Keysight Technologies
LTE and LTE-Advanced Solutions

KEYSIGHT
TECHNOLOGIES
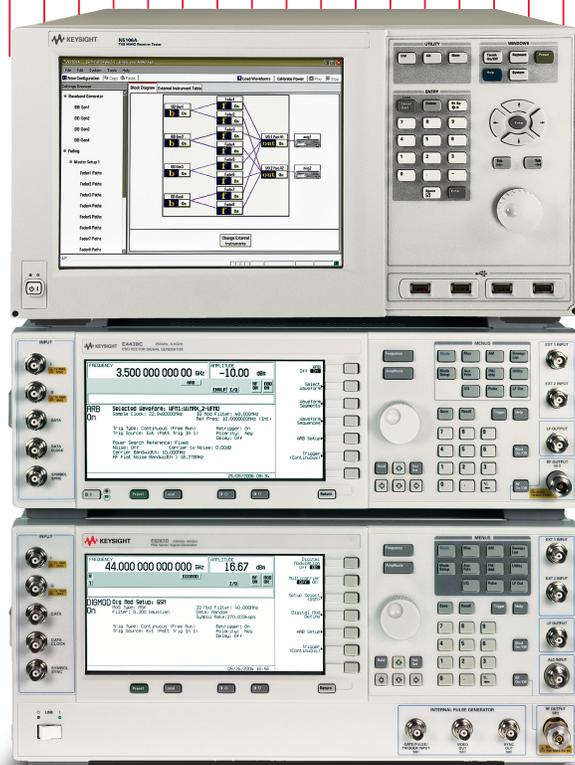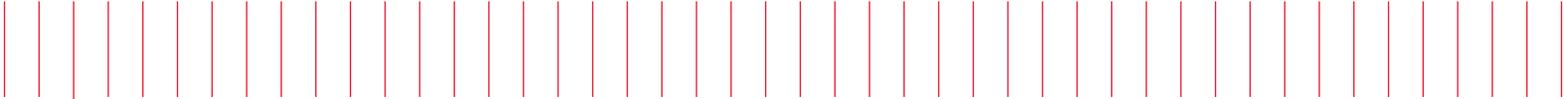
Accelerate Wireless Design and Test
With flexible, high-performance platforms

Today LTE or Long Term Evolution is well on its way to becoming the first single global standard for cellular communications. Providing the delivery of the next generation of mobile broadband, LTE and now LTE-Advanced continues to provide many challenges to the engineers developing and delivering products that work to the standards.

Keysight Technologies, Inc. is a leader in wireless test, focused on the highest-performance design and test of wireless devices and networks, with application-focused platforms optimized for existing and emerging standards. Integrated platforms feature the industry's broadest range of both hardware (benchtop and modular instruments) and software building blocks, and span the entire development cycle—from early design simulation to manufacturing. Leveraging Keysight unparalleled wireless measurement and application expertise, these building blocks help you anticipate and respond to emerging RF challenges in wireless devices and networks with the high performance and flexibility needed to provide the right solution for any situation.

Keysight is a member of 3GPP and an active contributor to the development of next-generation specifications. Keysight product plans are based on the knowledge and insight gained from this participation to ensure our suite of design and test solutions keep pace with evolving technology. Our robust knowledge library of application notes, webcasts, videos, CDs and now with our 2nd Edition of the LTE book is designed to help you interpret, clarify and test to an evolving LTE and LTE-Advanced standard. Accelerate wireless design and test.

Keeping Pace with Technology

LTE-Advanced

Moving Forward to Increase Capacity

LTE-Advanced is the evolved version of LTE that is being developed by 3GPP to meet or exceed the requirements of the International Telecommunication Union (ITU) for a true fourth generation radio-communication standard known as IMT-Advanced. LTE-Advanced is defined in Release 10 and all the follow on releases including Release 12. LTE-Advanced is focused on higher capacity with increased peak data, higher spectral efficiency, increased number of simultaneously active subscribers and improved performance at cell edges.

TD-LTE

Evolving LTE Specifications — from FDD-LTE to TD-LTE

Following the integration of the Chinese TD-SCDMA standard, based on Time Division Duplex (TDD), into the 3GPP specifications for LTE, chipset and device designers are now working to include TDD capability. Now known as TD-LTE, the standard caters to the asymmetric needs of mobile data usage, and allows carriers to make use of the unpaired spectrum that many of them already own. Keysight was the first to provide solutions for testing this new technology and currently offers TD-LTE solutions from design simulation to signal generation and analysis.

