Keysight Technologies

LTE-Advanced (89601B/BN-BHH) & LTE (89601B/BN-BHE) TDD Modulation Analysis

LTE-Advanced (89601B/BN-BHG) & LTE (89601B/BN-BHD) FDD Modulation Analysis

89600 VSA Software

Application Brief

KEYSIGHT TECHNOLOGIES

Key Features

- See through the complexity of LTE and LTE-Advanced signals with a comprehensive set of demodulation tools
- Inter-band and intra-band carrier aggregation with up to 5 component carriers for LTE-Advanced
- Enhanced uplink with clustered SC-FDMA for LTE-Advanced
- Analyze UL and DL, using color-coded displays for easy channel identification
- Time and frequency-selective analysis by carrier, symbol, or RB
- Examine performance of users, channels, or signals with up to 4X4 MIMO (for LTE); up to 8 channel beamforming (for LTE); up to 8x8 MIMO (LTE-Advanced)
- Complement 89600 VSA with 89600 WLA for LTE-FDD protocol layer analysis

Try before you buy!

Download the 89600 VSA software and use it free for 30 days to make measurements with your analysis hardware, or use our recorded demo signals which are available by selecting File > Recall > Recall Demo> LTE > or File > Recall > Recall Demo > LTE-A > on the software toolbar. Request your free trial license today:

www.keysight.com/find/89600_trial

LTE/LTE-Advanced Modulation Analysis

The 89600 VSA software has the capability to analyze LTE and LTE-Advanced signals in both FDD and TDD formats. Depending upon your requirements, each of the four available options provide comprehensive LTE/LTE-Advanced modulation analysis with powerful troubleshooting tools to characterize signals and identify errors and their causes.

Analyze both downlink (DL) and uplink (UL) signals, for all bandwidths, modulation formats and sequences. Perform up to 8x8 DL MIMO analysis, for LTE and LTE-Advanced FDD and TDD, and up to 8x2 beamforming for LTE FDD and TDD with supported platforms. Keep current with advanced capabilities such as carrier aggregation and higher-order MIMO.

View virtually every facet of a signal with color-coded results by user and channel, for quick and easy visual identification. 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.

New cumulative history and digital persistence displays find and isolate rare events, to make subtle problems easy to spot.

The 89600 VSA software supports more than 75 signal standards and modulation types, providing a comprehensive set of tools for demodulation and vector signal analysis. These tools enable you to explore virtually every facet of a signal and optimize your most advanced designs. As you assess the tradeoffs, the 89600 VSA helps you see through the complexity.

LTE

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 the competitiveness of 3G systems into the future, a long term evolution (LTE) of the 3rd Generation Partnership Project (3GPP) access technology was specified in Release 8 of the 3GPP standard. The LTE specification provides a framework for increasing capacity, improving spectrum efficiency, improving coverage, and reducing latency compared with current HSPA implementations. In addition, transmission with multiple input and multiple output (MIMO) antennas is supported for greater throughput, as well as enhanced capacity or range. To support transmission in both the paired and unpaired spectrum, the LTE air interface supports both frequency division duplex (FDD) and time division duplex (TDD) modes.

LTE-Advanced takes throughput to the next level with the capability of having up to five component carriers in inter-band and intra-band configuration and higher order MIMO of up to 8x8. Option BHG (LTE-Advanced FDD) and Option BHH (LTE-Advanced TDD) provide UL/DL carrier aggregation in both contiguous and non-contiguous bandwidths and 8x8 downlink MIMO for both FDD and TDD.

Analysis and Troubleshooting

Easy set-up

Use a standard preset, or use one of the provided E-UTRA test models to easily configure your VSA[1]. Adjust virtually any parameter manually to modify standard-compliant analysis setup to deal with early system development. A graphical user allocation map lets you select which channels to include in measurements and displays. To simplify data set-up and interpretation, there is consistent color-coding by user and channel or signals throughout configuration and measurement displays.

If you use Signal Studio for LTE (version 12 or later), you can recall .scp or .xml setup files for your test signals.

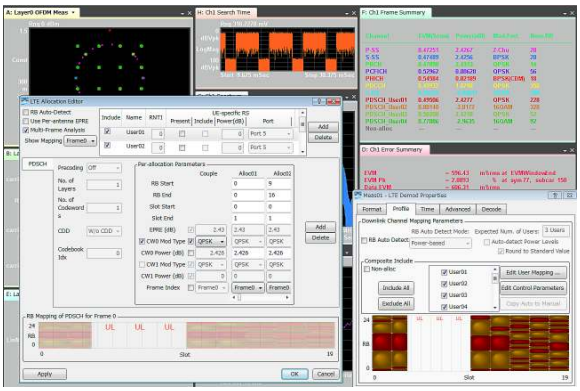

Figure 1. Configure your setup using presets, a supplied E-UTRA test model, or using the LTE allocation editor, which allows detailed manual setup.

