

# Greater Insight into LTE Design and Test



**Agilent Technologies**



*Third-generation (3G) wireless systems, based on W-CDMA, are deployed all over the world. W-CDMA maintains a mid-term competitive edge by providing high-speed packet access (HSPA) in both downlink and uplink modes. To ensure competitiveness into the future, the long-term evolution (LTE) of the 3rd Generation Partnership Project's (3GPP) UMTS is first specified in release 8 of the 3GPP specification, and covers the emerging needs of "mobile broadband" into the next decade.*

As a world leader in test and measurement solutions, Agilent Technologies is at the forefront of LTE, offering design and test solutions for the entire lifecycle — from early RF and digital design through conformance testing to network deployment and service assurance.

## **Agilent LTE Design and Test Portfolio — *Greater insight. Greater confidence.***

Agilent is a member of 3GPP and an active contributor to the development of next-generation specifications, including both the Frequency Division Duplex (FDD) and Time Division Duplex (TDD) variants of LTE and the concurrent System Architecture Evolution (SAE) required to realize full performance potential. We create our product plans based on the knowledge and insight gained from this participation to ensure our suite of design and test solutions keep pace with evolving technology.

Agilent is committed to helping you understand the intricacies of this evolving standard so you can get your products to market fast. Agilent's LTE design and test portfolio offers the broadest set of 3GPP LTE design and test tools from design software to signal analysis to conformance test and more. Our robust knowledge library of application notes, CDs and more is designed to help you interpret, clarify and test to an evolving LTE standard. Agilent LTE Design and Test Portfolio – *Greater insight. Greater confidence.*



## Keeping Pace with Technology

### 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. Agilent 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. Agilent offers a complete set of design and test solutions for MIMO technology – from design simulation to signal generation and analysis through manufacturing and deployment.

### Femtocells

#### Adding to the LTE Architecture with Femtocells

New network components such as femtocells, also known as access-point base stations, are home and small-office base stations designed to connect to the cellular network via DSL or cable modem broadband connections. W-CDMA and HSPA+ femtocells are commercially available, and LTE femtocells are in development. Building on our demonstrated history of leadership and proven track record delivering base-station test equipment, Agilent offers femtocell design and test solutions to help you meet your design and production-cost goals.

### *Moving Forward with Evolving Technologies*

*The complexity inherent in these evolving technologies brings both development and test challenges to the engineers involved in product development – from components to complete systems. Agilent is committed to the wireless communications industry and is dedicated to ensuring that test will never stand in the way of meeting your time-to-market goals with these evolving technologies.*

# LTE Design Simulation

## Baseband Design & Verification

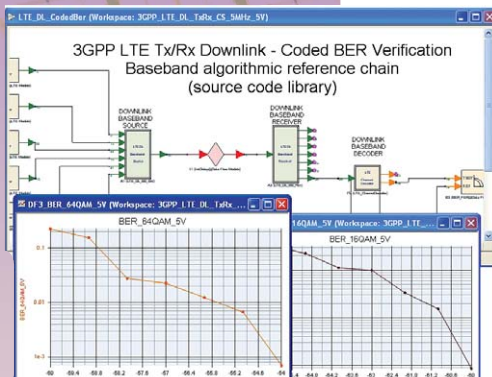
- System-level architecture design
- Physical-layer (PHY) algorithm development
- Signal processing hardware

Agilent's SystemVue 2008 is a new electronic system-level (ESL) design environment for baseband PHY architectures and algorithms. SystemVue provides two levels of capability for 3GPP LTE that bring instrument-like compliance to your earliest design efforts. SystemVue's baseband verification library is a fast, pre-built set of parameterized LTE algorithmic reference models that provide a "gold" standard to compare waveforms and generate test vectors at any point within a signal processing chain. The baseband exploration library goes further and opens up the algorithmic source code to help you create LTE designs even faster.

