

Keysight EEsof EDA

Software and Modular Solutions for Universities

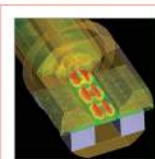
Keysight for Universities



Advanced
Design System



Genesys



EMPro



SystemVue

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Overview of Keysight's Academics Program

Education and Research for the Next Generation

Our Commitment to You...

Keysight Technologies, Inc. will continue to support universities world wide. There is no better way for students to prepare for the real world than building skills that will be in demand wherever their talent and interests lead. That is one of the many reasons why Keysight EEsof EDA, the leading supplier of Electronic Design Automation (EDA) software for communications product design, has supported Universities worldwide for over twenty five years with programs that make our products easy to integrate into engineering studies.



This brochure provides a guide to the educational programs of interest to university educators and students. You will learn about Keysight EDA's donation program, hardware and software tools available for education and research and other educational resources available to the education communities.

Premier

As the world's premier measurement company, Keysight works in close collaboration with engineers, scientists and researchers around the globe to meet the communications, electronics, life sciences and chemical analysis challenges of today and tomorrow. Keysight is committed to providing innovative measurement solutions that enable our electronics and bio-analytical customers and partners—the leaders in their fields—to deliver the products and services that make a measurable difference in the lives of people everywhere.

Reliable

Keysight works closely with academia, government, and industry to provide the tools that enable development of new technology and supports the scientific process of investigation, discovery and analysis by providing reliable measurement solutions.

Committed

We are committed to making an ongoing contribution to academia by stimulating education and research, in areas of importance to the next generation of engineers' future contributing time, and expertise to research programs and teaching tools.

Overview of Keysight's Academics Program

Keysight EEs of EDA University Educational Support Programs

The Keysight EDA's University Educational Support Program offers full versions of Keysight EDA software to qualified academic institutions for instructional use. This software, the same as used in industry, creates a full RF-EDA experience to help students develop skills that will serve them throughout their careers. A working knowledge of Keysight EDA's design tool capabilities allows students to enter the workforce as industry-ready engineers. Additionally, the software enables professors to encourage student creativity and students to capture and present that creativity in a form that's recognized and trusted in conference papers, presentation and proposals.

The University Support Program is available to qualifying institutions offering academic instruction in electrical engineering, RF and communications system design, electromagnetic analysis, high-speed digital design and device modeling. Keysight EDA provides resources for Educators, Researchers, and Students.



Worldwide education program in over 850 locations

Keysight EEs of EDA University Educational Donations



Georgia Institute of Technology

News Release. Keysight Technologies commits a donation in the form of software to Georgia Institute of Technology.

Georgia Tech dedicates a laboratory to Keysight after the company made a substantial donation to the university's School of Electrical and Computer Engineering (ECE).

Academic uses of Keysight EDA software will focus on Keysight EDA's Advanced Design System (ADS) and SystemVue solutions. ADS is the world's leading electronic design automation software for RF, microwave and high-speed digital applications, pioneering innovative and commercially successful technologies such as X-parameters and 3-D electromagnetic simulators. SystemVue is Keysight's premier platform for designing communications systems. It enables system architects and algorithm developers to innovate the physical layer of wireless and aerospace/defense communications systems and provides unique value to RF, DSP and FPGA/ASIC implementers.

See YouTube video:
www.keysight.com/find/GeorgiaTechandKeysight_video



University of South Florida

News Release. Keysight Technologies makes a in-kind donation, the largest ever received by USF.

A record-setting gift to the University of South Florida from Keysight is positioning USF's College of Engineering among the top schools in the nation offering access to one of the engineering industry's leading design tools.

Keysight software provides the means to speed engineers through the process of turning ideas—even those scribbled on a napkin—into schematics and products. Thanks to the California-based design, test and measurement company, USF's engineering students will have access to the same software professionals use.

See YouTube video:
www.youtube.com/watch?v=ntntpHgl1M&noredirect=1

Georgia Institute of Technology

"Georgia Tech is among the best research universities in the world...Maintaining that position requires the best teachers and facilities and, increasingly, key partnerships with companies like Keysight. Thanks to Keysight's support, our students now have access to the industry's leading software and hardware tools."

Steve McLaughlin, chair of Georgia Tech's School of Electrical and Computer Engineering.

University of South Florida

"Every student who graduates from our electrical engineering program will have had hands-on experience with ADS (Advanced Design System) and that fact strengthens the value of their degree. This training and experience gives our students a skill set and familiarity with an industry-leading software, which will give them an edge in the job market. From an employer's standpoint, it will eliminate a six-month training period."

John M. Wiencek, College of Engineering Dean

Educational Support Programs For Educators

Resources for Educators



As a university educator, your route to building skills with Keysight EDA products begins with your local Keysight EDA Field Engineer and/or our University Program Manager. Participation in our Academic Licensing program is provided at nominal cost to the University.

Access to download and install software releases, find information on hotfixes, patches, and add-on software as well as installation and licensing instructions is available on the educators resource page.

Dreamcatcher University

Courseware includes teaching slides, lab exercises and reference design files. It has been made available specifically for educators and students involved with the Keysight EDA University Educational Support Programs. The course provides complete educator resources for:

- RF/MW & Wireless Comms
- Digital & Embedded Systems
- General Electronics



Qualify for Keysight EDA educational support

It's easy to find out if your University can qualify. Just contact your local Keysight EDA Field Engineer and request a University Application, and be prepared to share some plans on how Keysight EDA products will be used in your classroom and RF/Microwave program.

Keysight EDA's program for classroom use of our products in Higher Education has expanded to include major additions to product families. Our programs feature fully operational versions of our commercial products and are available to qualifying institutions offering academic instruction in:

- Microwave and RF Circuit Design
- Communications System design
- Electromagnetic Analysis
- Signal Integrity
- Device Modeling

www.keysight.com/find/dreamcatcher

Educational Support Programs For Students

Resources for Students



As a university student you are eligible for the Keysight EDA Student License Program which offers access to Keysight EDA tools for use on a student's personal computer. These licenses allow students to access Keysight EDA tools anyplace and anytime. Stu-

dents attending universities participating in the Keysight EDA University Educational Support Program can request licenses by completing and submitting a Student License Request form on our website.