Time or frequency-selective analysis (on each component carrier for LTE-Advanced)

Look at your signal's error by carrier, symbol, or RB. Sharpen your view by highlighting only a portion of the time, frequency, or RB error information available. Just double-click on the display annotation or use the X-axis expand select tool to mark the area of interest.

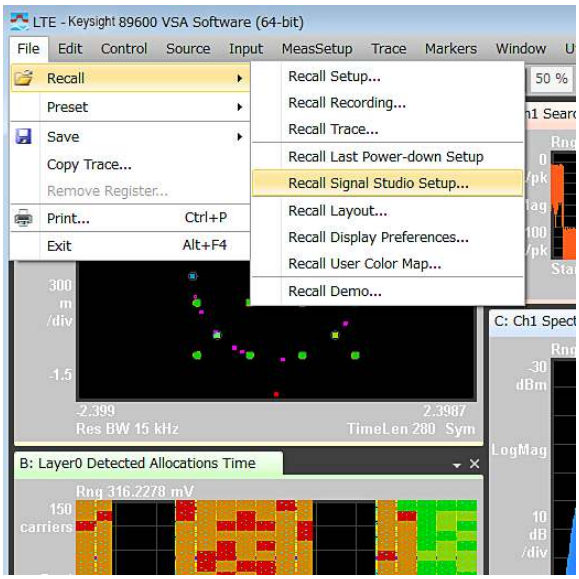

Figure 2. Easily copy the configured signal settings in .scp or .xml files in Signal Studio for LTE.

You can upgrade!

UPGRADE

All 89600 VSA software options can be added after your initial purchase and are license-key enabled. For more information please refer to www.keysight.com/find/89600_upgrades

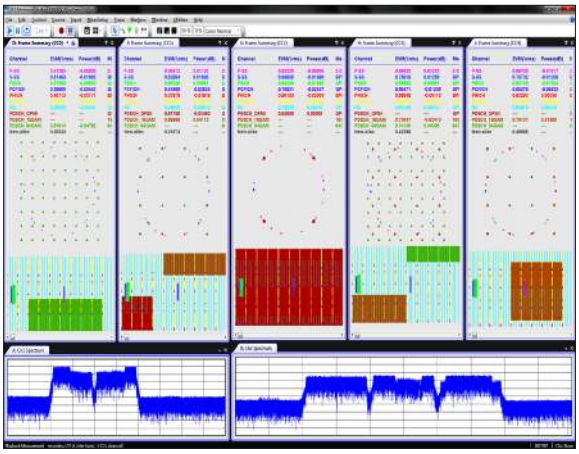

Figure 3. Inter-band carrier aggregation: Fully characterize up to 5 component carriers—simultaneously. Set up the measurement parameters and view different measurements on each.

1. Unless noted, all measurements shown are available for both LTE TDD, and FDD. The actual display contents may vary per format.

Zero in to analyze select channels and signals

Go to the Profile tab and choose which elements to include in your error analysis: you can select/de-select users, signals, or channels, allowing you to focus on the behavior you want to investigate.

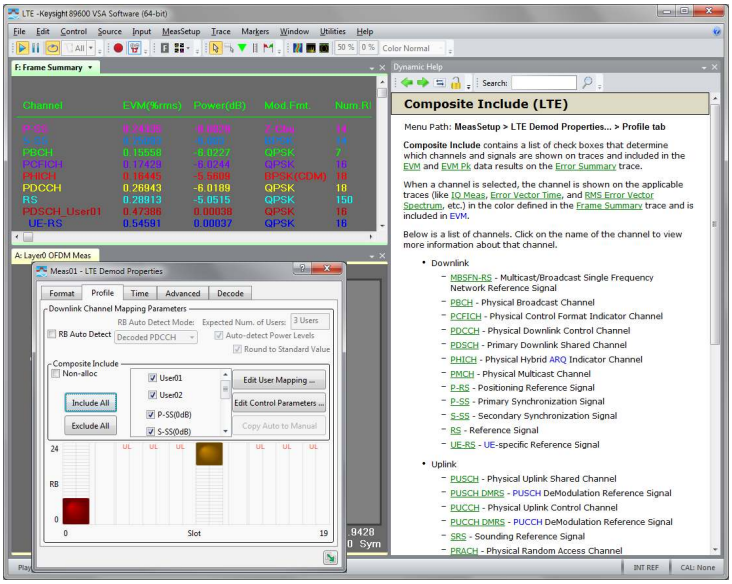

Figure 4. Choose any combination of users, control channels, or synchronization signals for inclusion in measurements and displays. To learn more about the Profile tab, Dynamic Help links you to comprehensive help text, including information on each of the channels and signals listed. The frame summary table shows the color-coding used throughout each display.

Decode UL and DL

Tables provide decoded UL and DL information from control channels. Decoded information for each frame is displayed following the same channel color-coding displayed in the frame summary trace and used throughout.

