCore® SC3850 or SC3900 DSP cores and its MAPLE baseband accelerator platform that efficiently implements standardized building blocks for each air inter-

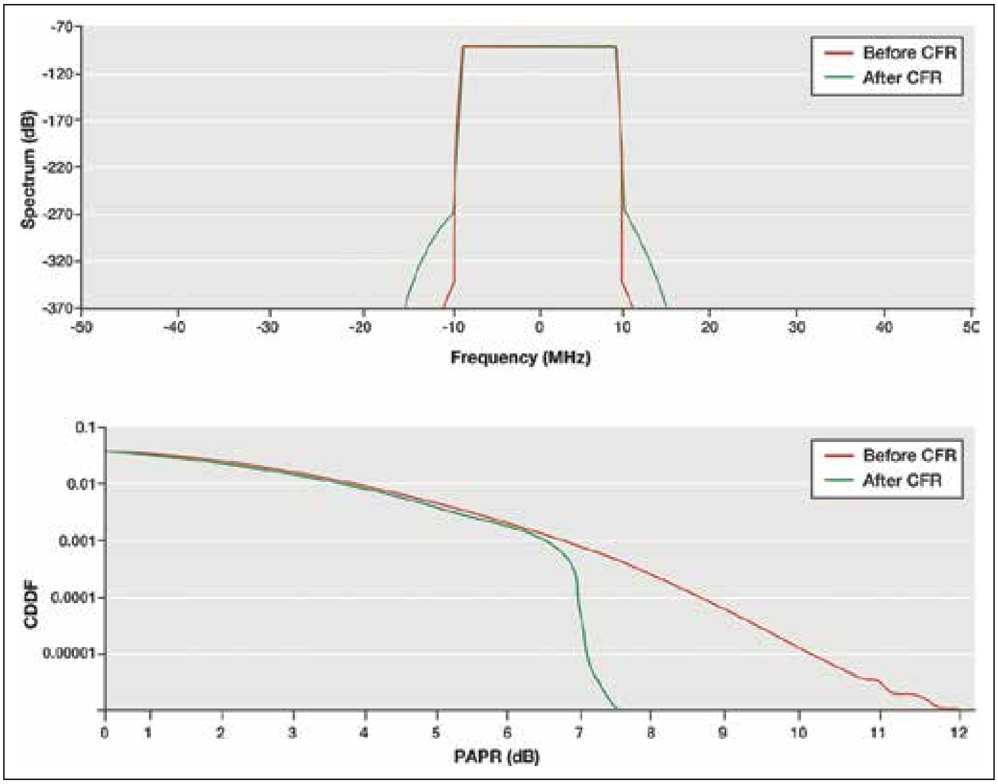

Figure 2 • The positive effects of CFR (a). PAPR extraction via the CCDF (b) can be used to size the RF power amplifier.

face standard in single- and multimode operation. Programmable DSP cores provide upgrade paths for each supported wireless standard while also supporting legacy standards.

The MAPLE hardware block enables multimode operation such as turbo and Viterbi decoding and turbo encoding. Algorithms for Layers 2 and 3 are performed by Freescale Power Architecture® general-purpose cores to efficiently implement any standard along with multimode operation. In macro base stations, the baseband channel card employs a single general-purpose processor and multiple DSPs to handle transmit and receive sectors, which vary depending with the number of users and required throughput. Femtocells and picocell base stations usually have only a single sector and a specific number of users and data rates, and unified system-on-chip (SoC) solutions are now available that integrate the general-purpose processor and DSP.

Signal Optimization

The digital front end prepares and multiplexes the signals created by the baseband processing subsystem and sends them to the RF power amplifier for transmission. A digital upconverter receives the carriers created by Layer 1 and then pulse-shapes and sums them according to the carrier's specified pattern using oversampling and filtering. The digital front end can employ crest factor reduction (CFR) for limiting peak-to-average power ratio (PAPR) and signal linearization using digital predistortion (DPD), both of which can increase amplifier efficiency.

Crest factor reduction has proven to be very effective tool for reducing the PAPR of complex modulated signals. When characterized in the frequency domain by their power spectrum, signal amplitude can be characterized in the time domain through the signal's statistical distribution (Figure 2). This exercise extracts the PAPR, which can be used to size the RF power amplifier and its devices. If average trans-

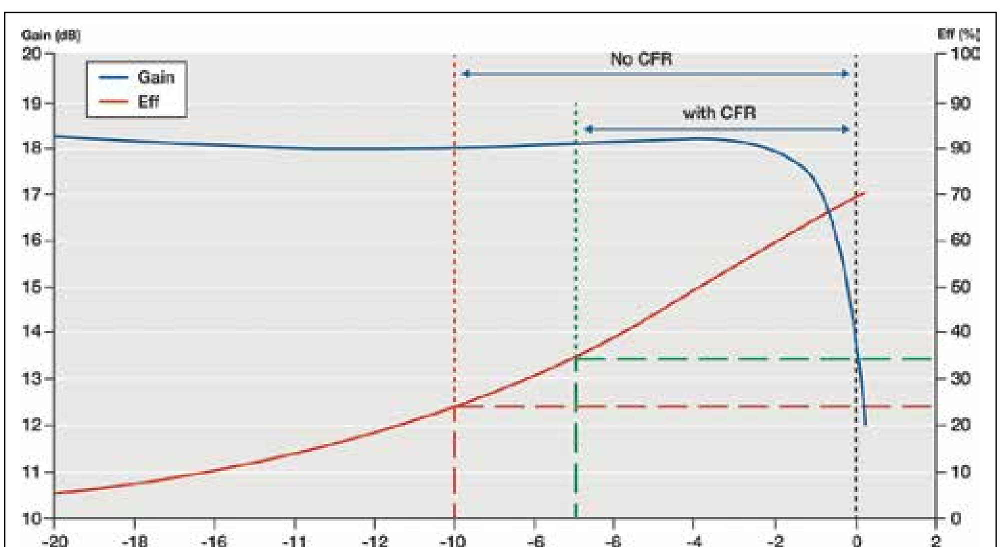

Figure 3 • The PAPR directly impacts amplifier efficiency as it decreases as OBO increases.

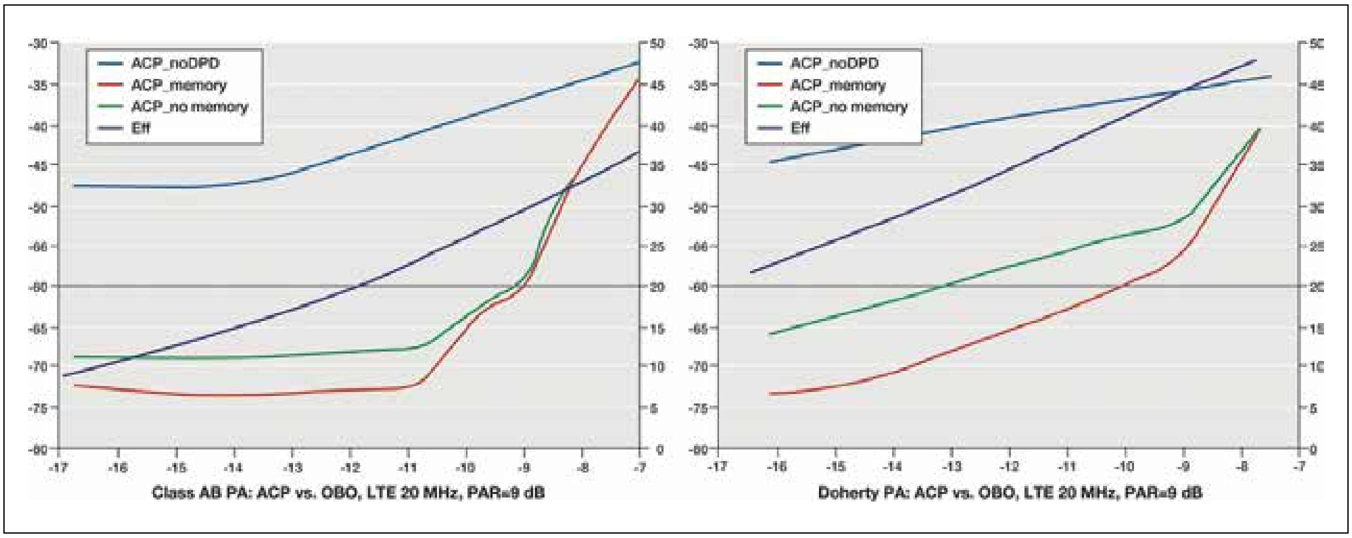

Figure 4 • Adjacent Channel Power (ACP) with and without the use of DPD in simulated Class AB (a) and Doherty (b) amplifiers fed with 20-MHz-wide LTE signals that have a PAR of 9 dB.

mit power must be +30 dBm with a PAPR of 10 dB, the amplifier's saturated power (Psat) should be greater than 40 dBm (30+10=40 dBm).

The PAPR dictates the minimum output back-off (OBO) from saturated power at which the amplifier usually operates and directly impacts amplifier efficiency because PAPR decreases as OBO increases (Figure 3). Consequently, reducing the PAPR helps to reduce both the size (and thus cost) of the devices used in the RF power amplifier and the amplifier's power consumption. This is obviously of major interest in small cell design.

