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JANUARY 2013

HIGH FREQUENCY ELECTRONICS

Design, Construction and Characterization of an IF Processor for the FFT Spectrometer of the Yebes Radio Telescope

IN THIS ISSUE:

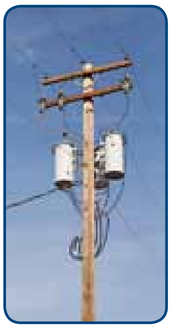
The Future of Instrumentation: The Software Revolution

Using Analyst™ to Quickly and Accurately Optimize a Chip-Module-Board Transition

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

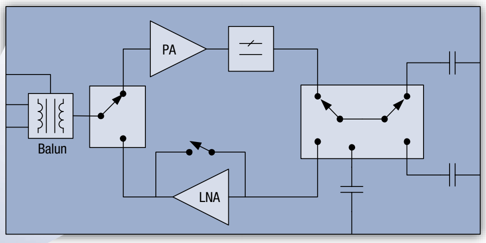
Smart Energy, Connected Home and Automation Solutions

▪ ZigBee® (IEEE 802.15.4) ▪ Automated Meter Reading (AMR) ▪ Advanced Metering Infrastructure (AMI)
▪ Wireless Local Area Network (WLAN) ▪ Industrial and Home Control ▪ Unlicensed Band Radios



Neighborhood Area Network (NAN)

Home Area Network (HAN)



SKYWORKS

Front-end Module (FEM) Block Diagram

Front-end Modules (FEMs)

Part Number	Function	P_{OUT} (dBm)	Tx Gain (dB)	Rx Gain (dB)	I_{CC} Tx (mA)	Package (mm)	Frequency Band (MHz) < 170	410–470	868–930	2400–2500
SKY66100	Tx / Rx Front-end Module with Rx / Tx Bypass	20–27	30	-0.5	110–300	MCM 4 x 4	•			
SKY65367-11	High Power Tx / Rx Front-end Module with Rx / Tx Bypass	30	35	-0.5	600	MCM 4 x 4	•			
SKY65338	Tx / Rx Front-end Module	27	32	–	315	MCM 8 x 8		•		
SKY65342-11	High Power Tx / Rx Front-end Module with Rx Bypass	29	34	-0.6	650	MCM 8 x 8		•		
SKY65378	Low Power Front-end Module with Tx Bypass and LNA	–	–	14–17	3–7 (1)	QFN 4 x 4			•	
SKY65346-21	Tx / Rx Front-end Module with LNA	26	35	13.7	200	MCM 5 x 5			•	
SKY65313-21	Tx / Rx Front-end Module with LNA	30.5	28	16.6	695	MCM 6 x 6			•	
SKY65364	High Power Tx / Rx Front-end Module with LNA, PA, Tx / Rx Bypass, HD Filter	30.5	30	15	730	MCM 6 x 6			•	
SE2435L	High Power Tx / Rx Front-end Module with LNA	30	28	16	550	QFN 4 x 4			•	
SE2442L	High Power Tx / Rx Front-end Module with Rx Bypass	30	28	-0.7	550	QFN 4 x 4			•	
SE2438T	Low Power Tx / Rx Front-end Module with LNA	10–14	16	12.3	20–33	QFN 3 x 3				•
SE2431L	Tx / Rx Front-end Module with LNA	20	23	12	110	QFN 3 x 4				•
SE2432L	Tx / Rx Front-end Module with LNA	20	22	11.5	110	QFN 3 x 4				•
SE2436L	High Power Tx / Rx Front-end Module with LNA	27	28	11.5	400	QFN 4 x 4				•

1. SKY65378: I_{cc} Rx gain value shown.

Power Amplifiers

Part Number	Function	P_{OUT} (dBm)	Gain (dB)	$P_{1 dB}$ (dBm)	Package (mm)	Frequency Band (MHz) 450	915	2400
SE2433T	2-Stage Power Amplifier	24	22	24	QFN 2.5 x 2			•

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New products indicated in **blue, bold** are continually being introduced at Skyworks.

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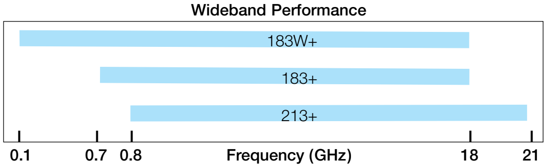
NEW ZVA-183WX+	0.1-18	28±3	27	35	4.0	1345.00
ZVA-183X+	0.7-18	26±1	24	33	3.0	845.00
ZVA-213X+	0.8-21	25±2	24	33	3.0	945.00

* Heat sink must be provided to limit base plate temperature. To order with heat sink, remove "X" from model number and add $50 to price.

Wideband Performance



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U.S. Patents 7739260, 7761442

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JANUARY 2013
Vol. 12 No. 1

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Improving an Information Conduit

Scott L. Spencer
Publisher

I have never been one for New Year's resolutions. My reasoning is that if something needs to be corrected or improved, why wait until January 1st to make a change? Besides, according to the *Journal of Clinical Psychology,* of the 62% of all Americans who usually or occasionally make New Year's resolutions, only 8% are successful in achieving the goal.

A little over a year ago we set out to make some significant improvements to *High Frequency Electronics.* These changes could not be implemented in a single incident; as a single event. Some of them might not even be readily apparent to the reader. For example, improvements focused on circulation development are consistent with our goal to provide every design engineer whose work involves RF and microwave technology the opportunity to receive *HFE* in either print or digital formats. These efforts have resulted in an active and curious audience that is 100% 1-year qualified and verified by BPA Worldwide, a recognized leader in circulation auditing since 1931.

We have added sales personnel for new account development, better European coverage, and cost effective "Showcase" and display advertising. All of which are designed to provide a conduit for information from industry to the reader.

Senior Technical Editor

One very visible change has been the addition of Sr. Technical Editor Tom Perkins. His many years of real-world engineering experience, coupled with his enthusiasm for the science, have had a positive influence on the quality of the articles we present each month. His ongoing involvement with the Microwave Theory and Techniques Society and IEEE Life Members Chapter, including past service as Chapter Chair, Vice Chair and Co-Chair, affords him access to industry and academic leaders who are shaping the future.

We have also been fortunate, largely through Tom's efforts, to assemble a distinguished panel of Editorial Advisors consisting of leaders from both industry and academia. This includes a very impressive group of women, two of whom—Dr. Karen Panetta and Sherry Hess—are recognized in this issue for their activity to promote women's entry into science, technology, engineering and math (STEM) majors and their leadership roles in IEEE's Women in Engineering and IEEE Women in Microwaves, respectively.

There have been subtle but noteworthy alterations to the manner in which *High Frequency Electronics* is produced and published. Better use of graphics in our regulars columns like "In the News" are more pleasing to the eye and make for a more enjoyable read. Based on reader comments the larger "three to a page" *Product Highlights* offers a cleaner, more appealing look. The printed version of *HFE* is published using advanced digital printing technology on the highest quality paper that is produced using sustainable forestry practices. Our on-line edition is posted each month at www.highfrequencyelectronics.com which has seen upward of 14,000 unique visitors each month.

One thing that hasn't changed is our commitment to presenting a balanced mix of editorial in each issue. We will invite and present material covering topics that have a foundation in the electromagnetic principles described by Maxwell's equations. This includes inductance, capacitance, transmission line behavior, waveguide behavior, dispersion, radiation, resonance effects, skin effect, dielectric effects, near-field radiation, and propagation. Material that is useful to engineers for developing high frequency and high-speed systems for applications in wireless and wireless communications, military and civilian defense, navigation, computing, imaging, and more. Our goal is to meet the informational needs of today's engineers who are confronted with the tremendous advances in materials and software, all while crossing the boundaries between digital and analog across the electromagnetic spectrum.

This Month's Issue

This past September considerable reader interest resulted when I reported on the unveiling of National Instruments' innovative new PXIe-5644R vector signal transceiver, the world's first software-designed instrument. A follow-up meeting at EuMW in Amsterdam with National Instruments' Matthew Friedman resulted in his contributed article *The Future of Instrumentation.* In it he provides a perspective regarding the direction and potential for this game-changing approach to test and measurement. Also this month, José Antonio López-Pérez and David Cuadrado-Calle from the Spanish *Centro Astronómico de Yebes* in Madrid, describe the design, construction and characterization of an IF processor for the radio astronomy receivers used in the Yebes 40 meter radio telescope.

As we look ahead to 2013 we anticipate many challenges, but also growing opportunities arising from advances in technology. On behalf of everyone here at *High Frequency Electronics,* let me extend my sincere wishes for a safe and prosperous New Year!

Conferences

January 29 – 30, 2013
DesignCon 2013
Santa Clara, Calif.
http://www.designcon.com/santaclara/

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

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, & WCDM
Course 221: BER, EVM, & Digital Modulation Testing for Test & Product Engineers
Course 230: EMI/EMC Design and Troubleshooting
Course 231: Radio Frequency Basics for Electronics Professionals
Course 222: RF Power Amplifier Techniques

Company-Sponsored Training & Tools

Agilent Technologies
Advanced Agilent VEE Pro
January 23 - 26, 2013
Las Vegas, Nev.
http://www.home.agilent.com/agilent/eventDetail.jspx?cc=US&lc=eng&ckey=701878-14&nid=-34787.0.00&id=701878-14

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

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

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http://www.linear.com/designtools/software/

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Online
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Object-Oriented Design and Programming in LabVIEW
Online
http://sine.ni.com/tacs/app/fp/p/ap/ov/pg/1/

Call for Papers

IEEE RFIC 2013
June 2 – 4, 2013, Seattle, Wash.
Technical Paper Summary Deadline: January 7, 2013
Final Manuscript Deadline: March 7, 2013
http://www.rfic-ieee.org

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

2013 IEEE Wireless Power Transfer (WPT)
May 15 – 16, 2013, Perugia, Italy
Abstract Deadline: January 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)
January 28 – 31, Annapolis, Md.
Abstract Deadline: May 1, 2013
www.mwp2013.org

RF Power Amp Sales for Wireless Infrastructure Should Top $2.4B

Although 2012 turned out to be an off year for RF power amplifiers and devices for wireless infrastructure the market still held its own. The current year should be viewed as a breathing space before both segments resume stable and moderate growth after an explosive 2011.

The Asia-Pacific Region, including Japan, continues to account for over 75% of the RF power semiconductor devices that are sold into the mobile wireless infrastructure segment. According to research director Lance Wilson, "For the foreseeable future the Asia-Pacific region, particularly China, will remain the most important region and focus for RF power amplifiers and high-power RF devices for wireless infrastructure."

Despite the off year RF power amplifier sales for wireless infrastructure will top $2.4B and RF power device sales will be over $600M.

LTE will become an increasingly important factor in both of these businesses even though the rollout has not been as rapid as the industry would like. Nevertheless, it is already worldwide in scope. "Although LTE has not significantly impacted RF power amplifier and device sales as of yet," says Wilson, "it is going to bolster RF power sales in the wireless infrastructure space from 2012 on."

The continuing overall need for wireless data remains an important driver for the overall market for both RF power amplifiers and RF power devices.

—ABI Research
abiresearch.com

Tunable Antennas Improve Smartphones

Compact, integrated antenna tuners shipped into several popular smartphones in 2011, the first of a wave of such tuners from Peregrine Semi, RFMD and others. The Strategy Analytics report, "Outlook for Active Antennas & Tunable Components in Cellular Phones" reviews the prospects for tunable RF components, comparing the different approaches and suppliers, and provides an upbeat forecast of the market through 2017.

Christopher Taylor, Director of the Strategy Analytics RF & Wireless Components market research service stated that, "Mobile devices that support 4G, 3G and 2G in multiple bands have complex RF front-ends, with compromises in antenna performance that can degrade calls, as Apple learned last year. Tunable components can reduce dropped calls and improve battery life, while simplifying the cellphone."

Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor market research service added that, "Antennas with tunable impedance match will emerge as an important piece of the cell phone RF front-end, and we expect antenna specialists including Ethertronics and Skycross, in combination with front-end component suppliers including Skyworks, RFMD, Avago Tech, TriQuint and Murata, to compete aggressively in this segment using GaAs, CMOS, RF MEMS and voltage-dependent dielectric variable capacitor technologies."

—Strategy Analytics
strategyanalytics.com

Silicon Valley Seeing Growth in Automotive Design

The Strategy Analytics Automotive Electronics Service (AES) has released its report Automotive Tier 1 Regional Strategies: Technical Capabilities Raised In Emerging Markets and Silicon Valley, an update to its earlier 2008 Insight. Along with the Tier 1 Vendor Regional Design Center Database, these are valuable resources to identify Tier 1 regional centers of investment, product expertise and design activity.

"Growth areas in automotive development include electrified powertrains, ADAS (Advanced Driver Assistance Systems), HMI (Human-Machine-Interface), smartphone connectivity and telematics," says Kevin Mak, Automotive Electronics Analyst. "This has propelled regions such as Silicon Valley, California, into the automotive spotlight. Such high tech hubs bring together other industry sectors who offer the technologies that can bring about the necessary solutions in these growth areas, which are often not available to automotive players from their existing centers."

—Strategy Analytics
strategyanalytics.com

Financial Infrastructure: $17B in Security Spending

Financial institutions have been under cyber-attack since they first ventured into the digital landscape and there is a long-standing cyber war being waged between organized cybercrime and the financial sector. Recent findings from ABI Research show that global spending on financial critical infrastructure security will total $17.14 billion by the end of 2017. This includes spending on counter measures, transaction, and data security, as well as on policies and procedures.

A strong underground economy is emerging; run by highly organized cyber-criminal elements that are creating targeted and sophisticated malware destined for financial attacks. Exploit kits, banking Trojans, and botnets are used in combination with social engineering tactics in persistent and highly evolved attacks. These tools are being eagerly picked up by an even more threatening group – nation states. Warring states will undoubtedly start to use these tools as cyber weapons to bring down enemy economies.

—ABI Research
abiresearch.com

National Instruments announced its acquisition of Dresden, Germany-based **Signalion** GmbH. The acquisition delivers strong wireless communications talent and technologies to the NI platform, which are critical to NI's goal to continue to drive long term growth in the communications test industry. Signalion founders **Dr. Tim Hentschel and Dr. Thorsten Dräger** will remain with the company as co-managing directors, and work closely with NI R&D to evolve the capabilities of **NI LabVIEW** system design software and modular PXI hardware for wireless test applications. Signalion will continue to operate as a wholly owned NI subsidiary and to sell and support its products through its direct, distributor and OEM channels.

The Air Force awarded **Alliant Techsystems** Operations L.L.C., Keyser, W.Va., (FA8213-13-C-0001) a $7,097,212 cost-plus-fixed-fee, firm-fixed-price contract for procurement of 500 AIM 9P rocket motors for the **AIM-9 Guided Missile**. The location of the performance is Keyser, W.Va.

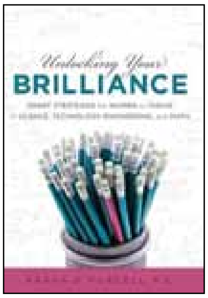
The Navy awarded The **Boeing Co.,** St. Louis, Mo., a $687,611,825 ceiling-priced modification to a previously awarded fixed-price-incentive-fee contract (N00019-09-C-0019) for the production and delivery of 15 fiscal 2013 (LOT 37) **F/A-18E** aircraft in accordance with the aircraft variation in quantity clause. Work will be performed in St. Louis, Mo.(45.2 percent); El Segundo, Calif.(44.6 percent); Hazelwood, Mo.(3.4 percent); Cleveland, Ohio (1.7 percent); Torrance, Calif. (1.4 percent); Vandalia, Ohio (1.0 percent); Ajax, Canada (1.0 percent), and various other sites within the continental U. S. (1.7 percent), and is expected to be completed in July 2015.

H. Richard **"Dick" Johnson**, co-founder with **Dean Watkins** of former microwave-industry powerhouse **Watkins-Johnson Company**, passed away last month in Palo Alto, Calif. Founded in 1957, Watkins-Johnson grew to become a premier manufacturer serving the communications, defense, and semiconductor-equipment markets. From components to highly sensitive receivers to sophisticated subsystems, WJ made it all, with a well-earned reputation for design expertise and reliability. While the company's operations have long since divested, its prodigious legacy continues even today as many former WJ employees populate the RF and microwave industry, some of whom went on to found companies of their own.

LPKF Laser & Electronics announced the appointment of a new COO, Dr. **Christian Bieniek**. As the fourth member of the LPKF Board of Managing Directors, Dr. Bieniek will oversee the operational performance of the company, including all management, control, and organizational processes. An engineer who also holds a Ph.D., Dr. Bieniek most recently served as head of operations at MAN, where he gained comprehensive corporate experience in the capital goods industry.

Delta Microwave, supplier of Amplifiers, Filters, Filter/Amplifiers, Multiplexers, and Integrated Microwave Assemblies, is proud to have supported the launch of **NASA's Radiation Belt Storm Probes** (RBSP). Delta's GPS Filter/Amplifiers are used in the United Launch Alliance Atlas V rocket for range safety during launch.

Skyworks Solutions, Inc. announced that it is powering several **smartphone platforms** that are leveraging Microsoft's new **Windows 8** operating system. With the addition of this latest OS, Skyworks' products are now enabling all major smartphone and tablet operating systems. Recent Windows 8 smartphone launches that Skyworks is supporting include HTC's 8S and 8X, which are utilizing Skyworks' SkyHi™ and LTE front-end solutions and industry leading switch technology and several other mobile devices from a leading handset OEM.