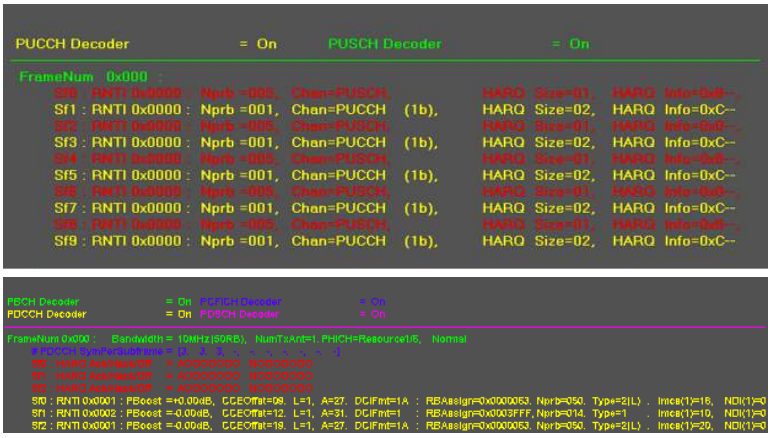

Figure 5. Decode UL and DL control channel information for each frame.

Enhanced uplink analysis

The 89600 VSA software with LTE-Advanced options enables enhanced uplink analysis capability with clustered SC-FDMA, giving you the ability to add multiple clusters on the same slot. Also available are simultaneous PUCCH and PUSCH analysis as well as support for PUCCH Format 3, a new control format added to 3GPP Release 10.

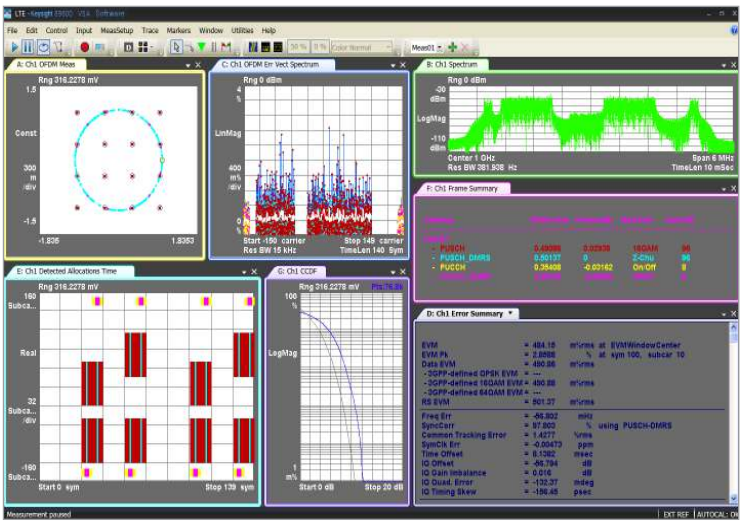

Figure 6. Use the LTE-Advanced option for complete characterization of the LTE-Advanced FDD uplink clustered SC-FDMA signal.

Explore antenna beam performance (FDD and TDD)

Beamforming analysis enabling verification and visualization of LTE base station RF antenna beamforming including Transmission Mode 7 (8x1 single layer using Port 5) and Transmission Mode 8 (8x2 dual layer using Ports 7 and 8).

Use the antenna beam pattern display to show the expected antenna radiation pattern, derived from actual measurement of the transmitter signals. Multiple patterns, one for each user, can be plotted to show the relative position of beams.

Figure 7. 8-channel TD-LTE beamforming with antenna patterns and EVM measurements per layer. The same measurement is available for LTE-FDD.

8x8 MIMO analysis (FDD and TDD)

Use the LTE-Advanced option for analysis and troubleshooting of a base station transmitting a Transmission Mode 9 (8x8, eight layer using antenna ports 7 through 14) signal. Various traces are available to look at per layer modulation quality and channel frequency response, as well as amplitude, phase, and time offset between each of the eight layers. Analysis of channel state information reference signal (CSI-RS) is also available.

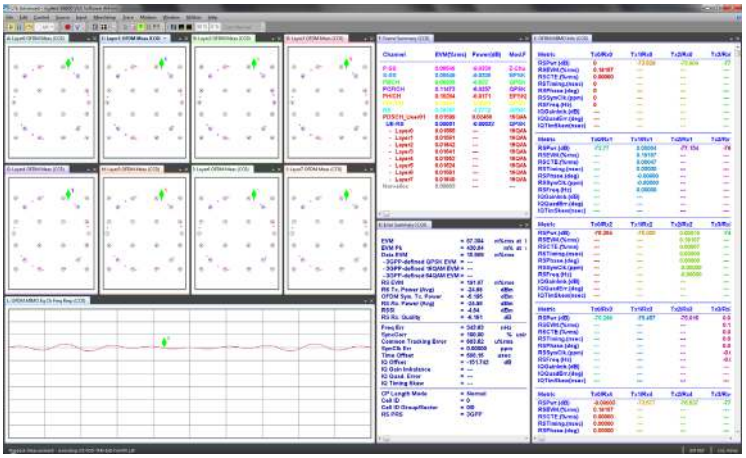

Figure 8. 8x8 MIMO with EVM measurement for each of the eight layers.