MIMO

New Multiple Input Multiple Output Transmission Scenarios

The specified RF environment for LTE includes not only basic signal transmission and reception, but also multiple input multiple output (MIMO) scenarios with up to four separate transmitters and receivers. For module and component test, complex frame-based test signals are passed through the device under test and measured using vector signal analysis to determine EVM and CCDF. Keysight offers a complete set of design and test solutions for MIMO technology—from design simulation to signal generation and analysis through manufacturing and deployment.

Heterogeneous Networks

Adding to the LTE Architecture with Small Cells

Another way to expand capacity is with small cells. Small cells offer flexibility, bring down the costs of installation and lower power usage but they also bring along test challenges such as interference design and test and the need for lower cost manufacturing. Building on our demonstrated history of leadership and proven track record delivering base-station test equipment, Keysight offers small cell design and test solutions to help you meet your design and production-cost goals.
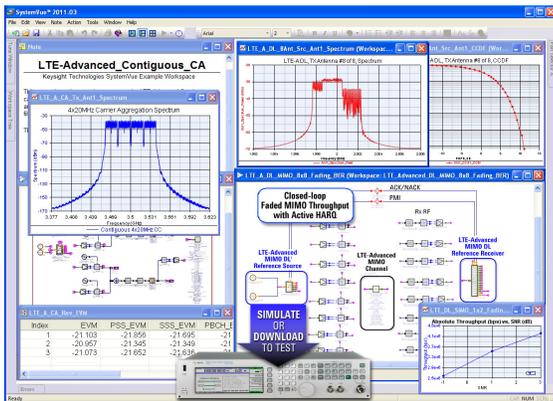
LTE Design Simulation

Baseband Design & Verification

– System-level architecture design
– Baseband algorithm and hardware implementation
– RF/Baseband co-verification with test equipment

Keysight's SystemVue is a multi-domain modeling & verification cockpit for electronic system-level (ESL) design. SystemVue that accelerates physical layer designs by integrating popular DSP modeling and implementation interfaces, such as MATLAB, C++, and VHDL, along with accurate RF EDA tools, Standards/IP references, and Test & Measurement links into a single, highly productive environment. Simulation-based TX and RX references are available for LTE-Advanced, 4G MIMO Channel models, older 3GPP standards, as well as DPD/CFR algorithms, allowing the earliest possible validation of RF and baseband components, even before hardware is available. SystemVue also interoperates with Keysight instruments and test software to unify the R&D development lifecycle.

SystemVue provides simulation references for 3GPP standards such as LTE-Advanced, allowing baseband, RF, and test engineers to validate TX and RX signal path designs.

RF Design & Verification

– Create waveforms to measure EVM, PAPR, CCDF, and ACLR performance
– Perform receiver measurements
– Access 3GPP LTE test benches for RFIC designers

Keysight's 3GPP LTE wireless library provides signal processing models and preconfigured simulation setups for Keysight's Advanced Design System (ADS) EDA software. The ADS 3GPP LTE wireless library enables you to create spectrally correct test waveforms that comply with 3GPP requirements, saving valuable design and verification time for RF designers and system integrators. The models and simulation test benches can be used as "Golden Reference" for simulation and verification of baseband algorithms, digital baseband/IF systems, and verification RF circuitry used in 3GPP LTE designs. Keysight's 3GPP LTE wireless library also can be imported into Keysight's RF Design Environment (RFDE), allowing RFIC designers to access 3GPP LTE test benches within the Cadence Virtuoso Custom IC platform through links developed as one result of the ongoing alliance between Keysight and Cadence. This enables early verification of PHY performance of RF hardware before committing RFIC and board designs to fabrication, saving costly design turns.