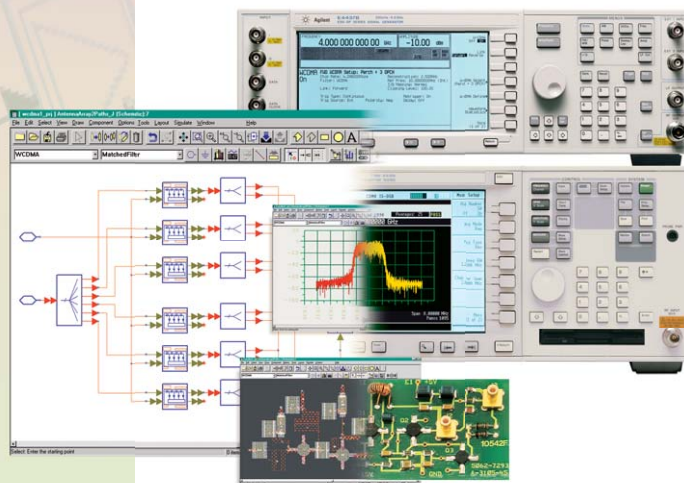
## RF Design & Verification

- Analog/RF design & verification
- System-level PHY integration
- Connected analog/digital co-verification

Agilent's 3GPP LTE wireless library for ADS saves valuable design and verification time for RF designers and system integrators, and helps improve raw, uncorrected PHY performance. This library provides signal processing models and preconfigured simulation setups for use within Agilent's ADS software. It creates and demodulates spectrally correct test signals that comply with the latest LTE specifications, including MIMO and TDD. This enables early verification of PHY performance of RF hardware before committing RFIC and board designs to fabrication, saving costly design turns. Unlike other solutions, Agilent's ADS library allows you to combine live, high-performance RF simulations, baseband simulations, and standards-compliant measurements from the real world to accelerate the integration and test phase of an overall working PHY.



Speed prototype design by measuring EVM, PAPR, CCDF and ACLR with Agilent's 3GPP LTE Wireless Library.



Agilent'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

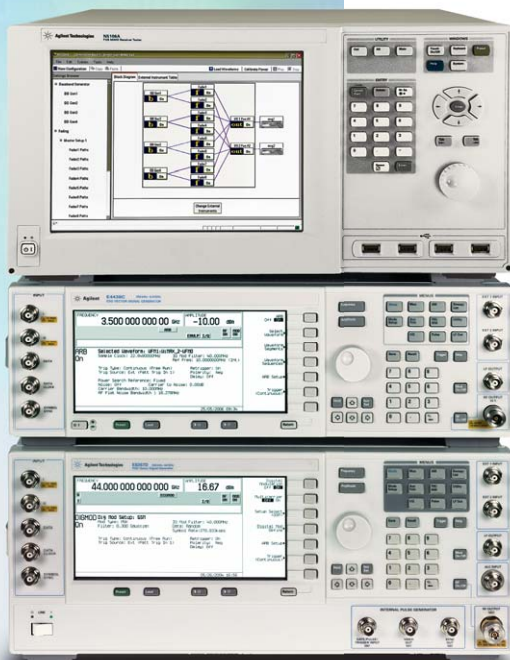
Agilent has built a solid reputation in the mobile communications industry with the combination of our signal generators and Signal Studio signal creation software. The versatile and comprehensive software is available for the development and manufacturing of existing and evolving 2G, 3G, 3.5G and 4G 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

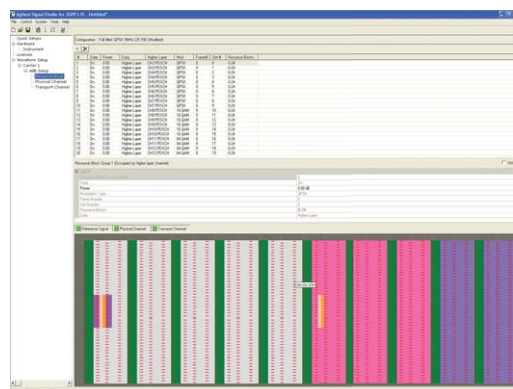
Signal Studio applications enable the configuration of standard-based test signals to verify the performance of components, receivers, and baseband ASICs for multiple technologies. Use this software with the Agilent MXG signal generator for the industry's best adjacent channel leakage ratio (ACLR) performance 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

Agilent ESG signal generator. Additionally Signal Studio software can be used with the Agilent 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 4x4 MIMO configurations (spatial multiplexing / TX diversity)
- Real-time fading with the Agilent PXB for up to 4x2 or 2x4 MIMO
- Predefined setups for fixed reference channels and E-UTRA test models
- Mixed-carrier configuration with W-CDMA
- Co-existence testing using the Agilent PXB with 4 independent baseband generators
- Create multi-carrier signals for uplink and downlink
- Real-time HARQ feedback for performance requirements testing