University to industry transition

Assistance Licenses. If you are graduating, take advantage of Keysight EDA's University-to-Industry Transition Assistance Program—please note that the software is provided to you so that you can keep your skills and expertise in our products current while you search for employment. To request your free transition, complete and submit a University-to-Industry Transition Assistance License Request on our website.

E-learning courses for ADS

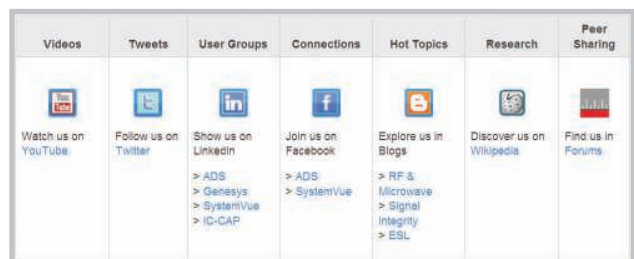
Gain confidence at your leisure using our self-paced e-Learning courses. The courses contain narrated slides, videos showing the Advanced Design System (ADS) in action and step-by-step lab exercises (PDF format) that you can print out and perform. Begin, stop, and start learning again at your own pace as the system will remember where you left off. You can also complete individual sections of the course as required for your review. Learn the basics of ADS design and simulation and gain confidence in using the industry's leading RF/MW design software.

Student license program

Keysight EDA's University Educational Support Program offers full versions of Keysight EDA software to qualified academic institutions for instructional use. This software, the same as used in industry, creates a "Full RF-EDA Experience" to help students develop solid skills that will serve them throughout their career. With a working knowledge of the full capability range of Keysight EDA's design tool capabilities, students are able to enter the workforce with skills highly valued by industry leading employers. The "Full RF-EDA Experience" also enables professors to more effectively encourage student creativity and allows that creativity to be captured and presented in a form that's immediately recognized and trusted in conference papers, presentation and proposals. ***(The student license program is offered in the Americas, Europe and Japan.)***

This program provides access of EEsof software on student's personal computers which allows students to use EEsof software without having to use university lab computers or to login to the university system to access EEsof license servers. The licenses allow students access to EEsof software anyplace and anytime—licenses are to be used for classroom purposes only and not for commercial use. Students can request licenses by completing and submitting the Student License Request form available on our website.

Keep connected with us. Social networking resources available on our website.



Educational Support Programs For Researchers

Resources for Researchers



As a researcher you are eligible to utilize Keysight's large selection of resources for university researchers and those working in university incubators. Resources include emerging business assistance, application notes in all areas of Test and Measurement, valuable links

to research sites, tools to help you locate and track grants and other funding sources.

As a University Researcher, your route to building skills with Keysight EDA products begins with your local Keysight EDA Field Engineer and/or our University Program Manager. Participation in our Academic Licensing program is provided at nominal cost to the University.

University relations

The Keysight for Universities home page provides world wide higher education support with a view into the programs of greatest interest to university faculty, students and staff. Learn more about our latest research collaborations, research grants, PhD fellowships, Keysight Thought Leader Program, research tools, education support, recruiting of top university talent, and philanthropy.

www.keysight.com/univ_relation/index.shtml

Researcher discounts

AAS A RESEARCH INSTITUTION you can take advantage of Keysight's EDA's 50% discount on products and support. When used in conjunction with Keysight EDA's time-based licenses, this discount allows access to a wide variety of EDA tools with minimal costs and no long term commitments. This combination of time-based licenses and discounts is ideal for time limited research projects.

Knowledge center

Students and educators attending universities participating in our Keysight EDA University Educational Support Program have access to our Keysight EDA Knowledge Center database. The web-based Knowledge Center is an around-the-clock resource for comprehensive support information and downloadable examples for all our products. It hosts software updates and has a tracking feature that makes it easy for you to submit and manage support cases and related enhancement requests. The search feature makes it easy to find and sort through available solutions by date, popularity, or user ratings. The Knowledge Center also contains product discussion forums that put you in touch with other users, support engineers, and product developers. On the Knowledge Center login page. Click the Register Button to request an account.

<https://edocs.soco.keysight.com/login.action>

Educational Support Programs Textbook Resources

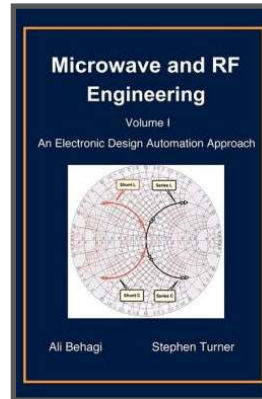
Textbook Resources

ADS cookbook

The Advanced Design System Circuit Design Cookbook (version 2.0) is a comprehensive collection of useful materials that every student of RF and Microwave Design should have on their PC. The ADS cookbook contains valuable RF design examples utilizing ADS. This is an excellent source for lab assignments with step-by-step procedures and design insights.

This content-rich, educational resource contains topics such as:

- Getting Started with ADS
- Tuning and Optimization
- Harmonic Balance Simulation
- Planar EM and FEM Simulation
- RF System Design
- Microwave Discrete and Microstrip Filter Design
- Microwave and CPW Power Divider Design
- Microwave Amplifier Design
- Statistical Simulations (Monte Carlo and Yield Analysis)
- MESFET Frequency Multiplier Design
- Active Mixer Design
- Power Amplifier Design..., and much, much more.



Microwave and Engineering

Ali A. Behagi and Stephen D. Turner's book, "Microwave and RF Engineering: An Electronic Design Automation Approach" is an innovative text book that takes away traditional mathematical complexity so engineers and students can get started learning this subject right away.