According to a recent story in the *Des Moines Register*, 11,388 women – or one in three female college students enrolled in **science, technology, engineering and math (STEM) majors** at the University of Iowa, Iowa State University, and University of Northern Iowa, a 13% increase from three years ago. The cause? According to university officials, outreach efforts directed to girls in high school is credited for the boost in STEM study interest. **Karen Purcell**, author of ***Unlocking Your Brilliance: Smart Strategies for Women to Thrive in Science, Technology, Engineering, and Math,*** points to lack of exposure to such fields as a possibility in their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early years as the biggest obstacle young women face who may otherwise pursue a STEM career. "Typically, girls and women interested in STEM do not get to experience the level of exposure or encouragement in these fields as our male counterparts," Purcell says. "In my field, I strongly believe that women early in their engineering career and young women – those who don't even know yet that they will become engineers – are unquestionably the future of our profession."


Hess


Panetta

HFE Editorial Advisors **Dr. Karen Panetta** and **Sherry Hess** are both active in promoting women's entry into STEM. Hess serves as organizer for the IEEE MTT-S Women in Microwaves **(WIM)**, and has pursued an aggressive outreach program to increase group membership and awareness. Dr. Panetta is the Worldwide Director of the IEEE's **Women In Engineering**; the Editor-In-Chief of the IEEE WIE Magazine; and the advisor for the Society of Women Engineers student chapter at Tufts University. She created the nationally acclaimed **"Nerd Girls"** program, under which undergraduate engineers research renewable energy topics and serve as role models for younger students.

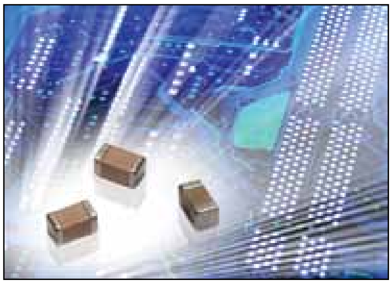
CTS Corp, a global leader in ceramic, quartz and piezoelectric technologies, received the **Rosemount Supplier Award** in recognition of continuous improvement in the areas of quality, speed, flexibility, service, technology, and best cost from **Emerson** Process Management, Rosemount Inc.

The **CST University Publication Award** is an annual grant to university institutes and researchers for work related to 3D EM field simulation applications. The winners are awarded extensions and upgrades to their **CST STUDIO SUITE®** installations to recognize the importance of their work and to promote further research. The following papers have been selected to receive the CST University Publication Award 2012: "Beamforming by Left-Handed Extraordinary Transmission Metamaterial Bi- and Plano-Concave Lens at Millimeter-Waves"; Miguel Navarro-Cía, Miguel Beruete, Igor Campillo, and Mario Sorolla Ayza; "Effects of shape and loading of optical nanoantennas on their sensitivity and radiation properties"; Yang Zhao, Nader Engheta, and Andrea Alù; "Design of a Broadband All-Textile Slotted PIFA"; Ping Jack Soh, Guy A. E Vandenbosch, Soo Liam Ooi, and Nurul Husna Mohd Rais.

Rogers Corp. received the 2012 **Innovation Excellence Award** from the Connecticut Technology Council. The annual award recognizes significant technology leadership and innovation by Connecticut-based technology companies. "Rogers is honored to receive this prestigious award that highlights our long history of innovation," said **Robert Daigle**, Senior Vice President and CTO.

ROGERS CORPORATION

Rohde & Schwarz has been working intensively on relaunching its **website**. The main objective is to help users find products and topics of interest to them as fast as possible. To do this with a portfolio encompassing some 4,600 products, clear navigation structures and a modern design are key prerequisites. Easy contact options and an optimized site search function round out the relaunch. Readers are invited to visit www.rohde-schwarz.com.



Capacitors

AVX Corp. introduced a series of ultra-miniature chip capacitors for the RF and microwave communications market. Featuring copper electrodes in place of standard precious metal electrodes, the new CU Series chip capacitors provide extremely low ESR, high Q, and tight tolerances. Available in 01005 and 0201 case sizes, the units are ideal for power amplifiers, handheld devices, GPS, vehicle location systems, and matching networks for wireless LANs.

AVX Corp.
avx.com

Switch

This RLC Electronics' Miniature Coaxial Switch is a single pole, two position type. The switch provides extremely high reliability, long life and excellent electrical performance characteristics over the frequency range of DC - 65 GHz. The miniature package utilizes high density packaging techniques, hence the overall volume of the switch is less than ¾ cubic inch.

RLC Electronics
rlcelectronics.com

RF Amp

AR RF/Microwave Instrumentation introduced a family of solid-state RF amplifiers that instantaneously covers the 10 kHz - 400 MHz frequency range with both 200 watt

and 400 watt models. They are designed to deliver all the power required for applications using MIL-STD, DO 160, and other automotive standards. These models can be used independently or with AR's RF conducted immunity generators when specific tests require higher powers than our standard CI Systems can generate.

AR RF/Microwave Instrumentation
arworld.us

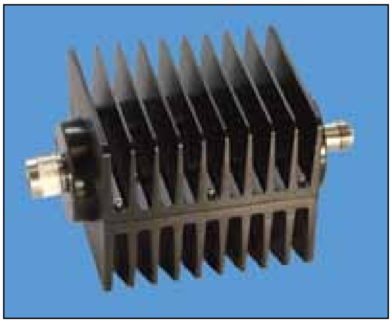
PIM Tester

AWT Global launched a line of portable Passive Intermodulation (PIM) Testers with an extended carrier power range: the PIM+ series. These systems are equally suited for testing macro cells as well as outdoor and in-building DAS installations. While 2 x 20 W (2 x 43 dBm) carrier power is the reference for standard for PIM test systems, the new PIM+ offers an extended adjustable power range of +15 dBm to +44 dBm for each carrier.

AWT Global
awt-global.com

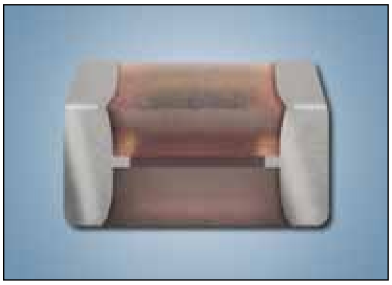
Attenuators

Aeroflex/Inmet's improved 100 watt fixed attenuators are ideal for high power PA testing, load simulation and many other test environments. Inmet's 6N100W-XX operates from DC- 6 GHz, has excellent attenuation accuracy (30 dB +/- 1.5 dB) and a VSWR of less than 1.45:1. They



are available in standard values of 3, 6, 10, 20, 30 and 40 dB and with Type N, SMA, 7/16-DIN or TNC connectors. Other dB values and custom connector configurations are available as options.

Aeroflex/Inmet
aeroflex.com



Resistors

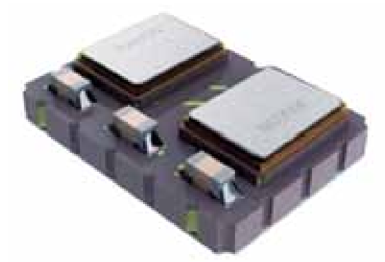
ATC announced the 504L Series next generation surface mount Ultra-Broadband Resistors. This new thin film product has been designed and manufactured with the highest quality materials to provide reliable and repeatable performance. It utilizes proprietary Glass Sandwich Flexiterm® Technology (GSFT). The Flexiterm® is a surface-mountable automotive-qualified termination that adds an extra margin of safety against damage due to flexture during installation.

American Technical Ceramics
atceramics.com

TCXO

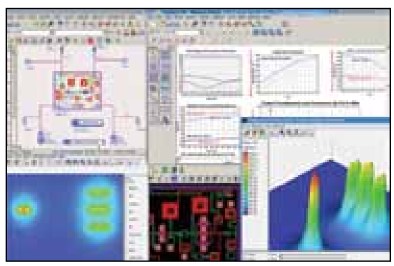
Rakon UK developed a 7.0 x 5.0 mm small form factor acceleration tolerant TCXO. The RFPT705 is available with frequencies from 16 to 40 MHz and uses patented dual-crystal design, giving better than 0.5 ppb/g acceleration sensitivity. It is based on Rakon's proprietary PlutoTM TCXO ASIC, a single chip

FEATURED PRODUCTS



oscillator with an analog compensation circuit, which results in a frequency versus temperature stability as tight as ± 200 ppb. The design has a low component count, making it reliable for highly ruggedized environments.

Rakon
rakon.com



EDA Software

Agilent Technologies Inc. announced shipment of Advanced Design System 2012, its flagship RF and microwave EDA software platform. ADS 2012 features new capabilities that improve productivity and efficiency for all applications the system supports and breakthrough technologies applicable to GaAs, GaN and silicon RF power-amplifier multichip module design.

Agilent Technologies
agilent.com

Terminations

RLC Electronics' precision coaxial terminations provide extremely low VSWR, 50 ohm matched terminations over broad frequency ranges in a wide selection of connectors and power ranges. The terminations provide low VSWR terminations over a full range of RF frequencies. These units utilize either a precision coaxial structure as the terminating element or a lossy dielectric medium. Heat transfer is accomplished efficiently by the utilization of cooling fins.

RLC Electronics
rlcelectronics.com

Limiters

Herotek's product family (LL Series) of low leakage level limiters features a frequency range of 10 MHz to 18 GHz with leakage levels as low as -10 dBm. This limiter product family has maximum input power handling capability of 1 Watt CW and 100 Watt Peak power along with options for leakage levels of -10 dBm, -5 dBm, 0 dBm, or +5 dBm. Bias of +5V is required with 5mA typical current draw.

Herotek
herotek.com

3G Infrastructure Test

Aeroflex Limited announced that the TM500 Test Mobile is the first to market to support full protocol stack UE (user equipment) emulation that enables network testing and measurements for the DC-HSUPA (Dual Cell High-Speed Upload Packet Access) standard specified in 3GPP W-CDMA Release 9. DC-HSUPA allows a UE to simul-

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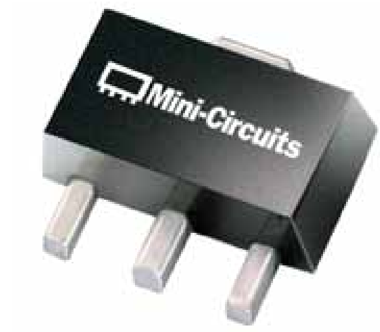
taneously transmit data over two independent enhanced uplink data channels, boosting both the uplink data rate and the network capacity, enabling maximum per-UE uplink data rates approaching 23 Mbps, effectively doubling the maximum rate.

Aeroflex
aeroflex.com

Amplifier

The GVA-60+ (RoHS compliant) is a wideband amplifier fabricated using HBT technology and offering ultra flat gain over a broad frequency range and with high IP3. In addition, the GVA-60+ has good input and output return loss over a broad frequency range without the need for external matching components



and has demonstrated excellent reliability. 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

Transmitter

MITEQ introduced a new high reliability Fiber Optic Transmitter with an operating bandwidth to 6 GHz. Model HRT-50K6G-28-20-M14 has a noise figure of 12 dB and is available in three different optical wavelengths (1550, 1490, 1310 nm). Operating temperature range is -40 to +85°C. With MITEQ's line of fiber optic receivers it now is possible to have a complete fiber optic link that is sealed from the environment and has a spurious-free dynamic range of 103 dB/Hz. MITEQ has fiber optic links with operating bandwidths up to 20 GHz and all of its fiber optic links are available in a variety of packaging options.

MITEQ
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The Future of Instrumentation: The Software Revolution

By Matthew Friedman

Engineers are becoming empowered to make measurements and create test systems specifically suited to their exact needs.

65 years ago Bell Labs forever changed technology with the invention of the transistor. Considered one of the greatest inventions of the twentieth century, it is hard to find an element of our life that has not been impacted by its existence. This of course has had a profound impact on instrumentation as well. Companies like Hewlett-Packard were born from this silicon revolution and their instruments replaced the vacuum tube instruments of General Radio before them. Like 45 years ago, we are now at another crossroads in instrumentation with the software revolution. Just as everyone expects their smartphone to have apps customized to their exact needs, engineers are struggling to make do with fixed functionality instruments. As we stand at the precipice of this new era, we are seeing a fundamental shift as engineers are becoming empowered to make measurements and create test systems specifically suited to their exact needs.

Test Complexity Drives Change in Instrumentation

With increased technological innovation comes the challenge of testing each new breakthrough. For example, as wireless standards become more complex, the number of operational modes for these devices increases exponentially. As we progress to the latest WiFi standards like 802.11ac, there are many new modulation schemes, additional channels, more bandwidth settings, and extra spatial streams that increase testing complexity. Additionally, characterizing WLAN transceivers is especially challenging when faced with thousands of independent operational gain settings (Figure 1).

With such complexity, manual testing techniques become infeasible and some level of automation is required. This is traditionally achieved by connecting box instruments over

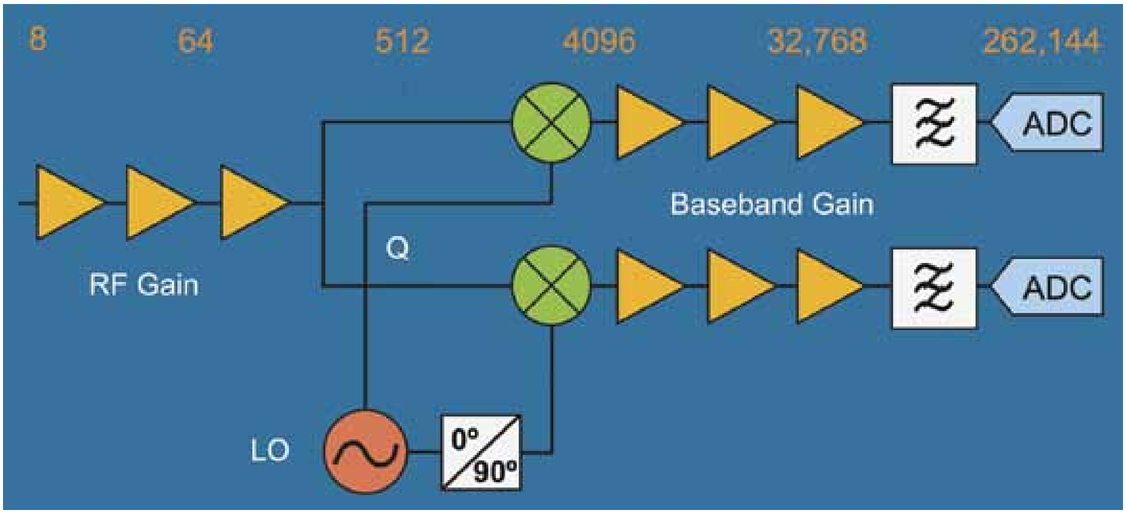

Figure 1 • An example block diagram of a typical WLAN receiver shows how each component has multiple gain stages, resulting in hundreds of thousands of different possible gain settings for a single receiver. (Courtesy of Qualcomm Atheros).

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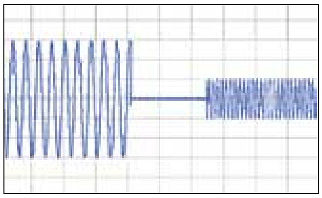
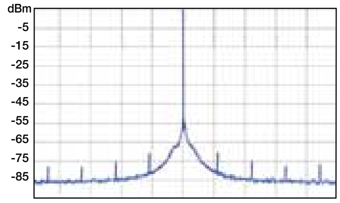


Frequency and power hopping.



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U.S. Patents 7739260, 7761442

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an instrument control interface to a computer, and then using a software application to automate the system. While these systems have been functional, they are often inefficient and do not apply the instrument as they are intended to be used.

Traditional box instruments are designed for when an engineer or technician wants to manually test or troubleshoot a device. When automation is required, the instruments' screens, knobs, and buttons can often become a waste of space and money. Furthermore, these instruments are not typically designed to maximize measurement speed or data throughput.

The Move to PXI Modular Instruments

Over the last few years, the industry reached a tipping point and is making the switch to PXI. Optimized for automating measurements, PXI provides a solution that is often faster, smaller, and more cost-effective than traditional box instruments. For example, TriQuint Semiconductor saw their testing complexity massively increase as they had to characterize their latest generation RF power amplifiers over a wide range of frequencies, voltage supply levels, temperatures and power ranges. For the typical part, this requires 30,000 – 40,000 lines of data to completely test the design. Using traditional box instruments, a full characterization would take about two weeks to complete. By making the switch to PXI modular instruments for the bulk of their measurements, Triquint was able to significantly reduce testing times (Figure 2) and complete full characterization in about a day.

Based on commercial, off-the-shelf technology, PXI provides a solution that is faster, smaller and more cost effective than traditional solutions. Some of the key features include (Figure 3):

Small, modular architecture: PXI modules are available from DC to 26.5 GHz and can be mixed and matched to create a full test system in a small benchtop footprint or 3U of rack space.

High throughput data transfer: Based on the PCI Express bus, PXI is able to achieve data transfers more than 20 times faster with 100 times less latency than traditional instrument control interface like Ethernet and GPIB.

	Traditional Bench Test Time (s)	PXI Test Time (s)	Speedup
GSM Test	6	1.1	6X
EDGE Test	14	1.1	14X
WCDMA Test	9	1.1	9X

Figure 2 • Triquint Semiconductor realizes test speeds 6 to 14 times faster using PXI modular instruments over traditional instruments.