Keysight's unique connected solutions allows virtualization of a working RF physical layer, allowing RF and baseband designers to co-verify interoperability and system performance months before a completed hardware prototype can be formally tested.
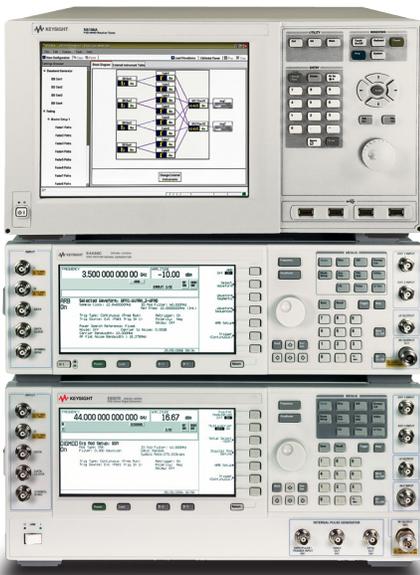
LTE Uplink and Downlink Signal Generation

Keysight has built a solid reputation in the mobile communications industry with the combination of our signal generators and Signal Studio signal creation software. The versatile and comprehensive software is available for the development and manufacturing of existing and evolving 2G, 3G, 3.5G and 4G communication systems. You can quickly and easily create performance-optimized LTE reference signals for component-level parametric test, baseband subsystem verification, receiver performance verification and advanced functional evaluation.

Speed Signal Simulation with Signal Studio LTE Applications

Signal Studio applications enable the configuration of standard-based test signals to verify the performance of components, receivers, and baseband ASICs for multiple technologies. Use this software with the Keysight MXG signal generator for the industry's best adjacent channel leakage ratio (ACLR) performance making it ideal for the characterization and evaluation of BTS components such as multi-carrier power amplifiers. For applications that require lower phase noise, the best level accuracy, or digital I/Q inputs and outputs then use Signal Studio software with the Keysight ESG signal generator. Additionally Signal Studio software can be used with the Keysight

PXB baseband generator and channel emulator for applications that require MIMO fading, creation of interfering stimulus, digital I/Q inputs and outputs, real-time signal creation or closed loop testing of advanced LTE capabilities like HARQ. Highlights of LTE Signal Studio Software include:

– Create FDD and TDD frame structures (type 1/type 2)
– Physical layer coded signals for component test
– Transport channel coded signals for receiver test
– Create all LTE bandwidths: 1.4 MHz to 20 MHz
– Create all modulation types: BPSK, QPSK, 16QAM, and 64QAM
– Up to 8x8 MIMO configurations (spatial multiplexing/TX diversity)
– Real-time fading with the Keysight PXB for up to 4x2, 8x2, and 4x4 MIMO
– Predefined setups for fixed reference channels and E-UTRA test models
– Create MSR (Multi-Standard Radio) waveforms with combinations of LTE, W-CDMA/HSPA, and GSM/EDGE
– Create mixed carrier configurations with combinations of 2G, 3G, and 4G Signals
– Coexistence testing using the Keysight PXB with 4 independent baseband generators
– Create multi-carrier signals for uplink and downlink
– Real-time HARQ & Timing Adjustment feedback for performance requirements testing
– Create envelope tracking signals for testing new PA designs

Industry-leading performance with the Keysight PXB baseband generator and channel emulator and the Keysight MXG and ESG vector signal generators.
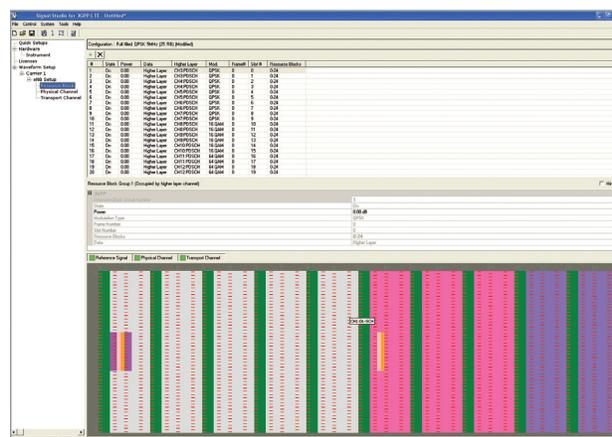

Flexible resource mapping with scalable system bandwidth is available with Keysight's Signal Studio Software.

