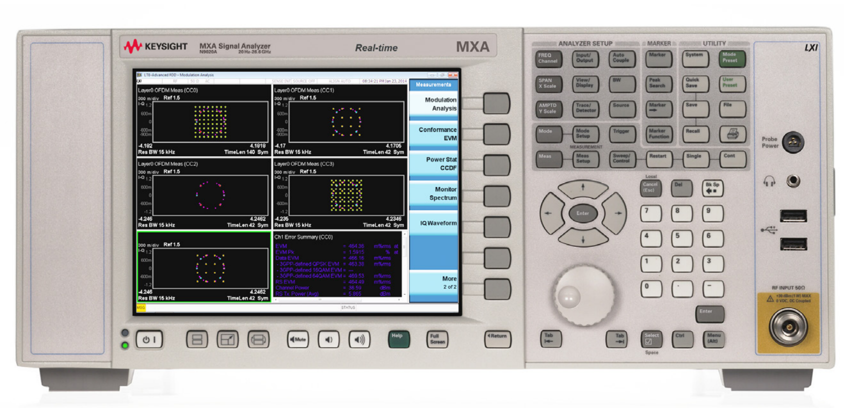
Keysight

LTE and LTE-Advanced FDD/TDD X-Series Measurement Application N9080B and N9082B



Technical Overview

– Perform LTE plus LTE-Advanced FDD and TDD base station (eNB) and user equipment (UE) transmitter tests
– Accelerate measurements with one-button RF conformance tests as defined by 3GPP TS 36.141 and 36.521 specification
– Analyze carrier-aggregated signal of up to 5 contiguous/noncontiguous component carriers
– Use hardkey/softkey manual user interface and SCPI remote user interface
– Leverage built-in, context-sensitive help
– Extend test assets with transportable licenses between X-Series (PXA/MXA/EXA) signal analyzers

KEYSIGHT TECHNOLOGIES

LTE/LTE-Advanced FDD and TDD Measurement Applications

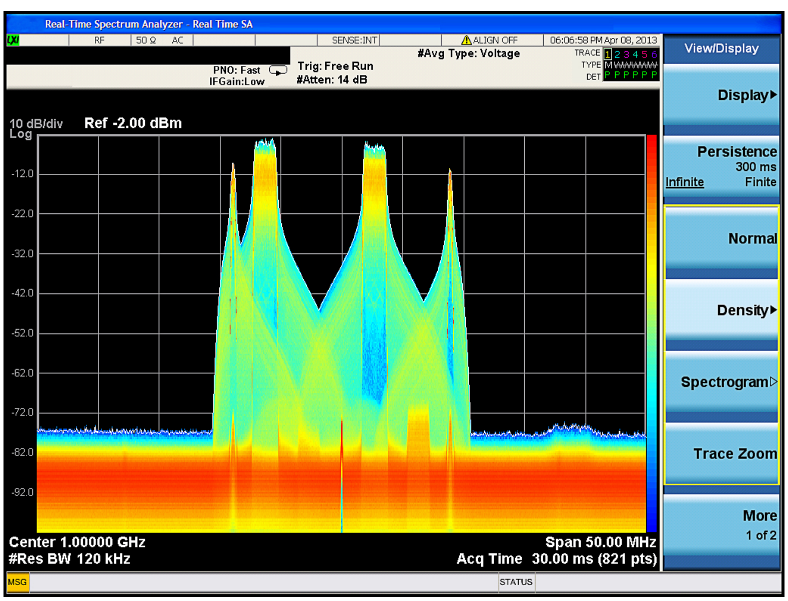
The LTE/LTE-Advanced FDD and TDD measurement applications transform the X-Series signal analyzers into 3GPP LTE/LTE-Advanced standard-based RF transmitter testers. The applications provide fast, one-button RF conformance measurements to help you design, evaluate, and manufacture your LTE and LTE-Advanced base stations (eNB) and user equipment (UE). The measurement applications closely follow the 3GPP standard, allowing you to stay on the leading edge of your design and manufacturing challenges.

X-Series signal analyzers

The Keysight X-Series is an evolutionary approach to signal analysis that spans instrumentation, measurements, and software. It gives you the flexibility to satisfy your business and technical requirements across multiple products and programs—now and in the future. Optimize your investment and extend instrument longevity with upgradeable CPU, memory, disk drives, and I/O ports. Proven algorithms, 100% code-compatibility, and a common UI across the platform create a consistent measurement framework for repeatable results and measurement integrity so you can leverage your test system software through all phases of product development.

X-Series measurement applications

X-Series measurement applications increase the capability and functionality of Keysight signal analyzers to speed time to insight. They provide essential measurements for specific tasks in general-purpose, cellular communications, wireless connectivity and digital video applications, covering more than 40 standards or modulation types. Applications are supported on both benchtop and modular, with the only difference being the level of performance achieved by the hardware you select. Choose the level of performance necessary for your application and have full assurance that the calculations and algorithms are the same across your signal analyzers, from development through manufacturing. Further extend your test assets by transporting these applications across multiple X-Series analyzers.



Real-time spectrum analysis for LTE/LTE-Advanced

Adding real-time spectrum analysis to a PXA or MXA signal analyzer addresses the measurement challenges associated with dynamic RF signals such as bursted transmissions of LTE/LTE-Advanced-TDD, and enables identification of interference caused by signals in adjacent bands or in the case of intra-band, non-contiguous carrier aggregation in adjacent sub-blocks.

- Accurately observe power changes for an LTE signal within a 160 MHz real-time bandwidth.
- Capture random interfering signals with durations as short as 3.57 µs.
- Perform fast, wideband measurements without compromising EVM, ACPR, or other RF measurements.