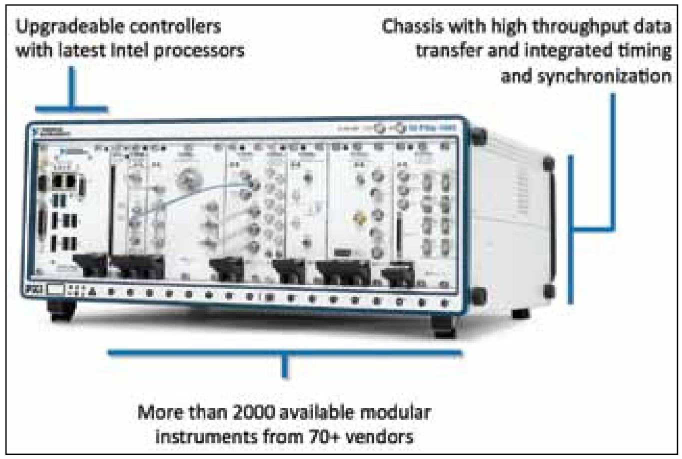

Figure 3 • The PXI platform is ideally suited to meet today's and tomorrow's testing needs.

Upgradeable, modular controllers: Engineers can add extra processing capabilities by simply swapping the controller while keeping the same chassis and instrumentation. For example, to improve performance, they can easily switch a system built in 2001 operating at 2.5 GFLOPS with a controller running the latest Intel core i7 processor at over 35 GFLOPS.

Integrated timing and synchronization: PXI chassis incorporate dedicated 10 and 100 MHz reference clock and trigger lines to every slot to address the needs of synchronizing multichannel and MIMO test systems.

The PXI market has grown immensely since its introduction 15 years ago. According to Frost and Sullivan, it is expected to be over billion-dollar market by 2017. Already today there are more than 70 companies with more than 2,000 different products.

The Revolution of Software

While PXI provides a faster, smaller, and more cost-effective option, its real power lies in allowing the user to create test systems better suited to their exact needs. For example, ST Ericsson had the challenge of the increasing complexity of testing their latest RF platforms for mobile phones and tablets. These platforms containing multiple radios, such as GPS, Bluetooth, WCDMA, and LTE, require approximately 800,000 measurements to fully test. Further complicating the tests is that they must work with multiple standards and custom digital protocols to properly interface their chips. When traditional box instruments proved not to be flexible enough to meet their needs, ST Ericsson turned to NI LabVIEW system design software and NI PXI hardware to perform the needed DUT interfacing, RF measurements and analysis. Not only was the system much more flexible, ST Ericsson was able to reduce test time by a factor of 10, from 3 days to 8 hours.

Figure 4 • The NI PXIe-5644R is the world's first software-designed instrument.

However, even with all this flexibility, there is often a need for more. For example, many new tests require capabilities like frequency domain triggering, real-time spectral masks and embedded control algorithms. These tasks can be difficult to execute as they are required to be directly executed within the instrument's embedded firmware and typically must be implemented by the vendor. Fortunately, there is a new paradigm in instrumentation called software-designed instruments that opens up the instrument's firmware and allows the engineer complete access to add their required functionality.

The first instrument to support this paradigm is the NI PXIe-5644R vector signal transceiver (Figure 4). Combining a vector signal analyzer, a vector signal generator and high-speed digital I/O in one three-slot PXI module, the NI PXIe-5644R vector signal transceiver is a fraction of the size and cost of traditional solutions while maintaining industry-leading measurement performance. What makes it a software-designed instrument is that is has an open, user-programmable FPGA at its core. Users can modify its software and firmware, which is based on LabVIEW, to create an instrument specific to their needs.

Out of the box, the vector signal transceiver provides a software experience similar to other instruments with a quick time to first measurement/generation and a programming interface for the most common functions. However, the true power comes from the fact that all LabVIEW software and firmware source code is provided to enable users to modify their instruments to their specific needs. System design software like LabVIEW is well suited to software designed-instruments because it is capable of abstracting the processing implemented on an FPGA and the microprocessor on the PXI controller in a way that does not require extensive knowledge of computing architectures and data manipulation. This frees the user to focus on the functionality of algorithms and instrument control to meet their specific application needs.

Qualcomm Atheros is one of the initial users of the software-designed vector signal transceiver in the testing of their latest 802.11ac WLAN transceiver. They were faced with the challenge of their latest designs having multiple gain settings at each stage of the radio structure. This resulted in hundreds of thousands of data points that needed to be acquired for a single operational mode. Using traditional instruments it was not feasible to perform all these measurement and instead used a best estimate gain table that would only produce approximately 40 meaningful data points per iteration. However, after making the switch to the vector signal transceiver, they were able to

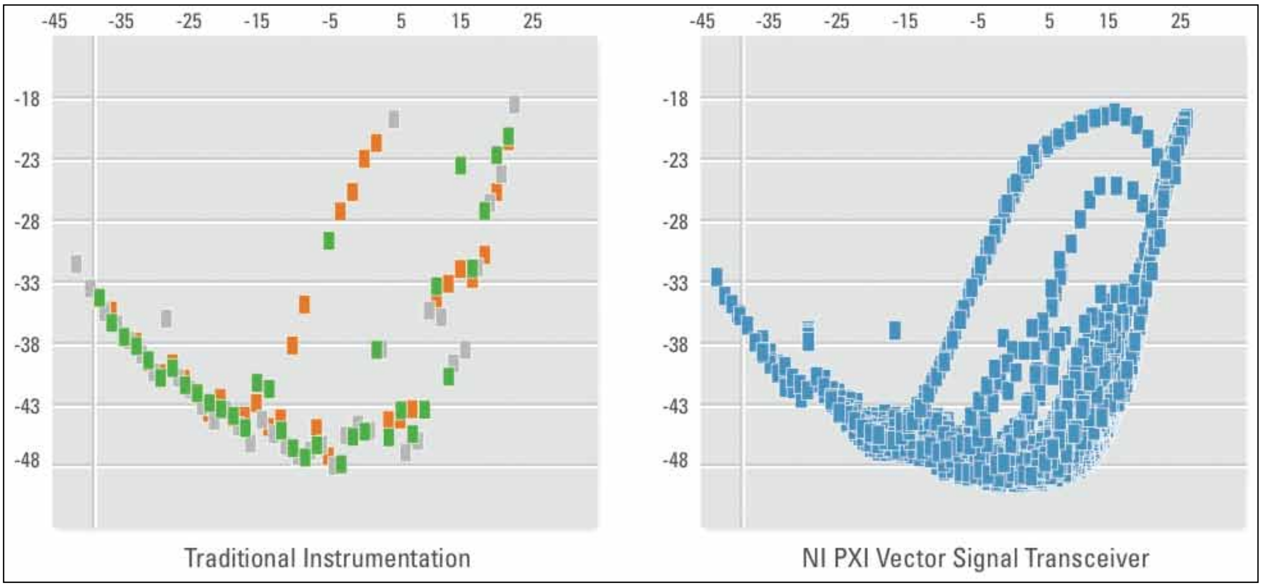

Figure 5 • Qualcomm Atheros realized a 200 times improvement in measurement speed and a better understanding of their devices after making the switch to the vector signal transceiver.

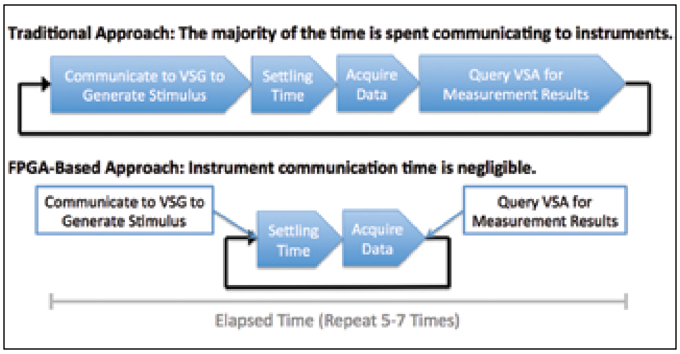

Figure 6 • Embedding power amplifier servoing control algorithms directly in the instrument can provide over an 800 times reduction in test time.

perform DUT control and data processing directly within the instrument. This resulted in 200 times improvement in measurement speed and also allowed a test sweep to acquire all 300,000 data points for a better determination of optimal operational settings (Figure 5).

Examples of Software-Designed Instrument Applications

With software designed-instruments, engineers are empowered to create the instrument specifically suited to their exact needs. Early users of the vector signal transceiver are already customizing it in many different ways; two recent examples are those of power amplifier servoing and channel emulation.

Example: Power-Level Servoing for Power Amplifier Test

It is important for power amplifiers (PAs) to have an expected output power, even outside their linear operating modes. To accurately calibrate a PA, a power-level servo feedback loop is used to determine the final gain. Power-level servoing captures the current output power with an analyzer and controls the generator power level until desired power is achieved, which can be a time-consuming process. In simplest terms, it uses a proportional control loop to swing back and forth in power levels until the output power-level converges with the desired power. The vector signal transceiver is ideal for power-level servoing because the process can be implemented directly on the user-programmable FPGA, resulting in a much faster convergence on the desired output power value (Figure 6).

Example: Radio Channel Emulation

As RF modulation schemes are growing in complexity, bandwidth increases and radio spectrums are becoming more crowded, it becomes important to not only test wireless devices in a static environment, but to understand how these devices behave in a dynamic real-world environment. A radio channel emulator is a tool for emulating wireless communication in a real-world environment. Fading models are used to simulate air interference, reflections, moving users, and other naturally occurring phenomenon that can hamper an RF signal in a physical radio environment. By programming these mathematical fading models onto the FPGA of the vector signal transceiver, the module can be reconfigured to go beyond a traditional VSA/VSG paradigm and become an embedded device providing real-time impairments of your RF signals (Figure 7).

With software-designed instruments, the user is truly able to create the instrument specifically designed to their exact needs. Already, we are seeing unique and novel ways to apply this concept and overcome the challenges of instrumentation defined by the vendor. The future will always hold new testing challenges but we can be confident that a user empowered with software-designed instruments will be able to rise to the occasion.

About the Author:

Matthew Friedman is the Senior Product Manager for the RF and Microwave platform at National Instruments. Prior to his current position, Matthew was the product manager for instrument control software. Along with his work at National Instruments, he is active in test & measurement standards bodies. He serves as a director and marketing co-chairman in the PXI Systems Alliance and was previously the marketing chairman of the IVI Foundation.

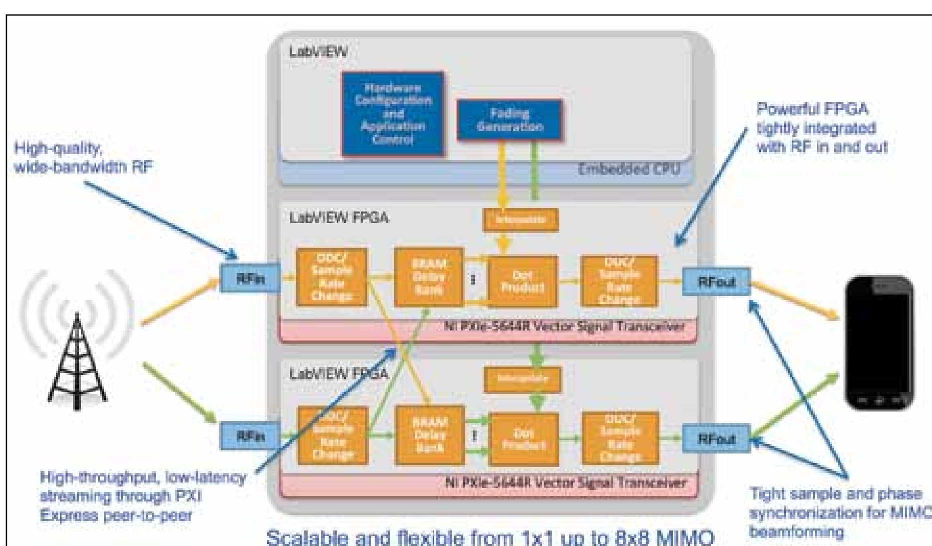

Figure 7 • Software-designed instruments can be reconfigured into embedded devices like channel emulators to aid in the understanding of how devices will work in real-world environments.

Design, Construction and Characterization of an IF Processor for the FFT Spectrometer of the Yebes 40 Meter Radio Telescope

By José Antonio López-Pérez and David Cuadrado-Calle;
Centro Astronómico de Yebes (CAY)

Describes the design, construction and characterization of an IF processor for the adaptation of the IF signal frequency range of radio astronomy receivers.

Abstract

The radio astronomy receivers installed in the receiver room of the 40 meter radio telescope at the Spanish Centro Astronómico de Yebes (CAY) provide an intermediate frequency (IF) signal in the standard Very Long Base-Line Interferometry (VLBI) frequency range from 500 MHz to 1000 MHz. For single-dish observations, the IF signal must be sent to the Fast Fourier Transform spectrometer (FFTS) placed in the backend room of the radio telescope. This spectrometer is configurable in four different resolution modes that correspond to four different base band input frequency ranges. As the FFTS base band frequency input range doesn't match with the IF signal range from the receivers, a frequency down conversion is needed and it is provided by an analogue IF processor.

The present work shows the design, construction and characterization of an IF processor for the adaptation of the IF signal frequency range of the radio astronomy receivers to two of the Fast Fourier Transform spectrometer input frequency ranges. These frequency ranges are the one between DC and 100 MHz and the one between DC and 500 MHz.

The processor is made of commercial off-the-shelf (COST) components (amplifiers, filters, mixers, etc.) and it has been integrated inside a standard 19" 2U rack with 2 inputs for the receivers' IF signals (LHCP and RHCP channels), 2 outputs for the DC-100 MHz range and 2 outputs for the DC-500 MHz one. The resulting processor has been tested showing input and output return losses better than 13 dB and 15 dB, respectively, a mean power gain of 25 dB (± 1.5 dB) in its linear zone and an output power of +10 dBm at -1 dB gain compression point.

Introduction

The CAY 40 meter radio telescope is equipped with a Fast Fourier Transform spectrometer, so-called FFTS, from Radiometer Physics GmbH, for the detection and observation of molecular lines in *single-dish* mode.

The spectrometer has eight modules, each one configurable during booting in any of the operation modes described in Table 1.

Mode	Bandwidth (MHz)	Channels	Resolution (KHz)	ENBW* (KHz)
A	DC - 1500	8192	183,1	212
B	DC - 750	16384	45,8	53
C	DC - 500	16384	30,5	35
D	DC - 100	16384	6,1	7

Table 1 • Operation modes of the FTTS of the 40 m radio telescope. * ENBW = Equivalent Noise Band Width.

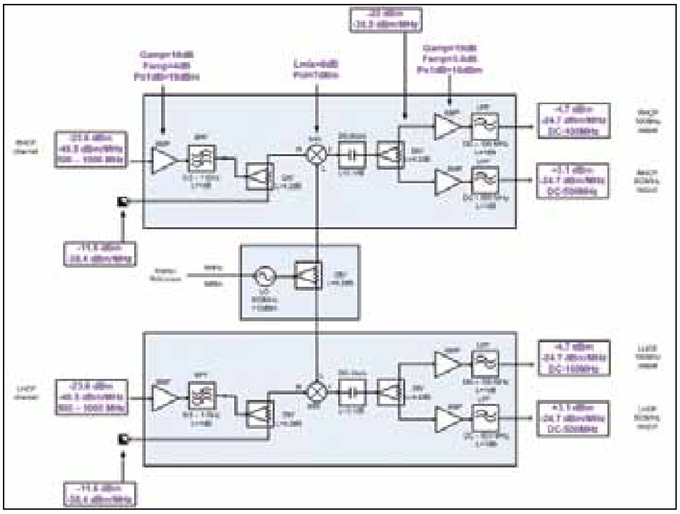

Figure 1 • Block diagram of the IF processor and power levels.

As the receivers installed in the radio telescope have their IF in the range between 500 and 1000 MHz, according to the specifications for standard VLBI receivers, a previous unit for down conversion to the FFTS input frequency range is needed, particularly for C and D modes, where the narrower resolutions can be achieved.

Design

Figure 1 shows the block diagram of the IF processor. The processor is composed of two equal conversion chains (one for each circular polarization sense, LHCP and RHCP, according to VLBI standards) and one common local oscillator (LO) at 500 MHz that enables the necessary frequency down-conversion.

The IF input signals are amplified and filtered in the 500 MHz to 1000 MHz range, before reaching the mixer, to filter out unwanted signals and noise. One sample of the input signal is sent to an auxiliary output by means of a power splitter. This is to allow the connection of other devices for analysis (backends, Mk-4 terminal...) or diagnosis (spectrum analyzer). After the mixer, the signal, which is now in base band, is divided into two ways and amplified again. Then one way is low-pass filtered to DC - 100 MHz and the other to DC - 500 MHz.

Integration

All the components shown in the block diagram of Figure 1 have been integrated in a standard 19" 2U rack. Figure 2 shows the final look of the processor.

Laboratory Measurements of the IF Processor

Return losses of the input ports

Figure 3 shows the result of the S11 parameter measurement in the input ports of both LHCP and RHCP channels of the IF processor.

It can be seen that both channels have a good input matching in the frequency range between 500 and 1000 MHz with return losses better than 13 dB.