LTE Baseband Analysis

LTE Digital Real-Time Decode & Debug

Combine Keysight's vector signal analysis software with Keysight's Infiniium 90000A, 90000X, or 90000Q series oscilloscopes to analyze wideband and multi-channel signals. The 90000 A, X, and Q series oscilloscopes provide up to 13, 33, and 63 GHz of analysis bandwidth respectively and are well suited to digitizing satellite, LMDS, and MMDS signals, as well as WiMedia-based UWB or other extremely broadband

signals. Four-channel Infiniium scopes can also make the coherent two, three, and four channel MIMO measurements needed for IEEE 802.11ac, WiMAX™, and LTE-Advanced. The acquired signals can be analyzed using Keysight's 89600 Vector Signal Analyzer software directly on the oscilloscope, or transferred via GPIB, USB, or LAN to an external PC running the 89600 software. The frequency, time, and modulation analysis tools of the 89600 VSA can be used to evaluate and troubleshoot the signal.
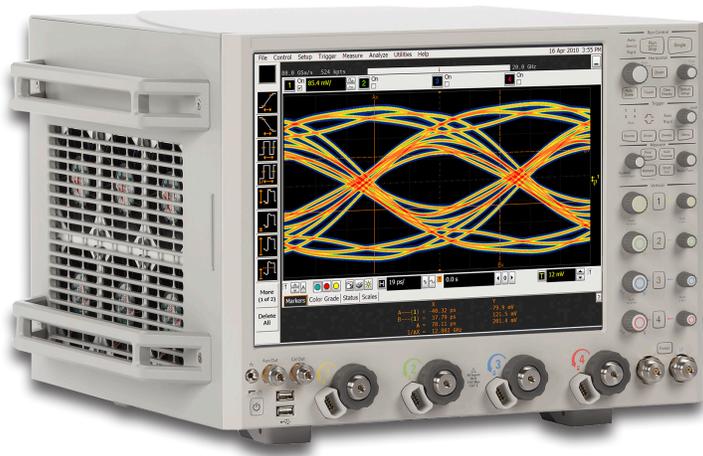
Keysight Infiniium 90000 A, X, and Q series of high performance real-time oscilloscopes deliver superior signal integrity for world class signal analyzer measurement performance. They offer the industry's lowest DANL, best amplitude accuracy, deepest acquisition memory (up to 2 Gpts).

Troubleshoot digital glitches with the Keysight DSO90000A high-performance, real-time oscilloscope.
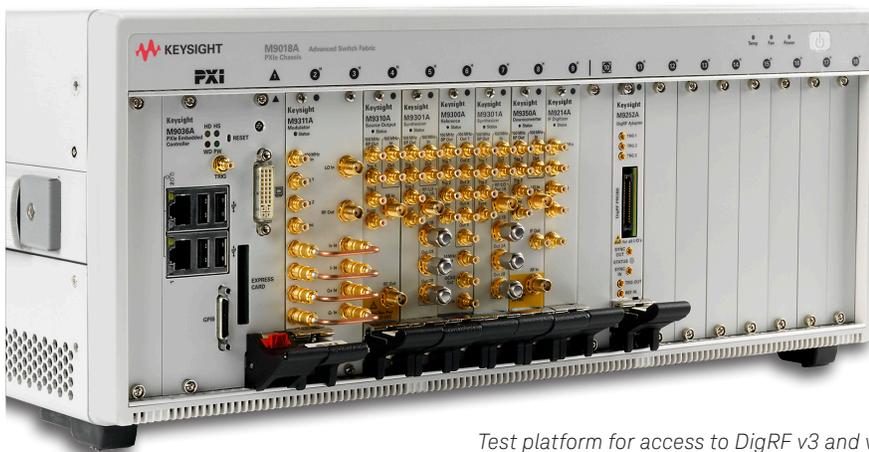
Test platform for access to DigRF v3 and v4 interfaces as well as digital IQ data.

DigRF Digital Interface

If you are using the MIPI DigRF v4 based BBIC and RFIC components, the Keysight M9252A PXI test module, combined with the Keysight M9381A VSG and the M9391A PXI VSA , provide a complete test solution to characterize and validate your design in both Digital and RF domains.

For RFIC test, the M9252A provides simultaneous generation and analysis of control traffic and signals, helping you validate both uplink and downlink paths.

LTE/LTE-Advanced Uplink and Downlink Signal Analysis for R&D

Development becomes more complex when faster data rates intersect with today's crowded spectral environment. Finding a signal problem is essential—but achieving the clarity to pinpoint the answer is the crucial challenge. The 89600 VSA software is a comprehensive set for demodulation and vector signal analysis. These tools, in combination with Keysight's X-Series (PXA/MXA/EXA/CXA) signal analyzers, enables you to explore virtually every facet of your LTE/LTE-Advanced signal and optimize your most advanced designs. As you access the tradeoffs, the 89600 VSA helps you see through the complexity.