LTE/LTE-Advanced FDD and TDD Overview

LTE is the long term evolution of 3GPP's universal mobile telephone system (UMTS). The aim of LTE is to provide a new radio access technology focused on packet-switched data only. Multiple requirements are set to achieve increased downlink and uplink peak data rates, scalable channel bandwidths, spectral efficiency improvements, control/user-plane latency, and co-existence with legacy standards while evolving towards an all-IP network. LTE accommodates both paired spectrum for frequency division duplex (FDD) and unpaired spectrum for time division duplex (TDD) operation. There is a high degree of commonality between FDD and TDD modes. These two modes are coordinated in the sense that they both share the same underlying framework including radio access schemes orthogonal frequency division multiple access (OFDMA) for the downlink, and single-carrier frequency division multiple access (SC-FDMA) for the uplink. Both modes share a single radio-access specification, equally applicable to paired and unpaired spectrum. There are some significant differences in specifications between FDD and TDD, most notably on the physical layer in the frame structure. There are few differences on the higher layers.

LTE-Advanced is not a new technology, instead it is an evolution step in the continuing development of LTE. It was initially specified as part of Release 10 of the 3GPP standard with continued evolution with additional features in Release 11 and more upcoming features in Release 12 and beyond. The three key LTE-Advanced technologies that are essential for meeting the ITU 4G requirements are: carrier aggregation, enhanced uplink multiple access, and enhanced multiple antenna transmission. Carrier aggregation is one of the key features of LTE-Advanced and the earliest deployed technologies of LTE-Advanced. It allows two or more (up to 5) component carriers to be aggregated in both contiguous and non-contiguous configurations in order to support up to 100 MHz transmission bandwidth.

Table 1. Physical layer comparisons of LTE and LTE-Advanced FDD/TDD

	LTE FDD (3GPP Rel 8/9)	**LTE TDD (3GPP Rel 8/9)**	**LTE-Advanced FDD (3GPP Rel 10/11)**	**LTE-Advanced TDD (3GPP Rel 10/11)**
Radio access mode	FDD	TDD	FDD	TDD
Radio frame length	10 ms (20 slots, 10 sub-frames)			
Transmission scheme	Downlink: OFDMA		Downlink: OFDMA	
	Uplink: SC-FDMA		Uplink: SC-FDMA, clustered SC-FDMA	
Channel bandwidth (BW)	Maximum: 20 MHz 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz		Maximum: 100 MHz with carrier aggregation; BW per component carrier (CC): 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz	
Data type	Packet switched for both voice and data, no circuit switched			
Data modulation	Downlink: QPSK, 16 QAM, 64 QAM		Downlink: QPSK, 16 QAM, 64 QAM	
	Uplink: QPSK, 16 QAM; 64 QAM for UE category 5 only		Uplink: QPSK, 16 QAM; 64 QAM for UE categories 5, 7, and 8 only	
Peak data rate	Downlink: 300 Mbps		Downlink: 1 Gbps	
	Uplink: 75 Mbps		Uplink: 500 Mbps	
MIMO technology	Downlink: Up to 4x4 spatial multiplexing; transmit diversity; multi-user (MU) MIMO; beamforming		Downlink: Up to 8x8 spatial multiplexing; transmit diversity; MU-MIMO; beamforming	
	Uplink: MU-MIMO - more than one UE transmit in the same time-frequency resource		Uplink: Up to 4x4 spatial multiplexing for data (PUSCH); transmit diversity for control (PUCCH); MU-MIMO	

RF Transmitter Tests

With the LTE/LTE-Advanced FDD and TDD measurement applications, you can perform RF transmitter measurements on eNB and UE devices in time, frequency, and modulation domains. Measurement setups are simplified with automatic detection of downlink channels and signals. For eNB conformance testing, measurement is simplified by recalling E-TM presets according to 3GPP TS 36.141 specification.

For LTE-Advanced demodulation measurements, such as EVM and frequency error, the measurement application uses an automatic sequencing function, instead of a single wideband capture of the multi-carrier signal, eliminating the need for the wide analysis bandwidth option on the signal analyzer and thereby reducing the overall test equipment cost. The measured results of up to 5 CCs for LTE-Advanced can be viewed side-by-side and represented in multiple domains such as resource block, sub-carrier, slot, or symbol. Graphical displays with color coding and marker coupling allows you to search for problems faster and troubleshoot the found problems quicker. For manufacturing, “conformance EVM” measurement provides significant speed improvement over the traditional EVM measurement.

In addition, the measurement applications allow you to test beyond physical layer by using the transport layer decoding functionality. Troubleshoot transport layer problems and verify the channel encoding is correct by accessing data at different points in the receiver chain such as demapped, deinterleaved, descrambled, deratematched, and decoded data.

For unwanted emissions, 3GPP Release 11 adds LTE-Advanced RF conformance requirements for intra-band, non-contiguous carrier aggregation because the spectrum in the sub-block gap can be deployed by another service provider, perhaps using a different technology. These new RF requirements are cumulative adjacent channel leakage power (CACLR), to measure the contributions from carriers on both sides of the sub-block gap, and cumulative spectrum emissions mask (SEM) measurement where a new special limit mask is defined for unwanted emissions within a sub-block gap calculated as the cumulative sum of contribution from each sub-block. The LTE-Advanced embedded measurement application provides limits for both CACLR and SEM in non-contiguous carrier aggregation.

Choosing between X-Series embedded applications and 89600 VSA software

X-Series measurement applications provide embedded format-specific, one-button measurements for X-Series analyzers. With fast measurement speed, SCPI programmability, pass/fail testing, and simplicity of operation, these applications are ideally suited for design verification and manufacturing. 89600 VSA software is the industry-leading measurement software for evaluating and troubleshooting signals in R&D. PC-based and supporting numerous measurement platforms, 89600 VSA software provides flexibility and sophisticated measurement tools essential to find and fix signal problems in R&D.

www.keysight.com/find/89600_vsa

Standard-Based RF Transmitter Tests

The RF transmitter conformance test requirements for LTE/LTE-Advanced FDD and TDD are defined in 3GPP 36.141 (eNB) and 36.521-1 (UE) of the 3GPP standard. Table 2 shows the required eNB RF transmitter tests along with the corresponding measurements available in the X-Series and 89600 LTE/LTE-Advanced applications. Table 3 shows similar information for UE transmitter tests.