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



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



# LTE Baseband Analysis

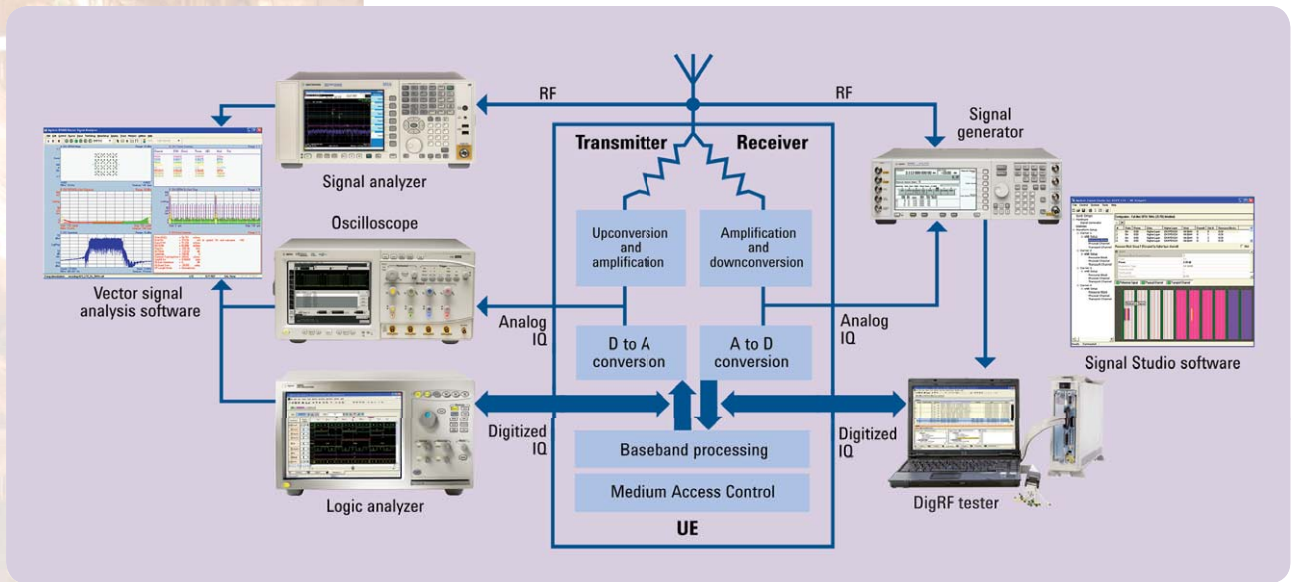
## Logic Analysis

In next-generation architectures the physical link between the RF front-end and baseband processing evolves from an analog to parallel, or high-speed, serial digital bus. New interface standards require test equipment to provide appropriate serial digital inputs and outputs.

The combination of an Agilent RDX tester or logic analyzer and Agilent's Vector Signal Analysis (VSA) software provides the only digital VSA (DVSA) package for digital baseband, IF and RF signal analysis. This combination enables digital signal processing (DSP) designers to effectively design and debug interfaces that were once analog and are now digital. The VSA software performs signal analysis functions such as I/Q analysis, EVM, Fourier spectrum, etc., using the digital signal captured by the logic analyzer as the input.

To validate RFIC operation, engineers can also leverage the combination of signal generation software and the RDX tester connected to the system-under-test through a DigRF v3 or v4 digital connection to test the transmit signal path.

For R&D engineers designing or integrating MIPI (Mobile Industry Processor Alliance) D-PHY devices within a mobile handset, the same logic analysis solution can be used as a MIPI D-PHY protocol test solution, with support for display (DSI) and camera (CSI-2) interfaces. The solution includes a configurable stimulus platform which offers bit-to-video level test capabilities for embedded displays, real-time analysis and protocol viewing capabilities. Engineers can gain valuable insight into the exchanges between MIPI D-PHY enabled devices.



Characterize behavior of devices, from baseband to antenna, with access throughout the block diagram.