Amplitude-modulated signals pose challenges for the amplifier as its non-linear behavior creates in-band distortion that increases Error Vector Magnitude (EVM) and out-of-band distortion (spectral regrowth). To meet increasingly stringent linearity and efficiency requirements, the power amplifier must be linearized using DPD. This consists of approximating amplifier characteristics using a behavioral model with the required level of correction depending on the accuracy of the model and its ability to follow the amplifier's behavior over temperature and with changes in carrier frequency and RF output power. These "memory effects" are changes in the amplitude or phase (or both) of distortion components as a function of input signal frequency and tend to be extremely difficult to model using standard steady-state characterization techniques. The less the contribution of memory effects, the easier linearization will be.

The simplest DPD scheme is open-loop correction without memory effect compensation and is based on static AM/AM and AM/PM power amplifier behavior. Closed-loop DPD includes memory effect correction and requires a demodulation path to sample the output signal and compare it with the desired transmitted signal. Figure 4 shows adjacent channel power (ACP) versus OBO for simulated final-stage Class AB and Doherty power amplifiers.

To demonstrate the effects of CFR and DPD and estimate RF power amplifier DC power budget for various types of small cells, an analysis was performed using 5-VDC GaAs and 28-VDC LDMOS RF power transistors in Class AB and Doherty power amplifier architectures. The amplifier line-up provided more than 50 dB of gain and had signals with a PAR of 10 dB without CFR and a PAR of 7 dB with CFR (at 0.01% CCDF probability). Depending on the power amplifier architecture and DPD scheme, margin for linearity varies from 1 to 4 dB including 3 dB of loss incurred by the isolator and filters between the amplifier output and the antenna.

From Figure 5 it can be assumed that low-power transmitters (less than 15 dBm), do not require CFR or DPD and as power increases (15 to 24 dBm), CFR pro-

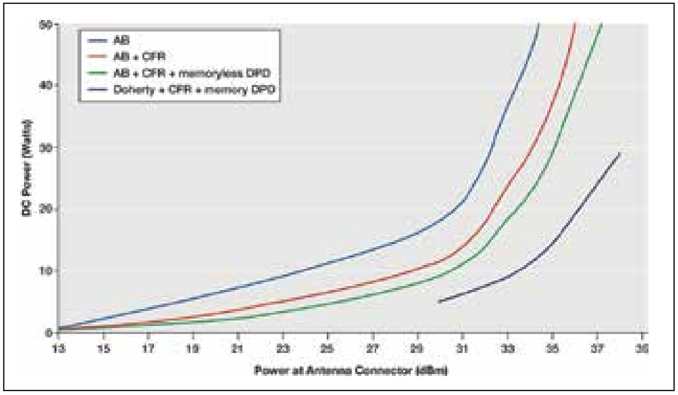

Figure 5 • The results of the amplifier DC power budget analysis provide insight as to the need for CFR or DPD under specific conditions.

Figure 6 • The femtocell reference platform based on Freescale's baseband architecture and RF devices, built by Benetel, and available to designers.

vides a modest improvement (with greater system complexity and cost). For power levels greater than 24 dBm, DPD helps keep transmitter power consumption in check and at power levels greater than +31 dBm the Doherty architecture is desirable. It is important to remember however, that performance can be improved with CFR and DPD together with an optimized RF amplifier architecture.

However, analyses of DC power consumption and estimates of the cost associated with processing features implemented by the digital front end is required to achieve optimum system definition. The results in Figure 5 are based on a single transmitter although equipment usually includes at least two and sometimes four RF power amplifiers to implement MIMO.

The modulation schemes and wireless access methods that the small cell is required to process, amplify, transmit, and receive impact the required resolution and dynamic range of the analog-to-digital and digital-to-analog converters. Conversion speed depends on signal bandwidth and the presence or absence of DPD, as the predistorted signal should include intermodulation products up to the fifth order. DPD also requires an additional return path to sample the output signal and send it to the front end for adapting the pre-distorted signal. This added complexity has a cost, which should be justified or offset depending on the small cell's performance improvements.

An Integrated Approach

As noted earlier, Freescale's baseband architecture is based on its StarCore data processing engines and Power Architecture technology, which scale from femtocells to macrocells. The company offers processors dedicated to small cells within its QorIQ Qonverge™ BSC913x series. For example the BSC9131 incorporates a Power Architecture processor, StarCore DSP engine, MAPLE baseband accelerator with LTE, W-CDMA, and CDMA2000 support, trusted-boot security, and an 800-MHz DDR3 memory interface and flash memory controller. The RF interface includes an antenna controller, two pulse-width modulators to control external components, and three JESD207/MaxPHY serial baseband interfaces. Controllers include two Gigabit Ethernet and one for USB 3.0, DMA, GPIO, UART, SPI, eSDHC, and two for PCs.

The BSC9131 targets applications with up to 16 users and integrates one e500 Power Architecture core and one SC3850 DSP core. The BSC9132 is optimized for picocell base stations serving up to 100 users and employs two of Freescale's e500 cores containing Power Architecture technology and two SC3850 DSP cores. The QorIQ Qonverge B4420 baseband processor is designed for microcells and the B4860 processor for macrocells.

In collaboration with Benetel, Freescale has created a BSC913x-based reference design platform (Figure 6) that can implement most major frequency bands throughout the world as well as LTE-FDD/TDD and WCDMA (HSPA+) access methods, allowing manufacturers to speed development of 3G Home Node B femtocells. The RF module in the platform delivers RF output power of 13 dBm and covers low-band (700 MHz to 1 GHz) and high-band (1.5 to 2.7 GHz) transmit/receive configurations, including 2x2 MIMO (Figure 7).

The RF module has JESD207 (JEDEC) and MaxPHY serial interfaces to the BSC913X and supports software-selectable dual-band operation, which allows the platform to support most wireless allocation throughout the world. There are two transmit and two receiver inputs for each frequency band to support 2x2 LTE and 3GPP W-CDMA (HSPA+) transmission and reception.

Freescale's linear, efficient MMZ09312B and MMZ25332B GaAs HBT power amplifiers and GaAs E-pHEMT low-noise amplifiers complete the transmit/receive path. The onboard MML09211H and MML20211H low-noise amplifiers have high sensitivity and cover UMTS frequency bands from 1 to 14. The MMZ25332 MMIC drives the final amplifier stage with 25 dB of gain and 33 dBm P1dB RF output power from 1.8 to 2.7 GHz and can also be used as the final stage in a picocell, providing an embedded RF power detector for monitoring and providing alarm information. The MMZ09312B covers 400 to 1000 MHz with P1dB RF output power of 29.6 dBm, gain of 31.7 dB, and an OIP3 of 42 dBm (all at 900 MHz). Both devices have externally-adjustable active bias control and RF power detection for monitoring and alarm, and operate from a single 3 to 5 VDC supply.

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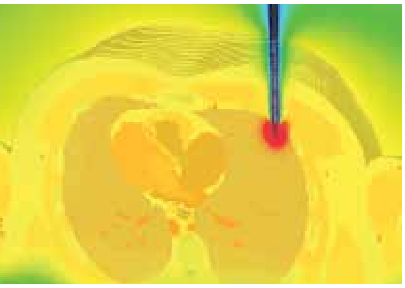

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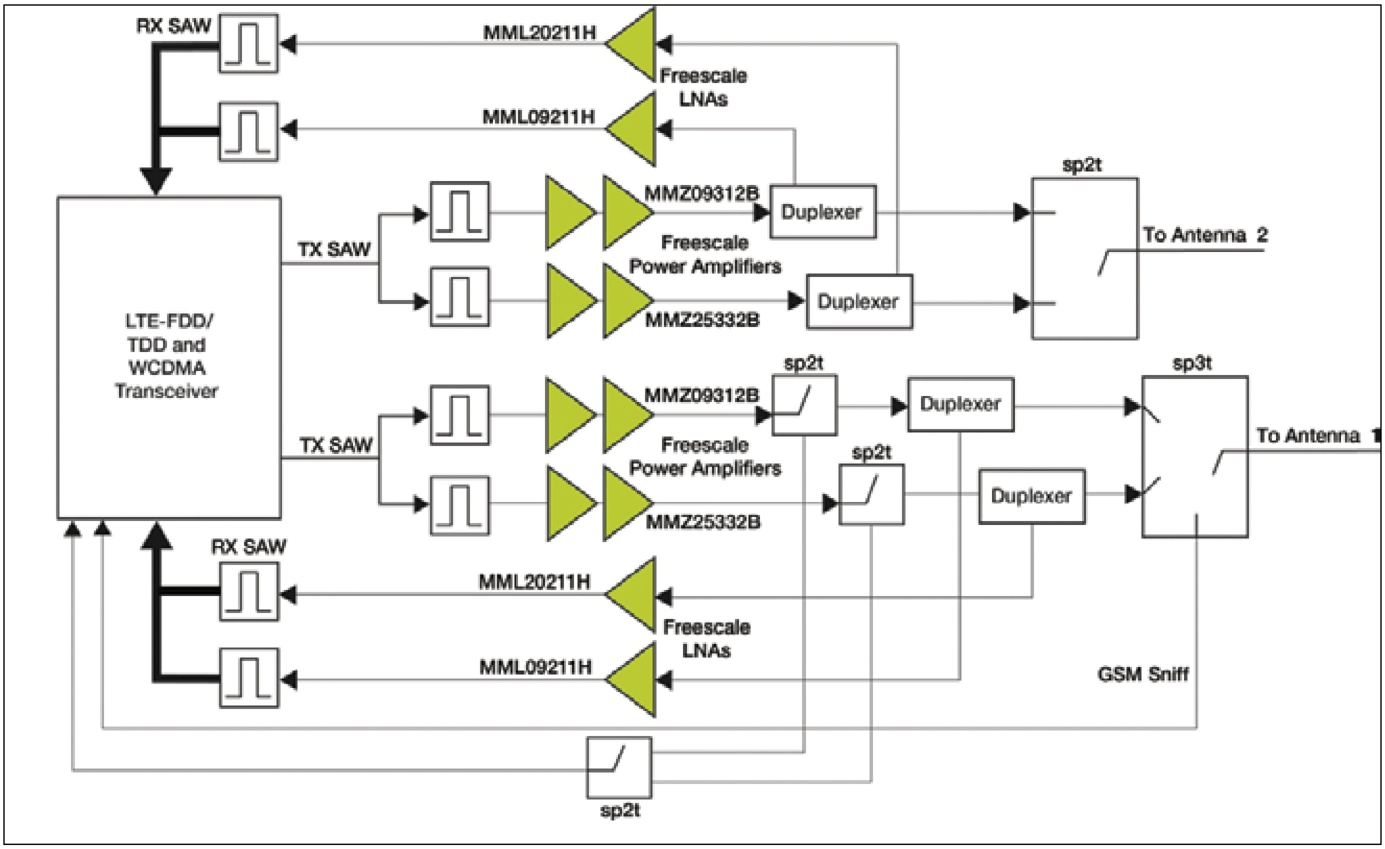