The book adopts a practical, hands-on approach to introduce the latest simulation and design methodology used in the industry. The authors have selected Genesys RF/Microwave Design Software as the simulation tool used in writing the book. Genesys was selected for its low cost and proven capabilities in the design of Keysight's state-of-the-art instrumentation. It has been endorsed worldwide by a loyal following of users for over 20 years.

Textbook workspaces for Genesys

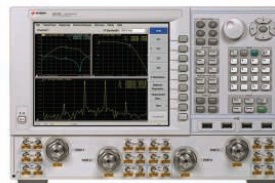
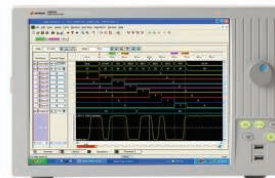
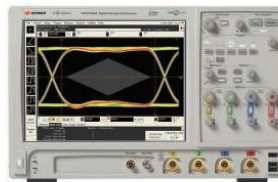
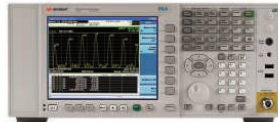
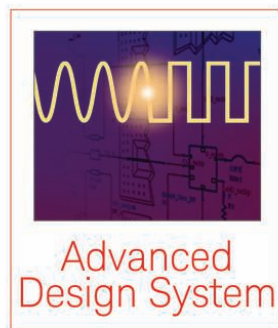
This exclusive complementary download from Keysight contains 48 selected workspaces from the book. The workspaces contain useful design utilities, automated scripting for performing routine design tasks, useful starting points for your design—it is an excellent learning companion.

Tools to Accelerate your Research

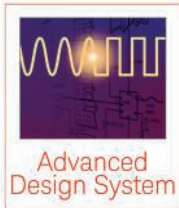
Keysight RF Workflow Environment

Keysight's RF workflow environment—integrating software and hardware—is the comprehensive set of tools to simulate, measure and analyze communications components and systems. Through application-specific solutions, we can help you achieve greater levels of confidence in your research and designs. The foundation is proven hardware and software products that let you leverage our decades of experience in high-frequency systems.

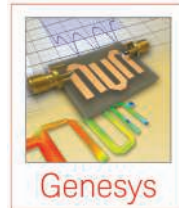
Accelerate with Keysight and turn your ideas into validated designs—faster.



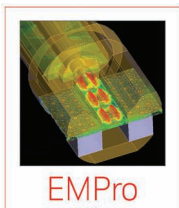
Software Enabling Communications Design Flow



Advanced Design System (ADS) is the leading electronic design automation software for RF, microwave, and high speed digital applications. ADS pioneers the most innovative and commercially successful technologies, such as X-parameters* and 3D EM simulators, used by leading companies in the wireless communication & networking and aerospace & defense industries.



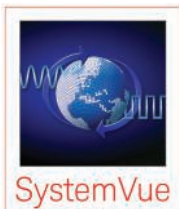
Genesys is an affordable, high-performance design tool created for the RF and microwave circuit board and subsystem designer. Providing the optimal balance of design capabilities and ease-of-use, designers can quickly attain the skill set necessary to operate the tool while realizing unbeatable engineering productivity in the shortest time possible.



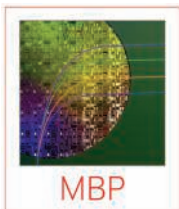
Electromagnetic Professional (EMPro) is a 3D modeling and simulation environment for analyzing the 3D electromagnetic (EM) effects of high-speed and RF/microwave components. EMPro features a modern design, simulation and analysis environment, high capacity time- and frequency-domain simulation technologies and integration with ADS, the industry's leading high-frequency and high-speed design environment.



MQA provides the complete solution and framework to fabless design companies, IDMs, and foundries for SPICE model library validation, comparison, and documentation.



SystemVue is a focused EDA environment for electronic system-level (ESL) design that enables system architects and algorithm developers to innovate the physical layer (PHY) of next-generation wireless and aerospace/defense systems. As a dedicated platform for ESL design and signal processing realization, SystemVue replaces general-purpose digital, analog, and math environments and provides unique value to RF, DSP, and FPGA/ASIC implementers



MBP is a one-stop solution that provides both automation and flexibility for silicon device modeling.



GoldenGate provides the framework for RF-Mixed Signal (RF-MS) designers to rapidly simulate circuits, verify specs and validate potential yield of complex highly integrated RFICs. Designers can confidently simulate blocks, combinations of blocks and full receive/transmit chains to understand the influences introduced by noise, distortion, parasitics and numerous other effects confronted in modern RF-MS IC design.



Integrated Circuit Characterization and Analysis Program (IC-CAP) is the industry standard for DC and RF semiconductor device modeling. IC-CAP extracts accurate compact models used in high speed/digital, analog and power RF applications. IC-CAP is the most advanced, customizable modeling software and includes measurement, simulation, optimization and statistical analysis tools.

Applications for Education and Research Antenna Array

SMART ANTENNAE architectures incorporating multiple antenna elements in an array are used in many applications. Wireless communications standards like 802.11ac, radio astronomy and array RADARs are all examples of applications where multiple antennas are employed for various requirements derived from spatial signal processing. Though the types of processing used and beamforming techniques differ by application, there is a common test challenge. It is difficult to align the antennas in an array in phase and amplitude so they can be used together effectively. As the number of antennas increase in an array, the test time to do the alignment increases drastically.

Solution

- Advanced research large scale experiments in hydrodynamics, plasma fusion (Tokamak/Stellarator), particle physics, microwave astronomy, and others
- Radar and satellite: multi-channel phase-coherent wideband measurements in active antenna calibration and test, beam-forming, electronic warfare (EW), or MIMO

INDUSTRY AWARD

Keysight M9703A AXIe high-speed digitizer won the "Best in Test" award from Test & Measurement World. This award recognizes the innovation making a significant contribution to the test industry, and demonstrating excellence in creating value for customers.