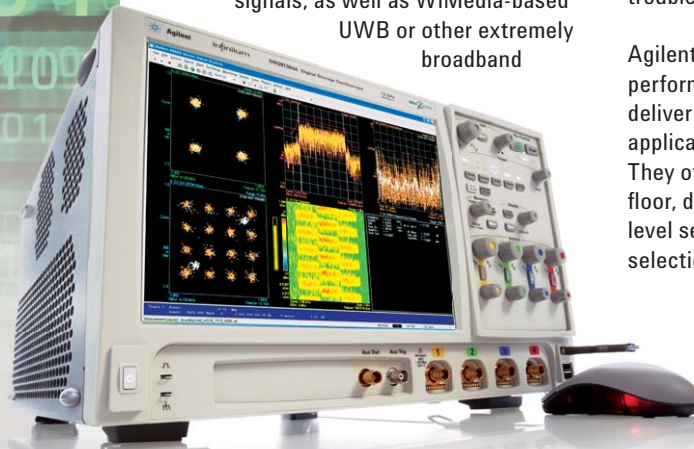
# LTE Baseband Analysis

## LTE Digital Real-Time Decode & Debug

Combine Agilent's vector signal analysis software with Agilent's Infiniium 90000A series oscilloscope to analyze wide-bandwidth signals. The 90000A oscilloscope provides up to 13 GHz of analysis bandwidth and is well suited to digitizing down-converted satellite, LMDS, and MMDS signals, as well as WiMedia-based UWB or other extremely broadband

signals. Two-channel Infiniium scopes can also make the coherent two-channel MIMO measurements needed for IEEE 802.11n and WiMAX™. The digitized signals are transferred via GPIB, USB, or LAN to the PC running the 89600 VSA software where the frequency, time, and modulation analysis tools of the 89600 VSA can be used to evaluate and troubleshoot the signal.

Agilent Infiniium 90000A series high performance real-time oscilloscopes deliver superior signal integrity, deep application analysis, and excellent insight. They offer the industry's lowest noise floor, deepest memory (1 Gpts), only three-level sequence triggering, and widest selection of applications.

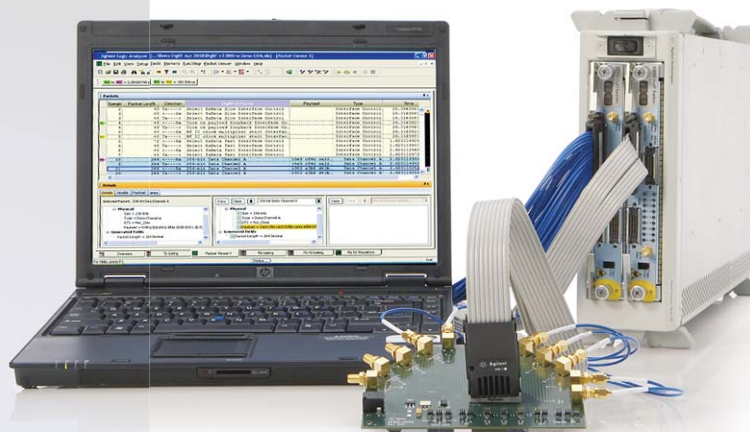


*Troubleshoot digital glitches with the Agilent DSO90000A high-performance, real-time oscilloscope.*

## DigRF Digital Interface

If you are using the DigRF (v3 or v4) baseband IC to RFIC interface, the Agilent RDX platform provides a comprehensive test solution that brings insight into both the digital and RF domains. The RDX platform allows engineers to work in either the

digital or RF domain for digital protocol test as well as RF (digital IQ) physical layer stimulus and analysis. The integration of the RDX platform with the Agilent RF portfolio provides cross-domain solutions that will help you rapidly deploy your DigRF designs, aiding both baseband and RF IC development, debug and characterization.



*Access DigRF v3 and v4 interfaces, as well as digital IQ data, with the RDX test platform.*

# LTE Uplink and Downlink Signal Analysis for R&D

The ever-increasing complexity of emerging broadband communication systems demands flexible signal analysis with in-depth modulation analysis, as well as RF power measurements. The Agilent X-Series (PXA/MXA/EXA) signal analyzers ease measurements of complex signals by providing world-class accuracy, flexibility and standards-compliant measurement applications. In addition, the Agilent 89600 VSA software, in combination with Agilent's X-Series signal analyzers provide sophisticated general-purpose and standards-compliant signal evaluation and troubleshooting tools for R&D engineers.

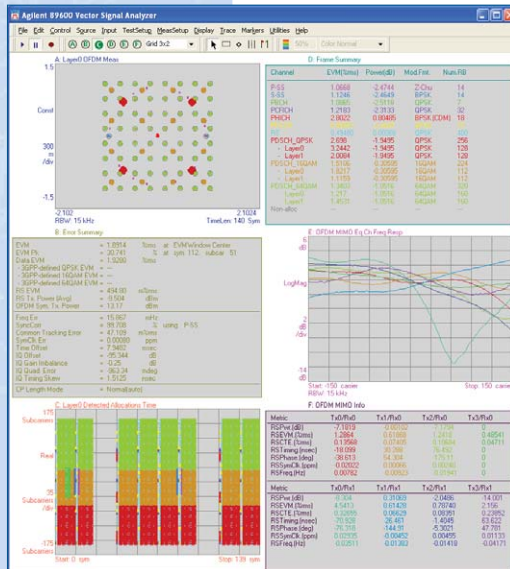
## Reach Deeper into LTE Signals with the 89600 VSA Software