Table 2. Required base station (eNB) RF transmitter measurements and the corresponding measurements in N9080B/N9082B and 89600 VSA

3GPP TS36.141 paragraph #	Transmitter test	E-TM required	N9080B (FDD) N9082B (TDD) measurement applications [1]	89601B Option BHD/BHG (FDD) Option BHE/BHH (TDD) [1]
6.2	Base station output power	E-TM 1.1	Channel power [2]	Channel power using band power marker [2]
6.3.2	Total power dynamic range	E-TM 2 E-TM 3.1	OFDM symbol Tx. power (OSTP) [3]	OFDM symbol Tx. power [3]
6.4	Transmit ON/OFF power (TDD only)	E-TM1.1	Transmit ON/OFF power (N9082B only) [4]	Not available
6.5.1	Frequency error	E-TM 2 E-TM 3.1	Frequency error [3]	Frequency error [3]
6.5.2	Error vector magnitude	E-TM 3.2 E-TM 3.3	EVM [3]	EVM [3]
6.5.3	Time alignment error (TAE)	E-TM 1.1	MIMO summary or cross-carrier summary [5]	MIMO info table or cross-carrier summary [5]
6.5.4	DL RS power	E-TM 1.1	RS Tx power (RSTP) [3]	RS Tx power [3]
6.6.1	Occupied bandwidth	E-TM 1.1	Occupied BW	89600-based solutions offer modulation-quality measurements; for one-button, non-demodulation measurements such as ACLR and spectrum emission mask, the embedded application should be used
6.6.2	Adjacent channel leakage power ratio (ACLR)	E-TM 1.1 E-TM 1.2	ACP	
6.6.2.6	Cumulative ACLR (LTE-Advanced only)	E-TM 1.1 E-TM 1.2	ACP	
6.6.3	Operating band unwanted emissions (SEM)	E-TM 1.1 E-TM 1.2	Spectrum emission mask	
6.6.3	Cumulative mask for SEM (LTE-Advanced only)	E-TM 1.1 E-TM 1.2	Spectrum emission mask	
6.6.4	Transmitter spurious emission	E-TM 1.1	Spurious emissions	
6.7	Transmitter intermodulation	E-TM 1.1	ACP, SEM, spurious emissions	

1. All of the measurements are available for single carrier (LTE) or multiple-carrier LTE-Advanced with up to 5 component carriers. N9080B/N9082B option 1FP is LTE, option 2FP is LTE-Advanced.
2. These are pre-demodulation channel power measurements. Channel power reading is also available after demodulation under "Error Summary" trace.
3. For N9080B/N9082B, these measurements are available under "Error Summary" trace in Mod Analysis as well as under "Conformance EVM" measurement. For 89600, they are available under "Error Summary" trace.
4. For LTE-Advanced, this measurement is supported for contiguous carrier aggregation and requires analysis bandwidth on X-Series signal analyzer wide enough to cover the aggregated bandwidth.
5. "MIMO Summary"/"MIMO Info Table" traces are used to measure TAE for MIMO and Tx diversity signals. For carrier aggregation, "Cross-carrier Summary" trace is used to measure TAE.

Standard-Based RF Transmitter Tests (continued)

For uplink, LTE-Advanced added transmitter RF conformance test for carrier aggregation (CA) and uplink MIMO (UL-MIMO) as shown in Table 3. Even though demodulation of UL-MIMO spatial multiplexing is not supported in the N9080B and N9082B embedded applications, the transmitter conformance test for UL-MIMO only requires testing the DUT at each antenna port using UL RMC (same as LTE), so the applications can also be used for UL-MIMO RF conformance test.

Table 3. Required user equipment (UE) RF transmitter measurements and the corresponding measurements in N9080B/N9082B and 89600 VSA

3GPP TS 36.521-1 paragraph #			Transmitter test	N9080B (FDD) N9082B (TDD) measurement applications	89601B Option BHD/BHG (FDD) Option BHE/BHH (TDD)
LTE Rel 8 and up	LTE-Advanced CA	LTE-Advanced UL-MIMO			
6.2.2	6.2.2A	6.2.2B	UE maximum output power (MOP)	Channel power	Channel power using band power marker
6.2.3	6.2.3A	6.2.3B	Maximum power reduction (MPR)		
6.2.4	6.2.4A	6.2.4B	Additional maximum power reduction (A-MPR)		
6.2.5	6.2.5A	6.2.5B	Configured UE transmitted output power		
6.3.2	6.3.2A	6.3.2B	Minimum output power		
6.3.3	6.3.3A	6.3.3B	Transmit off power	Channel power or transmit on/off power	
6.3.4	6.3.4A	6.3.4B	On/off time mask	Transmit on/off power	Not available
6.3.5	6.3.5A	6.3.5B	Power control	Not available	Not available
6.5.1	6.5.1A	6.5.1B	Frequency error	Frequency error [1] and frequency error per slot [2]	Frequency error and frequency error per slot trace
6.5.2.1	6.5.2A.1	6.5.2B.1	Error vector magnitude (EVM)	EVM [1]	EVM
6.5.2.1A	N/A	N/A	PUSCH-EVM with exclusion period	EVM [1]	EVM
6.5.2.2	6.5.2A.2	6.5.2B.2	Carrier leakage	IQ offset [1] and IQ offset per slot [2]	IQ offset & IQ offset per slot
6.5.2.3	6.5.2A.3	6.5.2B.3	In-band emissions for non-allocated RB	In-band emissions [2] (not available for CA)	In-band emissions (not available for CA)
6.5.2.4	N/A	6.5.2B.4	EVM equalizer spectrum flatness	Equalizer channel frequency response per slot [3]	Per slot equalizer channel frequency response
6.6.1	6.6.1A	6.6.1B	Occupied bandwidth	Occupied BW	89600-based solutions offer modulation-quality measurements. For one-button, non-demodulation, measurements such as ACLR and spectrum emission mask, the embedded application should be used.
6.6.2.1	6.6.2.1A	6.6.2.1B	Spectrum emission mask (SEM)	SEM	
6.6.2.2	6.6.2.2A	6.6.2.2B	Additional SEM	SEM	
6.6.2.3	6.6.2.3A	6.6.2.3B	Adjacent channel leakage power ratio (ACLR)	ACP	
6.6.3.1	6.6.3.1A	6.6.3B.1	Transmitter spurious emission	Spurious emissions	
6.6.3.2	6.6.3.2A	6.6.3B.2	Spurious emission band UE co-existence	Spurious emissions	
6.6.3.3	6.6.3.3A	6.6.3B.3	Additional spurious emissions	Spurious emissions	
6.7	6.7A	6.7B	Transmit intermodualtion	ACP	
N/A	N/A	6.8B	Time alignment	Time offset [1]	Time offset