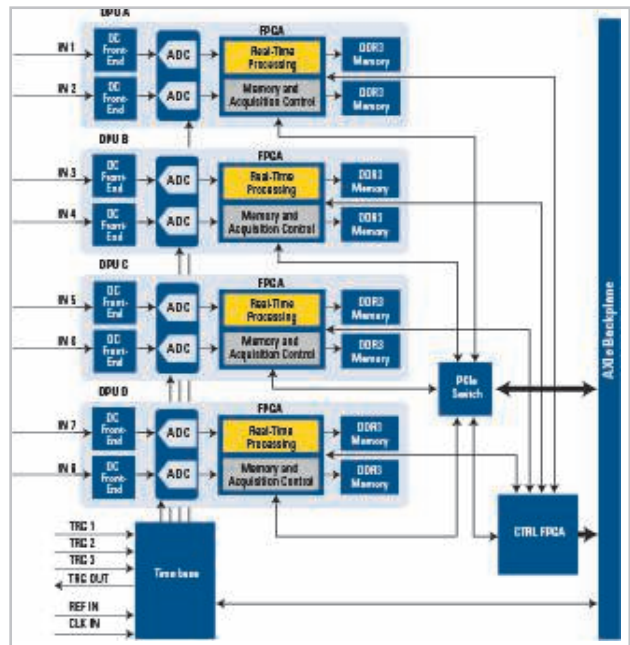




M9703A AXIe high-speed digitizer and M9536A AXIe controller placed within the M9502A 2-slot AXIe chassis.

Performance Specifications:

- 8 channels (4 when interleaving) with 12-bit resolution
- Up to 3.2 GS/s sampling rate (with -SR2 and -INT options)
- DC to 2 GHz input frequency range (with -F10 option in non-interleaved acquisition)
- 1 V / 2 V selectable full scale range (FSR)
- Accurate time-to-trigger interpolator (TTI)
- Up to 4 GB (256 MSamples/ch) on-board memory
- PCIe® backplane providing >650 MB/s data transfer speed
- Wideband digital downconverter (DDC)
- 8 phase-coherent channels with independent local oscillators (LO) setting, tunable with 0.01 Hz resolution
- Adjustable analysis bandwidth from 300 MHz down to less than 1 kHz
- Magnitude trigger



Applications for Education and Research Digital Pre-Distortion

A TRANSITION is now underway in the wireless communications industry, as wireless service providers embrace broadband communication standards such as LTE-Advanced and IEEE 802.11ac.

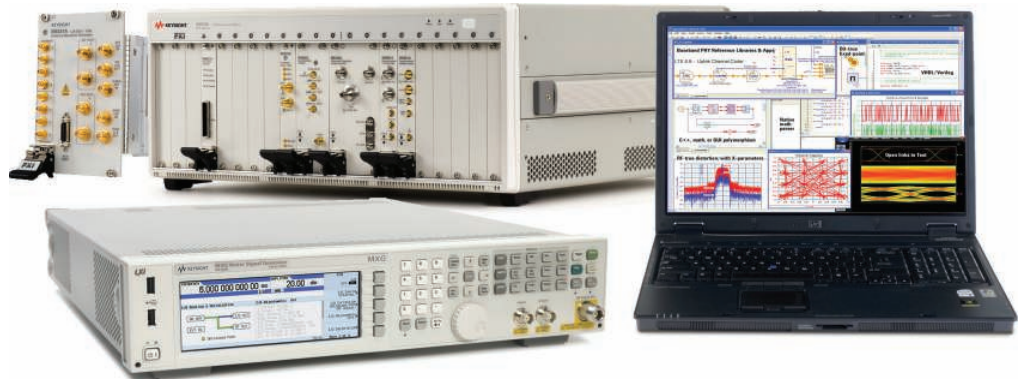
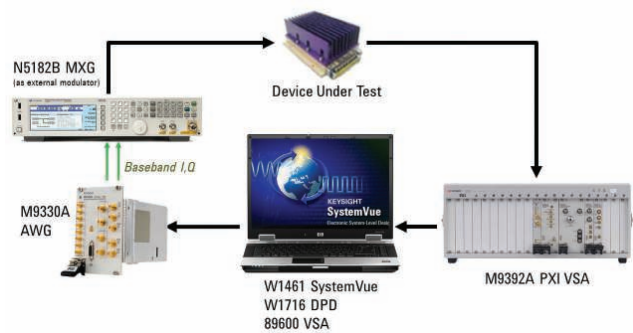
In order to achieve Gb/s link-level throughput, these new formats use wider bandwidths, multiple-input multiple-output (MIMO) space-time coding, and higher order orthogonal frequency division multiplexing (OFDM) modulation formats. These requirements place new demands on linearity, bandwidth and power consumption in wireless components. For example, LTEAdvanced supports up to 100-MHz bandwidth to reach 1Gb/s and 500 Mb/s data rates for the downlink and uplink, respectively. IEEE 802.11ac will support 80-MHz and 160-MHz bandwidths to achieve throughputs of at least 1 Gb/s for multi-station and 500 Mb/s maximum for a single link.

For the communications system architect and the RF power amplifier (PA) designer, these new formats introduce a number of challenges. Designers must determine the performance gap between their existing 3G designs and tomorrow's 4G operating environments, and whether these 3G designs will need to be redesigned, or a new vendor qualified. The hardware must also meet or exceed absolute performance metrics such as ACPR, EVM or throughput (e.g., BLER, BER and PER), while also meeting internal product design goals.

Because smart phones and other advanced wireless devices rely so heavily on battery power, getting the most efficiency out of a design is critical. The RF PA plays a particularly key role choosing and designing the right PA to meet design goals is a significant challenge.