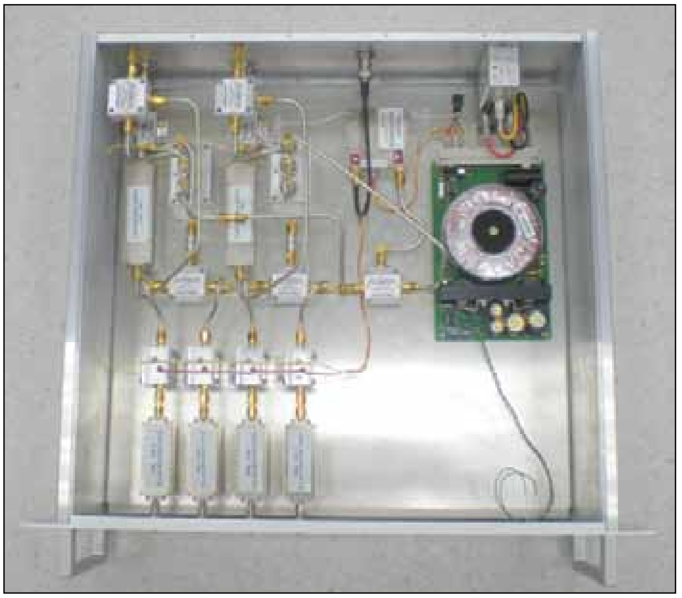

Figure 2 • Integrated IF processor.

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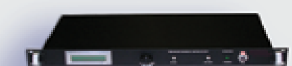

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SM-20M3G-8X8	0.02 - 3.0	8 / 8	14	60	45	100	2.0:1	20
SM-20M3G-16X16	0.02 - 3.0	16 / 16	16	60	45	100	2.0:1	20
SM-20M3G-32X32	0.02 - 3.0	32 / 32	19	60	45	100	2.0:1	20
SM-2G18G-4X4	2.0 - 18.0	4 / 4	14	60	45	100	2.0:1	20
SM-2G18G-8X8	2.0 - 18.0	8 / 8	16	60	45	100	2.0:1	20
SM-2G18G-16X16	2.0 - 18.0	16 / 16	19	60	45	100	2.0:1	20
SM-2G18G-32X32	2.0 - 18.0	32 / 32	23	60	45	100	2.0:1	20
SM-18G40G-4X4	18.0 - 40.0	4 / 4	16	60	45	100	2.0:1	20
SM-18G40G-8X8	18.0 - 40.0	8 / 8	18	60	45	100	2.0:1	20
SM-18G40G-16X16	18.0 - 40.0	16 / 16	22	60	45	100	2.0:1	20
SM-18G40G-32X32	18.0 - 40.0	32 / 32	25	60	45	100	2.0:1	20

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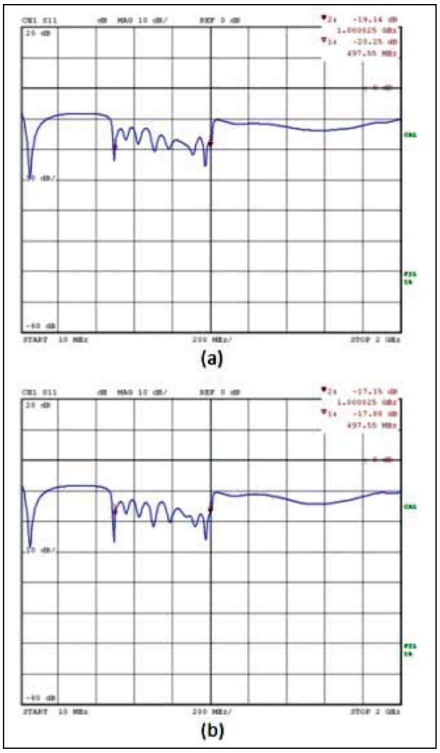


Figure 3 • LHCP (a) and RHCP (b) input ports return losses.

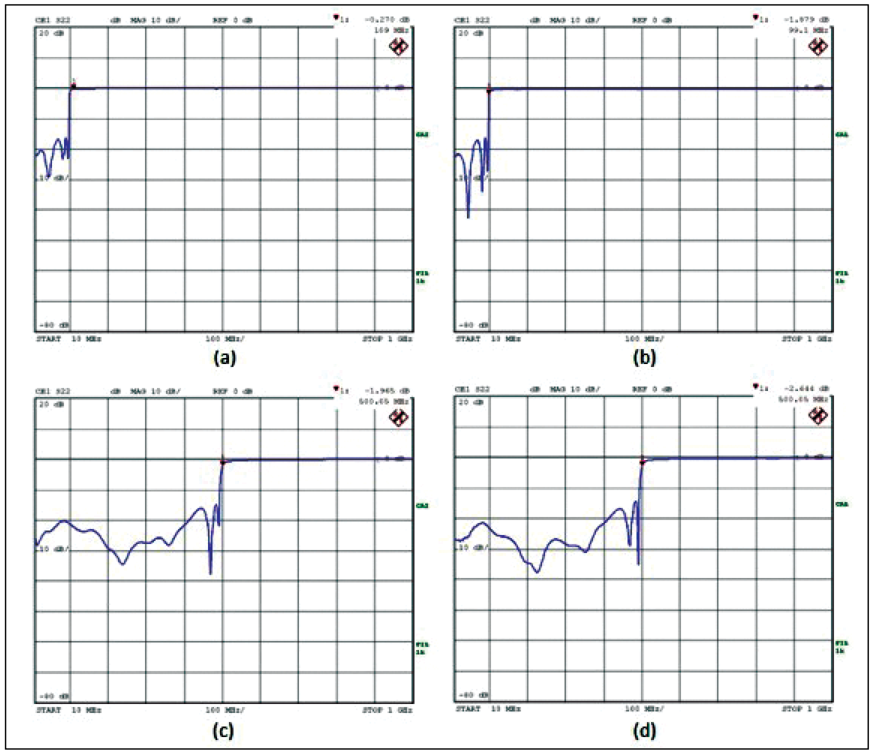


Figure 4 • Return losses of the output ports LHCP DC-100 MHz (a), RHCP DC-100 MHz (b), LHCP DC-500 MHz (c), RHCP DC-500 MHz (d).

Return loss of the output ports

Figure 4 shows the return losses of the output ports of the processor.

According to these measurements, the return losses at the output ports are better than 15 dB through all the output frequency range.

Gain curves and 1 dB compression point

In order to determine the processor's gain, a power sweep has been carried out at several frequencies of the input signal. The resulting gain curves are represented in Figure 5.

According to these graphs, both channels have a gain of 25 dB (± 1.5 dB) on their linear zone.

The output power at -1 dB gain compression of the processor has been calculated for the wideband output of both LHCP and RHCP channels. The computations have been carried out at 950 MHz, and the results are shown in Figure 6.

Hence, it can be considered that *the output power at -1 dB compression is +11 dBm for the LHCP channel and +10 dBm for the RHCP channel.* As the processor has a mean gain of 25 dB and it is highly recommended to leave a security margin of 5 dB at least, the *maximum recommended input power to the processor is -20 dBm.*

Installation in the Radio Telescope

Once the processor has been completely characterized in terms of matching, power levels and gain, it has been

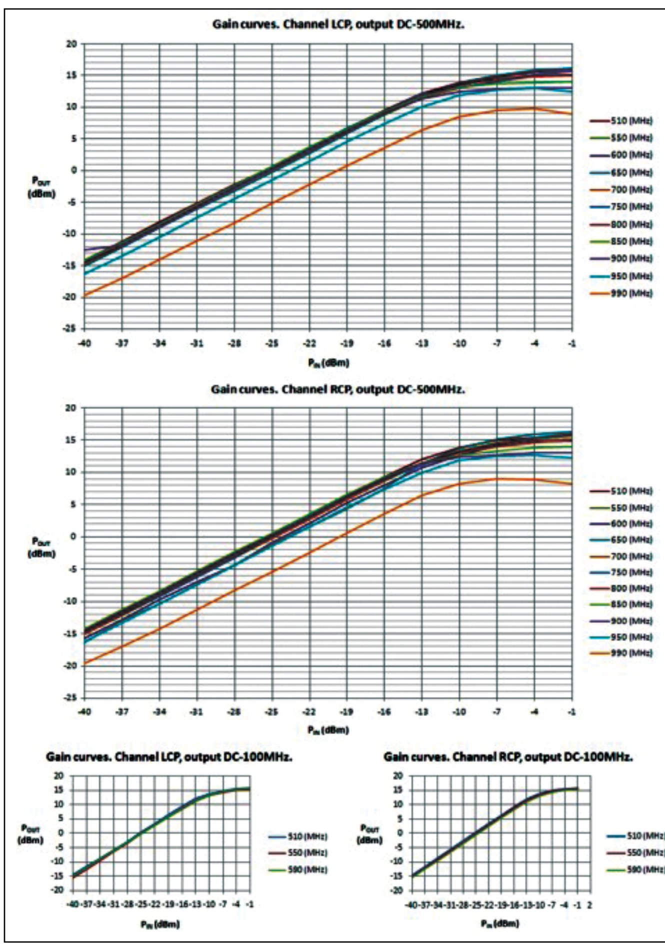


Figure 5 • Gain curves.

Rosenberger® Rmor™ Cables Assembly

PHASE STABLE THROUGH 70GHz

Rosenberger Rmor™ cables are designed for rugged environments for indoor and outdoor applications. Each shielded coaxial cable is protected with flexible, SPIRAL-wound 304 Stainless Steel armor coated with extruded Polyurethane. The connector ends are sealed and encapsulated with a pressure injection-molded polymer strain relief. This combination of materials and technology provides superior ruggedization, environmental resistance, RF shielding effectiveness and stability under flexure and vibration.

Additional connector interfaces and armor/cable diameters are available on request.

DESCRIPTION

Rosenberger connectors, cable assembly, standard length 915mm or 36 inches

GENERAL ELECTRICAL SPECIFICATIONS

Impedance:	50 +/- 1 Ohms
Operating frequency:	DC to 70 GHz
Return loss:	14 dB minimum up to 70 GHz
Cable insertion loss:	.67 dB/ft @ 10.0 GHz
Velocity of propagation (%):	78 % nominal
Capacitance:	24.7 pf/ft. nominal
Shielding effectiveness:	< -90 dB
Dielectric withstand voltage:	1000 Vrms
Amplitude & phase stable:	+/- .03dB & +/- 1° @10GHz

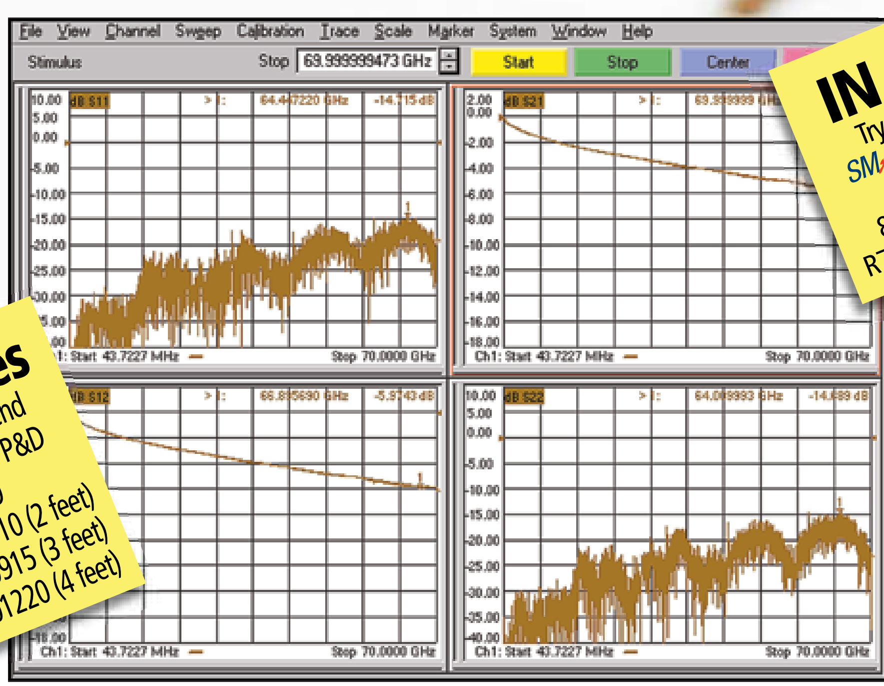
MECHANICAL SPECIFICATION

Cable jacket & armor outer diameter:	092 inches nominal & .250 inches nominal
Minimum bend radius:	.5 inches
Armor crush strength:	450 lbs/in (min)
Connector retention:	≥25 lbs.
Mating torque:	7-10 inch pounds

MATERIALS AND FINISHES

Armor type:	SPIRAL-wound 304 SS & Polyurethane blue jacket
Connector environmental testing:	Per MIL-STD-202, Meth 101,106,107,204 & 213
Connector interface dimension:	IEC 60169-17 Per MIL-PRF-39012 DINEN122200

Note: Cable assemblies also available with interfaces such as 1.85mm, 2.4mm, 2.92mm, SMA +, SMA, N.



Example of typical 36 inches assembly up to 70 GHz

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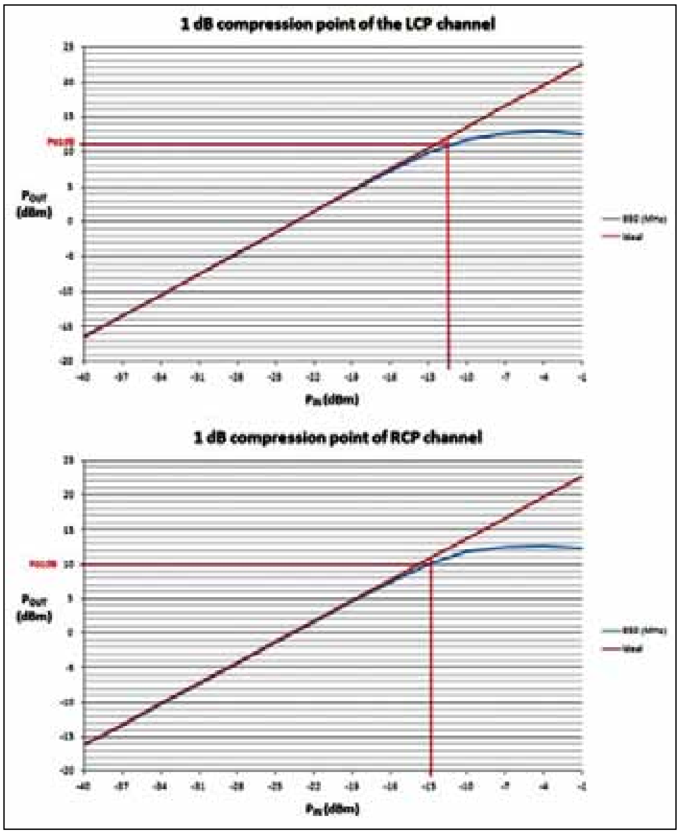

Figure 6. Linearity of the IF processor.

Figure 7. Front view of the IF processor (bottom rack) installed in the backend room below the FFTS.

installed in the backend room of the Yebes 40 meter radio telescope.

As it is shown in Figure 7, the IF processor has been installed in the same rack as the FFT spectrometer, just below it.

Measurements in the Backend Room

In order to measure the behaviour of the IF processor in the backend room, an additive white gaussian noise (AWGN) generator has been used together with a band pass filter between 500 MHz and 1000 MHz. This system provides a signal with similar characteristics than the astronomical one. The set AWGN generator plus filter has been characterized according to the set-up shown in Figure 8.

Once the level of the test signal has been measured, it has been injected in the IF processor where the power levels and the spectrum of each output port have been measured. The test bench used for carrying out these measurements is shown in Figure 9.

The power level values obtained at each output port are shown in Table 2.

Figure 10 shows the spectrum of the input signal and the ones obtained at the monitoring ports, the DC-100 MHz outputs and the DC-500 MHz outputs. These spectra have been obtained with the spectrum analyzer configured with 10 dB/div and a resolution bandwidth of 1 MHz.

Dynamic Power Range

The FFTS has a power detector and a LED diode indicator on each module that allows one to know whether the power at the input of the analogue-to-digital converter (ADC) is optimum or not. This detection system, together with the AWGN generator, have enabled several tests to find out the optimum power range at the input of the IF processor for the suitable operation of the set IF processor plus FFTS. Table 3 shows the results.

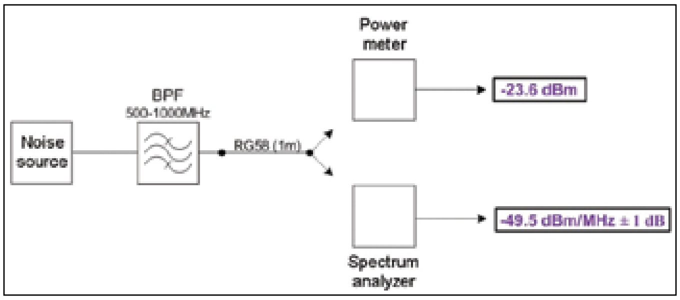

Figure 8 • Test signal characterization.

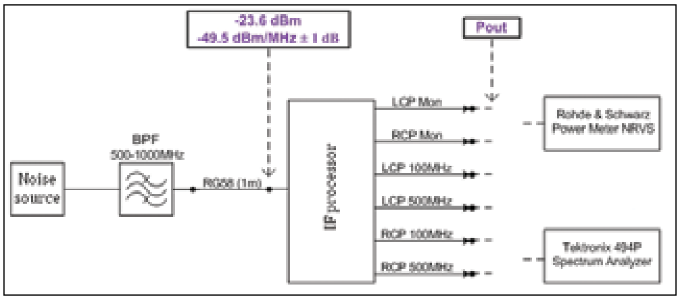

Figure 9 • Test bench for the IF processor measurements in the backend room.