1. These values are found in "Error Summary" table under Mod Analysis measurement or under Conformance EVM measurement for N9080B and N9082B.
2. These measurements are part of the Mod Analysis measurement. Once in Mod Analysis, they are found under [Trace/Detector] -> {Data} > {Demod Error}.
3. This measurement is part of the Mod Analysis measurement. Once in Mod Analysis, it is found under [Trace/Detector] -> {Data} > {Response}.

Standard-Based RF Transmitter Tests (continued)

Measurement details

All of the RF transmitter measurements as defined by the 3GPP standard, as well as a wide range of additional measurements and analysis tools are available with a press of a button (Table 4 and 5). These measurements are fully remote controllable via the IEC/IEEE bus or LAN, using SCPI commands.

Analog baseband measurements for LTE/LTE-Advanced are available on a PXA or MXA signal analyzer equipped with BBIQ hardware. Supported baseband measurements include all of the modulation quality plus I/Q waveform measurement.

It is important to note that the measurements shown in Tables 4-5 for LTE FDD and TDD are available for a single carrier, while the measurements for LTE-Advanced FDD and TDD columns are available for multiple carriers with up to 5 component carriers.

Measurement details for eNB transmitter test

Table 4. List of eNB measurements provided by N9080B and N9082B measurement applications

Technology	**LTE FDD**	**LTE-Advanced FDD**	**LTE TDD**	**LTE-Advanced TDD**
X-Series measurement application	**N9080B-1FP**	**N9080B-2FP**	**N9082B-1FP**	**N9082B-2FP**
X-Series signal analyzer	PXA, MXA, EXA			
Modulation quality (error summary table)				
– EVM (RMS, peak, data, RS)	•	•	•	•
– Channel power	•	•	•	•
– RS Tx. power (RSTP)	•	•	•	•
– OFDM symbol Tx. power (OSTP)	•	•	•	•
– RS Rx. power (RSRP)	•	•	•	•
– RSSI	•	•	•	•
– RS Rx. quality (RSRQ)	•	•	•	•
– Frequency error	•	•	•	•
– Common tracking error	•	•	•	•
– Symbol clock error	•	•	•	•
– Time offset	•	•	•	•
– IQ (Offset, gain imbalance, quad error, timing skew)	•	•	•	•
Conformance EVM	•	•	•	•
Demodulated error traces				
– EVM vs. frequency (sub-carrier)	•	•	•	•
– EVM vs. time (symbol)	•	•	•	•
– EVM vs. resource block	•	•	•	•
– EVM vs. slot	•	•	•	•
– Frequency error per slot	•	•	•	•
– Power vs. resource block	•	•	•	•
– Power vs. slot	•	•	•	•
Symbols table				
– Numerical values of demodulated symbols (encoded)	•	•	•	•
Decoded symbol table				
– Numerical values of demodulated data include demapped, deinterleaved, descrambled, deratematched, and decoded data	•	•	•	•
Downlink decode table				
– Decode information from PBCH, PDCCH, PHICH, and PCFICH	•	•	•	•
Frame summary table				
– EVM, power, modulation format, and number of allocated RB and RNTI for all active channels and signals	•	•	•	•
Cross-carrier summary				
– Time alignment error (TAE) and channel power summary of each CC relative to the selected reference CC		•		•

Standard-Based RF Transmitter Tests (continued)

Table 4. List of eNB measurements provided by N9080B and N9082B measurement applications (continued)

Technology	**LTE FDD**	**LTE-Advanced FDD**	**LTE TDD**	**LTE-Advanced TDD**
X-Series measurement application	**N9080B-1FP**	**N9080B-2FP**	**N9082B-1FP**	**N9082B-2FP**
X-Series signal analyzer	PXA, MXA, EXA			
TX diversity MIMO (up to 4 Tx antenna) traces				
– Info table				
– RS power	•	•	•	•
– RS EVM	•	•	•	•
– RS CTE	•	•	•	•
– RS timing	•	•	•	•
– RS phase	•	•	•	•
– RS symbol clock	•	•	•	•
– RS frequency	•	•	•	•
– IQ gain imbalance	•	•	•	•
– IQ quadrature error	•	•	•	•
– IQ time skew	•	•	•	•
– Channel frequency response	•	•	•	•
– Channel frequency response difference	•	•	•	•
– Equalizer impulse response	•	•	•	•
– Common tracking error	•	•	•	•
Detected allocations trace (resource block vs. symbol)	•	•	•	•
Response				
– Equalizer channel frequency response	•	•	•	•
– Instantaneous equalizer channel frequency response	•	•	•	•
– Equalizer channel frequency response difference	•	•	•	•
– Instantaneous equalizer channel frequency response difference	•	•	•	•
– Equalizer impulse response	•	•	•	•
Channel power	•	•	•	•
ACP	•	•	•	•
Cumulative ACLR (CACLR)		•		•
Transmit on/off power			•	•
Spectrum emission mask (SEM)	•	•	•	•
Cumulative SEM		•		•
Spurious emissions	•	•	•	•
Occupied bandwidth	•	•	•	•
CCDF	•	•	•	•
Monitor spectrum	•	•	•	•
I/Q waveform	•	•	•	•

Standard-Based RF Transmitter Tests (continued)

Table 5. List of UE measurements provided by N9080B and N9082B measurement applications