Performance Specifications:

- Analysis bandwidths up to 250 MHz
- Frequency range from 50 MHz to 26.5 GHz
- Input: 2 GS/s, 12-bit, -60 dBc SFDR in a bandwidth up to 300
- Output: 1.25 GSa/s sample rate, 15-bit resolution with up to 500 MHz bandwidth. Can be used to generate IQ signals to apply to an External IQ modulator such as the MXG or PSG signal generators



Applications for Education and Research MIMO

THE WIDEBAND MIMO PXI Vector Signal Analyzer delivers simultaneous, wide bandwidth analysis on up to 4 channels in a 4U form factor M9018A PXIe chassis.

For researchers working on 802.11ac applications, this PXI configuration provides analysis capabilities for up to 4x4 MIMO, and is ideal for 80 + 80 MHz SISO, and 80 MHz or 160 MHz MIMO 802.11ac measurements. This configuration provides up to 800 MHz analysis bandwidth to address current and future wireless standards. Instrument control is provided through a soft front panel and programmatic interfaces tuned to your application development environment of choice.

Solution

The Keysight wideband MIMO PXI Vector Signal Analyzer is supplied with a comprehensive portfolio of module drivers, documentation, examples and software tools to help you quickly develop test systems with your software platform of choice.

When combined with the Keysight 89600 VSA software, this configuration provides a comprehensive set of 802.11ac analysis tools to analyze EVM by symbol, carrier or burst, measure I/Q parameters, center frequency, bandwidth, power, ACPR and demodulate to bit level.

Performance Specifications

- Up to 4 channels in a single chassis
- Frequency range 10 MHz to 26.5 GHz
- Analysis bandwidth up to 800 MHz
- Error vector magnitude < -42 dB Exceeds 802.11ac standards
- IF digitizer resolution 12-bits
- Sample rate 2 GS/s
- Size is 4U rack space for 3 channel configuration



Keysight 89600 vector signal analyzer software soft front panel.



Wideband MIMO PXI Vector Signal Analyzer system includes the M9036A controller, 3 of the M9168A attenuator modules, M9302A local oscillator, M9362A-D01 quad downconverter, M9352A amplifier/attenuator and 3 of the M9302A IF digitizer modules placed within the M9018A PXI chassis.

Applications for Education and Research Multichannel Streaming

THE AIRWAVES are becoming increasingly crowded as demand for RF spectrum continues to grow. As a result, every type of wireless communication system faces a complex and unpredictable signal environment. Going forward, the development of successful wireless designs depends on the ability to thoroughly analyze and model real-world sources of interference. These tasks are made difficult by a diverse range of possible interference signals with attributes such as complex timing, burst characteristics, dynamically changing modulation schemes, and variable power levels. Troubleshooting becomes especially challenging when the interference problems are intermittent.

When dealing with intermittent interference, traditional measurement techniques that rely on swept spectrum analyzers are at risk of missing important information during and between every sweep. An emerging alternative uses two high-speed digitizers, two local oscillators and gapless recording of the RF spectrum to a Redundant Array of Independent Disks (RAID) system.

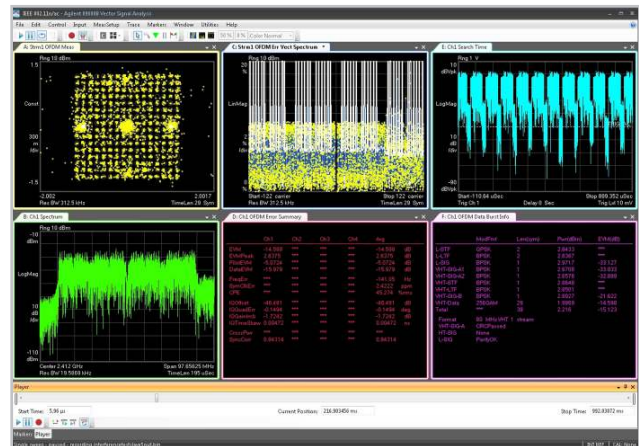
Captured data is analyzed using tools such as data viewer software and a signal analysis toolkit with search capabilities. Once the interfering signal has been identified, its characteristics can be used as trigger parameters for one digitizer as it monitors in-channel or adjacent-channel signals. A trigger event initiates in-band acquisition with the other digitizer. To capture a more complete view of the interference, pre-trigger delay can be used to acquire signal data for a specified time prior to the trigger event within the capacity of the buffer memory.

Solution

The foundation of the recommended digitizer-based system is a two-channel Keysight M9392A PXI vector signal analysis system (50 MHz to 26.5 GHz) and three software applications: Keysight's free data viewer application, the Keysight 89600 VSA software and the X-COM Spectro-X signal analysis toolkit.

Performance Specifications

- Frequency range from 50 MHz to 26.5 GHz
- Up to 250 MHz analysis bandwidth
- Up to 100 MHz streamed analog bandwidth on each channel
- Independently tuned channels








The Keysight 89600 VSA software screen shot.



Two-channel Keysight M9392A PXI vector signal analysis system (50 MHz to 26.5 GHz) includes the M9036A controller, 2 of the each of the following: M9302A local oscillator modules, M9360A attenuator/preselector modules, M9361A downconverter modules, M9351A downconverter modules and M9202A IF digitizer modules placed within the M9018A PXI 18-slot chassis.

Research and Design Instrumentation

The products showcased below are a small sampling of Keysight's portfolio in the PXI and AXIe modular form factor. For a full offering visit www.keysight.com/find/pxicatalog.