Figure 7 •The reference platform's dual-band RF front end showing Freescale's driver and final-stage amplifiers and low-noise amplifiers.

Summary

Although they perform similar function, small cell base stations differ from macrocells in ways that place significant demands on the designer. However, the ability to start from a reference design that addresses every system element from baseband through RF and microwave transmit and receive circuits, then adding differentiating features, reduces the time, cost -- and frustration inherent in building such a complex product in such a small enclosure. Additional small cell resources are available from Freescale at www.freescale.com/RFMMIC and www.freescale.com/BSC9131RDB.

About the Authors:

Jean-Christophe Nanan is a senior member of the technical staff at Freescale Semiconductor, which he joined in 1999 as an RF applications engineer. He previously designed RF front ends for 1 to 36 GHz radios at Sodielec (France). His main fields of interest include RF power amplifier architecture evolution, including Doherty, LINC, and envelope tracking. Nanan received his Diploma of Engineer in Electronics at ENSEEIHT (Toulouse, France). He can be reached at jean-christophe.nanan@freescale.com.

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HFE

2013 EDITORIAL CALENDAR

HIGH FREQUENCY ELECTRONICS

Regular monthly columns include:

- In the News
- Meetings & Events
- New Products
- Featured Products

In addition to the coverage to the right, each monthly issue will offer the reader a balanced mix of subject matter at levels of technical depth ranging from fundamental tutorials to advanced theory. Each month the subject matter is carefully selected to be both practical and useful to engineers who are developing high frequency and high-speed systems for applications in wireless and wireless communications, military and civilian defense, navigation, computing, imaging, and more.

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- Passive Components
- Cables and Connectors
- Engineering Education

Bonus Distribution:
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- Frequency Synthesis
- IMS 2013 Preview

Bonus Distribution:
IMS 2013
Seattle, June 2 – 7, 2013
Antennas & Propagation
Symposium,Orlando,
June 7 – 13, 2013

June

- Antennas
- Integrated Circuits
- Defense Electronics

July

- Power Amplifiers
- Cable Assemblies and Connectors
- EMC

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August 5 – 9, 2013
National Instruments Week, Austin,
August 5 – 9, 2013

August

- ICs and Devices
- EDA
- Active Components

September

- Resistive Products
- Design Tools
- EuMW 2013 Preview

Bonus Distribution:
EuMW 2013,Nuremburg
December 6 – 11, 2013, AOC, Washington,
December 13 – 18, 2013

October

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- Control Components
- Cables and Connectors Asia

Bonus Distribution:
Pacific Microwave Conference, Seoul, December 5 – 8, 2013 MILCOM, San Diego, December 19 – 21, 2013

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- ISM Technology
- High Power Amplifiers
- RFICs and MMICs

December

- Radio Communications
- Signal Analysis
- Software Design Radio

Bonus Distribution:
Wireless Week, Austin,
January 20 – 23, 2014

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Press releases for our informational columns should be sent by the first of the month prior to the desired publication date (e.g., April 1 for the May issue). Late-breaking news can be accommodated, but please advise the editors of urgent items by telephone or e-mail.

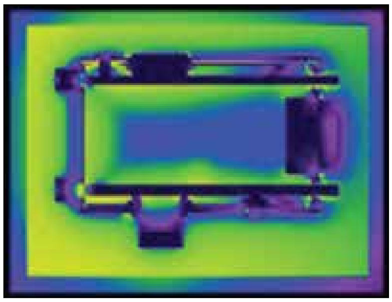
tim@highfrequencyelectronics.com

Article Contributions

We encourage the submission of technical articles, application notes and other editorial contributions. These may be on the topics noted above, or any other subject of current interest. Contact us with article ideas:

tim@highfrequencyelectronics.com

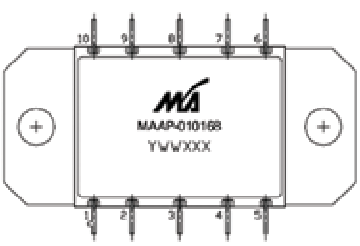
NEW PRODUCTS



EMI/EMC Test

Many electronic products must be tested before production to ensure compliance with regulations regarding emissions and interference. The use of Remcom's simulation software can aid in the development of products by providing quick feedback on the performance of many iterations of designs prior to costly prototyping and laboratory measurements.

Remcom
remcom.com



Amplifier

The MAAP-010168 is a two staged amplifier operating between the 500 MHz to 3.0 GHz frequency range. The device is fully matched for input and output at 50Ω, which eliminates the need for any sensitive external RF tuning components. It boasts high reliability with added excellent efficiency and gain, providing a high power off-the-shelf solution. It is fabricated using a high reliability pHEMT process to realize higher power. The amplifier provides a nominal gain of 24 dB with excellent input and output return loss of 10 dB across the 500 MHz to 3.0 GHz band.

M/A-COM Technology Solutions
macomtech.com

Tunable Load

Model SWL-1023-T1 and SWS-10-T1 are W band instrumentation grade tunable load and tunable

short covering the frequency range of 75 to 110 GHz. Both products are constructed with linear bearing and high precision Mitutoyo micrometer tuning configuration to guarantee smooth, no turning and long term repeatable mechanical movements. The electric performance of both products is realized through non-contacting structure. While SWL-1023-T1 tunable load offers 30 dB minimum return loss and handles up to 23 dBm RF power, the SWS-10-T1 tunable short exhibits perfect short circuits in any tuning position.

SAGE Millimeter
sagemillimeter.com

Adapter

Mini-Circuits' new SFFL-SF50+ coaxial adapter features: flat response; excellent VSWR; passivated stainless steel; four hole flange mount. Applications: interconnection of RF cables; instrumentation.

Mini-Circuits
minicircuits.com

PLL Synthesizer

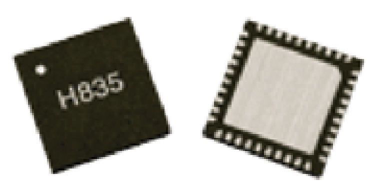
Richardson RFPD, Inc. announced availability and support for a new 18 GHz microwave phase locked loop (PLL) synthesizer from Analog Devices, Inc. (ADI). The ADF41020 can be used to implement local oscillators as high as 18 GHz in the up-conversion and down-conversion sections of wireless receivers and transmitters. It consists of a low noise, digital phase frequency detector, a precision charge pump, a programmable reference divider, and high frequency programmable feedback dividers (A, B, and P).

Richardson RFPD
richardsonrfpd.com

Capacitors

Vishay Intertechnology, Inc. announced a new series of surface-mount aluminum capacitors that combine a high temperature range to + 150 °C with very low impedance, high ripple current, and long useful life. For increased processing flexibility, the Vishay BCcomponents 160 CLA devices meet the rigorous IPC/JEDEC J-STD-020 soldering guidelines for severe reflow conditions. The capacitors are available in six case sizes, ranging from 12.5 mm by 12.5 mm by 13 mm to the larger 18 mm by 18 mm by 21 mm.