Technology	LTE FDD	LTE-Advanced FDD	LTE TDD	LTE-Advanced TDD
X-Series measurement application	**N9080B-1FP**	**N9080B-2FP**	**N9082B-1FP**	**N9082B-2FP**
X-Series signal analyzer	PXA, MXA, EXA			
Modulation quality (error summary trace)				
– EVM (RMS, peak, data, RS)	•	•	•	•
– Frequency error	•	•	•	•
– Common tracking error	•	•	•	•
– Symbol clock error	•	•	•	•
– Time offset	•	•	•	•
– IQ (offset, gain imbalance, quad error, timing skew)	•	•	•	•
– Channel power	•	•	•	•
– In-band emissions result	•	• Not available for CA	•	• Not available for CA
– Spectral flatness result	•	•	•	•
Conformance EVM	•	•	•	•
In-band emissions	•	• Not available for CA	•	• Not available for CA
Spectrum flatness (eq. ch freq response per slot)	•	•	•	•
Demodulated error traces				
– EVM vs. frequency (sub-carrier)	•	•	•	•
– EVM vs. time (symbol)	•	•	•	•
– EVM vs. resource block	•	•	•	•
– EVM vs. slot	•	•	•	•
– IQ offset per slot	•	•	•	•
– Frequency error per slot	•	•	•	•
– Power vs. resource block	•	•	•	•
– Power vs. slot	•	•	•	•
Symbols table				
– Numerical values of demodulated symbols (encoded)	•	•	•	•
Decoded symbol table				
– Numerical values of demodulated data and descrambled data for PUSCH	•	•	•	•
Frame summary table				
– EVM, power, modulation format and number of allocated RB for all active channels and signals	•	•	•	•
Detected allocations trace (resource block vs. symbol)	•	•	•	•
Response				
– Equalizer channel frequency response	•	•	•	•
– Instantaneous equalizer channel frequency response	•	•	•	•
– Equalizer channel frequency response difference	•	•	•	•
– Instantaneous equalizer channel frequency response difference	•	•	•	•
– Equalizer impulse response	•	•	•	•
– Equalizer channel frequency response per slot	•	•	•	•
Channel power	•	•	•	•
ACP	•	•	•	•
Transmit on/off power	•	•	•	•
Spectrum emission mask (SEM)	•	•	•	•
Spurious emissions	•	•	•	•
Occupied bandwidth	•	•	•	•
CCDF	•	•	•	•
Monitor spectrum	•	•	•	•
I/Q waveform	•	•	•	•

Standard-Based RF Transmitter Tests (continued)

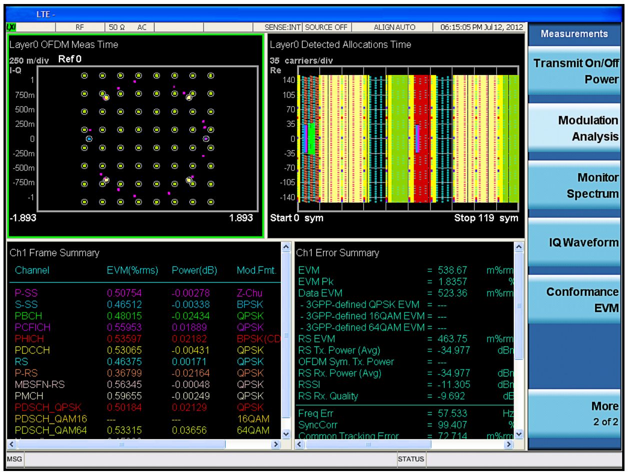


Figure 1. LTE downlink modulation analysis measurement showing constellation, detected allocation, frame summary, and error summary information. Measurements are color-coded based on channel type for ease of troubleshooting.

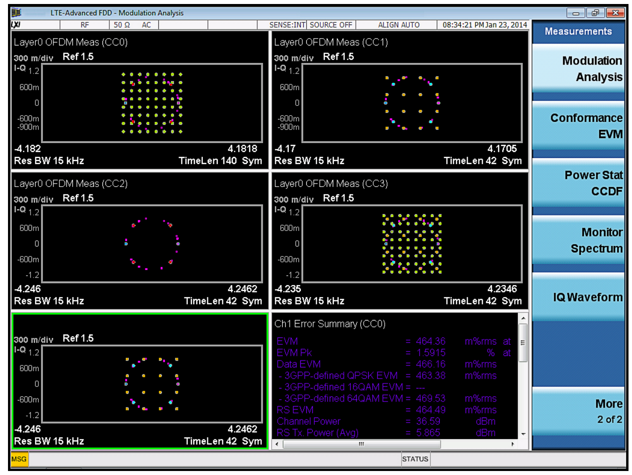


Figure 2. LTE-Advanced downlink modulation analysis showing constellation of five component carriers side-by-side.

Figure 3. Uplink modulation analysis measurement showing constellation, EVM vs. subcarrier, detected allocation, and EVM vs. symbol information for two component carriers. Measurements are color-coded based on channel type and up to 12 markers with marker coupling between measurements are available for easier troubleshooting.

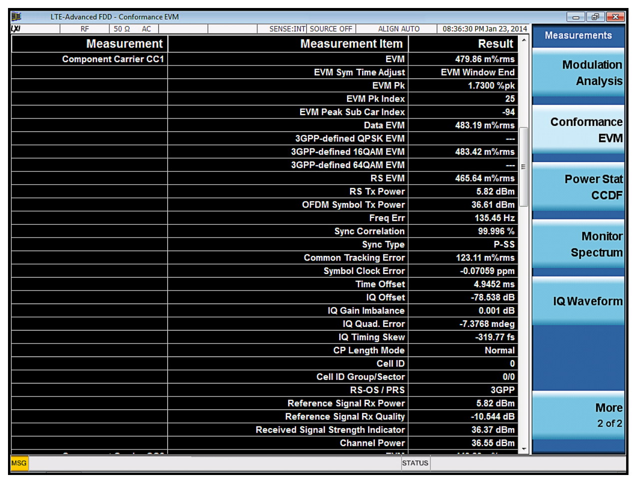


Figure 4. Conformance EVM measurement showing all required modulation quality metrics. This measurement is optimized for manufacturing because of its fast measurement speed.