	Absolute power (dBm)	Power density (dBm/MHz)
LCP Mon	-13.3	-39.7
RCP Mon	-13.3	-40.1
LCP DC-100MHz	-5.3	-25.1
LCP DC-500MHz	2.5	-26.1
RCP DC-100MHz	-5.2	-25.1
RCP DC-500MHz	2.6	-25.1

Table 2 • Power level values at the output ports.

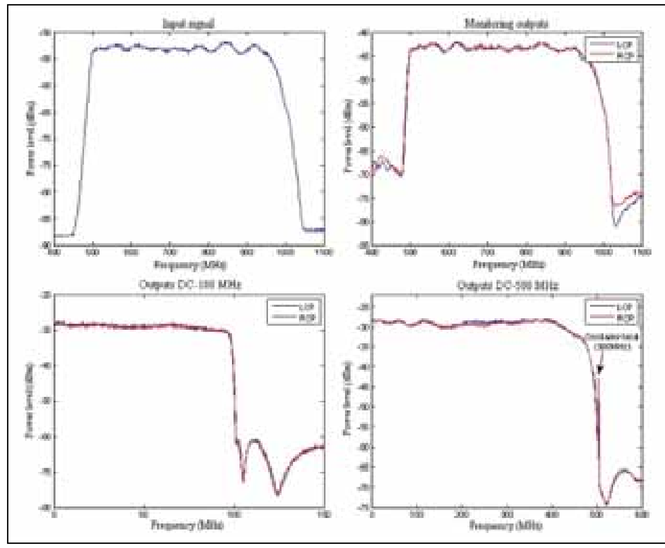

Figure 10 • Spectrum on each port of the IF processor in the backend room.

Conclusions

An analogue IF processor has been designed, built and characterized in Yebes laboratories to adapt the output signal of the 40 meter radio telescope VLBI receivers to the input frequency range of the FFT spectrometer (modes C and D).

The final performance of the IF processor is summarized as follows:

- The input and output return losses are always better than 13 dB and 15 dB, respectively.
- The processor has a mean power gain of approximately 25 dB (± 1.5 dB) on its linear zone.
- The output power at -1 dB compression point is +11 dBm for the LHCP channel and +10 dBm for the RHCP channel.

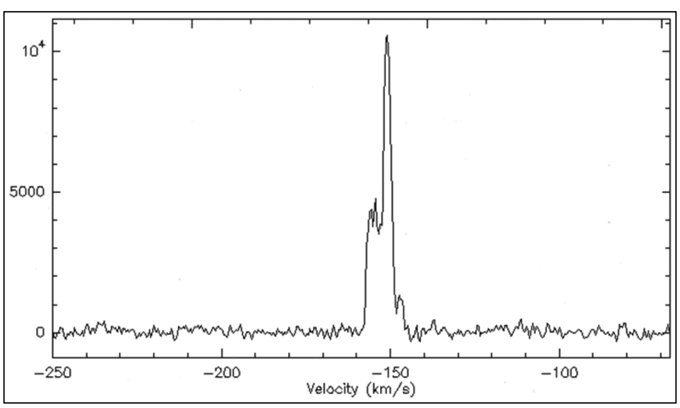

Figure 11 • Uncalibrated spectrum of SiO maser emission at 86 GHz from IK-Tau star.

Channel	Input power range of the IF processor
Channel RCP 100MHz (Board 1 of the FTTS)	-30.6 dBm (-56.5 dBm/MHz) < $P_{IN\ PROCESSOR}$ < -20.6 dBm (-46.5 dBm/MHz)
Channel LCP 100MHz (Board 2 of the FTTS)	-30.6 dBm (-56.5 dBm/MHz) < $P_{IN\ PROCESSOR}$ < -20.6 dBm (-46.5 dBm/MHz)
Channel RCP 500MHz (Board 3 of the FTTS)	-36.6 dBm (-62.5 dBm/MHz) < $P_{IN\ PROCESSOR}$ < -27.6 dBm (-53.5 dBm/MHz)
Channel LCP 500MHz (Board 4 of the FTTS)	-37.6 dBm (-63.5 dBm/MHz) < $P_{IN\ PROCESSOR}$ < -27.6 dBm (-53.5 dBm/MHz)

Table 3 • Power levels study for the proper operation of the FFTS.

Currently, the processor is installed in the backend room of the radio telescope. It is in operation and has an excellent performance. It is being used for the detection of molecular lines in different frequency bands. For instance, Figure 11 shows a 7 KHz resolution spectrum of the silicon monoxide (SiO) maser at 86 GHz from IK-Tau star.

About the Authors:

José A. López-Pérez received his Degree in Telecommunication Engineering in 1996 and his Doctorate in 2012, both from the Polytechnic University of Madrid. After finishing his degree, he joined the Institut de Radio Astronomie Millimétrique (IRAM) in Grenoble (France) for two years. After this, he became part of the staff of the Yebes Astronomy Center (CAY) in Spain, where he currently works. He is responsible for the design and construction of the radio astronomy receivers, for the holography measurements of the 40 meter radio telescope surface and the monitoring of the RFI environment. Contact information: +34 949290311 (Ext. 205); ja.lopezperez@oan.es.

David Cuadrado-Calle received his Bachelor's Degree in Telecommunication Systems Engineering in 2010 and his Master's Degree in Information and Communication Technologies in 2012, both from the University of Alcalá (Spain). He has worked at the receivers division of the Yebes Astronomy Center (CAY) for more than one year and his areas of interest are related to RF and microwave circuits and systems. Contact information: +34 626967299; d.cuadrado@oan.es.

Using Analyst™ to Quickly and Accurately Optimize a Chip-Module-Board Transition

By Dr. John Dunn

Optimizing the transition from a board-to-module-to-chip signal path.

3D electromagnetic (EM) simulators are commonly used to help design board-to-chip transitions. AWR now makes life easier for circuit designers with the introduction of Analyst™, the industry's first full featured, 3D EM finite element method (FEM) simulator integrated within the circuit design environment, without the need to launch a third party drawing and simulation tool.

The key advantage of Analyst over other available 3D simulators is its tight integration within Microwave Office® (MWO), AWR's circuit design and simulation environment. This paper highlights the unique features of Analyst by demonstrating the optimization of the transition from a board-to-module-to-chip signal path. The example shows how the ability to access Analyst from within in the MWO environment saves designers time and provides ready access to powerful layout and simulation tools that are not available in typical circuit design tools.

Analyst simplifies layout setup and drawing by offering preconfigured 3D parametric cells (Pcells) for the bond wires and ball grid arrays (BGAs). Hierarchy is supported in the EM layout, enabling easier reuse of designs. Tuning, optimization, and sensitivity and yield analysis can be quickly implemented through the use of parameterized layout, without having to leave the MWO environment. Since Analyst is optimized for RF designers with automatic simulation settings for typical technologies, users usually do not need to go into the simulation settings of the software. Designers can now concentrate on their design, easily using 3D EM simulation when needed, without having to spend time learning a complicated third product tool. Indeed, if they already use AXIEM®, AWR's planar EM simulation tool, they will find Analyst looks almost the same. The learning curve for making effective designs is therefore very short.

A Chip-Module-Board Transition

Figure 1 shows the board, module, and periphery of the chip being investigated. The signal goes from Port 1 on a trace on a PC board onto a module by means of a BGA, along a trace on top of the module, and over to Port 2 on the chip by means of a bond wire. The design goal is to have a return loss of less than -20 dB over the frequency range of interest, 10 to 20 GHz.

The simulation results for the layout using Analyst for the return loss of the initial design are shown in Figure 2. Clearly, the design goal of less than -20 dB is not being met.

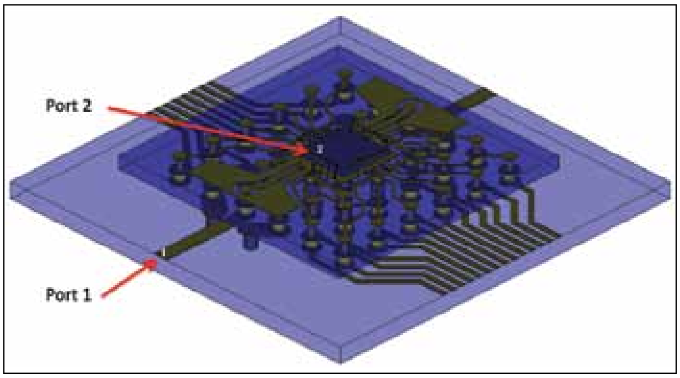

Figure 1 • The performance of the transition from Port 1 on the board to Port 2 on the chip is under investigation. The signal goes up the BGA ball, onto the module, and then onto the chip by means of a bond wire.

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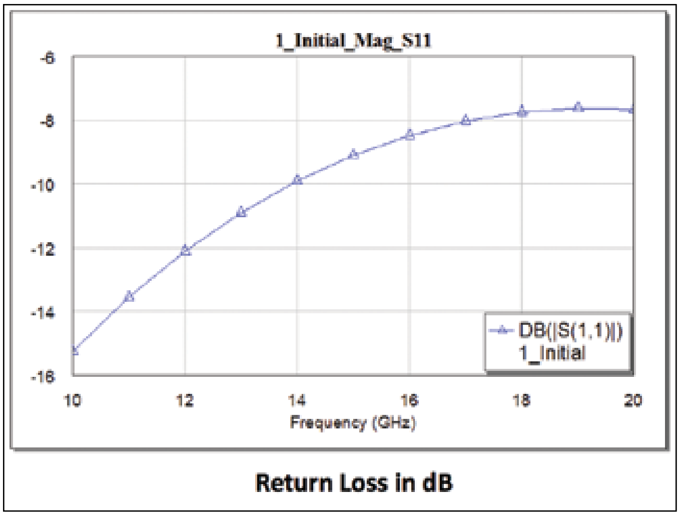


Figure 2 • The return loss in dB is shown from 10 to 20 GHz. The design goal of less than -20 dB is clearly not being met.

The problem can be fixed using a three-stage strategy. First, the specific area(s) causing the poor performance need to be identified. Second, the designer needs to understand why that area of the layout is electrically behaving the way it is. For example, there could be extra inductance or capacitance in that section of the layout. Third, the problem needs to be corrected by modifying the layout.

Analyst has a number of features that designers can take advantage of as the design is modified. Analyst has the ability to simulate only portions of the layout, thereby reducing problem size and increasing simulation flexibility. Simulation ports can be added where needed so that the problem area of the layout can be probed for better understanding. Because Analyst is part of the Microwave Office environment, these ports can easily be added where the designer suspects extra capacitance is needed. The Analyst results are then inserted into a schematic, capacitors are attached to the ports, and their values tuned and optimized. Finally, the layout is tweaked to give the desired extra capacitance or inductance. Again, only the portion of the layout of interest need be simulated. Analyst is designed to minimize the amount of setup time required for a simulation.

Let us now look at this design process in more detail. Starting with the launch area, the designer is focused on the return loss for Port 1. Only the part of the circuit close to the signal line running from Port 1 to Port 2 is relevant. Figure 3 shows the area of interest, in which the designer has drawn a new simulation boundary. The top half of the diagram shows the simulation boundary used. The bottom half of the figure shows the 3D view after initial meshing has occurred: the mesh in the air region above the board is not shown in the interests of clarity. (Note: viewing the mesh is not required of Analyst but is shown here for users' benefit given prior familiarity with 3D FEM EM point tools).

The first port appears on the edge of the boundary. Analyst treats this as a wave port, standard to all FEM simulators. Traditionally, the designer is required to go through the time-consuming step of setting up this type of port manually in a 3D EM tool In addition, the designer must to set up the number of modes analyzed and define their port impedance definitions. Because these concepts are not very familiar to the mainstream circuit designer, Analyst has been preconfigured for reasonable settings for the port for typical planar layouts, enabling users to focus on their design instead of worrying about tweaking the settings. In situations where the preconfigured settings are not optimal, the default settings can be changed.

The bond wire is attached to a pad on the chip. A second port is attached to the pad. Notice that it is interior to the boundary, unlike Port 1, and so Analyst automatically treats it as an internal port. In this type of port, a voltage is excited from the port to the port's ground. (The ground is specified with a mathematical "strap" from the

(Continued on page 52)

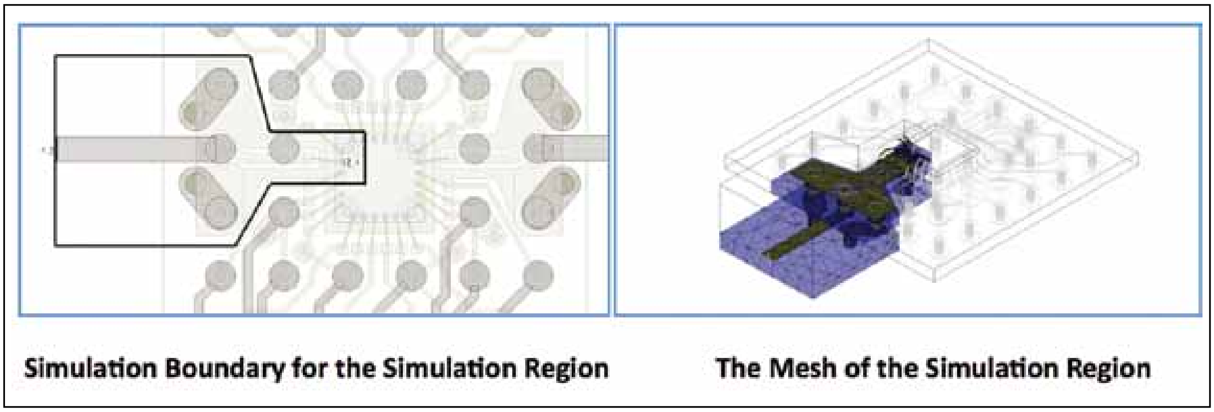
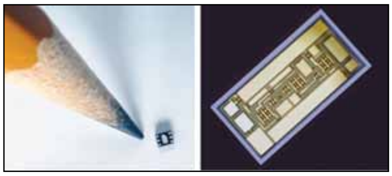


Figure 3 • A simulation boundary is used to reduce the size of the problem. Note that the mesh for the air region is not shown in the 3D view.



Detectors

M/A-COM Technology Solutions Inc. introduced a new line of small package directional detectors for power monitoring in point-to-point radios, aerospace and defense systems, radar, IMS, VSAT, and electronic warfare applications. The small package detectors are housed in a miniature, surface mount 1.5 x 1.2 mm lead-less plastic package. They require a small bias current of less than 0.5 mA for proper performance.

M/A-COM Technology Solutions
macomtech.com

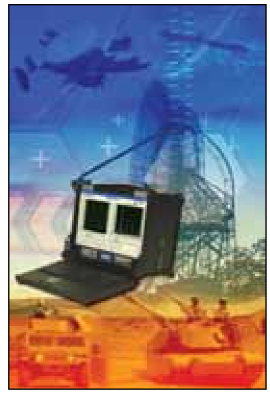
Matching Load

Model SWL-5253-S1A is a WR-51 waveguide high power matching load that offers better than 1.20:1 VSWR in the frequency range of 15.0 to 22.0 GHz. It can handle 200 watts CW power. The load measures 2.56" W x 7.87" L x 2.17" H. Higher power handling. The matching loads with other waveguide bands, such as WR-62 and WR-75 and other power handling capacities, are also available as standard models in the frequency range up to 110 GHz.

SAGE Millimeter
sagemillimeter.com

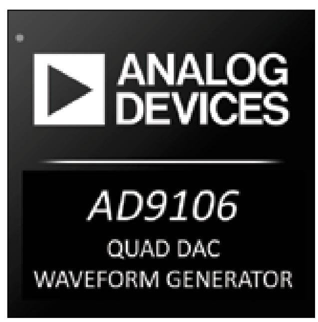
Signal Recorder

Pentek, Inc. announced the Talon® RF/IF signal recording and playback system: a rugged, portable recorder suitable for military and aerospace applications. It features recording and playback of IF signals up to 700 MHz with signal bandwidths to 200 MHz. It can be configured with 500 MHz 12-bit A/Ds or 400 MHz



14-bit A/Ds and an 800 MHz 16-bit D/A. Pentek's SystemFlow software allows turnkey operation through a graphical user interface (GUI), while its application programming interface allows easy integration of the recording software into custom applications.

Pentek
pentek.com



D/A Converters

Analog Devices introduced the AD9106 quad-channel, 12-bit, and the AD9102 single-channel, 14-bit, 180-MSPS waveform generators, integrating on-chip static random access memory (SRAM) and direct digital synthesis (DDS) for complex waveform generation. The converters generate the high-speed, high-dynamic-range, multichannel complex waveforms required in applications such as portable instrumentation, signal generators and arbitrary waveform generators.

Analog Devices
analog.com

Up/Downconverters

SignalCore introduced a matching pair of RF up and downconverters with the frequency range of 1 MHz to 3.9 GHz. These high performance multi-staged converters are avail-

able in three form factors - USB, PXI Express, and a core module with your choice of SPI, USB, or RS-232 communication interfaces. The up and downconverters exhibit very low phase noise and have very wide dynamic range, ranking them among the best in the industry for precise frequency translation.

SignalCore Inc.
signalcore.com

Antennas

Pulse Electronics Corp. introduced a line of Shadow Low Profile Transit (SLPT) NMO and direct mount antennas to support public safety, WLAN, smart grid/smart metering, 3G, and 4G applications including long term evolution (LTE). These high-performance, rugged, IP-67 rated antennas are provided in a slim, low profile radome of only 2.5" to 3" (63.5mm to 76.2mm) tall with a 1.5" (38.1mm) diameter base and high gains of 4 to 5.6 dBi.