Choosing between 89600 VSA software and X-Series measurement applications

89600 VSA software is the industry-leading measurement software for evaluating and troubleshooting wireless signals in R&D. PC-based, supporting numerous measurement platforms, the 89600 VSA software provides the flexibility and sophisticated measurement tools essential to finding and fixing signal problems.

X-Series measurement applications provide embedded format-specific, one-button measurements for X-Series analyzers. With fast measurement speed, pass/fail testing and simplicity of operation, these applications are ideally suited for design verification and manufacturing.

www.keysight.com/find/X-Series_apps

Software Features

Options BHG, BHH, BHD, and BHE include all of the following features. Please note that for the LTE-Advanced options, the specifications below are for individual component carriers. The user may have up to 5 component carriers.

Feature	Description	
	LTE	LTE-Advanced
Standards supported	Option BHD demodulates LTE frame type 1 FDD signals; Option BHE demodulates LTE frame type 2 TDD signals	Options BHG and BHH demodulate carrier aggregated LTE-A frame type 1 FDD signals and LTE-A frame type 2 TDD signals, respectively, with each component carrier conforming to the following standards
The demodulators support signals that are compliant with the following 3GPP technical specifications	36.211 V9.1.0 (2010-03) 36.212 V9.4.0 (2011-09) 36.213 V9.3.0 (2010-09) 36.214 V9.2.0 (2010-06)	36.211 V10.7.0 (2013-02) 36.212 V10.7.0 (2012-12)[1] 36.213 V10.9.0 (2013-03) 36.214 V10.1.0 (2011-03)
EVM calculations and conformance testing are compatible with these specifications	36.141 V9.10.0 (2012-07) 36.521-1 V9.8.0 (2012-03)	36.141 V10.10.0 (2013-03) 36.521-1 V10.5.0 (2013-03)
Common setup parameters (LTE-Advanced only)	**Access the common setup parameters for multiple component carriers, available for both Option BHG and BHH**	
Number of component carriers	Up to five	
Frequency of each carrier	Configurable individually; both inter-band and intra-band configuration supported	
Format setup parameters	**Access basic demod configuration parameters; all parameters available to BHD, BHE, BHH (per CC), and BHG (per CC), unless otherwise noted; All CC to be FDD or all to be TDD for LTE-Advanced options (BHG, BHH)**	
Duplex mode	FDD (Option BHD/BHG); TDD (Option BHE/BHH)	
TDD parameters (BHG/BHH only)	UL/DL configuration; Dw/GP/Up length. All component carriers need to be either UL or DL	
Direction	Downlink, uplink	
Bandwidth	1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz	
Sync type (downlink)	P-SS or C-RS	
Sync type (uplink)	PUSCH DMRS, PUCCH DMRS, SRS, PRACH	
Cell ID (downlink)	Auto-detected, or manually set	
RS-PRS (downlink)	3GPP or custom	
Preset to standard	Sets the demodulator to the specified bandwidth and sets the Demod Properties dialog box parameters for the current direction (Uplink or Downlink) to the default values	
Downlink format parameters		
Number of C-RS Ports	1, 2, or 4	
Ref C-RS Ports	Port 0-3	
Number of measurement channels	1-8	
Ref measurement channel	Ch 1-8	
P-SS/S-SS antenna port	Port 0-3; all	
Ant. Det. Threshold	Sets the threshold for Tx antenna port signal detection	
Include inactive antenna paths	Yes, no	
MIMO decoding	3GPP MIMO decoding; none	
PDSCH cell specific ratio	p_B/p_A=1; p_B=0; p_B=1; p_B=2; p_B=3	

1. Uplink transport layer decoding is supported per this release of the standard. Downlink transport layer decoding is per 3GPP Release 9 standard (v.9.4.0).

Software Features (continued)

Uplink format parameters	
Half subcarrier shift	Yes, no
PUSCH DFT swap	Yes, no
Profile setup parameters	**Allows you to specify user channel allocations as well as which channels are shown on traces and used in the EVM and EVM Pk data results on the Error Summary trace**
RB auto-detect	Yes, no
RB auto-detect mode	Power-based; decoded PDCCH (downlink only)
Expected num. of users (downlink)	Specifies the number of user allocations to show in the Composite Include list
Auto-detect power levels (downlink)	Detects the relative PDSCH power level for each user allocation (P_A).
Composite include	Determine which channels and signals are shown on traces and included in the EVM and EVM Pk data results on the Error Summary trace
Non-allocated	Include non-allocated channels in displays and measurements
Edit user-mapping	Open LTE allocation editor where user allocations are set up
Include all	Downlink only
Exclude all	Downlink only
Edit control parameters	Launches downlink control channel properties dialog menus; downlink only
Copy auto to manual	Copies auto-detected allocations to manual definitions in the LTE Allocation Editor
User allocation map	Shows the manually-specified user allocations defined with the LTE Allocation Editor and allows you to select which user channels to show on the traces and include in calculations; downlink only
Time setup parameters	**Sets time data parameters used for demodulation; graphical timing diagram provided for ease in visualization**
Result length	Determines how many slots will be available for demodulation
Measurement offset	Specifies offset from the start of the result length to the beginning of measurement interval (the data sent to the demodulator); in slots + symbol-times
Measurement interval	Determines how much data after the measurement offset is sent to the demodulator; in slots+ symbol times
Analysis start boundary	Specifies the alignment boundary of the result length time data; frame, half-frame, sub-frame, slot