See Through the Complexity of Your LTE/LTE-Advanced Signals with the 89600 VSA Software

The 89600 VSA software provides the most comprehensive set of demodulation tools to analyze LTE and LTE-Advanced RF and baseband designs with powerful troubleshooting tool to characterize signals and identify errors and their causes:

- Analyze both downlink (DL) and uplink (UL) LTE/LTE-Advanced signals, for FDD and TDD modes, all bandwidths and all modulation formats
- Inter-band and intra-band carrier aggregation with up to 5 component carriers for LTE-Advanced
- Up to 8x8 DL MIMO analysis for LTE-Advanced; up to 4x4 MIMO for LTE; and up to 8 channel beam-forming for LTE FDD and TDD
- Decode and verify layer 2 and layer 3 LTE messages with 89600 wireless link analysis (WLA) software
- View virtually every facet of a signal with color-coded results. Perform measurements on the entire signal or on individual channels.
- Get greater clarity with an unlimited number of traces and markers, and trace-to-trace marker coupling.

Keysight PXA high performance signal analyzer with LTE software running internally.
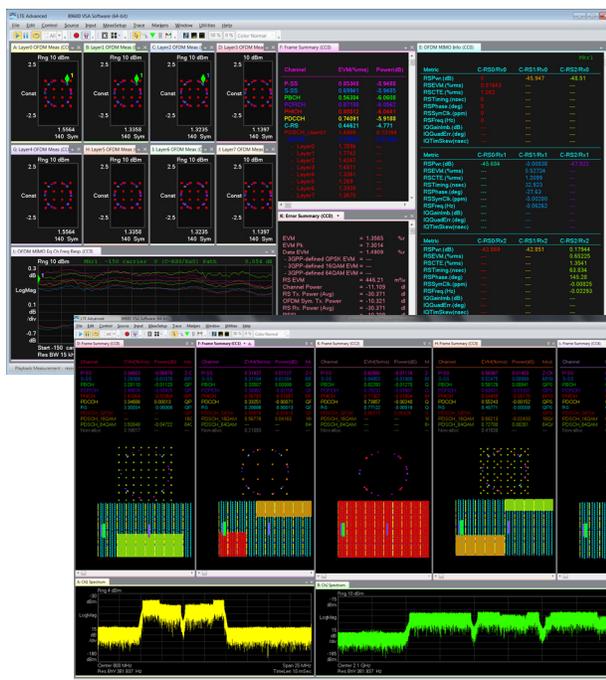
LTE-Advanced 8x8 MIMO analysis showing per layer error traces and tables as well as frequency response trace color-coded for each layer.

Fully characterize up to 5 component carriers—simultaneously.

89600 WLA showing LTE-FDD PHY, MAC, RLC and RRC messages with their decoded content.

LTE Device Development

E6621A PXT Wireless Communication Test Set

The Keysight E6621A PXT wireless communication test set is designed to provide RF and Functional Test

The E6621A PXT wireless communication test set—for LTE UE RF and Functional Test.

solutions for LTE chipset and UE design, integration, and validation test. Highlights of the Keysight E6621A include:

– Real-time, bench top network emulation for easy-to-use, real-world design
  integration and validation testing
– 2-cell eNode-B emulation
– LTE TX and RX measurements
– 6 GHz frequency range and internal PC controller with Windows XP
– Cat 3 end-to-end IP data rates with 2x2 MIMO
– Inter-RAT handover test with the Keysight 8960

LTE Uplink and Downlink Signal Analysis for Automation Test

Speed your LTE time to market with the Keysight X-Series N9080A LTE FDD and N9082A LTE TDD measurement applications. Based on the industry-leading 89600 VSA software's LTE modulation analysis option, the N9080A and N9082A provides the same rich feature set plus:

– SCPI remote user interface for automation test
– Hardkey/softkey manual user interface using the familiar Keysight X-Series signal analyzer front panel
– One-button, standard-based power measurements (channel power, ACP, SEM etc.) with pass/fail tests

Supported features:

– Uplink (SC-FDMA) and downlink (OFDMA) in a single option
– All LTE bandwidths: 1.4 MHz (6 RB) to 20 MHz (100 RB)
– E-UTRA Test Models (E-TM) recall function for RF power measurements as well as modulation quality measurements
– Channels and signals color-coded to highlight errors
– Analysis of data in a frame, sub-frame, slot, symbol, sub-carrier, and resource block
– Flexible markers: Up to 12 markers that can be coupled across different measurements and traces
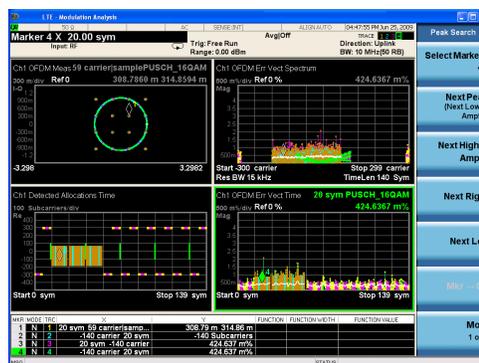
Modulation analysis measurement with marker coupling across all traces.
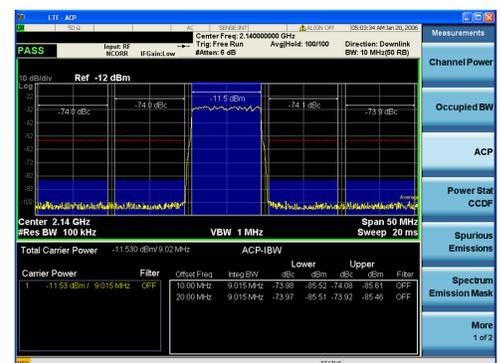
One-button ACLR measurement with pass/fail limit for E-UTRA Test Model (E-TM) waveform.

LTE UE Compliance Test

Keysight offers RF, RRM and Signaling conformance test solutions and new products for LTE and inter-system testing.

Not Just Conformance, But a Whole Lot More

As LTE and other data-centric technologies eclipse earlier standards; test labs, service providers and device makers are embracing new test paradigms.

Compliance test themes are used across the development cycle for cellular products. Sensitivity, spectral and modulation quality measurements are traceable to techniques defined by industry standards bodies. Signaling Conformance Test, RF Conformance Test and RRM test performed in accredited testing laboratories provide a foundation for the smooth operation of multi-vendor global standards. GCF and PRCRB test regimes, operator test plans, performance and interoperability test have grown dramatically as newer radio formats squeeze ever higher data rates from limited spectrum. Equipment makers build their design verification, pre-conformance and regression test plans to enable products to smoothly move from the development lab and into the hands of delighted consumers. Keysight works hand-in-hand with reference design makers, device makers, operators and test labs at every stage in the development and conformance test cycle.

The T4000S family of products is the Keysight solution for conformance and design verification testing of LTE UE RF, RRM and protocol requirements. The T4000S products are built around the T2010A LTE Wireless Communication Test Set, a powerful multi-RAT network emulator with an integrated fader and noise generator, supporting up to MIMO 4x2 channel emulation.

Since all systems within the T4000S family share the same underlying hardware and software platform, RF, RRM and Protocol testing capabilities can coexist on the same test system for maximum convenience and cost-effectiveness. The T4010S system is the solution for LTE RF conformance and design verification testing of LTE devices, while the T4020S and T4110S systems support RRM and Protocol conformance test requirements, respectively.

The T4000S systems are targeted at laboratories within UE and chipset manufacturers and third party certification test houses. The validation status over an increasing number of bands, and the support of GCF and PTCRB specific requirements, together with the complete test system automation capabilities and reduced overall footprint make the Keysight T4000S the most competitive test platforms to have in any laboratory environment.

T4010S LTE RF Conformance Test Solution
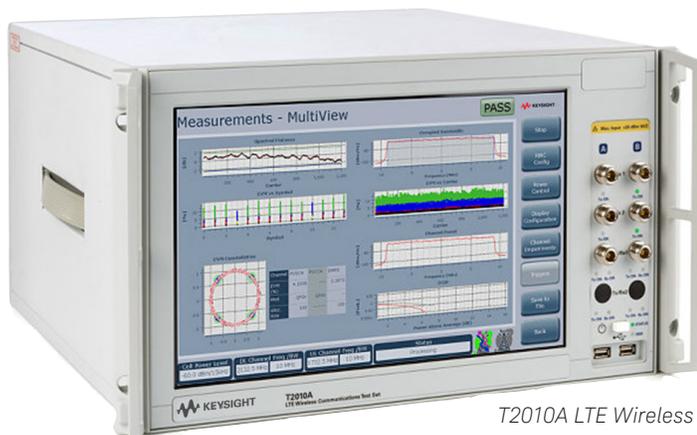
T2010A LTE Wireless Communication Test Set