Gain greater insight into the performance of your LTE devices using the 89600 VSA software with LTE analysis capability. This high-performance VSA software provides RF and baseband engineers with the industry's most comprehensive LTE physical layer signal analysis. Highlights of the 89600 VSA software include:

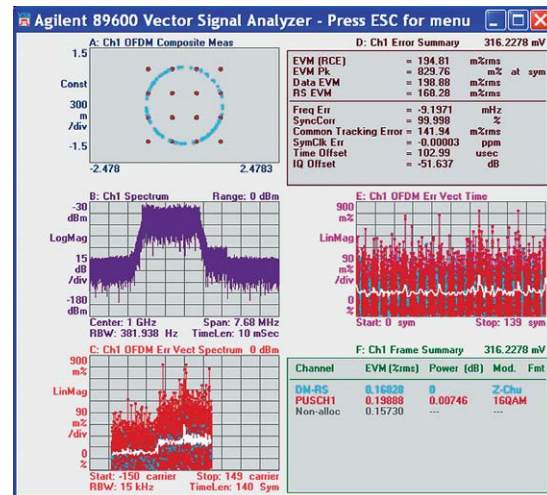
- Downlink (OFDMA) and uplink (SC-FDMA) in a single option
- FDD mode, type 1 generic frame structure
- TDD mode, type 2 generic frame structure
- All LTE bandwidths: 1.4 MHz to 20 MHz
- All modulation formats and sequences: BPSK, QPSK, 16QAM, 64QAM and CAZAC (Zadoff-Chu)
- Up to 4x4 DL MIMO with supported 4-channel platforms
- Auto detection and demodulation of downlink user bursts
- Industry-leading EVM of < -50 dB (<0.35%) (dependent on choice of measurement platform)
- A rich selection of in-channel measurements and traces — overall/data/RS EVM, EVM per channel, carrier, symbol, resource block and slot.
- Well-designed user interface - up to six simultaneous, user-selected displays, color coding and marker coupling among multiple traces



Agilent PXA high performance signal analyzer with LTE software running internally.



A downlink 4x4 MIMO analysis showing per layer error traces and tables as well as frequency response trace color-coded for each layer.



An uplink LTE analysis made on the demodulation reference signal (DM-RS) and payload data. The DM-RS uses a CAZAC sequence as shown by the constant amplitude on trace A.



# LTE Device Development

## E6621A PXT wireless communication test set

The Agilent E6621A PXT wireless communication test set is designed to provide leading-edge solutions for the LTE UE



The E6621A PXT wireless communication test set—from early RF development through conformance test.

development lifecycle from early development through RF conformance test and interoperability test. Highlights of the Agilent E6621A include:

- Real-time, bench top network emulation for easy-to-use, real-world design integration and validation testing
- LTE TX and RX measurements Suite
- MIMO 2x2
- 6 GHz frequency range and internal PC controller with Windows XP®
- Supports 2-cells
- High end-to-end data rates
- Inter-RAT handover test with the Agilent 8960

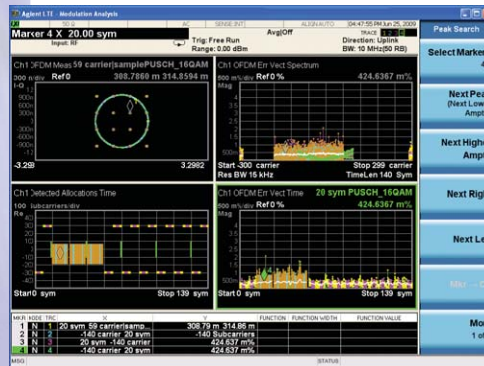
## LTE Uplink and Downlink Signal Analysis for Automation Test

Speed your LTE time to market with the Agilent 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:

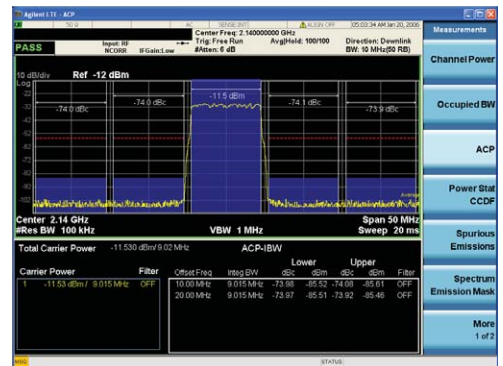
- SCPI remote user interface for automation test
- Hardkey/softkey manual user interface using the familiar Agilent X-Series signal analyzer front panel
- One-button, standard-based power measurements (channel power, ACP, SEM etc.) with pass/fail tests

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

Agilent offers both RF and Signaling conformance test solutions and new products for LTE and inter-system testing.