Advanced setup parameters	**Specifies advanced configuration parameters, which modify the default standard-compliant analysis algorithm**
CP Length	Auto, normal, extended
Extend Freq Lock Range	Increases demodulator lock range ; yes, no
Mirror Frequency Spectrum	Flips entire frequency spectrum around carrier frequency; yes, no
Time Scale Factor	Sets the value by which to scale the bandwidth and time lengths of the measured signal in order to compensate for mis-tuned crystals or to allow demodulation of signals at a lower rate, such as half rate or 1/10 rate
Multi-carrier filter	Additional filtering to reject adjacent carriers
Uplink present in signal (TDD DL only) or Downlink present in signal TDD UL only	Yes, no
Antenna Group (downlink)	Defines set of antennas used for beamforming: number of elements, element spacing
Exclude EVM Transient Time (uplink)	Yes, no
Equalizer Training	Sets demodulator equalization of the signal; off, RS, RS+Data, ZF (UL only), LS (UL only)
Moving Average Filter (downlink)	Yes, no and value
Normalize Chan Freq Resp (downlink)	Yes, no
EVM Minimization	Off, 3GPP, tracking; select EVM corrections of amplitude, frequency/phase, timing, and IQ offset
Symbol Timing Adjust	Max of EVM Window Start/End; Min of EVM Window Start/End; EVM Window Start; EVM Window End; EVM Window Center; % of FFT Size
EVM Window Length	Specifies the length of the window used for EVM calculations
Results Format	Choose all or none of: report EVM in dB; power boost normalize; report relative power levels
Decode setup parameters	**Configures decoded symbol table results and other decode parameters**
Decoded symbol table results	Specifies how much coding to undo before showing bits from PBCH, PCFICH, PDCCH, PDSCH for downlink, and PUCCH, PUSCH for uplink
DCI Formats 1, 1B, 1D Detection Include	Used to configure how the demodulator detects DCI formats 1, 1B, and 1D. (DL only)
RNTI ranges (User Defined)	Downlink only
RA-RNTI range	Specifies the range of RNTI values that are assumed to be RA-RNTIs when decoding PDCCH transmissions
TPC-RNTI range	Specifies the range of RNTI values that are assumed to be TPC-RNTIs when decoding PDCCH transmissions
PUSCH decode parameters	Specifies info size and offset index for HARQ-ACK, RI, and CQI-PMI; uplink only
PUCCH decode parameters	Specifies info size for HARQ-ACK, CQI/PMI; uplink only
Trace data	**Available measurement displays**
Channel data	**Pre-demodulation information about each of the input channels**
CCDF	Displays the complementary cumulative distribution function of the data in the measurement interval for the selected channel
CDF	Displays the cumulative distribution function of the data in the measurement interval for the selected channel
Correction	Shows the correction data derived by the analyzer from the calibration data and applied to the acquired data's spectrum
Instantaneous spectrum	Non-averaged frequency spectrum of the pre-demodulated Time trace data for the current measurement
PDF	Displays Probability Density Function, a normalized histogram of the Time data
Raw main time	Shows the raw data read from the input hardware or playback file for the selected channel
Search time	Displays the time record data after resampling and time adjustment
Spectrum	Displays the frequency spectrum of the pre-demodulated Time trace data
Time	Shows the time data that is to be demodulated (the data in the measurement interval) for the selected channel