LTE Manufacturing Test

In wireless device manufacturing, meeting ever-tougher goals and tighter schedules is easier when you have access to the best resources. Look to Keysight and our new EXM wireless test set. It's scalable to meet your production needs and in sync with the latest cellular and WLAN chipsets. Better yet, the EXM delivers the speed, accuracy and port density you need to ramp up rapidly and optimize full-volume manufacturing.

Optimize multi-device testing with up to four TRX channels per EXM. Cover up to 6 GHz with 160-MHz bandwidth through each transmit/receive (TRX) channel. Create high-density multi-port test stations with two full-duplex and two half-duplex ports per TRX. Customize to connect up to 32 DUTs with multi-port adapter (MPA) technology.

Test multi-format devices including 2G, 3G and 4G cellular as well as WLAN. Cellular technologies include LTE-Advanced, LTE FDD/TDD, HSPA+, W-CDMA, 1xEV-DO, cdma2000®, GSM/EDGE Evo and TD-SCDMA. Add in WLAN 802.11ac, 802.11a/b/g/n, *Bluetooth*®, GPS/GNSS, and digital video and you have a powerful multi-format instrument.

Maximize throughput with raw hard-ware speed and advanced sequencing. Get ultra-fast data processing with quad- core controller and high-speed PXIe backplane. Accelerate test execution with advanced sequencing and single-acquisition multiple measurements.

Increase first-pass yield with superior signal purity and measurement accuracy with receiver EVM for 160 MHz 802.11ac: < −42 dB and absolute level accuracy, 380 MHz to 3.8 GHz: at < ±0.5 dB (nominal).

Get up and running in hours, not days, with validated turnkey chipset solutions.
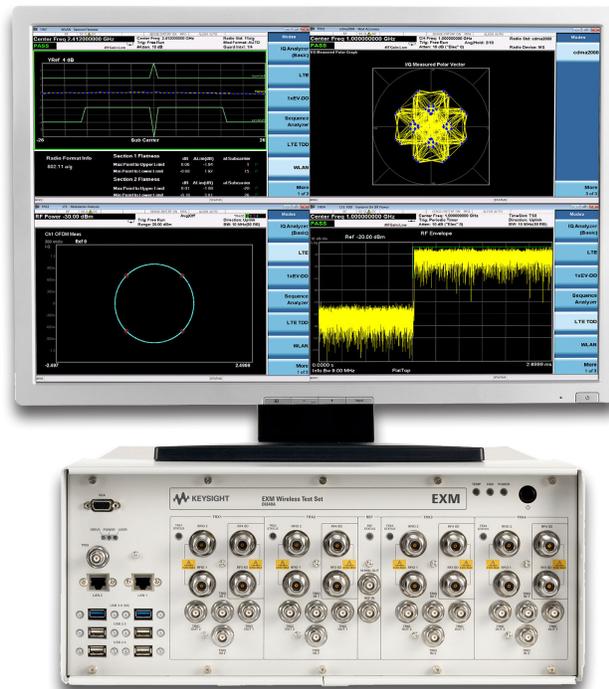
Use the EXM with four TRX channels to parallel test wireless devices. WLAN, cdma2000, LTE FDD and LTE TDD shown.

Modular Solutions Give You a Choice

As we continue to innovate in PXI, our goals are to help you accelerate time-to-market and achieve a lower cost of test. Through a growing range of PXI modular products, Keysight provides quality, performance and measurement expertise to bring you breakthrough capabilities. To help you quickly develop test systems with your software platform of choice, Keysight provides PXI modules with a comprehensive portfolio of instrument drivers, documentation and examples for Microsoft C/C++, C#, or Visual Basic, MATLAB, VEE, LabVIEW and LabWindows/CVI software platforms.