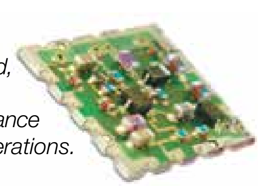
Vishay Intertechnology
vishay.com



PLL

Hittite Microwave Corp. launched the HMC835LP6GE, a wideband fractional-N PLL with integrated VCO that generates continuous fractional frequencies between 33 MHz and 4100 MHz. Targeted at the cellular infrastructure market,


Mini-Circuits



NEW PRODUCTS

the HMC835LP6GE features industry-leading PLL & VCO phase noise performance with a PLL Figure of Merit of -230 dBc/Hz in integer mode, and -227 dBc/Hz in fractional mode, and typical VCO phase noise of -134 dBc/Hz at 4 GHz output frequency and 1 MHz offset.

Hittite Microwave Corp.
hittite.com

EMI Test

Rohde & Schwarz designed the new R&S ESRP for diagnostic and precompliance measurements in the frequency range from 10 Hz to 7 GHz. It is not only an extremely fast EMI test receiver with standard-compliant bandwidths and detectors but also a full-featured spectrum analyzer, as well. The R&S ESRP offers two methods for measuring disturbance signals: the fast, FFT-based time domain scan and the traditional – but slower – stepped frequency scan. Both methods comply with the CISPR 16-1-1 standard for EMC measurements.

Rohde & Schwarz
rohde-schwarz.com

Circulator

Renaissance has designed a new dual junction circulator for LTE applications that can operate from 700 - 915 MHz and provide over 50 dB isolation within the band. Aimed at test and measurement applications, this device can handle 100 W with -150 dBc intermod products.

Renaissance Electronics
rec-usa.com

Switch

RLC Electronics' offers a micro miniature SMA transfer switch which is an extremely compact design. The switch incorporates SMA connectors to allow high-density packaging and excellent electrical performance through 26.5 GHz; VSWR 1.7:1 max, insertion loss 0.7 dB max and isolation 50 dB min. The switch is available in failsafe and latching configurations with a choice of three different frequency ranges and three different coil voltages. It has a unique feature in that it adds a position indicator despite the small package size.

RLC Electronics
rlcelectronics.com

Coax Cable

Samtec's line of coax cable systems includes a cost effective, micro discrete wire coax solution for high speed applications. The coax cable assembly (FCF8 Series) and board level connector (FCS8 Series) create a high performance system featuring a compact design and rugged features ideal for applications that require a space saving, economical solution for high speed transmission of data in micro-industrial, medical/military instrumentation, and many cable-to- board high speed signaling applications.

Samtec
samtec.com

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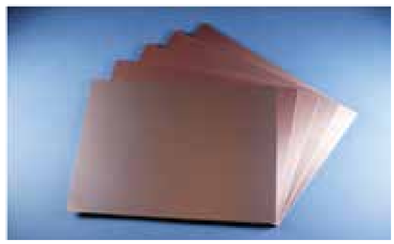
Attenuator

Model SKA-2734033040-2828-D1 is a PIN diode based digital controlled attenuator. In the entire Ka Band frequency range from 26.5 to 40 GHz, the attenuator offers 3.0 dB insertion loss and 40 dB dynamic range. Attenuation flatness is +/- 1.5 dB cross the band and power handling is +23 dBm CW. Attenuation level is controlled by a digitizing driver which features 6 bits TTL control capacity. The step size of the standard model is set at 1.0 dB and control accuracy is +/- 0.5 dB; however, the attenuator is ready for up to 0.25 dB step size and +/- 0.25 dB control accuracy by carefully calibrating the system. Control speed is around 100 ns and bias voltage required is +/- 10 Vdc/25 mA.

SAGE Millimeter
sagemillimeter.com



PCB Materials

Rogers' next generation RO4000® materials, RO4835™ high frequency laminates, specially formulated with improved oxidation resistance, were developed for applications needing a special level of electrical stability over time and temperature, while maintaining the cost advantages of a thermoset, FR-4 processable material. RO4835 laminates offer a dielectric constant of 3.48 at 10 GHz, a low loss tangent of 0.0037 at 10 GHz, and a low z-axis coefficient of thermal expansion (CTE) for excellent plated-through-hole (PTH) reliability under a variety of processing and operating conditions.

Rogers Corp.
rogerscorp.com

Synthesizer

Pronghorn Solutions' model PHS-4000 handheld synthesizer has been enhanced with a built-in rechargeable battery, allowing it to be used for up to 4 hours in the field without recharging. The PHS-4000 frequency range has been extended with models that cover up to 18 GHz on the high end and sub-10 MHz at the low end. These units have very low harmonics and excellent phase noise suitable for most applications. They can be operated with a built in 10 MHz reference oscillator or an external reference, and are capable of digitally phase locked sweep over the entire frequency range.

Pronghorn Solutions
pronghorn-solutions.com

Amp

Comtech PST's model BME69189-20 solid state power amplifier module features 6 to 18 GHz; 20 watts; ultra wideband operation; high efficiency; full power across the entire bandwidth; rugged and reliable; low harmonic distortion; compact and lightweight; GaN technology.

Comtech PST
comtechpst.com

Connectors

API Technologies Corp. announced its new hermetically sealed circular connectors for aerospace applications with high differential pressure. These connectors meet MIL-DTL-38999 fine leak requirements and are ideal for aerospace engine control, hydraulic, and caustic environments where harsh conditions could exist. The connector's receptacle has a seal of 10-7 cm3 and comes in filtered and unfiltered versions. They can be utilized in any application where unfiltered custom mechanical variations or filtering are required with a ruggedized seal.

API Technologies Corp.
apitech.com

Unequal Power Splitters

MECA Electronics launched a new line of unequal power splitters or tappers, developed to unevenly split high power signals for In-Building Distributed Antenna Systems (DAS) applications and designs. The line consists of six models offering a 2, 3, 4, 6, 8, or 10:1 signal-split ratio respectively, over 698 - 2700 MHz (Cellular, PCS, AWS, and BRS/EBS frequencies) and feature low PIM ratings (-155 dBc typical), with ultra-low VSWR and minimal coupling variation over the entire frequency band. They easily handle high power levels of 300W (CW) and have an operational temperature range of -55°C to +85°C.

MECA Electronics
e-meca.com

RF Adapters

Trilithic, Inc. released a new series of COTS RF adapters, available in a wide selection of connector types and configurations. In-series and between series Adapters are available in DC to 18 GHz frequency range with passivated stainless steel body material and gold plated beryllium copper contacts. Most connector types can be accommodated to fulfill your specific requirements. All adapters are RoHS compliant.

Trilithic, Inc.
trilithic.com

RFIC Test

Agilent Technologies Inc. announced a protocol testing solution for MIPITM Alliance Gear2 DigRf v4 RFICs. The Agilent M9252A DigRF host adapter allows developers to speed testing and analysis of RF-ICs used in cellular phones, tablets and other mobile devices. It provides the serial stimulus needed to evaluate and characterize circuits based on the DigRF v4 specification. A single module combines stimulus and Rx side capture to generate configurable control and data traffic and allow developers to observe the response from the device under test.

Agilent Technologies
agilent.com

Coupler

Mini-Circuits' new ADC-20-13+ directional coupler features: power handling up to 4 Watts; low mainline loss, 0.20 dB typ.; high directivity, 25 dB typ.; excellent VSWR, 1.2:1 typ.; aqueous washable. Applications: cable tv; VHF/UHF receivers; cellular.

Mini-Circuits
minicircuits.com

Signal Generator

New options extend the baseband of the R&S SMBV100A vector signal generator to 160 MHz, making it the only signal generator to directly support high-speed modes for WLAN IEEE 802.11ac. An external PC is not needed. In the 5 GHz ISM band, the R&S SMBV100A offers exceptional signal performance (0.44 % EVM) for 160 MHz signals.

Rohde & Schwarz
rohde-schwarz.com

Catalog

Times Microwave Systems announced the 17th edition of the LMR® Wireless Products Catalog. The 250-page catalog includes the entire range of LMR® cables, the Times-Protect® line of innovative lightning surge protector products for RF equipment including the unique IP-67 weatherized LP-BTRW series, the LP-18-400 series

of connector-protectors all-in-one, and the latest SilverLine® test cable innovations. Also included in this latest edition are the LMR®-SW low loss, low PIM cables, the latest –X no-braid-trim LMR® connectors, the Times-Protect® Smart-Panel™, and SilverLine® LP Low PIM test cables.

Times Microwave Systems
timesmicrowave.com

Converters

Murata announced the PAQ series of 150 Watt isolated DC-DC converters. Packaged as an industry standard open-frame quarter brick module with through-hole mounting, it has a 2:1 input range of 36 - 75 VDC around a nominal 48 VDC input. The single 29.8 VDC nominal output can be trimmed from 23.83 (-20%) to 32.78 (+10%) VDC in order to accommodate specific voltage requirements. It is ideally suited for a broad range of RF power amplifier applications: telecommunications infrastructure, CATV systems, satellite communications, RF test, and MRI imaging equipment.

Murata Power Solutions
murata-ps.com

TWT Amp

The model 277 TWT amplifier is dual mode, grid pulsed and CW and provides 150 Watts at pulse widths from 0.05 µseconds to CW. The model 277K frequency range is 18 to 26.5 GHz, while the model 277Ka frequency range is 26.5 to 40 GHz. The RF output pulse width tracks the input 5 volt video pulse. All power supplies are regulated, Phase Shifted Resonant Mode DC to DC converter designs operating at 50 KHz.