Demodulation data (Uplink and downlink)	Provides demodulation results (not specific to a particular layer)
Common tracking error	Shows the corrections calculated by EVM minimization
Eq chan frequency response diff	Shows the channel response's rate of change with respect to frequency; instantaneous value trace also available
Eq chan freq resp	Displays the equalization frequency response of the currently selected Ref Input Channel; instantaneous value trace also available
Eq impulse response	Shows the channel equalization impulse response of the currently selected Ref Input Channel
Error summary (uplink and downlink)	Contains information about the quality of the signal being analyzed (in the Measurement Interval)
Common tracking error	RMS average of the correction applied to each symbol by EVM Minimization
CP length mode	Current CP Length: normal or extended (useful when CP length is set to Auto in demod properties)
Data EVM	3GPP-defined RMS Error Vector Magnitude of the QPSK, 16 QAM, 64QAM user channels
EVM	RMS Error Vector Magnitude for all selected channels in Composite include setup parameter
EVM pk	Peak EVM value and coordinates
Channel power	Average power of the LTE signal calculted in time domain over all symbols int he measurement interval
Freq err	Average error in carrier frequency calculated for the data in the measurement interval
IQ offset	Magnitude of carrier feed-through
IQ quadrature error	Amount of angle skew between I and Q
IQ timing skew	Time difference between the I and Q parts of the signal
RS EVM	RMS Error Vector Magnitude of the reference signal
Sync corr	Correlation between the measured P-SS signal and the reference P-SS signal
Symbol clock err	Frequency error of the measured signal's symbol clock
Time offset	The distance from the start of the Search Time trace to the beginning of the measure-ment interval
Error summary (downlink only)	
Cell ID	Physical-layer Cell ID of the signal
Cell ID group/sector	Signal's Cell ID group and Cell ID sector, determined by physical-layer Cell ID
IQ gain imbalance	I vs Q amplifier gain imbalance (ratio of I-gain to Q-gain)
OFDM symbol Tx power	Average power (dBm) for OFDM data subcarriers
RS-PRS	Current setting of the RS-PRS measurement parameter
RS Tx pwr (avg)	Average (dBm) reference signal power
RS Rx quality	A measure of the quality of the received signal as defined in Section 5.1.3 of 3GPP TS 36.214
RS Rx. power (avg)	Used to calculate RSRP as defined in Sectioin 5.1.1 of 3GPP TS 36.214
RSSI	Average power for all symbols containing RS from Tx antenna port 0
Error summary (uplink only)	
In-band emission result	Pass/Fail result is displayed along with the narrowest margin of pass or widest margin of failure and its location in terms of RB/slot
Spectral flatness result	Pass/Fail result is displayed along with the narrowest margin of pass or widest margin of failure and its location in terms of subcarrier/slot
Frame summary	Table showing EVM, power, modulation format, and number of RBs for channels present in a frame, color-coded by channel
Downlink channels included	Non-Alloc; P-SS; S-SS; C-RS; PBCH; PCFICH; PHICH; PDCCH; PDSCH; P-RS; MBSFN-RS; PMCH
Uplink channels included	Non-Alloc ; PRACH; PUCCH; PUCCH DMRS; PUSCH; PUSCH DMRS; SRS
Freq err per slot	Average frequency error for each slot
Inst eq chan freq resp diff	Displays the channel frequency response derivative for the current measurement
Inst eq chan freq resp	Displays the channel frequency response of the current measurement

Demodulation data (uplink only)	Provides demodulation results
Decoded symbol table	Shows decoded PUSCH and PUCCH data
Detected allocations time	Color-coded display showing a two dimensional grid where each point on the grid represents a single resource element
Error vector spectrum	Difference between the measured values and the reference values for each resource element
Error vector time	Difference between the measured symbols and the reference symbols for each symbol in the measurement interval
In-band emissions	Shows the resource block power spectrum for the measurement data; includes pass/fail mask
IQ frequency meas	IQ data taken after the OFDM symbol FFT has been performed on the measured data
IQ frequency reference	Displays the reference (demodulated) IQ values of the subcarriers for each OFDM symbol point at the output of the FFT
IQ measured time	Displays the same information as IQ Meas when the data is displayed in the Const or I-Q trace format
IQ measured	Displays a composite trace of the measured IQ values for PUSCH after despreading (IFFT), overlaid on the measured IQ values of the other physical channels and signals' subcarriers from the output of the FFT
IQ offset per slot	Displays the average IQ offset for each slot in the measurement interval
IQ ref time	Displays the same information as IQ Ref when the data is displayed in the Const or I-Q trace format
IQ ref	Displays a composite trace of the reference IQ values for PUSCH after despreading (IFFT), overlaid with the reference IQ values of the subcarriers from the output of the FFT for other channels and signals
Per slot eq chan freq resp	Shows the frequency response of the channel for each slot in the Measurement Interval; includes UL spectrum flatness pass/fail mask
RB error mag spectrum	Shows the EVM of each resource block
RB error magnitude time	Displays the EVM of each resource block (RB)
UL decode info	Contains the decoded information from PUCCH and PUSCH
RB power spectrum	Shows the resource block power spectrum for the demodulated data specified by measurement interval and measurement offset
RB power time	Shows the resource block power for each slot in the time interval specified by Measurement Interval and Measurement Offset
RMS error vector spectrum	Root Mean Square (RMS) average EVM for each subcarrier
RMS error vector time	Root Mean Square (RMS) average EVM for each symbol
Symbol table	Demodulated bits, color-coded by channel/signal type
Demodulation data (downlink only)	**Provides demodulation results**
Antenna beam pattern	IQ diagram depicting beam-forming pattern
CW0/1 decoded symbol table	Shows the decoded bits for the physical layer channels PBCH, PDSCH, PCFICH, and PDCCH for codeword 0/1
DL Decode info	Contains the decoded information from PBCH, PDCCH, PHICH, and PCFICH
UE-specific RS weights	Shows the subcarrier locations and weights for all UE-specific Reference Signal resource elements present in the measurement data
Cross-carrier summary (uplink & downlink)	**Provides metric across multiple component carriers (CCs)**
Cross-carrier (CC) summary	Timing alignment error (TAE) relative to CC0, Max/Min values in sec, channel power in dB