### Not just conformance, but a whole lot more.

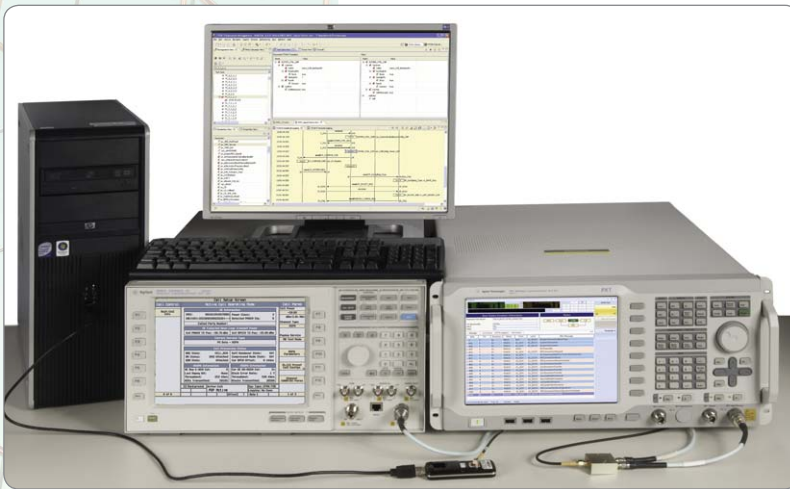
As LTE and other data-centric technologies eclipse earlier standards; test labs, service providers and device makers are embracing new test paradigms.

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. Agilent 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 Agilent N6070A series LTE Signaling Conformance Test system is built around the new E6621A PXT. With GCF/PTCRB validated test cases, the system is being used by equipment makers, operators and test labs around the world. Inter-RAT handovers to legacy GSM, W-CDMA and cdma2000 based technologies are also being supported by the system.

The LTE RF environment ranges in complexity from basic signal transmission and reception to multiple input multiple output (MIMO) scenarios with many 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. Agilent's scalable range of RF pre-compliance to full conformance test systems cover cellular technologies from GSM to HSPA, adding the E6621A PXT extends this range to include LTE.



N6070A Series LTE Signaling Conformance Test Solutions



GS8800 RF Conformance Test Solutions

# Network Deployment and Optimization

## Meets current and future network installation and maintenance challenges for LTE

The Agilent FieldFox RF analyzer (4 GHz/6 GHz) is the world's most integrated, fast, and rugged handheld RF analyzer for LTE network installation and maintenance. This six-in-one RF tester combines cable and antenna analysis, spectrum analysis, interference analysis, power meter measurement, vector network analysis, and a vector voltmeter into one rugged, compact, lightweight, and weather-resistant package.

With the 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.

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.

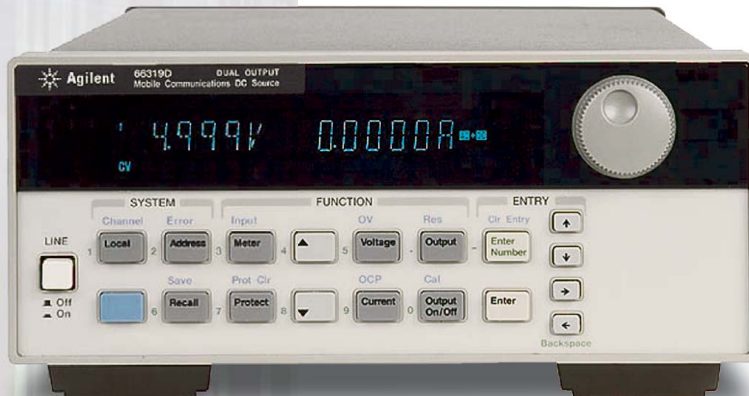


*Designed for the field environment, the N9912A FieldFox RF Analyzer, Handheld Cable and Antenna Analyzer and Handheld Spectrum Analyzer works to 4 or 6 GHz.*



## Battery Current Drain Measurement and Analysis

The Agilent 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 15V, 3A output, a high-speed 64KSa/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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