The Keysight M9391A PXIe vector signal analyzer (PXI VSA) is a modular solution that provides frequency coverage from 1 MHz to 3 or 6 GHz and works seamlessly with the M9381A PXI VSG. The combined PXI VSA/G provides a complete solution for fast, high quality measurements optimized for RF manufacturing test environments. Keysight's X-series measurement applications, 89600 VSA software and SystemVue further increase the efficiency of the PXI VSA.

The M9391A PXI VSA is MIMO ready, enabling design validation engineers to ensure their LTE designs perform well under a variety of conditions. MIMO transmitter testing is based on Keysight's industry-recognized 89600 VSA software with full support for PHY-layer measurements including MIMO EVM, cross-channel isolation, and channel flatness.

The Keysight M9381A PXIe vector signal generator is a compact modular solution that provides frequency coverage from 1 MHz to 3 GHz or 6 GHz. The M9381A reduces test time with fastune, an exclusive baseband tuning technology innovation, enabling you to switch amplitude and frequency in less than 10 µs.

The M9381A PXI VSG is MIMO ready, enabling design validation engineers to ensure that their LTE designs perform well under a variety of conditions. MIMO receiver testing is supported by Keysight's multi-format Signal Studio software, with full support for LTE and LTE-Advanced standards.

Combine the M9391A PXIe vector signal analyzer with the M9381A PXIe vector signal generator for a fast, compact RF component test solution.

Network Deployment and Optimization

Carry Precision With You

Measuring up and earning a spot in your kit is the driving idea behind Keysight's FieldFox analyzers. Carry the precision of our microwave models: they deliver Keysight-quality measurements wherever you need to go. Boost your readiness with an RF unit: every operating mode is flexible enough to meet the needs of novices and experts alike. And count on the durability of handheld analyzers designed to withstand your toughest working conditions. Add FieldFox to your kit—and see how it measures up.

Available with a maximum frequency range of 4 GHz up to 26.5 GHz, FieldFox portable analyzers are configurable as cable and antenna analyzers (CAT), vector network analyzers, spectrum analyzers and all-in-one combination analyzers.

To save space in a field kit, built-in capabilities can be added to provide up to 10 instruments in 1. Additional capabilities include: power meter, independent signal generator, vector voltmeter, interference analysis, variable DC source, frequency converter, and GPS receiver.

With FieldFox, verify eNB transmitter performance simply using one-button GSM/WCDMA/LTE power measurements. You can detect intermittent signals using the built-in spectrogram and waterfall display, record and playback functions. Plus, easily locate interfering signals in a complex signal environment with FieldFox's best-in-class dynamic range of 96 dBc, combined with fast sweep times under narrow resolution bandwidths.

Designed for the field environment, the N9912A FieldFox RF Analyzer, Handheld Cable and Antenna Analyzer and Handheld Spectrum Analyzer works to 4 or 6 GHz.
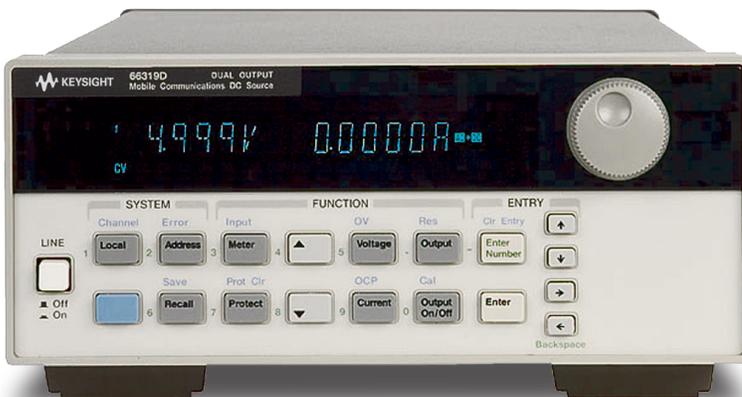
66319D Dual Mobile Comm DC Source with Battery Emulation

Battery Current Drain Measurement and Analysis

The Keysight 14565B software and 66319D/21D DC source provide a ready-to-use solution for battery current drain measurement and analysis for optimizing the power consumption of your devices. The 66319D/21D is a specialized DC source for testing LTE and other wireless mobile devices. It has a 15 V, 3 A output, a high-speed 64 KSa/sec 16 bit digitizer, and 3 current measurement ranges for making accurate current drain measurements from micro amps to amps, for testing off, sleep, and active operating modes of the DUT.

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