Layer data (downlink only)	Contains downlink demodulation results that are specific to a particular layer
Detected allocations time	Color-coded display showing a two dimensional grid where each point on the grid represents a single resource element of the selected layer
Error vector spectrum	Difference between the measured values and the reference values for each resource element in a layer
Error vector time	Difference between the measured symbols and the reference symbols for each symbol in the measurement interval
IQ measured time	Displays the same information as IQ meas when the data is displayed in the Const or I-Q trace format
IQ meas	Displays the measured IQ values of the subcarriers from the output of the FFT (frequency domain) for the selected layer
IQ ref time	Displays the same information as IQ Ref when the data is displayed in the Const or I-Q trace format
RB error mag spectrum	Displays the EVM of each resource block (RB) in the selected layer
RB error mag time	Displays the EVM of each resource block (RB) in the selected layer
RB power spectrum	Shows the resource block power spectrum for the demodulated data specified by measurement interval and measurement off for the selected layer
RB power time	Shows the resource block power for each slot in the time interval specified by measurement interval and measurement offset in the selected layer
RMS error vector spectrum	Root Mean Square (RMS) average EVM for each subcarrier
RMS error vector time	Root Mean Square (RMS) average EVM for each symbol
Symbol table	Demodulated bits, color-coded by channel/signal type
MIMO data	**Downlink only**
Common tracking error	Shows the common tracking error data for all Rx/Tx antenna paths
Eq chan freq resp difference	Displays the slope of the channel frequency response for all four antenna ports
Eq chan freq resp	Displays the channel frequency response for all four antenna ports
Eq cond number	Displays the MIMO condition number for each subcarrier
Eq impulse response	Displays the equalizer impulse response for all four antenna ports
Info table	Provides the following metrics for each Tx/Rx pair, color coded by path
RS power	Average (RMS) RS signal power
RS EVM	Average (RMS) RS EVM
RS CTE	Average (RMS) RS Common Tracking Error
RS timing	RS timing error
RS Phase	Average (RMS) RS phase error in degree
RS symbol clock	Average RS symbol clock error
RS frequency	RS frequency shift error
IQ gain imbalance	IQ gain imbalance in dB
IQ quadrature error	IQ quadrature error in degree
IQ time skew	IQ timing skew in nsec

Key Specifications

This technical overview provides nominal performance specifications for the software when making measurements with the specified platform.[1] Nominal values indicate expected performance, or describe product performance that is useful in the application of the product, but is not covered by the product warranty. For a complete list of specifications refer to the measurement platform literature.

LTE-Advanced FDD (Option BHG) and LTE FDD (Option BHD)

Note: LTE-Advanced specifications are per component carrier.

X-Series signal analyzers

	PXA (nominal)	MXA (nominal)	EXA (nominal)
Signal playback			
Result length	100 slots = 5 frames	100 slots = 5 frames	100 slots = 5 frames
Capture length	Complex samples, 32 bit packing		
20 MHz/100 RB LTE signal; 24 MHz analyzer span	17 sec	17 sec[2]	17 sec[2]
Accuracy	**Downlink or uplink signal; input signal range = 0 dBm, within 1 range step of overload, 20 averages**		
Residual EVM	Overall EVM and Data EVM, using 3GPP standard-defined EVM calculations		
Downlink			
Signal bandwidth			
5 MHz	–51 dB	–48 dB/–48 dB[3]	–45 dB
10 MHz	–50 dB	–48 dB/–46 dB[3]	–44 dB
20 MHz	–49 dB	–47 dB/–42 dB[3]	–44 dB
Uplink			
Signal bandwidth			
5 MHz	–53 dB	–49 dB/–49 dB[3]	–45 dB
10 MHz	–53 dB	–49 dB/–46 dB[3]	–45 dB
20 MHz	–53 dB	–49 dB/–42 dB[3]	–45 dB
Frequency error (relative to frequency standard)			
Lock range	±2.5 x subcarrier spacing = 37.5 kHz for default 15 kHz subcarrier spacing		
Accuracy	±1 Hz		
MIMO specifications		**MXA[4]**	**EXA[4]**
Measurement conditions		**2x2 spatial multiplexing MIMO configuration, 700 MHz center frequency, –10 dBm range**	
Overall EVM			
5 MHz		–48 dB	–45 dB
10 MHz		–48 dB	–45 dB
20 MHz		–47 dB	–44 dB
Inter-channel time offset, 5, 10, 20 MHz bandwidths		±25 ns	±25 ns
Inter-channel frequency offset, 5, 10, 20 MHz bandwidths		±0.1 Hz	±0.1 Hz
Inter-channel power deviation, 5, 10, 20 MHz bandwidths		±1 dB	±1 dB

1. Data subject to change.
2. This is with MXA or EXA hardware equipped with Option B40 (or higher bandwidth for MXA) or DP2 or MPB. Otherwise, the capture length under the same signal configuration is 88 msec.
3. With Option BBA BBIQ inputs.
4. In dual slaved configuration to provide 2-channel measurements.