Pulse Electronics Corp.
pulseelectronics.com

Filter

Trilithic, Inc. released a new series of compact LC bandpass filters for the Iridium telephony band. This pole placed bandpass filter passes the 1616.0 - 1626.5 MHz band with

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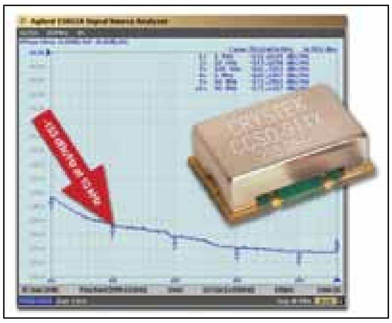
a maximum insertion loss of 2.6 dB while providing a minimum of 15 dB of isolation at GPS L1 and 70 dB minimum at GPS L2. It also provides 45 dB of isolation at 1710 - 1850 MHz band and 55 dB beyond that out to 10 GHz. Connectorized and PCB mount versions are available.

Trilithic Inc.
trilithic.com



Oscillator

Crystek Crystals announced a 250 MHz – 1090 MHz SAW Clock Oscillator (in single frequency band), the CCSO-914X. Crystek designed the module using proprietary circuitry and SAW (surface acoustic wave) resonator technology to provide ultra-low jitter/phase noise performance with true SineWave output. The resulting oscillator (250 MHz variant) features -153 dBc/Hz phase noise at 10 KHz offset and a noise floor of -173 dbc/Hz.

Crystek Corp.
crystek.com

Resistor Sample Kits

Vishay Intertechnology, Inc. is offering laboratory sample kits that put popular values for its precision MELF resistors at designers' fingertips to simplify prototyping and speed time to market for a wide range of electronic systems. Two new sample kits were released today, offering roughly 100 of the most popular resistance values in the MMA 0204 and MMB 0207 packages respectively. Each kit supplies 20 resistors for every fourth value of the E-96 series with 0.1 % tolerance and temperature coefficient of ± 25 ppm/K.

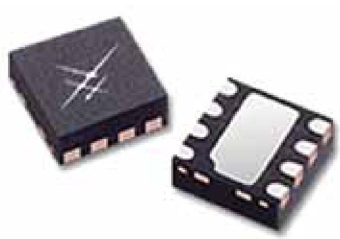
Vishay Intertechnology
vishay.com

Adapter

Model SWC-101F-E1 is a W band waveguide to coaxial inline adapter. It offers a convenient means for WR-10 waveguide to 1mm (F) connector transition. The inline configuration offers convenient means for the coaxial testing cable to waveguide adaption. The adapter has less than 0.5 dB insertion loss and better than 1.4:1 VSWR in the frequency range of 75 to 110 GHz. It measures 0.75" diameter and 0.45" long and weighs 0.35 Oz. WR-12 to 1mm (F) and WR-15 to 1.85 mm (F) end

launch adapters are also offered under model numbers SWC-121F-E1 and SWC-15VF-E1.

SAGE Millimeter
sagemillimeter.com



Driver

The SKY67130-396LF is a general purpose broadband InGaP HBT linear amplifier driver with an active bias and superior low current performance. The advanced InGaP HBT process provides excellent return loss and higher linearity performance in a compact, 2 x 2 mm, 8-pin Dual Flat (DFN) Skyworks Green package. The internal active bias circuitry provides stable performance over temperature, and process variation. Target applications include Cellular Infrastructure, WIFI Connectivity, Smart Energy, RFID, ISM Band and Military Communication.

Skyworks Solutions
skyworksinc.com

Connector

The 7 mm interface is a hermaphroditic precision coaxial connector available in panel mount, cable mount and between-series adapter configurations. Constructed of polished passivated 303 stainless steel coupling mechanisms and outer shells with gold plated beryllium copper inner contacts, the 7 mm operates over a DC to 18 GHz frequency range. Panel mount offers solid probe contact and extended dielectrics and tab contacts. Cable connectors are available for .141 and .250 inch diameter semi-rigid as well as popular high-frequency low-loss flexible cables. Adapters to 2.4 mm, 2.9 mm, 3.5 mm, SMA, SSMA, N Type and TNC connector types are all standard and available for immediate shipment.

SGMC Microwave
sgmcmicrowave.com

High-Flex Wire

TE Connectivity introduced the SHF-260 highly flexible wire for power distribution applications within the aerospace, defense and marine markets. This comes as an answer to the need for a combination of high temperature and high performance in wire insulation, which has become a critical factor in today's platforms. This is especially true in large-diameter power feeder applications where temperature and durability are vital.

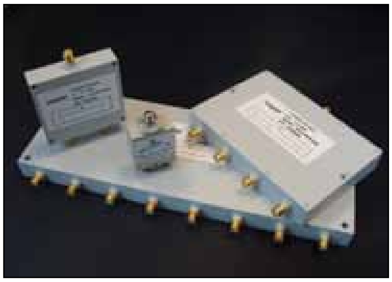
TE Connectivity
te.com

Analyzer Software

Anritsu Company introduced three software packages supporting LTE-Advanced and five packages supporting IEEE802.11ac that extend the analysis capability of its MS269xA/MS2830A signal analyzers and MG3710A/MG3700A vector signal generators. With the software installed in the instruments,

developers and manufacturers of LTE-Advanced UEs and components, as well as wireless LAN (WLAN) modules and devices have accurate solutions to verify performance, speed time-to-market, and lower cost-of-test.

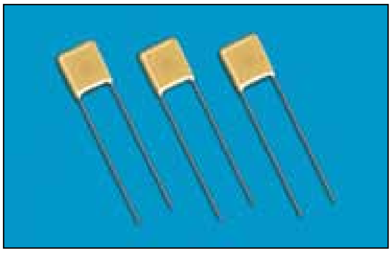
Anritsu Company
anritsu.com



Power Dividers

VidaRF offers a wide selection of 2-way through 16-way power divider/combiners, designed to cover 100 MHz to 20 GHz with average power handling of 30 Watts for narrow, octave, dual and multi-octave band applications. Standard Connector type: SMA female, other connectors available upon request. VidaRF is focused on being a solutions provider by building to customer specs and offering zero days lead time for custom parts through its stock and ship program.

VidaRF
vidarf.com



Capacitors

AVX Corp. added an N1500 super dielectric option to its high-voltage, multilayer ceramic (MLC), radial leaded capacitor series. An extension of the SV Series, the new

NEW PRODUCTS

N1500 super dielectric capacitors take up less board space and offer higher capacitance values than comparable C0G dielectric capacitors and are ideally suited for applications including snubbers in high-frequency power converters, resonators in SMPS, AC line filtering, and high-voltage coupling/DC blocking.

AVX Corp.
avx.com

Frequency Synthesizer Product Guide

Micro Lambda Wireless offers an extensive frequency synthesizer product line with standard designs covering from 500 MHz to 22 GHz. From low cost single-loop designs up to wideband configurations that outperform some test equipment, Micro Lambda leads the market today in YIG-based synthesizers. Standard product offerings include low-cost configurations covering 2 to 12 GHz in 2 or 3 GHz tuning ranges with as low as 100 kHz step size, narrowband multi-loop configurations covering the 2 to 16 GHz frequency range with 2 to 4 GHz tuning bands and low phase noise performance, wideband multi-loop configurations covering 600 MHz to 3 GHz and 2 – 10 GHz with 1 Hz step size and 2 to 20 GHz low noise PXI-based units with 1 kHz step size.

Micro Lambda Wireless
microlambdawireless.com

Mixer

Mini-Circuits' new ZX05-24MH+ wideband frequency mixer features: wide bandwidth, 7500 to 20000

MHz; low conversion loss, 7.0 dB typ.; high L-R isolation, 30 dB typ.; excellent IF BW, DC to 7500 MHz; rugged construction; small size; usable as up and down converter; protected by US patents, 6,790,049 and 7,027,795. Applications: fixed satellite; mobile; radio location.

Mini-Circuits
minicircuits.com

Amplifiers

Custom MMIC announced three new GaAs MMIC power amplifiers covering 5 to 11 GHz. The CMD169P4 (5 – 7 GHz), CMD170P4 (7.5 – 9 GHz) and CMD171P4 (9.5 – 11 GHz) each have an output 1 dB compression point of greater than +28 dBm, with gain levels from 20 to 30 dB. The designs require only positive bias, eliminating the need for costly sequencing circuitry. They also offer an on-chip detector for applications where power leveling is required. Units are housed in Pb-free RoHs compliant 4x4 QFN plastic packages and are 50-ohm matched on the input and output ports. DC blocks are not required.

Custom MMIC
custommmic.com

Circulator

Renaissance's new broadband circulator is ideal for transmitter protection application. Operating over 962 – 1213 MHz, this device can withstand 2000 W Peak and 20 W average power levels. It is designed to

sustain temperatures from -55 to +120 C while the loss is maintained below 0.5 dB.

Renaissance Electronics
rec-usa.com

Isolators

VidaRF offers a wide selection of Isolators and Circulators designed to cover 80 MHz to 40 GHz. Configured to Coaxial, Drop-In, Surface Mount or Waveguide. Standard Connector SMA Female; other connectors available upon request. Magnetically shielded, clockwise or counter-clock wise rotation (CCW), LOW IMD -80dBc, reflected power from 1 (W) to 250 (W) on pending models, single or double junction and RoHS compliant.

VidaRF
vidarf.com

Relays

The mid-range time delay relays combine multiple functions into a single package and are specifically designed for operation in extremes of temperature, shock, vibration and altitude. This series of time delay relays incorporates proven electromechanical relay design features along with advanced digital

timing circuitry. They are hermetically sealed and provide a variety of mounting configurations. All have contact ratings of 10 Amps and include four functional versions:.

TE Connectivity
te.com

Inductor

Vishay Intertechnology announced a new IHLP® low-profile, high-current inductor in the 8787 case size with industry-high rated current from 9.7 A to 180 A and a high operating temperature to + 155 °C. The IHLP-8787MZ-5A offers high efficiency with maximum DCR from 0.17 mΩ to 28.30 mΩ and a wide range of inductance values from 0.22 µH to 100 µH.

Vishay Intertechnology
vishay.com

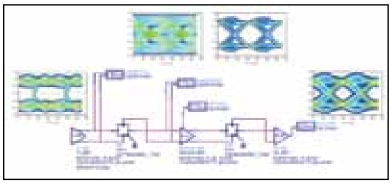
Test Cable

Mini-Circuits' new QBL1MSMQ-NM+ test cable features: Quick-Lock connector on one end for easy mating & demating; extra rugged construction with strain relief for longer life; stainless steel N connector for long mating-cycle life; useful over temperature range, -55°C to 105°C; double shield cable for excellent shielding effectiveness; flexible for easy connection & bend; excellent stability of insertion loss, VSWR & phase after thousands of flex cycles; 6 month guarantee.

Mini-Circuits
minicircuits.com

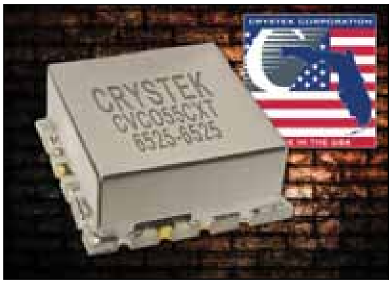
Modeling Solution

Agilent Technologies Inc. introduced a redriver modeling solution designed to quickly and accurately



solve the challenge posed by signal distortion in multigigabit-per-second systems. The redriver modeling solution, available in the Advanced Design System 2012 Transient Convolution Element and SystemVue 2012 AMI Modeling Kit, is used to design electrical redrivers into high-speed chip-to-chip digital links.

Agilent Technologies
agilent.com



Oscillator

Crystek's new CVCO55CXT-6525-6525 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 at 6525 MHz with a tuning voltage range of 0.3 Vdc to 4.7 Vdc. This coaxial VCO features a typical phase noise of -100 dBc/Hz @ 10KHz offset and has good linearity.

Crystek Corp.
crystek.com

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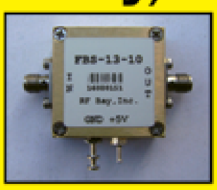
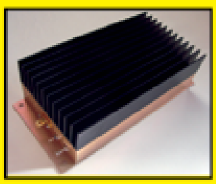
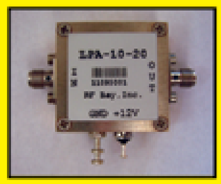


10GHz Divide-by 13 Prescaler



850-950MHz 10W Power Amplifier



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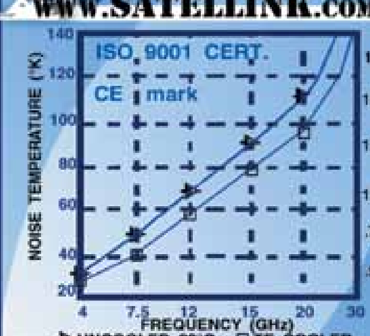

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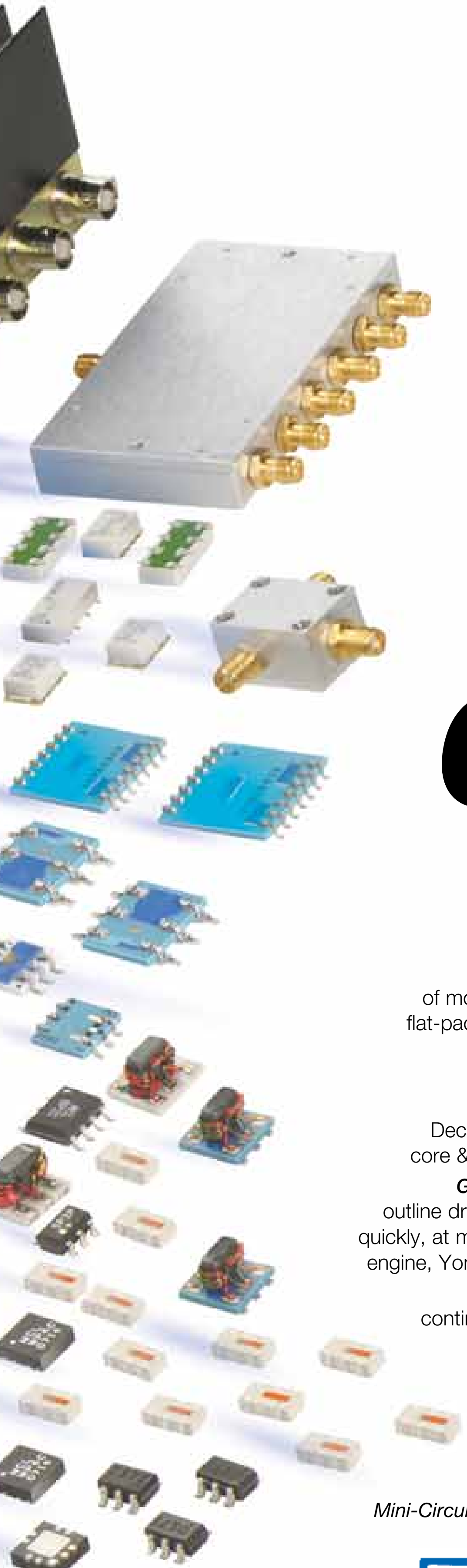

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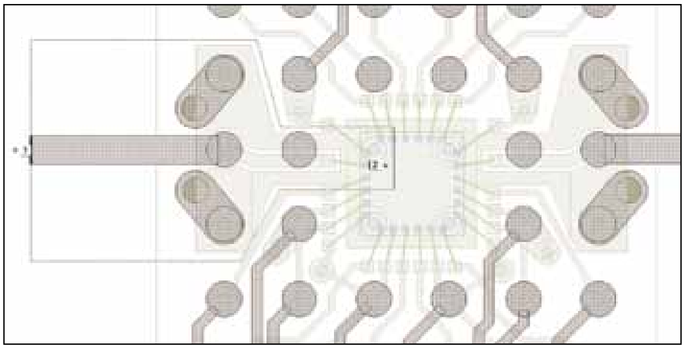

Figure 4 • A bond wire is drawn using a Pcell. The Pcell is shown as a symbol in a schematic, and has a 3D layout. No manual drawing is required.

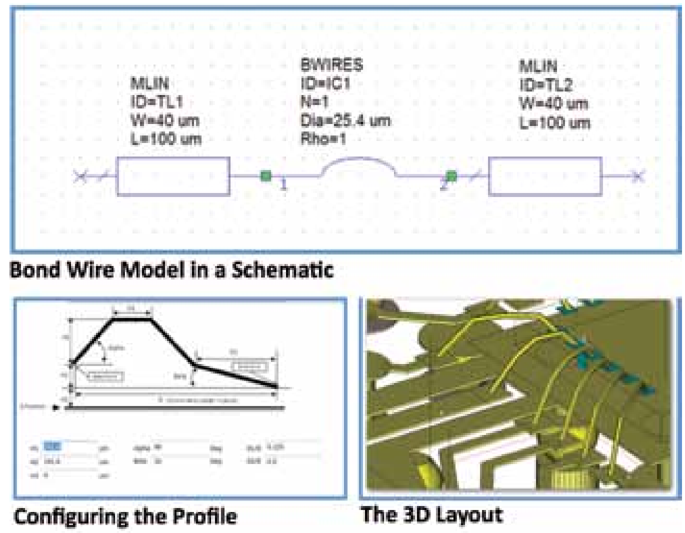

Figure 5 • The layout was constructed using hierarchy.

port to its ground. The strap can be set by the designer to go to the nearest ground plane above or below the port.) Later on, variations on this port will be shown, where the designer uses differential ports in which three ports act as a group to excite a coplanar circuit. The key point here is that it is not necessary for the designer to manually configure the port settings, a common source of error in EM simulation.