Applied Systems Engineering
applsys.com

Filter

Mini-Circuits' new ZFHP-0R12+ is a high pass filter in a connectorized package. This low frequency cut-off high pass filter eliminates noise that feed into RF/ baseband circuits from low frequency sources.

Mini-Circuits
minicircuits.com

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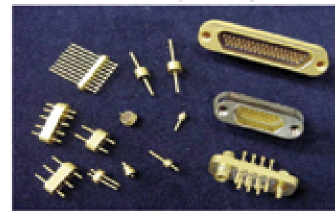
To be considered for publication, please submit text in Word along with a 300 dpi min. color JPG image of your product. *Submit to:*

tim@highfrequencyelectronics.com



Product Showcase

Product Highlights

Gunn Oscillator

Model SOL-24307-42-VG is a low cost, production ready K band Varactor tuned Gunn oscillator. The center frequency of the VCO is set at 24.125 GHz with +/-150 MHz frequency modulation bandwidth and +7 dBm nominal output power. The VCO operates from a single +5 .0 Vdc power supplier and typically draws 250-mA current and requires 0 to +15 volts voltage swing for electrical tuning. It is designed and manufactured to meet FCC Parts 15 regulations and exhibits -0.8 MHz/°C frequency and -0.03 dB/°C power stability. The operation temperature range of the VCO is from -40 to +85 °C.

SAGE Millimeter
sagemillimeter.com

Multi-Function Instrument

EasySYNC Ltd's new DS60M10, which is part of its USB Instruments™ range, combines an oscilloscope, data logger, spectrum analyzer, voltmeter and frequency meter in a single compact, lightweight and inexpensive product. With dual channel operation, it offers 10-/8-bit data streaming simultaneously on both channels. As it is USB-based, drawing 500 mA from a standard interface port, it does not need connection to any other power source.

EasySYNC Ltd
easysync-ltd.com

Amp

Comtech PST announced the release of a solid state Class "AB" linear amplifier which operates over the full 6-18 GHz frequency band and delivers a minimum of 20 watts. The amplifier uses the latest Gallium Nitride (GaN) technology and is packaged in a standard rack mountable enclosure measuring 19" x 22" x 3.5".

Comtech PST
comtechpst.com

Product Highlights

Couplers

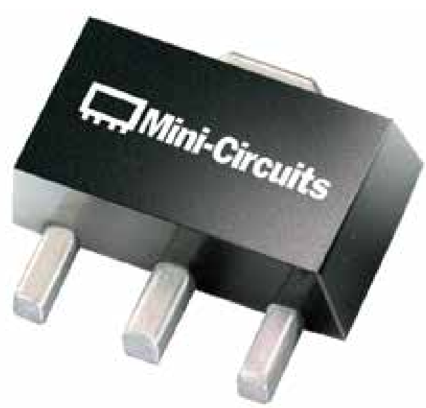
MECA Electronics line of H705D series high power 3 dB, 90° hybrid couplers covers all wireless band applications from UHF through UMTS (0.400 - 2.200 GHz) with power levels to 500 Watts (average), 10 kWatts (peak). Ideal for use as a duplexer for DAS head end systems or combining amplifiers for antenna sharing applications with high isolation. Low insertion loss and excellent VSWR. Made in the USA with a 36-month warranty.

MECA Electronics
e-meca.com

Spectrum Analyzer

Saelig Company, Inc. introduced the PSA Series II RF spectrum analyzers. Available in 1.3 GHz and 2.7 GHz versions, these instruments are smaller, lighter and have longer battery life than other more expensive handheld RF products. PSA Series II Analyzers incorporate a 4.3" (11cm) backlit TFT color touch-screen display, with a high capacity rechargeable Li-ion battery to give more than 8 hours operation per charge. The PSA Series II PSA1302 has a frequency range of 1 MHz to 1300 MHz, while the PSA Series II PSA2702 operates up to 2700 MHz. Dynamic range is 80 dB with a noise floor at -100dBm.

Saelig Company, Inc.
saelig.com



Amp

Mini-Circuits' PGA-106W-75+ (RoHS compliant) is an advanced wideband amplifier fabricated using E-PHEMT technol¬ogy and offers extremely high dynamic range over a broad frequency range with low noise figure and flat gain. Lead finish is SnAgNi. It has repeatable performance from lot to lot and is enclosed in a SOT-89 package for very good thermal performance.

Mini-Circuits
minicircuits.com

Product Highlights

Test Set

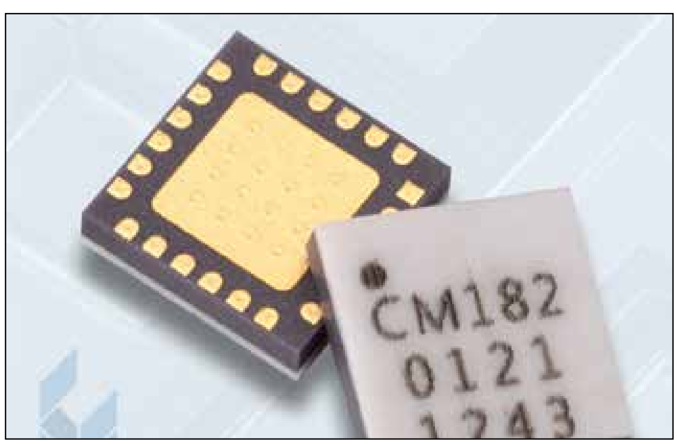
Aeroflex Limited announced that the 7100 Digital Radio Test Set has added support for carrier aggregation, a key component of LTE-Advanced (LTE-A). Carrier aggregation allows multiple carriers to be added together, allowing wider channel bandwidths and higher data rates to be achieved. The 7100 now supports all of the carrier aggregation scenarios specified in 3GPP Release 10, and is also ready for all those currently proposed for Release 11, as well as any other combination of two non-contiguous bands.

Aeroflex
aeroflex.com

Test Cables

Florida RF Labs has expanded its line of high-performance VNA test cables. ASR-F is a flexible version of the already popular ASR, a semi-flexible test assembly. These high frequency test cables feature a durable, yet extremely flexible monocoil that is additionally protected with an abrasion-resistant jacket for long-lasting performance in a test lab environment. They are manufactured using high quality materials; durable interfaces for repeated matings, special low-loss flexible cable construction for excellent stability over flexure & temperature.

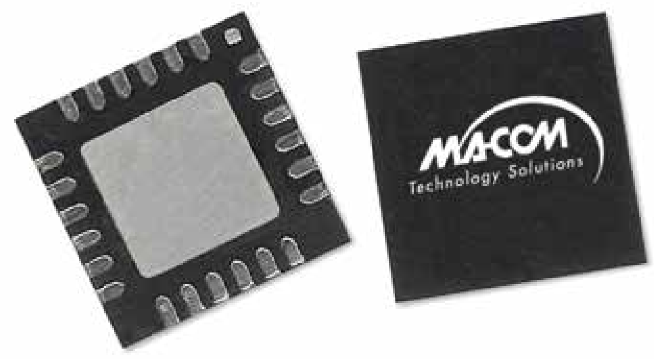
Florida RF Labs
rflabs.com



I/Q Mixer

Custom MMIC is now offering a new passive 6 - 10 GHz I/Q mixer, the CMD182C4. When paired with an external IF hybrid, the CMD182C4 can be used as either an image reject mixer or single sideband modulator, with 5.5 dB of conversion loss and 30 dB of image rejection/sideband suppression, while supporting an IF bandwidth of DC to 3.5 GHz. In addition, the CMD182C4 features very low LO to RF leakage of -35 dBm and an input P1dB of +9 dBm.

Custom MMIC
custommmic.com



Power Amps

M/A-COM Technology Solutions Inc. announced two power amplifiers for point-to-point (PtP) radios for cellular backhaul applications. The MAAP-010516 and MAAP-010517 are designed for customers who need a convenient and high power amplifier solution for PtP applications. Packaged in a fully molded 5 x 5 mm plastic QFN, the amplifiers include on-chip ESD protection structures with DC by-pass capacitors, allowing customers easy implementation and volume assembly of the packaged parts. The amplifiers boast excellent performance over the 12.75-13.25 GHz (MAAP-010516) and 14.5-15.35GHz (MAAP-010517) frequency range.

M/A-COM Technology Solutions
macomtech.com

Connector

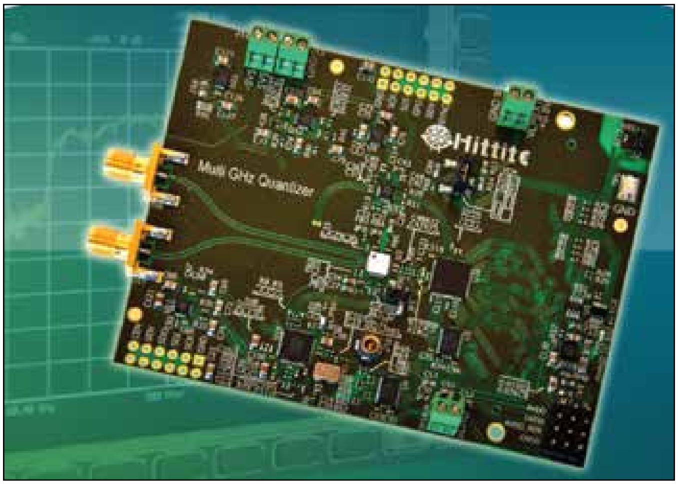
Amphenol Aerospace now offers a new high speed, rugged connector capable of delivering data rates up to 10 Gbps per pair. The high density Oval Contact System (OCS) features improved signal integrity via reduced cross talk as well as enhanced attenuation performance as compared to industry standard quadrax. Designed for high speed applications including, but not limited to 10/40G Ethernet, HDMI/DVI video, 1/2/4/8G Fibre Channel, SATA, Serial RapidIO and PCI Express, the rugged OCS connector is ideal for use in the defense, commercial and industrial markets.