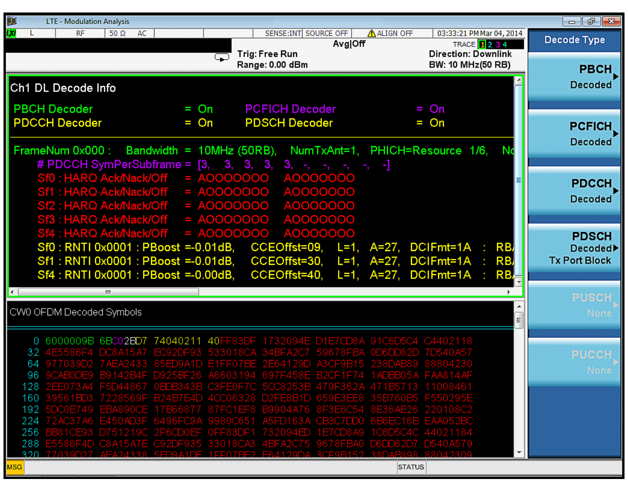


Figure 5. Downlink transport layer channel decoding measurement showing decoded information for PBCH, PDCCH, PCFICH, and PHICH channels. Similar capability is also available for uplink.

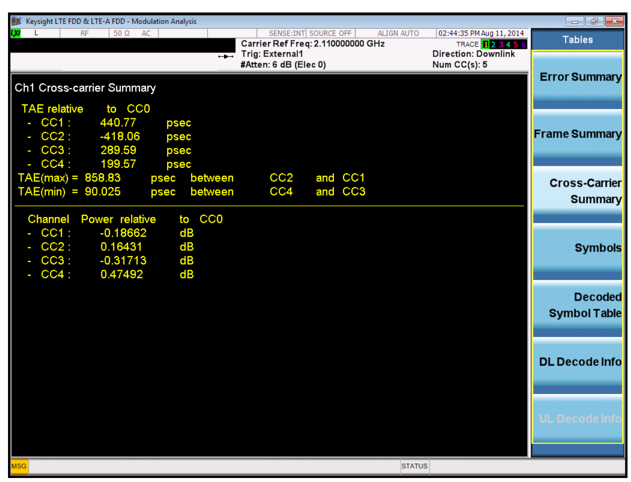


Figure 6. LTE-Advanced cross-carrier summary trace showing time alignment error (TAE) and channel power of each CC relative to CC0.

Standard-Based RF Transmitter Tests (continued)

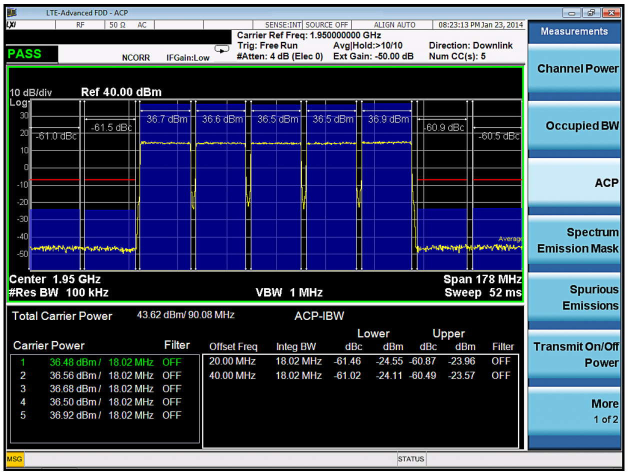


Figure 7. LTE-Advanced ACLR measurement with 5 contiguous component carriers.

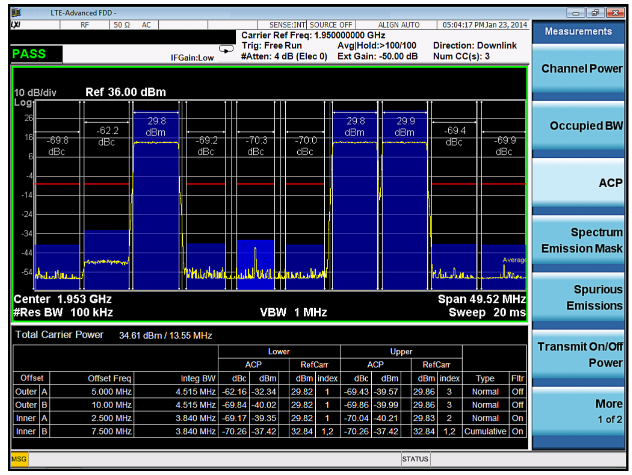


Figure 8. LTE-Advanced cumulative ACLR (CACLR) for non-contiguous carrier aggregation.

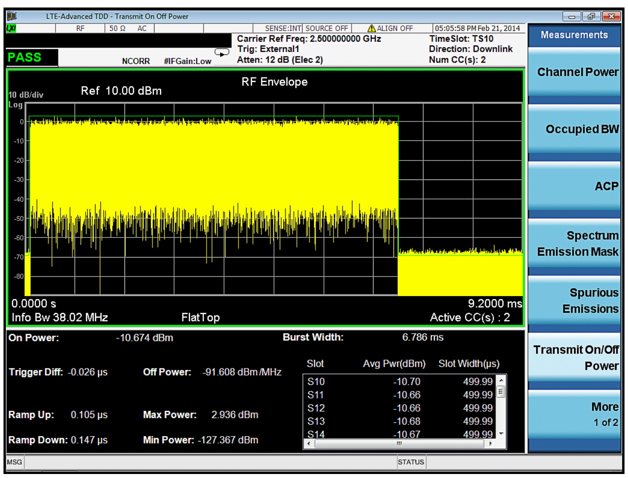


Figure 9. Transmit ON/OFF power measurement of an LTE-Advanced TDD downlink signal with two component carriers.