Model	Description	Performance
 <p>M9202A</p>	<p>PXIe IF Wideband IF Digitizer</p> <p>The M9202A is a one-slot 3U PXIe wideband IF digitizer running at 2 GS/s, with up to 1 GHz instantaneous analog bandwidth. The M9202A features a Xilinx® Virtex-6 FPGA that can implement different functionalities depending on which firmware option you choose.</p> <p>www.keysight.com/find/m9202a</p>	<ul style="list-style-type: none"> – Up to 2 GS/s sampling rate and 1 GHz bandwidth – 12-bit resolution – Real-time digital downconversion and data streaming
 <p>M9210A</p>	<p>PXI-Hybrid High-Speed Digitizing Scope</p> <p>The M9210A is a one-slot 3U PXI-Hybrid high-speed Digitizing Scope featuring 2 channels with 1.4 GHz analog bandwidth and up to 4 GS/s real-time sampling rate, significantly reducing data acquisition and testing times. The M9210A Digitizing Scope comes with on-board memory of up to 512 MB. Ideal for high-speed applications such as telecommunications, ATE, and semiconductor testing,</p> <p>www.keysight.com/find/m9210a</p>	<ul style="list-style-type: none"> – Up to 4 GS/s sampling rate and 1.4 GHz bandwidth – Large on-board memory up to 256 MSamples/channel – Selectable 50 Ω/1 MΩ input impedance
 <p>M9351A</p>	<p>PXI Downconverter</p> <p>The Keysight M9351A PXI downconverter converts RF signals from 50 MHz to 2.9 GHz into baseband frequency signals for use with Keysight's newest generation of PXI digitizers. The built-in pre-amp enables very low level signal measurements, down to -160 dBm, and the built-in calibration simplifies system power budget calculations.</p> <p>www.keysight.com/find/m9351a</p>	<ul style="list-style-type: none"> – Frequency range: 50 MHz–2.9 GHz – Multiple programmatic interfaces for easy integration into existing tests – Built-in pre-amp for low-level measurements – Image protected conversion—no need for a preselector
 <p>M9361A</p>	<p>PXI Downconverter</p> <p>The Keysight M9361A PXI downconverter converts microwave signals from 2.75 GHz to 26.5 GHz into baseband frequency signals centered at an IF frequency of 500 MHz. The built-in pre-amp enables very low level signal measurements, down to -160 dBm, and the built-in calibration simplifies system power budget calculations.</p> <p>www.keysight.com/find/m9361a</p>	<ul style="list-style-type: none"> – Frequency range: 2.75 GHz–26.5 GHz (under range to 2.25 GHz) – Aux input/switch for signal routing – Multiple programmatic interfaces enable easy integration into existing test environments
 <p>M9362A-D01</p>	<p>PXI Four Channel Downconverter</p> <p>The Keysight M9362A-D01 is well suited for wideband signal capture where multiple channels are required for applications such as multi-channel coherent signal analysis, radar, SIGNIT, ELINT, MASINT, EW signal capture and analysis, and RF and microwave recording and analysis.</p> <p>www.keysight.com/find/m9362a</p>	<ul style="list-style-type: none"> – Frequency range: 10 MHz–26.5 GHz or 50 GHz – 1.5 GHz bandwidth per channel – 4-channel coherent downconversion

Research and Design Instrumentation

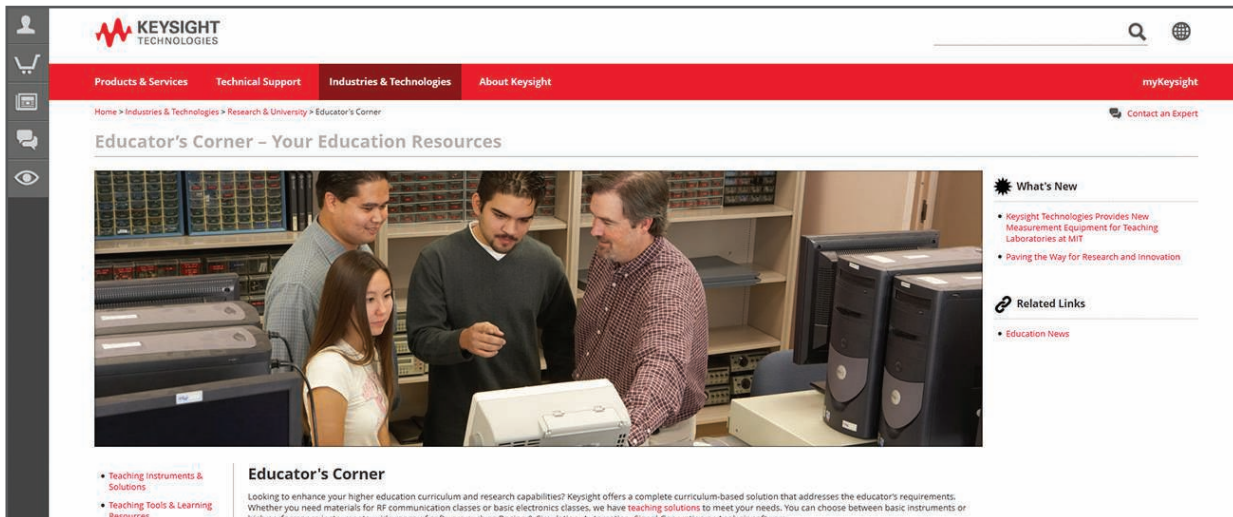
The products showcased below are a small sampling of Keysight's portfolio in the PXI and AXIe modular form factor. For a full offering visit www.keysight.com/find/pxicatalog.