Amphenol Aerospace
amphenol-aerospace.com

Oscillator

Rakon France launched the new mini ultra-low noise OCSO in a 48 x 60 x 13 mm package. The new B2 model has been scaled down in size by around 50% from 76 x 76 x 23 mm and is a mechanically improved version of the B1. The new package includes connectors and mounting pads and also provides an optional x2 internal multiplier, allowing an output frequency of 1GHz. The lower model profile and smaller package is an ideal solution when physical size counts. The B2 grade mini LNO delivers the best Phase Noise performance in the market and the best Phase Noise floor ever reached in the 500 MHz and 1 GHz frequency range.

Rakon
rakon.com



Chip Set

Hittite Microwave Corp. introduced a complete Multi-GHz Quantizer chip set that enables quantization of ultra wideband signals from DC to 18 GHz with excellent linearity and low noise. This solution can facilitate unparalleled levels of performance in test and measurement systems, Bit Error Rate Testers (BERTs), and Pulse Detection Systems including Pulse Doppler Radars where wideband sampling capability is a necessity. The chip set includes an 8-bit 1000 MSPS ADC (Analog to Digital Converter) and a high performance T/H (Track-and-Hold) amplifier which offers precision signal sampling over 18 GHz of input bandwidth.

Hittite Microwave Corp.
hittite.com

Cable Assembly

Samtec's line of standard high speed cable assemblies now includes an Edge Card Cable Assembly featuring 100Ω AcceleRate™ fully shielded twinax cable which is a low cost alternative to standard twinax cable assemblies, but with equivalent performance. Samtec's ECDP Series offers 4, 8, 16 or 32 pairs total on 0,80 mm (.0315") pitch with 1,60 mm (.062") card thickness. It is available with a choice of wire length, end two and wiring schematic options. In addition, a standard metal positive latching system provides higher withdrawal forces for harsh environments. An 85Ω impedance version is currently in development.

Samtec
samtec.com

Tester Software

Anritsu Company introduces Windows-based remote control software for its PIM Master MW82119A, the industry's first high-power, battery-operated, portable PIM test analyzer. With the software, field technicians on the ground can control an MW82119A configured on top of the tower, making it easier and more efficient to conduct highly accurate Passive Intermodulation (PIM) measurements, especially for difficult-to-access sites, such as Remote Radio Head (RRH) installations.

Anritsu Company
anritsu.com

Product Highlights

Analyzer

Agilent Technologies Inc. announced the launch of the Agilent x1149 boundary scan analyzer. Boundary scan has become an indispensable technology as engineers face increasing test access challenges. The x1149 boundary scan analyzer is a versatile yet easy to use board test tool designed to help users through board design and validation, and re-using the same x1149 test in manufacturing. Key features include: Cover-Extend Technology and Silicon Nails capability; STAPL player for CPLD/FPGA tests; Scan Path Linker to link multiple chains into a single chain; Fully compliant device support for IEEE 1149.1 and IEEE 1149.6 standard.

Agilent Technologies
agilent.com

Bandpass Filters

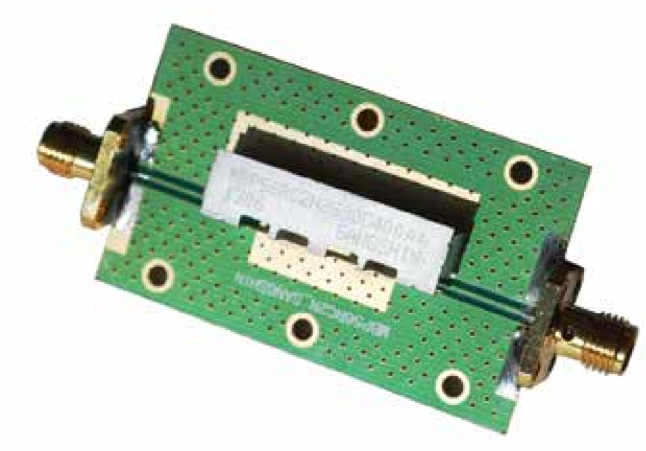
TriQuint's new bulk acoustic wave (BAW) bandpass filters combine high power handling, high rejection, low insertion loss and excellent temperature stability for base station and related applications including repeaters, distributed antenna systems and tower-mounted amplifiers. The 885024, 1960 MHz (Band 2 uplink), has a passband of 1930 - 1990 MHz and RF power handling of +33 dBm (2W). The 885025, 1880 MHz (Band 2 downlink), has a passband of 1850 - 1910 MHz and RF power handling of +30 dBm (1W). The 885009, 2535 MHz (Band 7 uplink), has a passband of 2500 - 2570 MHz, RF power handling of +30 dBm (1W) and rejection of 30 dB at 2170 MHz.

TriQuint Semiconductor
triquint.com

Regulator

Micrel, Inc. rolled out its latest-generation SuperSwitcher II™ family of integrated MOSFET buck regulators optimized for the 12V rails, with 6A/9A/12A output supply current. The new MIC2405x family is comprised of six common-footprint, DC-to-DC buck regulators that leverage Micrel's proprietary HyperSpeed Control™ and HyperLight Load® architectures. The devices provide flexible, cost-effective solutions for distributed power systems, communications networking and infrastructure, and industrial applications. The MIC24051/2 (6A), MIC24053/4 (9A), MIC24055/6 (12A) are currently available in volume quantities.

Micrel, Inc.
micrel.com



Filters

RFMW, Ltd. announced design and sales support for Sangshin Elecom ceramic monoblock filters targeting Digital Pre-Distortion (DPD) applications where anti-aliasing filters are required to improve system performance. Sangshin offers a complete line of filters with bandwidths of 400 MHz, 360 MHz, and 300 MHz in all popular cellular frequencies. The MBP56RC2N2590C400A has a center frequency of 2590 MHz with a 40 0MHz band width and offers 30 dB of rejection at 2290 MHz. Bandpass insertion loss is only 3 dB and the MBP56RC2N2590C400A can handle up to 1W CW of RF power.

RFMW, Ltd.
rfmw.com

Antenna

Teseq Inc. offers a double-ridged horn antenna that has a frequency range of 6 GHz to 18 GHz. The new PMM DR-01 is designed for radiated emissions and immunity applications, featuring an antenna factor of 36 dB/m to 41 dB/m and excellent sensitivity for emissions measurements. The PMM DR-01 is ideal for use with Teseq's PMM 9180 high-performance digital EMC/EMI receiver because of its size and axially located RF connector. The PMM 9180 is the only fully-compliant EMI receiver module on the market directly connected to an antenna located inside the testing chamber.

Teseq Inc.
teseq.com

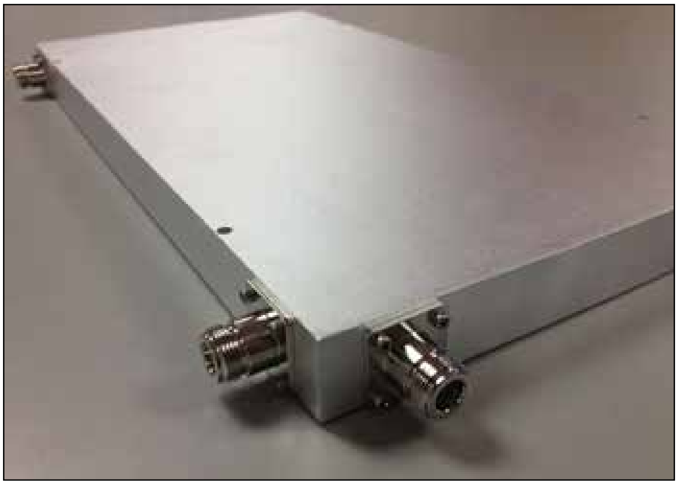
RFMD®

Power Amps

RF Micro Devices, Inc. announced the addition of multiple new products to RFMD's industry-leading portfolio of envelope tracking (ET) power management and power amplifier (PA) solutions. The new RF solutions — the RF7389, RF7390, RF7459, RF8081, and RF8085 — comprise ET PMICs, ET multimode multi-band (MMMB) PAs, and ET ultra-high efficiency PAs. RFMD's expanding ET product portfolio is compatible with the leading LTE chipsets and provides full ET compatible coverage of all FD-LTE and TD-LTE bands (1-14, 17-21, 25-28, 38, 40, 41, and 44).