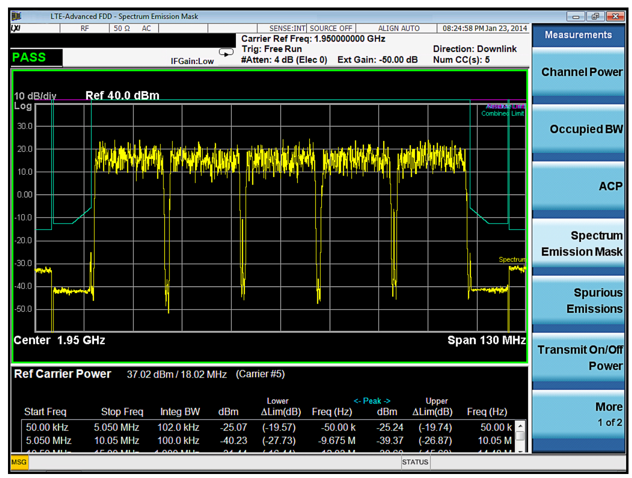


Figure 10. SEM measurement can be made on single carrier LTE or up to 5 component carrier LTE-Advanced signal.

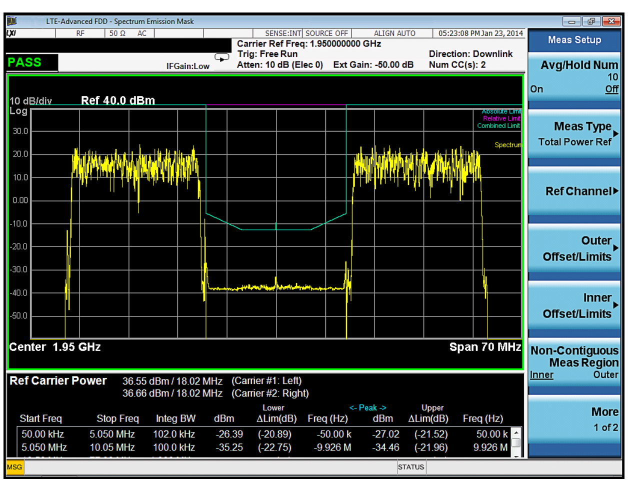


Figure 11. LTE-Advanced non-contiguous carrier aggregation SEM measurement with special cumulative mask inside the sub-block gap.

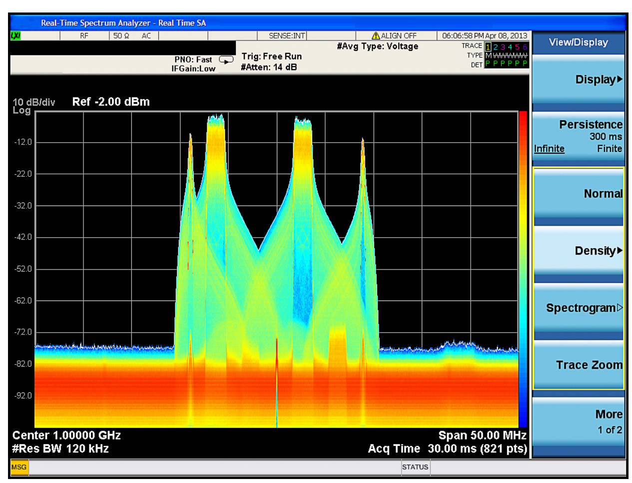


Figure 12. Real-time view of LTE-Advanced FDD uplink with simultaneous PUCCH and frequency hopped PUSCH signal configuration using the RTSA option on a PXA or MXA signal analyzer.

Key Specifications

Definitions

- Specifications describe the performance of parameters covered by the product warranty.
- The specifications apply to single carrier case only, unless otherwise stated.
- 95th percentile values indicate the breadth of the population (≈2σ) of performance tolerances expected to be met in 95% of cases with a 95% confidence. These values are not covered by the product warranty.
- Typical values are designated with the abbreviation "typ." These are performance beyond specification that 80% of the units exhibit with a 95% confidence. These values are not covered by the product warranty.
- Nominal values are designated with the abbreviation "nom." These 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.

Note: Data subject to change.

Supported devices and standards

Device type	**LTE FDD/TDD N9080B-1FP/ N9082B-1FP**	**LTE-Advanced FDD/TDD N9080B-2FP/ N9082B-2FP**
3GPP standards supported	36.211 V9.1.0 (March 2010) 36.212 V9.4.0 (September 2011) 36.213 V9.3.0 (September 2010) 36.214 V9.2.0 (June 2010) 36.141 V9.10.0 (July 2012) 36.521-1 V9.8.0 (March 2012)	36.211 V10.7.0 (March 2013) 36.212 V10.7.0 (December 2012) 36.213 V10.9.0 (March 2013) 36.214 V10.12.0 (March 2013) 36.141 V11.4.0 (March 2013) 36.521-1 V10.5.0 (March 2013)
Signal structure	FDD Frame Structure Type 1 TDD Frame Structure Type 2 Special subframe configurations 0-8	FDD Frame Structure Type 1 TDD Frame Structure Type 2 Special subframe configurations 0-9
Signal direction	Uplink and downlink UL/DL configurations 0-6	Uplink and downlink UL/DL configurations 0-6
Signal bandwidth	1.4 MHz (6 RB), 3 MHz (15 RB), 5 MHz (25 RB), 10 MHz (50 RB), 15 MHz (75 RB), 20 MHz (100 RB)	Bandwidth per component carrier: 1.4 MHz (6 RB), 3 MHz (15 RB), 5 MHz (25 RB), 10 MHz (50 RB), 15 MHz (75 RB), 20 MHz (100 RB)
Number of component carriers	1	1, 2, 3, 4, or 5
Physical signals		
– Downlink	PBCH, PCFICH, PHICH, PDCCH, PDSCH, PMCH	
– Uplink	PUCCH, PUSCH, PRACH	
Physical channels		
– Downlink	P-SS, S-SS, C-RS, UE-RS, P-PS (positioning), MBSFN-RS	P-SS, S-SS, C-RS, UE-RS, P-PS (positioning), MBSFN-RS, CSI-RS
– Uplink	PUCCH-DMRS, PUSCH-DMRS, S-RS (sounding)	PUCCH-DMRS, PUSCH-DMRS, S-RS (sounding)

For a complete list of specifications refer to the appropriate specifications guide.