Model	Description	Performance
 <p>M9330A</p>	<p>PXI Arbitrary Waveform Generator</p> <p>Keysight's M9330A arbitrary waveform generator delivers unprecedented performance for creation of complex wideband waveforms. High sampling rate and high bit resolution provided in a single instrument enable designers to create ideal waveforms for accurate test of radar, satellite and frequency agile systems. Each channel of the M9330A provides 500 MHz of modulation bandwidths and over 65 dBc of spurious free dynamic range. When the M9330A is combined with a wideband I/Q upconverter, modulation bandwidth of 1 GHz can be realized at microwave frequencies for authentic signal simulations for IF and RF subsystem test. Typical applications using these products include RADAR, EW T&M, UWB T&M, aerospace defense T&M and commercial T&M applications.</p> <p>www.keysight.com/find/m9330a</p>	<ul style="list-style-type: none"> – 15-bit resolution, -65 dBc harmonic distortion, -150 dBc/Hz noise floor – 1.25 GS/s sampling rate for 500 MHz of bandwidth per channel – Very high signal quality arbitrary waveform generator – 1 GHz modulated bandwidth – Advanced sequencing engine
 <p>M9381A</p>	<p>PXI Vector Signal Generator</p> <p>The Keysight M9381A is a 1-MHz to 3- or 6-GHz VSG that combines fast switching and excellent RF parametric performance: high output power, linearity and superior level accuracy, outstanding adjacent channel power ratio performance (for output levels up to +10 dBm or more) and wide modulation bandwidth (up to 160 MHz) for testing RF devices.</p> <p>www.keysight.com/find/m9381a</p>	<ul style="list-style-type: none"> – Frequency: 1 MHz to 3 GHz or 6 GHz – 10 us switching speed with an exclusive baseband tuning technology innovation – RF modulation bandwidth up to 160 MHz (± 0.3 dB flatness) – Better than ± 0.4 dB absolute amplitude accuracy
 <p>M9703A</p>	<p>AXIe Digitizer</p> <p>Based on the AXIe standard, the M9703A is a revolutionary 8-channel, 12-bit digitizer, able to capture signals from DC up to 2 GHz at 1.6GS/s. The interleaving capability of this high-speed digitizer allows waveform acquisition at up to 3.2 GS/s with exceptional measurement accuracy. The Keysight M9703A also provides very long acquisition capability by implementing up to 4 GBytes internal memory and real-time data processing with four Virtex 6 FPGAs.</p> <p>www.keysight.com/find/m9703a</p>	<ul style="list-style-type: none"> – Up to 3.2 GS/s sampling rate – 8 channels with 12-bit resolution and a DC to 2 GHz frequency range – Wideband real-time digital downconverter (DDC)
 <p>M8190A</p>	<p>AXIe Arbitrary Waveform Generator</p> <p>Keysight AWG is the source of greater fidelity, delivering high resolution and wide bandwidth – simultaneously. This unique combination lets you create signal scenarios that push your design to the limit and bring new insight to your analysis.</p> <p>www.keysight.com/find/m8190a</p>	<ul style="list-style-type: none"> – 14-bit resolution up to 8 GSa/s – 12-bit resolution up to 12 GSa/s – Up to 80 dBc SFDR – 2 GSa memory per channel – 5 GHz analog bandwidth

Research and Design Instrumentation

Model	Description	Performance
	<p>Optical Extenders</p> <p>The Optical Extenders for Instrumentation offer capability that is modular, scalable and upgradable to meet the demands of applications requiring long distance RF paths. Configure a single link, extend the PNA port, or design a system that includes remote operation of the measurements while achieving an RF signal path over long distances.</p> <p>www.keysight.com/find/oxi</p>	<ul style="list-style-type: none"> - 300 kHz–26.5GHz or 50 GHz - Distances up to and beyond 1000 meters - Operates without software or controller
	<p>Network Analyzers</p> <p>Choose from a growing selection of RF and Microwave network analyzers to measure S-parameters, insertion loss, gain, return loss, balanced parameters, differential measurements, compression, distortion and noise figure.</p> <p>www.keysight.com/find/pna</p>	<ul style="list-style-type: none"> - Frequency: 1 MHz to 3 GHz or 6 GHz - 10 us switching speed with an exclusive baseband tuning technology innovation - RF modulation bandwidth up to 160 MHz (± 0.3 dB flatness) - Better than ± 0.4 dB absolute amplitude accuracy
	<p>Spectrum Analyzers</p> <p>Spectrum and signal analyzers with an extensive array, from DC–325 GHz and beyond, designed to accurately measure frequency, amplitude and modulation, including distortion, spurious, phase noise and 2G–4G wireless communications.</p> <p>www.keysight.com/find/pxa</p>	<ul style="list-style-type: none"> - Frequency range: 3 Hz to 50 GHz - Analysis bandwidth up to 250 MHz - Displayed average noise level (DANL) up to -172 dBm
	<p>Signal Sources</p> <p>Choose from the widest selection of baseband, RF, and microwave signal generator (signal source) products from baseband to 67 GHz, with frequency extensions to 500 GHz with millimeter-wave source modules. Signal generator offerings range from basic to advanced functionality; with benchmark performance to address signal source requirements in design and manufacturing.</p> <p>www.keysight.com/find/psg</p>	<ul style="list-style-type: none"> - Frequency range from baseband to 67 GHz - Switching speed to 10 μs - Output power to +24 dBm
	<p>Portable Handheld Analyzer</p> <p>FieldFox handheld analyzers are precise and portable. Every operating mode is flexible for novices and experts alike. They withstand tough working conditions and are configurable as cable and antenna analyzers (CAT), vector network analyzers, spectrum analyzers or the all in one combination analyzers.</p> <p>www.keysight.com/find/fieldfox</p>	<ul style="list-style-type: none"> - Maximum frequency range of 4 GHz up to 26.5 GHz - Wide operating temperature -10 to $+55$ $^{\circ}$C, 14 to 131 $^{\circ}$F - VNA dynamic range up to 100 dB - SNA absolute amplitude accuracy ± 0.5 dB - 3.5 hour battery life and water resistant

Resources for Lecturers Researchers and Students



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Seven Decades Innovating Across Boundaries

History

Throughout our history, Keysight has invested heavily in research and development, firmly committed to technology leadership. Our depth and breadth of disciplines and technologies enable unique and often breakthrough advancements that transcend traditional boundaries. Particularly powerful innovations result when we combine very different technologies to form something entirely new. Some synergies on this chart involve new inventions, and some meld disparate existing technologies. All have contributed results that are truly Revolutionary.