RF Micro Devices
rfmd.com

Product Highlights



Coupler

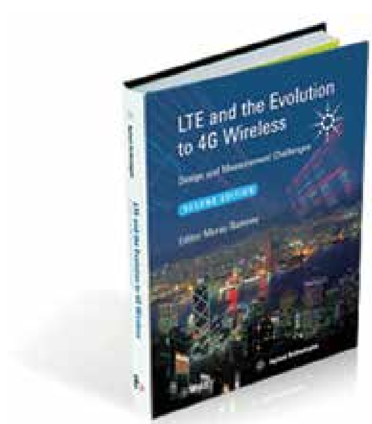
Response Microwave, Inc. announced a new high power, broadband coupler for use in radar and telecommunication transmit applications. The new RMCO5.32-1200Nf covers the 20-1200 MHz band offering typical electrical performance of 0.6 dB insertion loss, VSWR of 1.25:1, minimum directivity of 20 dB. Average power handling is 200W and the unit is operational over the -35 to +85 deg C range. Mechanical package is 15 x 8 x 1 inches. Connectors used are Type N female on the mainline and coupled ports. Optional connectors and coupling values available on request.

Response Microwave
responsemicrowave.com

CRO

Crystek's new CVCO55CXT-5270-5375 Coaxial Resonator Oscillator (CRO) is a coaxial-based VCO with an internal proprietary frequency doubler. The CVCO55CXT family's frequency doubling, 2X fundamental technology reaches new performance levels of lower phase noise and much lower harmonics over the competition, while achieving lower current consumption in the process. It operates from 5270 to 5375 MHz with a tuning voltage range of 0.3 Vdc to 4.7 Vdc. It features a typical phase noise of -102 dBc/Hz @ 10KHz offset and has good linearity.

Crystek
crystek.com

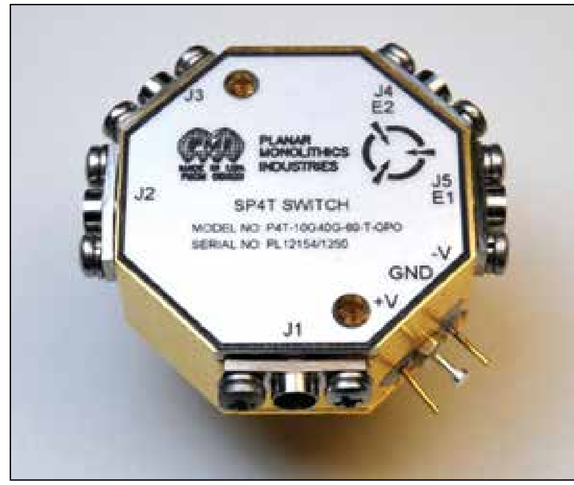


LTE Book

Agilent Technologies Inc. announced the second edition of its book "LTE and the Evolution to 4G Wireless: Design and Measurement Challenges," adding LTE-Advanced and more to its in-depth examination of the 3GPP LTE cellular technology and the challenges it poses to engineering design and test teams. With more than 40 authors and now at 648 pages, this edition (published by Wiley) provides technical and practical knowledge about the complex LTE and LTE-Advanced technology. The content comes from Agilent engineers working with the technology on a daily basis, both in the lab and on the committees that are defining the LTE standards.

Agilent Technologies
agilent.com

Product Highlights



RS-485 Evaluation Board

Analog Devices, Inc. and Bourns, Inc. introduced the industry's first certified RS-485 evaluation board for protecting against EMC (electro-magnetic compatibility) events in industrial and instrumentation equipment. The EVAL-CN0313-SDPZ board incorporates ADI's ADM3485E, 3.3-V RS-485 transceiver and various circuit protection devices from Bourns and meets IEC61000-4-2/4/5 ESD (electro-static discharge), EFT (electronically-fast transients), and power-surge specifications. The board is offered as part of ADI's Circuits from the Lab™ reference circuits library and includes circuit notes, test data and results to help engineers reduce design risk in applications such as motor controls, grid tied inverters, and programmable-logic controllers.

Analog Devices
analog.com

Switch

PMI Model No. P4T-10G40G-60-T-GPO is a single pole, four throw, absorptive, solid-state switch that operated over the frequency range of 10GHz to 40GHz. This model provides over 60dB of isolation and has an insertion loss of 6dB maximum. The VSWR is better than 2.0:1 into a 50 ohm impedance. This model is designed to handle operating input power levels up to 200mW (+23dBm CW) and has a maximum switching speed of 30nsec typical. This switch is supplied with GPO connectors at all RF ports. The housing is radial and measures 1.25" x 1.25" x 0.5".

Planar Monolithics Industries
pmi-rf.com

Heat Sink

CTS Electronic Components' Forged Heat Sink Series is a set of low profile, thin fin heat sinks. Its height ranges from 6.3mm to 32.6mm with thermal resistance as low as 1.9°C/Watt @ 200 LFPM convection flow conditions. These heat sinks attach to the integrated circuit via an adhesive tape or clip, whichever is appropriate for the application. As a result, they are easy to handle and require no special tools to assemble on the IC packages or additional holes on the PCB. CTS' line of forged heat sinks, AER, APF, and APR series, are ideal for large ICs with heat dissipation needs.

CTS Electronic Components
ctscorp.com

Product Highlights

Waveguides

Narda Microwave-East announced the expansion of its waveguide product line. The expanded line features 130 new models in four distinct categories. Included in the product line expansion are: Waveguide-To-Coaxial Adapters: (1.7 GHz – 40.0 GHz): • 2.92 mm, SMA, Type-N Connectors • Right Angle and End-Launch. Gain Horns: (1.7 GHz – 40.0 GHz); • 10, 15 and 20 dB Versions • Standard and Wideband Versions. Terminations: • Low Power (1.7 GHz – 40.0 GHz) • Medium Power (2.60 GHz – 40.0 GHz). Crossguide Directional Couplers: • SMA Connectors (7.05 – 40.0 GHz) • Type N Connectors (2.60 – 15.0 GHz.

Narda Microwave-East
nardamicrowave.com

A/D Converter

Hittite Microwave Corp. introduced the HMCAD1512, a 2/1 channel 8-bit ADC sampling at 450/900 MSPS. The HMCAD1512 is ideal for point-to-point microwave links and digital oscilloscopes. It is a versatile, high performance, low power analog-to-digital converter (ADC), utilizing time-interleaving to achieve higher sampling rate. The device contains two ADCs that can be interleaved by the user to act as a single channel or two channels. In dual channel mode, either of the two inputs can be selected for each ADC channel for maximum sample rate at 450 MSPS.

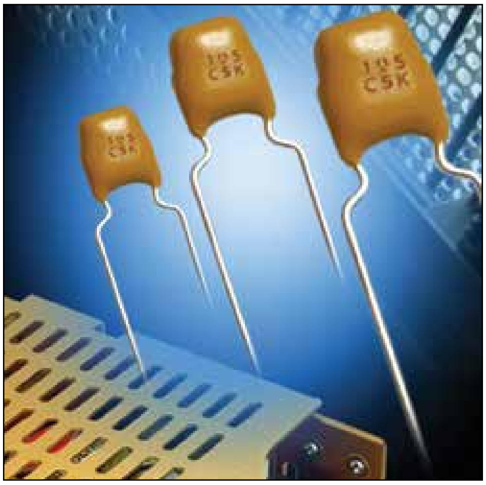
Hittite Microwave Corp.
hittite.com

Vented LTE Base Stations

PureWave Networks recently announced the latest addition to its portfolio of base stations – the PureWave Constellation™. This family of advanced LTE small-cell base stations delivers unmatched capacity in densely populated areas by providing high capacity wireless data service to as many as 256 simultaneous users. GORE® Protective Vents help the PureWave Constellation™ base stations perform reliably in fluctuating operating environments.

W.L. Gore & Assoc., gore.com
PureWave Networks, pwnets.com

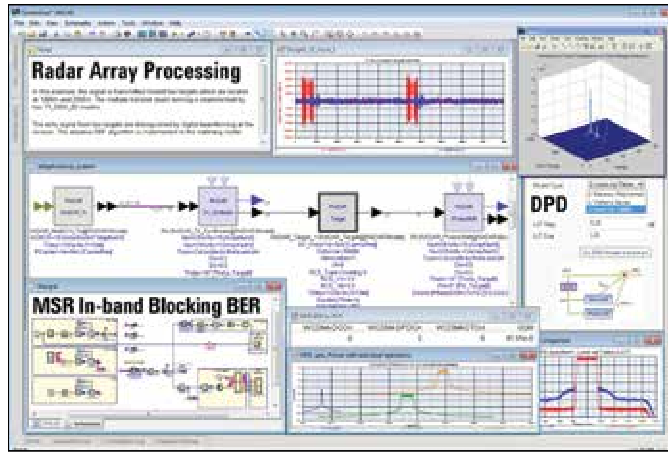
Product Highlights



Capacitors

AVX's new Skycap® High Voltage AR Series capacitors possess the robust construction, excellent vibration characteristics, considerable thermal resistance, and high quality for which the Skycap® Series is known. Capacitance values for the AR Series range from 470 pf to 68,000 pf and its tolerance values are ±5%, ±10%, ±20% and +80% - 20%. Fully qualified to automotive specification AEC-Q200, the Skycap® AR Series is ideal for use in power supply decoupling and filtering, and a variety of high voltage applications.