Layout of the Circuit and Hierarchy

A number of interesting features in the MWO environment were used to aid in drawing the circuit. First, the 3D bond wires and BGA balls were never drawn by hand. Rather, preconfigured Pcells were used. A Pcell is a model element that is controlled by parameters. For example, Figure 4 shows the Pcell used for the bond wires. The cell is placed in a schematic used for EM simulation. The figure shows it between two transmission lines.

It is easy to configure the profile of the bond wire using the Pcell properties menu, and place it in the EM layout. The 3D shape is automatically drawn, another feature highlighting how Analyst is optimized for ease-of-use for RF circuit design. Pcells are available for bond wires, tapered vias, bond straps, and BGA balls, to list the most commonly used elements.

The layout was drawn using hierarchy. There are three distinct levels of layout, as shown in Figure 5.

The chip level layout shows the chip pad locations. The module level layout uses the chip layout as a sub-cell. The final top-level layout uses the lower two levels of layout. There are a number of advantages to this approach. First, EM simulations can be carried out on various levels of the layout as the design progresses. For example, if a spiral inductor is simulated on its own, then the cells can be joined at a higher level to easily look at more than one spiral on the chip without any drawing, redrawing, or manual setup manipulations. Hierarchy makes it easy to organize the layout, and carry out smaller EM simulations as the design is being developed. Second, remember that there is the option of associating a layout with a schematic. With hierarchy, designers now have the flexibility of sub-circuits in schematics.

Improving the Transition

Next, the designer needs to figure out what the dominant source of reflection in the launch was. The next phase of the study is to isolate this source by systematically breaking the simulation region down further by adjusting the simulation boundary. The problem naturally breaks out into three regions: the line on the board up to the BGA balls; the transition from the board through the ball and vias to the signal line on top of the module; and transition from the module to the chip with a bond wire. Figure 6 shows the three regions that were used.

The designer was careful when specifying the boundary regions to make sure the enclosed structures were reasonably well isolated from the surrounding environment. An example of the issue is shown in Figure 7, which

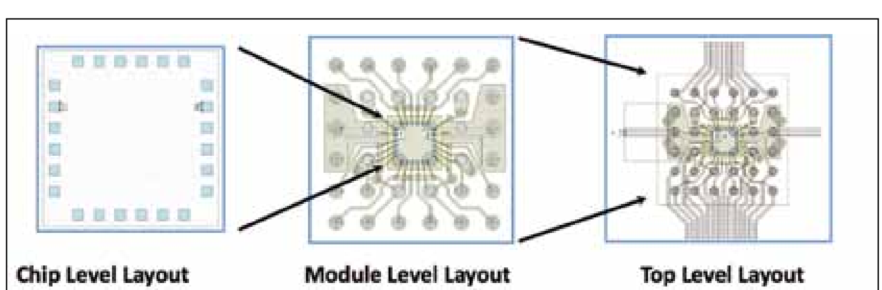

Figure 6 • The problem has been broken up into three different regions to determine the biggest contributors to the issue of reflection in the launch.

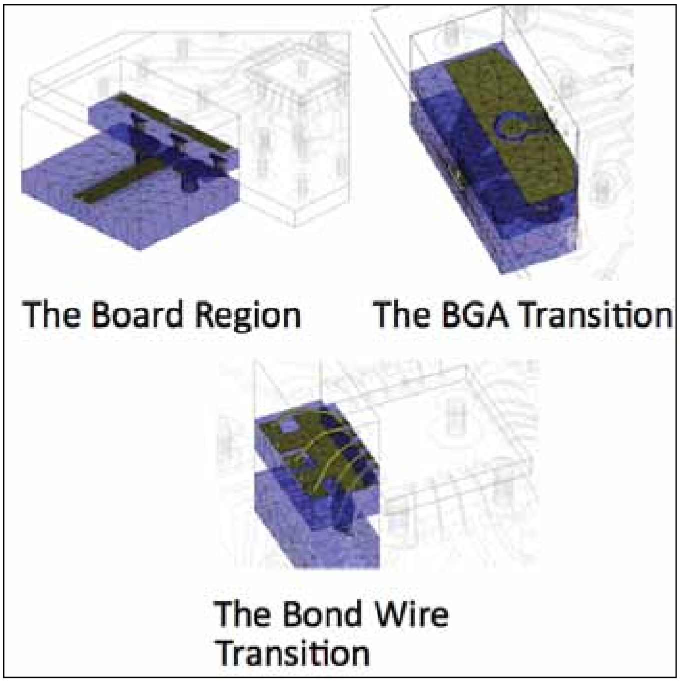

Figure 7. Detail of the second section. Notice the boundary is five-sided with different types of ports being used where needed.

provides the detailed layout for the BGA transition simulation.

The boundary was constructed with five sides in order to avoid coupling to other sections of the circuit. It depends on the technology being used, but typically a few substrate heights of distance are adequate for this type of problem. Analyst automatically sets the boundary to be an approximate open, where an impedance boundary condition mimics a perfect absorber to first approximation. Normally, this is the natural boundary condition to use, since the goal is to isolate the simulation region from other parts of the circuit. It is possible to override the default setting, but care is needed when choosing the boundary condition. For example, if a conducting boundary is chosen, it could actually short objects together in unintended ways.

The transition in Figure 7 also illustrates another interesting feature of Analyst. The location and type of ports used can be user-modified depending upon the circumstances. In Figure 7, Port 2 is a differential type of port. The current goes into the positive part of Port 2, and comes back on the neighboring ground returns, the ports of which are labeled with -2. The designer does need to make sure the ground for the ports is the same as the ground for the real layout. For example, in Figure 7 the differential port's grounds are the same as that of the module, and the return ground current is therefore the same as in real layout. The designer discovered that the second and third sections of Figure 6 needed the most improvement. The next step was to determine the specific causes of the poor performance. Extra ports were placed into the Analyst, and, once simulated, the results could then be placed into a schematic and the ports used to attach circuit elements. In this case, capacitors were added. This process is particularly easy in Microwave Office, because of the tight integration between the various parts of the software. The capacitor values can be tuned and optimized. To illustrate this procedure, Figure 8 shows that the designer added two more ports to Section 3 of the layout.

Ports 3 and 4 were inserted in the two most obvious trouble areas, near the bond wire and near the ball transition. Note that Port 4 is a differential port, which is the natural type of port to use in this situation, as it mimics the actual current flow in the real circuit. The current flows out of Port 4 and returns on the two ports labeled -4. The return current is coming back on the local ground of the port. The capacitor will be placed in the schematic from Port 4 to -4. Thus, the current return and local ground are all in agreement with the real layout. Port 3 is again a differential port, with the -3 part of the port attached to the local ground of the module.

The bottom half of Figure 8 shows the two capacitances added across Ports 3 and 4 in the schematic. Note that the capacitors are attached to ground symbols, which in this case means the local ground of the port, i.e., the negative port. The designer was surprised to find that the problem actually improved with negative capacitance at Port 4 near the BGA balls, i.e., inductance was required. Port 3, which is next to the bond wire, needed a positive capacitance.

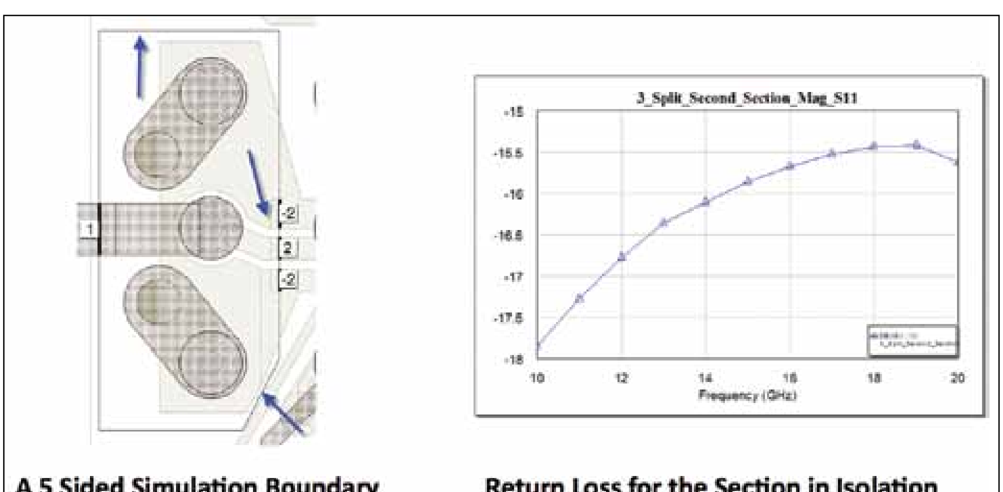

Figure 8 • Internal ports are added so that capacitance can be added and tuned on a schematic.

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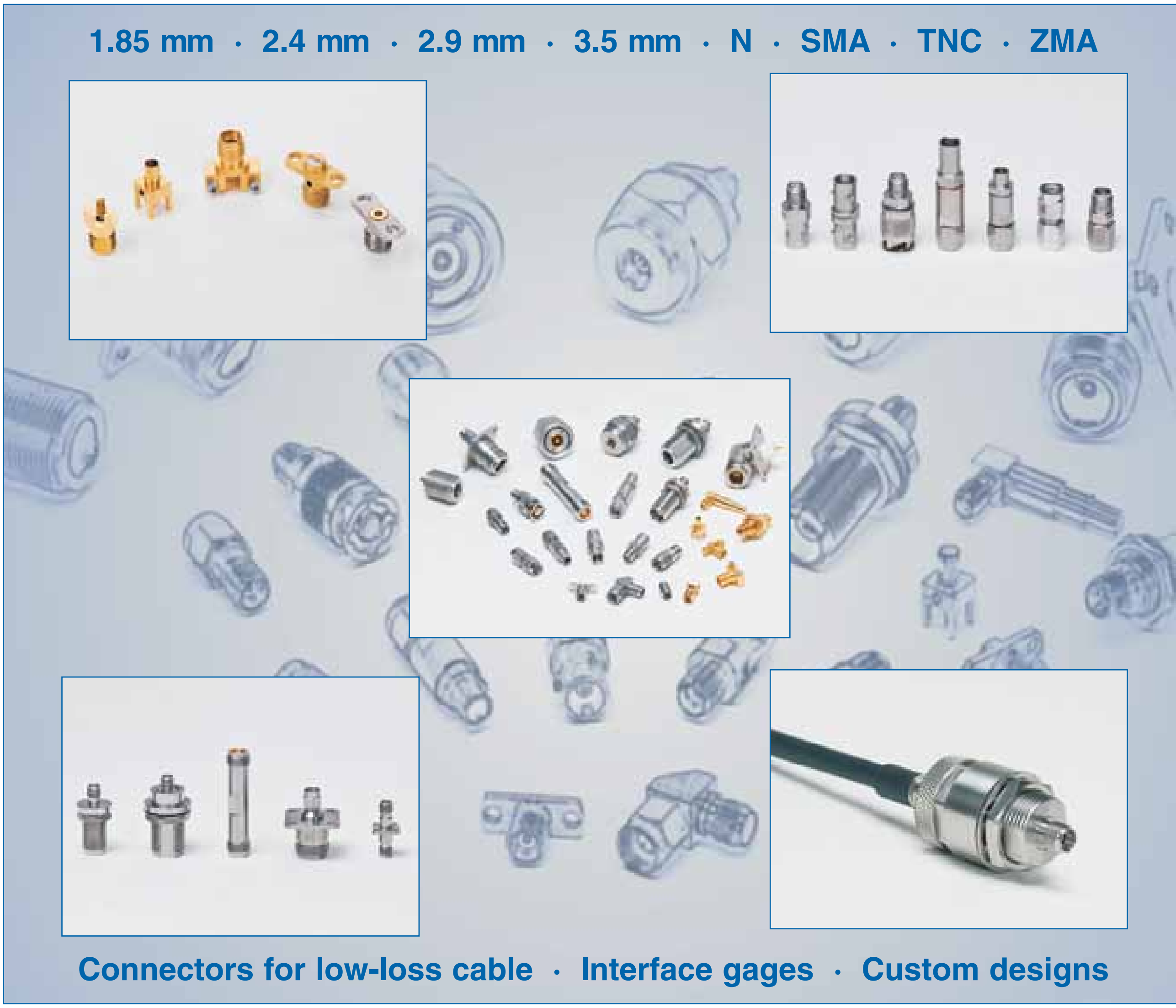

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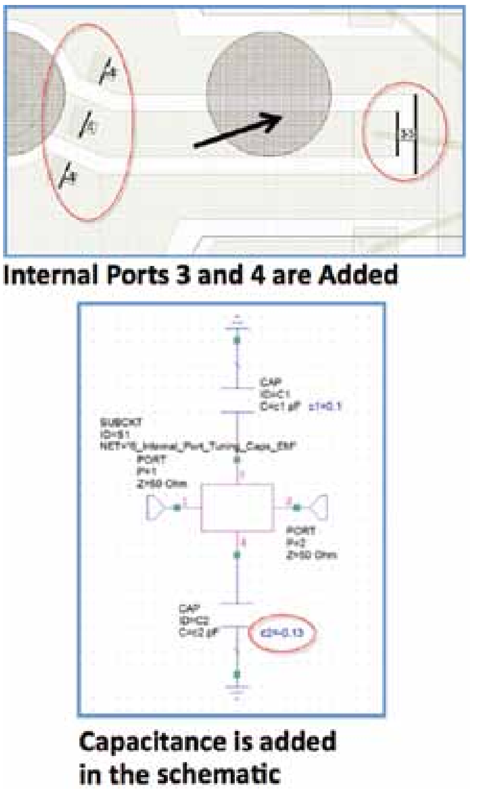


Figure 9 • The bond wire region is modified by doubling the bond wires, and reducing the gap from the pad to the side grounds. The ground vias on the board are moved away from the ground balls for increased inductance.

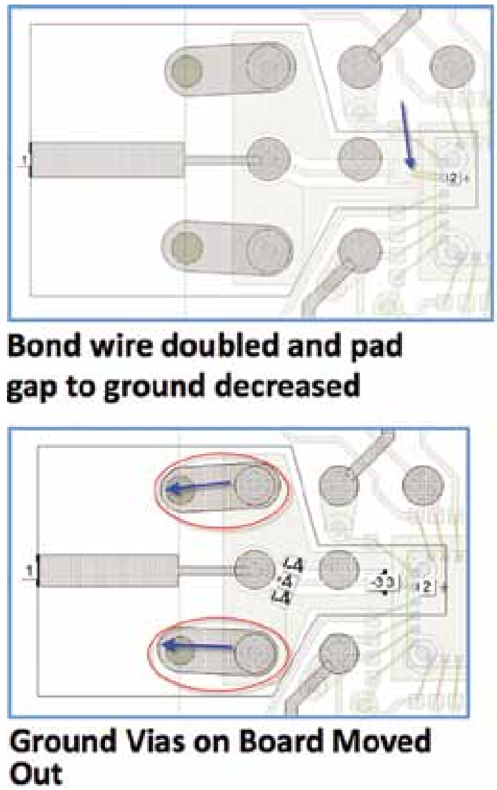


Figure 10 • The whole layout is simulated. The return loss meets the specification of being less than -20 dB over the desired frequency range.

To physically realize the extra capacitance near the bond wire, a variety of techniques were tried, including doubling the bond wires to reduce their inductance and narrowing the gaps between the line and the side grounds in the module. The extra inductance near the BGA balls was accomplished by adding extra loop length to the ground return on the board. The final solution is shown in Figure 9.

The ground vias on the board were moved away from the ground balls for increased inductance. The top diagram in the figure shows the bond wire has been doubled and shortened to reduce inductance. The gap between the bond wire pad and side grounds has been decreased to increase capacitance. The bottom figure shows the ground vias on the board being moved away from the ground balls to increase the loop inductance to compensate for the ball capacitance. The line on the module near the ball was also narrowed to increase inductance.

Finally, the entire structure was simulated for verification, as shown in Figure 10. The mesh is not shown in the air region for visual clarity. The return loss meets the desired specification, being less than -20dB over the frequency range of interest.

Conclusion

Within this design example, AWR's Analyst finite element 3D EM simulator was used to optimize the return loss for a board-to-module-to-chip transition. The novel features of Analyst were leveraged to speed up the study. Portions of the layout were simulated by redefining the simulation boundary and ports, without ever needing to manually redraw the structure. Pcells for the layout of the bond wires and BGA balls were used, so that these structures did not need to be manually drawn either. By adding extra internal ports, capacitance could be added to the parts of the transition quickly, and then the values could be tuned and optimized to determine where changes were needed. The preconfigured circuit simulation features in Analyst significantly reduced development time in this example: ports were automatically configured for optimal settings, 3D shapes were already drawn with Pcells, hierarchy of layout could be used, and simulation regions could easily be changed.