1. HETERODYNE DISTANCE MEASURING INTERFEROMETRY

This dates from 1971, and since then has been crucial in the lithography step that is key to the manufacture of integrated circuits. Over its long life this technology has been continuously refined, and today is capable of sub-1 nm measurement at extremely high data rates. It came about as the synergy of two long-standing HP/Keysight capabilities: quantum electronics and highspeed pulse counting. The former also led to the frequency standards that make Global Positioning Systems (GPS) possible.

2. POCKET CALCULATORS

In 1972 we introduced the world's first pocket calculator, the HP35, with our proprietary chips, semiconductor optical source technology for the red display light emitting diodes, high quality contacts for key pads and special algorithms for calculations. Mathematical users appreciate the Reverse Polish Notation (RPN) capability that enables them to enter complicated arithmetic expressions. Since Keysight became a company in 2000, HP has continued this business.

3. MICROWAVE SPECTRUM AND NETWORK ANALYZERS

In the 1960s we introduced the first spectrum and network analyzers for accurate measurement and analysis of radar and telecommunications signals and components. A key synergy was the development of YIG (Yttrium Iron Garnet) solid-state oscillator technology that provided a precision linear multi-octave microwave source. The YIG oscillators, combined with our GaAs microwave integrated circuits, extended the range of these instruments to more than 100 GHz by the mid-1980s. The electronics industry uses these analyzers for broadband characterization of RF and microwave signals and components for cell phones, computer backplanes and cable test.

4. PHOTONICS ANALYZERS

In the late 1980s we introduced photonics analyzers for measurement in fiber optics communications including laser transmitters and receivers, optical fiber and optical components. We combined our tunable lasers with microwave spectrum and network analyzer technologies to create a new class of photonics instruments that measure noise on lasers, electro-optical properties of lasers and signal distortion inducing effects in photonics components. Our industry-first optical spectrum analyzer employed a receiver similar to radios but worked at frequencies a factor of 200,000 higher, enabling a 1,000-fold improvement in optical resolution compared to earlier instruments. Researchers can visualize photonic signals and measure laser spectra with much greater precision than previously was possible.

5. NETWORK MONITORING

Our expertise in telecommunications test technology dates back to 1965. In 1992, augmented by our capabilities in time synchronization and computational mathematics, we developed a powerful new monitoring technology for SS7 telecommunications networks, and by 2005 this had become massively parallel and automated.

6. TUNABLE LASERS

Much like the first HP audio oscillator and YIG-based microwave oscillator, tunable lasers provided the optical source to support a wide variety of measurements, in this case for optical communications. Applying the optical source technology to the new field led to the first reliable tunable laser in the late 1980s. These precision laser sources form the foundation of a variety of measurement instrumentation and will continue to provide the laser light needed for new generations of photonics equipment.

7. OPTICAL MOUSE

In the 1980s HP realized that the fibrous structure of paper enables navigation across the surface. We made this practical with capabilities in integrated circuit design and light emitting diodes. In 1996 the blockbuster optical mouse soon displaced track-ball mice from the computer navigation market. In 2004 Keysight improved surface tracking by 20X with infrared laser technology we developed for fiber optic communications. This contribution allowed the mouse to operate on a wide variety of surfaces from carpet to photo paper. Avago Technologies (divested in 2006) continues to produce computer mice based on this technology.

Seven Decades Innovating Across Boundaries

8. RADIO FREQUENCY SURVEILLANCE

Keysight's RF surveillance technology identifies and physically locates unknown emitters within a wireless network. This synergy stems from our expertise in RF spectrum analysis and time synchronization within networks, which led to the IEEE 1588 standard. The 1588 technique allows large computer, telephone and video networks to be synchronized to within 20 nanoseconds.

9. MILLIMETER WAVE IMAGING

In the early 2000s state-of-the-art millimeter wave imaging systems used mechanically scanned linear transceiver arrays and took more than a minute to produce an image. Keysight harnessed its millimeter wave and lightwave technologies for a new approach; combining a single transceiver and an electronically controlled phased array antenna eliminates all moving parts and produces live real-time video. The antenna's computer generated millimeter wave holograms leverage previous research in diffractive optical elements for optical communications. Keysight licensed this technology to address the need for fast, accurate screening of people in airports.

10. SCANNING MICROWAVE MICROSCOPE

Network analyzers, image processing and atomic force microscopes (2005 acquisition of Molecular Imaging) are key Keysight technologies. In 2008 Keysight created an entirely new measurement platform— scanning microwave microscopy—by combining these three core capabilities from our electronic and bioanalytical businesses. The resulting platform provides significant new surface characterization capability for engineers and life scientists.

11. 30 GHz OSCILLOSCOPE

For several decades, Keysight has developed some of the world's highest performance integrated circuit technologies using gallium arsenide, indium phosphide and other compound semiconductor materials. These exotic materials enable performance unobtainable by conventional silicon IC technology, often leading to instrument specifications that competitors cannot match. Keysight's 30 GHz oscilloscopes include the synergy of our wide bandwidth proprietary compound semiconductor chips, our high performance ceramic microcircuit technology and Keysight-designed 20 billion sample per second CMOS analog-to-digital converters.

12. NETWORK SURVEILLANCE

In 2007 engineers realized that technologies to assure telecom network performance also could monitor network security. Based on this passive telecom network management expertise, Keysight launched a new business in network surveillance that couples our telecom solutions with our strengths in RF surveillance.

13. OPTICAL MODULATION ANALYZER

In 2009 we introduced the optical modulation analyzer (OMA) to measure the new types of signals (utilizing phase and polarization properties of light) that increase efficiency of fiber-optic pipes that transport Internet traffic. The OMA combines our tunable lasers, advanced photonics test algorithms, wide bandwidth oscilloscopes and vector signal analysis software used in microwave spectrum analyzers for wireless communications. These analyzers enable communications researchers to tune to an optical wavelength channel, quickly assess the quality of the complex 100G signals on that channel and measure degradations due to the fiber optic link.

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