AVX Corp.
avx.com



Design Software

Agilent Technologies Inc. announced the newest release of SystemVue, its premier platform for designing communications and defense systems. SystemVue 2013.01 provides new application support for system-level architects, digital signal-processing modelers, and test-and-measurement verifiers who are designing next-generation MIMO radar systems and wireless/4G infrastructure. The new release enables users to make critical decisions about RF and DSP architecture more effectively by bringing real-world modeling, standards-based validation and links to high-performance test equipment into the R&D environment.

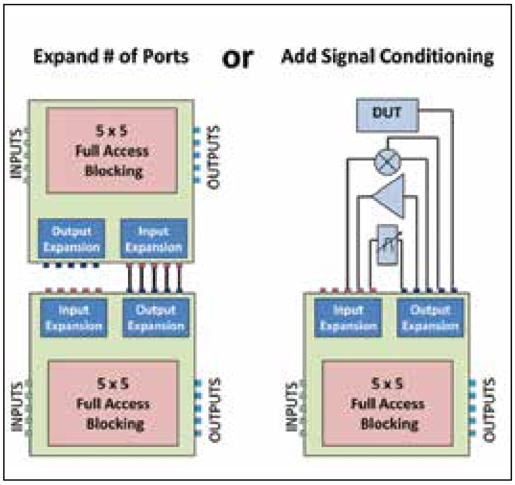
Agilent Technologies
agilent.com

FPGA Development

Analog Devices, Inc. unveiled the newest addition to its line of FPGA development platform-compatible FPGA mezzanine cards (FMC) incorporating JEDEC JESD204B SerDes (serializer/de-serializer) technology. Digital and analog designers can use the AD9250-FMC-250EBZ kit to simplify and rapidly prototype high-speed JESD204B A/D converter-to-FPGA platforms.

Analog Devices
analog.com

Product Highlights



Switch Matrices

FlexMatrix offers standard 5 x 5 and 10 x 10 switching configurations with frequency ranges from DC to 6, 26.5 or 40 GHz. The FlexMatrix expansion ports provide test engineers with the capability to expand their existing solutions to a greater number of ports. Using these expansion ports, test engineers can now easily route their required signal conditioning into RF switching paths without the need for external switching (see diagram).

SenarioTek
senariotek.com

DC/DC Converter

Texas Instruments Inc. introduced the industry's smallest monolithic point-of-load (POL) DC/DC converters for harsh environments, including radiation tolerant, geological, and heavy industrial applications. The 6.3-V, 6-A TPS50601 and the 6.3-V, 3-A TPS50301 are synchronous step-down converters optimized for small form factor designs. The devices' current mode control, high switching frequency, and integration of the high- and low-side MOSFETs slash board space by 50 percent compared to other solutions, reducing the size of equipment needed for tight spaces.

Texas Instruments
ti.com

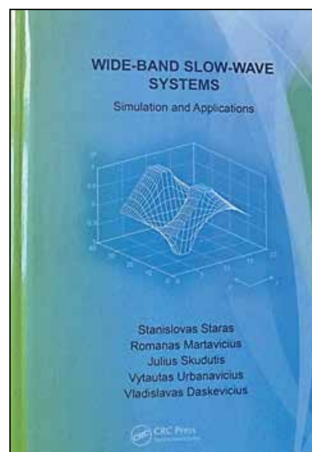
Limiter

Model LM-26G40G-14-20W-292MM is a high power limiter capable of withstanding an input power level of 20 Watts, 440 to 670 nsec Pulse Width, PRF 600 to 900 kHz, 40% Duty Cycle. This model operates in the 26.5 GHz to 40 GHz frequency range. The insertion loss is 4.0 dB maximum, VSWR of 2.0:1 and 250 nsec response time and a typical leakage of +14 dBm. This limiter is packaged in a small 0.50 X 0.50 X 0.22-inch housing and is supplied with 2.92 mm male connectors.

Planar Monolithics Industries
pmi-rf.com

Wide-Band Slow-Wave Systems

Simulation and Applications



By Tom Perkins
Sr. Technical Editor

Stanislovas Staras
Romanas Martavicius
Julius Skudutis
Vytautas Urbanavicius
Vladislavas Daskevicius

CRC Press 2012 ISBN 978-1-4398-8154-5 (Hardback)

This textbook is generally not must reading for today's research or microwave engineer, unless you are or anticipate designing travelling-wave tubes or delay lines.That said, it does present some unique information regarding structures that play a role in our modern systems. Included are helical, meander line and gutter-type (I might describe as trough or trench-type) structures. Application of current numerical software programs such as AWR Microwave Office®, CST MICROWAVE STUDIO®, and MATLAB® provides insight into unique and versatile uses for such analysis programs. The book includes discussion of some practical shielding methods for meander lines. Much of the information was heretofore only published in Russian and Lithuanian languages.

In today's sophisticated very broadband microwave systems, a new project can suddenly present challenges not previously dealt with or learned at the university. A book of this type can be just the right guide to provide insight into challenging analysis, synthesis and design problems that may arise. It is well organized, with symbols and acronyms explained, and lots of good references from the classical to the obscure and up-to-date.

International Microwave Symposium

IEEE 2–7 June 2013, Seattle, WA MTT–S

INTELLECTUAL PROPERTY, PATENTS AND COMMERCIALIZATION: OPTIMIZING YOUR SUCCESS!

Join IMS2013 for what is sure to be an exciting and fervent Plenary talk led by Dr. Patrick Ennis, Global Head of Technology, Intellectual Ventures.

Invention Capital: Why the World Needs More of it

Monday, 3 June 2013

"It is an exciting time to be a technologist. Every day, breakthroughs in research laboratories offer the promise of products and solutions to meet a range of global challenges and opportunities. However, it is very difficult to successfully commercialize technology; and unfortunately most efforts fail. We need to improve the success rate, otherwise billions of dollars of R&D funding will be wasted, and innovation-driven economies will stall. Invention Capital is a missing link in the value-creation chain."

Dr. Patrick Ennis will talk about how researchers from a variety of scientific and technical fields can optimize the value- creation chain. He will be sharing new models such as Open Innovation and Invention Capital that are necessary to successfully commercialize technology, in today's challenging environment where the speed of technology development and adoption has so accelerated that even leading technology companies find it hard to just keep up. This is an opportunity for leading researchers to understand the latest trends in managing valuable IP and bringing it closer to commercialization.

IMS IS WHERE...

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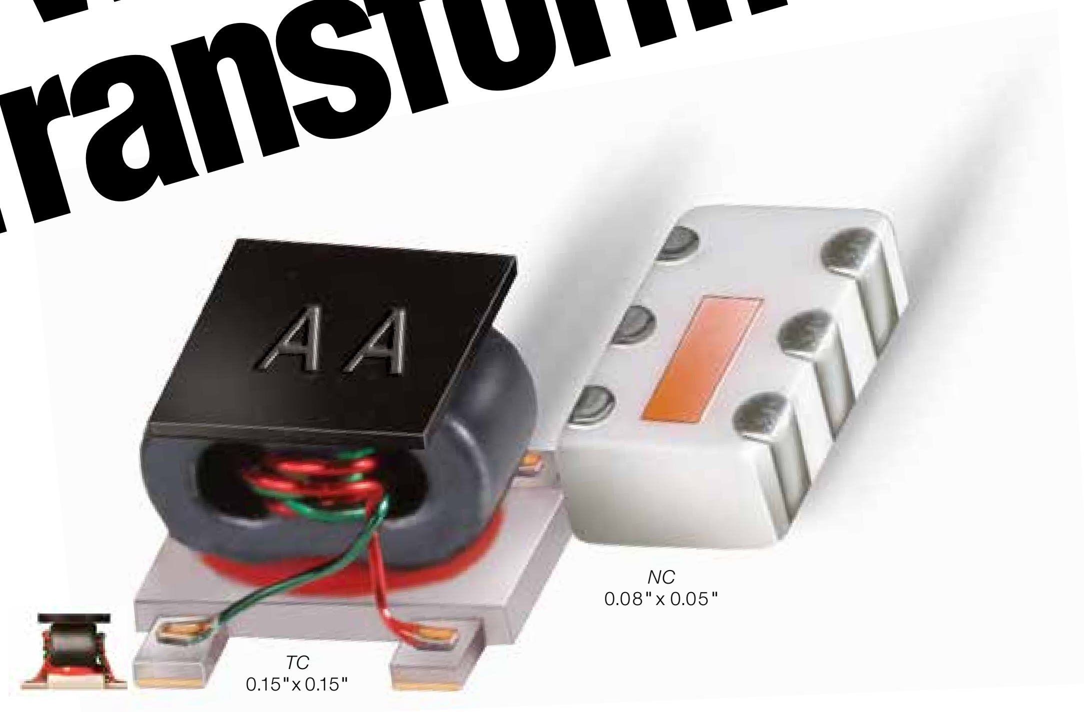
IEEE MTT-S

TINY

Wideband Transformers



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

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

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

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

See minicircuits.com for technical specifications, performance data, pricing, and real-time, in-stock availability!
Mini-Circuits...we're redefining what Value is all about!

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

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U.S. Patents 7739260, 7761442

IF/RF MICROWAVE COMPONENTS

377 rev Z

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