About the Author:

John Dunn is AWR Corp.'s electromagnetic technologist and is also in charge of training and university program development. His area of expertise is electromagnetic theory, simulation, and modeling. Dr. Dunn's past experience includes both the worlds of industry and academia. Prior to joining AWR, he served for four years as head of the interconnect modeling group at Tektronix, Beaverton, OR. Before entering the engineering industry, Dr. Dunn was a professor of electrical engineering at the University of Colorado, Boulder from 1986 to 2001, where he lead a research group in the areas of electromagnetic simulation and modeling. Dr. Dunn received his Ph.D. and M.S. degrees in applied physics from Harvard University, Cambridge, MA, and his B.A. in physics from Carleton College, Northfield, MN. He is a senior member of IEEE and has authored papers and presented at numerous conferences and symposia throughout the world.

Product Highlights

Coupler

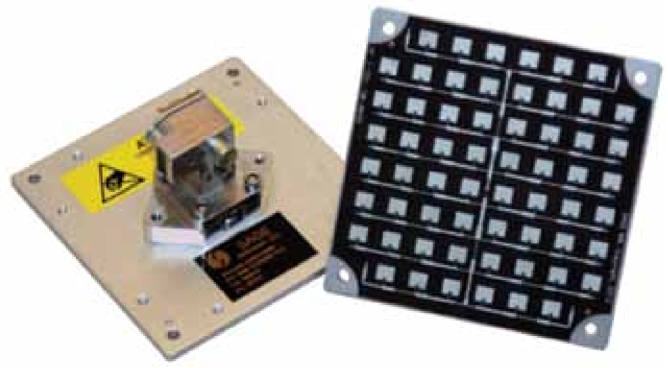
Mini-Circuits' new BDCN-14-22+ bi-directional coupler features: four-port coupler; wideband, 1930 to 2170 MHz; excellent return loss, all ports; ultra small size, hermetically sealed; minimal variation with temperature variation; protected by US Patent 7,049,905; DC current through input to output 0.5A Max. at 1.0 watt RF input power. Applications: UMTS; PCS.

Mini-Circuits
minicircuits.com

RAB Assembly

Coaxicom's Right-Angle Bend (RAB) Assembly provides an alternative to the standard right angle SMA coaxial connector with a low-profile device, delivering increased electrical performance at higher frequencies. The 3221-1-L series of pre-bent right angle assemblies use the center conductor of .141" semi-rigid cable as the contact. "L" represents the overall length of the RAB. This fact, combined with Coaxicom's ultra-short SMA male, provides the same or a smaller profile than a right-angle connector, but without the performance penalty.

Coaxicom
coaxicom.com



K-Band Speed Sensors

Model SSS-24307-20M-S1 and SSS-24307-20M-D1 speed sensor heads are based on the Doppler principle. Model SSS-24307-20M-S1 is designed and manufactured for moving target speed measurement; model SSS-24307-20M-D1 is for both speed and direction detection measurement. Operation frequency and output power are at 24.125 GHz and 7 dBm, respectively. The antenna implemented is a low loss, high performance microstrip patch array delivering 12° x 12° half power beamwidth, 20 dBi nominal gain and -20 dB side lobe levels. The modules are configured with a T/R diplexer, a single or I/Q receiver and a transmitter/receiver oscillator in an integrated package.

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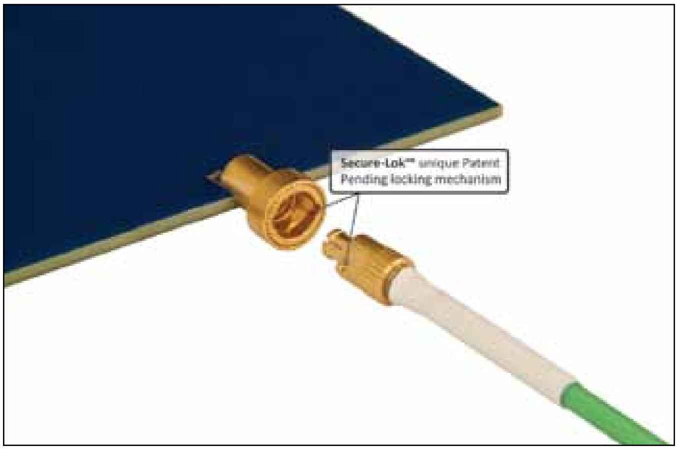
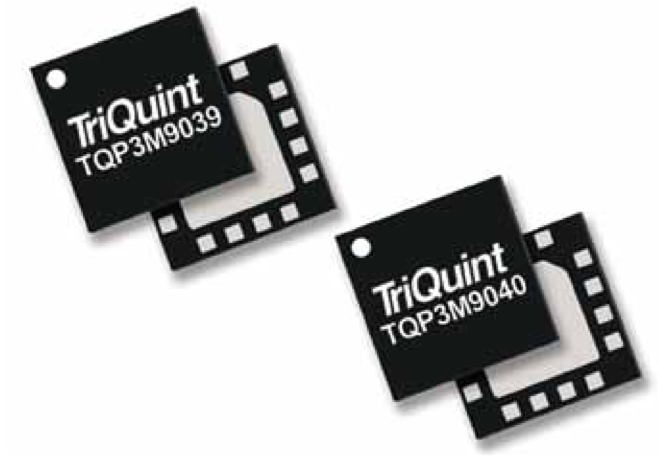




Connectors

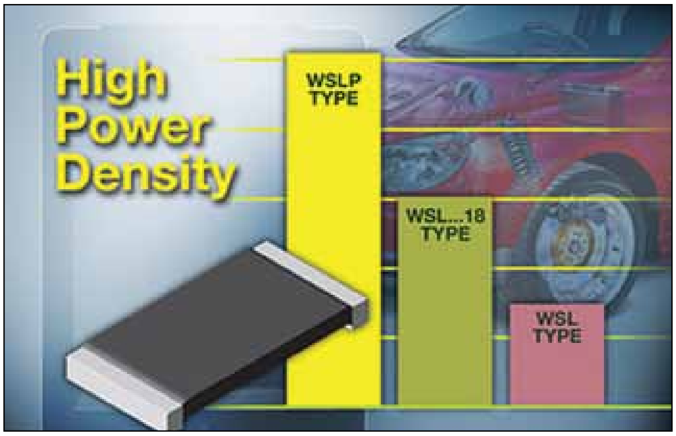
Carlisle Interconnect Technologies announced its family of Push-On connectors, SMP-L™, that incorporates a patent-pending locking mechanism called Secure-Lok™. The locking feature adds a strong retention force to the standard Push-On connector which makes it ideal for rugged military and commercial applications susceptible to vibration. In addition, this simple locking mechanism requires no additional tools to engage or disengage the connector. Finally, the small form factor of the SMP-L connector series reduces weight and size to accommodate dense packaging of RF/Microwave systems.

Carlisle Interconnect Technologies
carlisleit.com

Amplifiers

TriQuint Semiconductor released two new dual matched low noise amplifiers that are ideally suited for balanced high performance RF design configurations. These integrated LNAs are highly linear and offer very low noise figures, high output and include automatic shut-down capability for use in Time Division Duplex (TDD) and Frequency-Domain Duplex (FDD) applications. They are excellent choices for use as first-stage LNAs in base station receivers, tower-mounted amplifiers and repeaters.

TriQuint Semiconductor
triquint.com



Resistor

Vishay Intertechnology announced a new surface-mount Power Metal Strip® resistor in the 2010 case size that combines a high 2 W power rating with extremely low resistance values down to 0.001 Ω and stable resistance tolerances to 0.5 %. The advanced construction of the WSLP2010 resistor incorporates a solid metal nickel-chrome or manganese-copper alloy resistive element with low TCR (< 20 PPM/°C). This results in a high-power resistor with an operating temperature range of - 65 °C to + 170 °C while maintaining the superior electrical characteristics of the Power Metal Strip construction.

Vishay Intertechnology
vishay.com

Portable PIM Tester

Anritsu Company expanded its line of industry-leading Passive Intermodulation (PIM) test solutions with the introduction of the PIM Master™ MW82119A, the industry's first high-power, battery-operated, portable PIM test analyzer. One quarter the size and half the weight of alternative PIM test solutions, the MW82119A offers the inherent advantages of PIM Master – including 40W testing and Anritsu's patented Distance-to-PIM™ (DTP) – in a compact housing suited for difficult-to-access sites, such as Remote Radio Head (RRH) installations and indoor Distributed Antenna Systems (DAS).

Anritsu Company
anritsu.com

Software-Defined Tactical Radio

The new R&S SDTR software defined tactical radio enables high data rate, jam-resistant communications in network centric operations. The R&S SDTR is an open platform based on the software communications architecture (SCA) standard. SCA based waveforms and other manufacturers' waveforms can be ported to the radio, paving the way for interoperability with allied armed forces. The R&S SDTR is an investment for the future. It has the capability to handle future international standardized waveforms with data rates of up to several Mbit/s.

Rohde & Schwarz
rohde-schwarz.com

Modeling Software

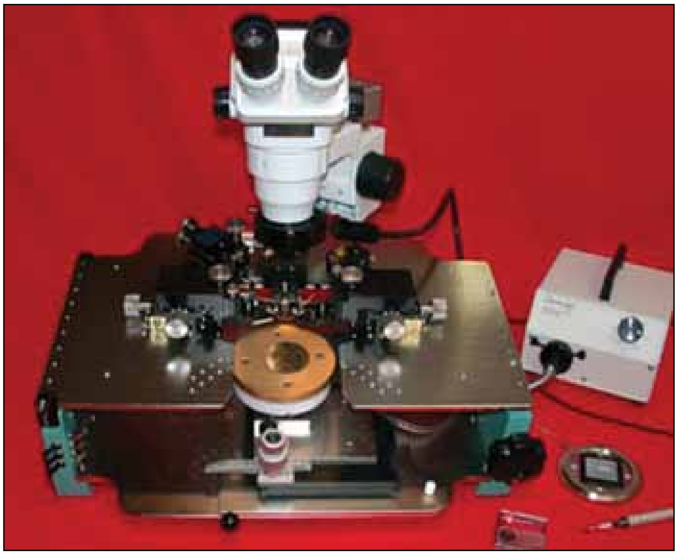
Agilent Technologies Inc. announced the latest release of its device modeling software platform, the Integrated Circuit Characterization and Analysis Program (IC-CAP). With IC-CAP 2013.01, Agilent introduces major improvements to its flagship product for high-frequency device modeling. One key improvement is turnkey extraction of the Angelov-GaN model, the industry standard compact device model for GaN semiconductor devices.

Agilent Technologies
agilent.com

Transmit Module

TriQuint introduced the world's smallest linear EDGE transmit module, which simplifies RF design for smartphones, tablets and other mobile devices. The new transmit module enhances performance and delivers a smaller, more affordable solution compared to discrete devices. Nearly 35% smaller than previous generations, the new QUANTUM Tx™ TQM6M9085 integrates as many as nine discrete parts into a tiny 5.25 x 6mm package, saving valuable board space. It also boasts best-in-class performance with 45% power added efficiency, providing longer battery life and more hours of operating time for mobile device users.

TriQuint Semiconductor
triquint.com



Probe Station

The JR-2745 Manual Probe Station is a low cost manual probe station for testing high speed, microwave and RF semiconductors with wafer sizes up to 200mm (8"). It features magnetic mount or 'bolt on' microwave positioners—up to 7 Microwave Positioners can be mounted. SW, W, NW, N, NE, E, and SE simultaneously. Top Plate Insert for true N,S,E,W probe placement; 4.5" probe card adapter available.

J microTechnology
jmicrotechnology.com

Filter

API Technologies Corp. announced a new transverse coupled resonator filter (TCRF). This new surface acoustic wave (SAW) filter is designed for narrowband intermediate frequency (IF) filtering such as in satellite transponders, directional finders and anti-jam modems. It is capable of fractional bandwidths of 0.04% to 0.1% and currently available from 80 - 1600 MHz.

API Technologies Corp.
apitech.com

Product Highlights

Panel Antenna

L-com, Inc. announced its HyperLink 2.4 GHz 14 dBi three element, dual polarized panel antenna. The HG2414DP-3NF provides combined vertical and horizontal polarization with high gain in a single enclosure. Compatible with IEEE 802.11 b/g/n standards, the HG2414DP-3NF combines three separate antennas in a single housing. The unit consists of two vertically and one horizontally polarized multi-patch antennas. It is a professional quality antenna designed primarily for MIMO point-to-multipoint and point-to-point applications.

L-com Inc.
l-com.com

Transformers

Pulse Electronics Corp. introduced a series of high isolation switch mode power transformers that provide a reinforced insulation power supply for RS485 and RS232 transceiver ICs. The transformers are designed on an SMD platform with offset pins to maintain a large separation between primary and secondary circuits. Applications include industrial control systems, building automation, smart grid, surveillance, and aeronautics. The Pulse Electronics PH9185NL transformers facilitate using a RS485/232 communications bus as a low cost alternative to Ethernet.

Pulse Electronics Corp.
pulseelectronics.com

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PUBLISHER
Scott Spencer
Tel: 603-472-8261
Fax: 603-471-0716
scott@highfrequencyelectronics.com

ADVERTISING SALES — EAST
Gary Rhodes
Vice President, Sales
Tel: 631-274-9530
Fax: 631-667-2871
grhodes@highfrequencyelectronics.com

ADVERTISING SALES — WEST
Tim Burkhard
Associate Publisher
Tel: 707-544-9977
Fax: 707-544-9375
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Jeff Victor
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PRODUCT SHOWCASE
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Fax: 201-666-6698
joanne@highfrequencyelectronics.com

U.K AND EUROPE
Sam Baird
Tel: +44 1883 715 697
Fax: +44 1883 715 697
sam@highfrequencyelectronics.com

U.K AND EUROPE
Zena Coupé
Tel: +44 1923 852 537
Fax: +44 1923 852 261
zena@highfrequencyelectronics.com

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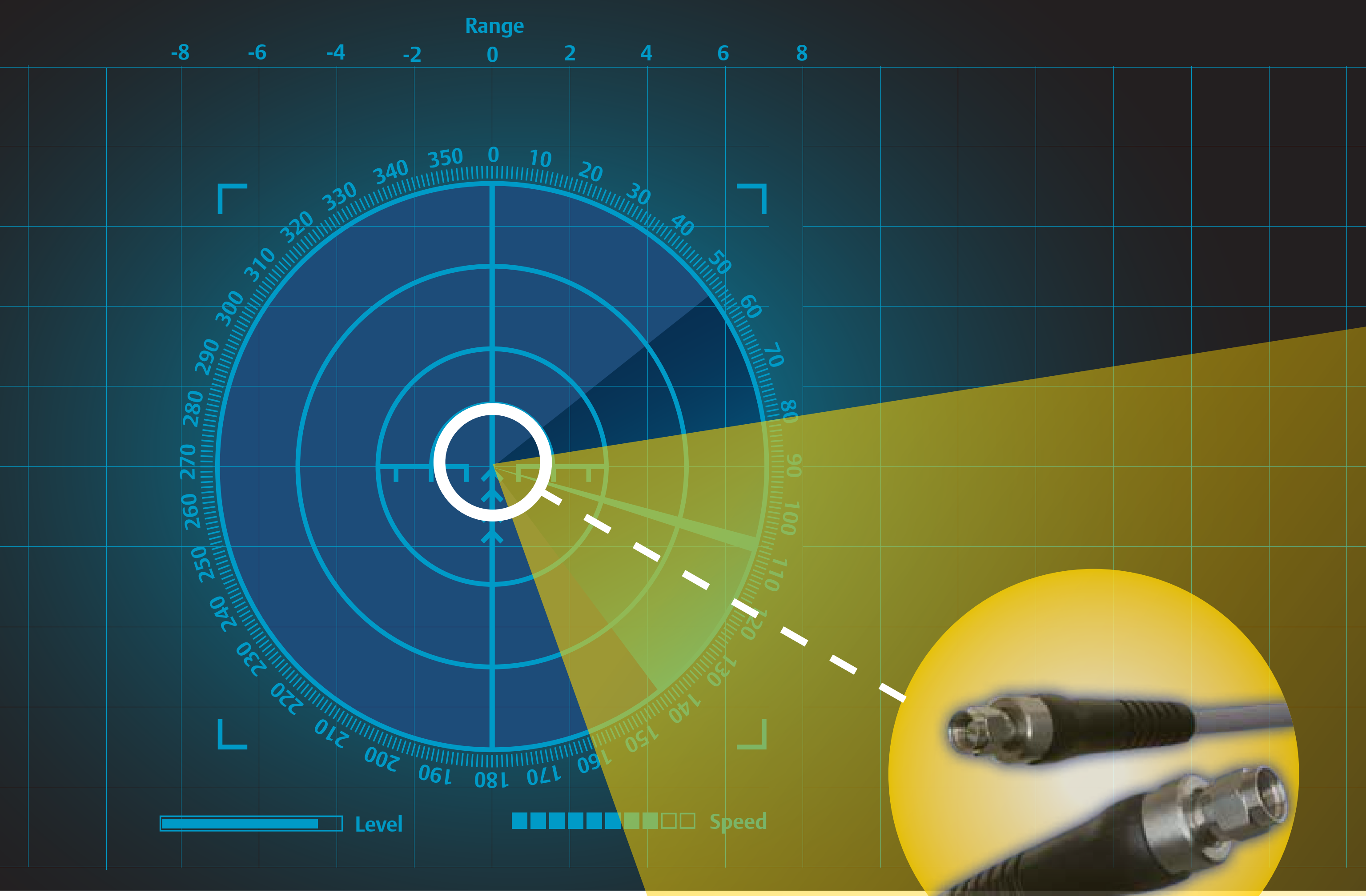

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Emerson Network Power Connectivity Solutions offers the **Semflex DKT Test Cable Assembly Series.** This line incorporates high performance cable with equally high performance connectors.

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