Other analysis platforms

MIMO specifications	90000 Series Infiniium oscilloscope		
Measurement conditions	**4x4 spatial multiplexing MIMO configuration, 700 MHz center frequency, –10 dBm range**		
Bandwidth	5 MHz	10 MHz	20 MHz
Overall EVM	–36 dB	–36 dB	–35 dB
Inter-channel time offset	±1 ns	±1 ns	±1 ns
Inter-channel frequency offset	±0.1 Hz	±0.1 Hz	±0.1 Hz
Inter-channel power deviation	±1 dB	±1 dB	±1 dB

MIMO specifications	N7109A multi-channel signal analyzer	
Measurement conditions	**4x4 spatial multiplexing MIMO configuration, 1 GHz center frequency**	
Bandwidth	5 MHz	20 MHz
Overall EVM	–43 dB	–42 dB
Inter-channel time offset	±7 ns	±7 ns
Frequency accuracy	±0.04 ppm	±0.04 ppm
Inter-channel power deviation	±1 dB	±1 dB

LTE-Advanced TDD (Option BHH) and LTE TDD (Option BHE)

Note: LTE-Advanced specifications are per component carrier.

X-Series signal analyzers

	PXA (nominal)	MXA (nominal)	EXA (nominal)
Signal playback			
Result length	100 slots = 5 frames	100 slots = 5 frames	100 slots = 5 frames
Capture length		Complex samples, 32 bit packing	
20 MHz/100 RB LTE signal; 24 MHz analyzer span	17 sec	17 sec[1]	17 sec[1]
Accuracy	**Downlink or uplink signal; input signal full range = 0 dBm, within 1 range step of overload, 20 averages**		
Residual EVM	Overall EVM and Data EVM, using 3GPP standard-defined EVM calculations		
Downlink			
Signal bandwidth			
5 MHz	–53 dB	–49 dB/–49 dB[2]	–45 dB
10 MHz	–51 dB	–47 dB/–47 dB[2]	–45 dB
20 MHz	–49 dB	–45 dB/–42 dB[2]	–41 dB
Uplink			
Signal bandwidth			
5 MHz	–52 dB	–49 dB/–48 dB[2]	–45 dB
10 MHz	–52 dB	–49 dB/–46 dB[2]	–45 dB
20 MHz	–52 dB	–48 dB/–42 dB[2]	–45 dB
Frequency error (relative to frequency standard)			
Lock range	±2.5 x subcarrier spacing = 37.5 kHz for default 15 kHz subcarrier spacing		
Accuracy	±5 Hz downlink (DL), ±1 Hz uplink (UL)		

1. This is with MXA or EXA hardware equipped with Option B40 (or higher bandwidth for MXA) or DP2 or MPB. Otherwise, the capture length under the same signal configuration is 88 msec.
2. With Option BBA BBIQ inputs.

X-Series signal analyzers (continued)

MIMO specifications	MXA[1]	EXA[1]
Measurement conditions	**2x2 spatial multiplexing MIMO configuration, 700 MHz center frequency, -10 dBm range**	
Overall EVM		
5 MHz	–48 dB	–45 dB
10 MHz	–49 dB	–45 dB
20 MHz	–48 dB	–45 dB
Inter-channel time offset	±25 ns	±25 ns
Inter-channel frequency offset	±0.1 Hz	±0.1 Hz
Inter-channel power deviation	±1 dB	±1 dB

Other analysis platforms

MIMO specifications	90000 Series Infiniium oscilloscope		
Measurement conditions	**4x4 spatial multiplexing MIMO configuration, 700 MHz center frequency, –10 dBm range**		
Bandwidth	5 MHz	10 MHz	20 MHz
Overall EVM	–36 dB	–36 dB	–35 dB
Inter-channel time offset	±1 ns	±1 ns	±1 ns
Inter-channel frequency offset	±0.1 Hz	±0.1 Hz	±0.1 Hz
Inter-channel power deviation	±1 dB	±1 dB	±1 dB

MIMO specifications	N7109A multi-channel signal analyzer	
Measurement conditions	**4x4 spatial multiplexing MIMO configuration, 1 GHz center frequency**	
Bandwidth	5 MHz	20 MHz
Overall EVM	–43 dB	–42 dB
Inter-channel time offset	±7 ns	±7 ns
Frequency accuracy	±0.04 ppm	±0.04 ppm
Inter-channel power deviation	±1 dB	±1 dB

1. In dual slaved configuration to provide 2-channel measurements.

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Additional Resources

Literature

89600 VSA Software, Brochure, literature number 5990-6553EN

89600 VSA Software, Configuration Guide, literature number 5990-6386EN

89600 VSA Software Opt 200 Basic VSA and Opt 300 Hardware Connectivity, Technical Overview, literature number 5990-6405EN

LTE and LTE-Advanced Solutions, Brochure, literature number 5989-7817EN

Keysight 3GPP Long Term Evolution: System Overview, Product Development, and Test Challenges, Application Note, literature number 5989-8139EN

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