PXA: http://www.keysight.com/find/pxa_specifications
MXA: http://www.keysight.com/find/mxa_specifications
EXA: http://www.keysight.com/find/exa_specifications

Key Specifications (continued)

Description		**PXA**	**MXA**	**EXA**
Channel power				
Minimum power at RF input			–50 dBm (nom)	
Power accuracy		± 0.63 dB	± 0.82 dB	± 1.04 dB
Power accuracy (95% confidence)		± 0.19 dB	± 0.23 dB	± 0.27 dB
Measurement floor (@ 10 MHz BW)		–81.7 dBm (nom)	–79.7 dBm (nom)	–76.7 dBm (nom)
Transmit on/off power (only applies to N9082B)				
Burst type			Traffic, UpPTS, DwPTS, SRS, PRACH	
Measurement time			Up to 20 slots	
Dynamic range for 5 MHz BW [1]		124.5 dB (nom)	124.5 dB (nom)	122.5 dB (nom)
Adjacent channel power				
Minimum power at RF input			–36 dBm (nom)	
Accuracy				
Radio	Offset frequency			
MS	Adjacent	± 0.07 dB (5 MHz) ± 0.11 dB (10 MHz) ± 0.21 dB (20 MHz)	± 0.13 dB (5 MHz) ± 0.20 dB (10 MHz) ± 0.38 dB (20 MHz)	± 0.16 dB (5 MHz) ± 0.24 dB (10 MHz) ± 0.41 dB (20 MHz)
			(ACPR range –33 to –27 dBc with Opt ML)	
BTS	Adjacent	± 0.23 dB (5 MHz) ± 0.33 dB (10 MHz) ± 0.52 dB (20 MHz)	± 0.57 dB (5 MHz) ± 0.82 dB (10 MHz) ± 1.19 dB (20 MHz)	± 1.03 dB (5 MHz) ± 1.29 dB (10 MHz) ± 2.04 dB (20 MHz)
			(ACPR range –48 to –42 dBc with Opt ML)	
BTS	Alternate	± 0.11 dB (5 MHz) ± 0.21 dB (10 MHz) ± 0.40 dB (20 MHz)	± 0.21 dB (5 MHz) ± 0.35 dB (10 MHz) ± 0.65 dB (20 MHz)	± 0.24 dB (5 MHz) ± 0.39 dB (10 MHz) ± 0.74 dB (20 MHz)
			(ACPR range –48 to –42 dBc with Opt ML)	
Dynamic range E-UTRA				
Offset	Channel BW			
Adjacent	5 MHz	83.5 dB (nom) (Opt ML –8.5 dBm)	74.2 dB (nom) (Opt ML –18.4 dBm)	70.0 dB (nom) (Opt ML –16.5 dBm)
Adjacent	10 MHz	82.1 dB (nom) (Opt ML –8.3 dBm)	73.8 dB (nom) (Opt ML –18.4 dBm)	69.3 dB (nom) (Opt ML –16.5 dBm)
Adjacent	20 MHz	Not available	71.7 dB (nom) (Opt ML –18.2 dBm)	68.4 dB (nom) (Opt ML –16.3 dBm)
Alternate	5 MHz	86.7 dB (nom) (Opt ML –8.5 dBm)	77.6 dB (nom) (Opt ML –18.6 dBm)	75.8 dB (nom) (Opt ML –16.6 dBm)
Alternate	10 MHz	83.7 dB (nom) (Opt ML –8.3 dBm)	75.1 dB (nom) (Opt ML –18.4 dBm)	73.2 dB (nom) (Opt ML –16.3 dBm)
Alternate	20 MHz	Not available	72.1 dB (nom) (Opt ML –18.2 dBm)	70.3 dB (nom) (Opt ML –16.3 dBm)
Dynamic range UTRA				
Offset	Channel BW			
2.5 MHz	5 MHz	86.2 dB (nom) (Opt ML –8.5 dBm)	75.9 dB (nom) (Opt ML –18.5 dBm)	70.5 dB (nom) (Opt ML –16.6 dBm)
2.5 MHz	10 MHz	84.2 dB (nom) (Opt ML –8.3 dBm)	76.2 dB (nom) (Opt ML –18.4 dBm)	70.5 dB (nom) (Opt ML –16.4 dBm)
2.5 MHz	20 MHz	Not available	75.0 dB (nom) (Opt ML –18.2 dBm)	71.4 dB (nom) (Opt ML –16.3 dBm)
7.5 MHz	5 MHz	87.3 dB (nom) (Opt ML –8.7 dBm)	78.4 dB (nom) (Opt ML –18.5 dBm)	76.5 dB (nom) (Opt ML –16.6 dBm)
7.5 MHz	10 MHz	87.0 dB (nom) (Opt ML –8.4 dBm)	78.6 dB (nom) (Opt ML –18.4 dBm)	76.5 dB (nom) (Opt ML –16.4 dBm)
7.5 MHz	20 MHz	Not available	78.1 dB (nom) (Opt ML –18.2 dBm)	75.7 dB (nom) (Opt ML –16.3 dBm)

1. This dynamic range is for the case of 5 MHz information bandwidth. For other information bandwidths, the dynamic range can be derived using the following equation: Dynamic Range = Dynamic Range for 5 MHz – 10*log10 (Info BW/5.0e6).

Key Specifications (continued)

Description	PXA	MXA	EXA
Spectrum emission mask			
Dynamic range			
– 5 MHz	82.9 (86.8 dB typ)	76.2 (82.9 dB typ)	72.6 (79.4 dB typ)
– 10 MHz	86.6 (90.7 dB typ)	77.8 (83.8 dB typ)	73.5 (80.3 dB typ)
– 20 MHz	84.3 (89.7 dB typ)	78.2 (84.9 dB typ)	73.4 (80.6 dB typ)
Sensitity	–98.5 (–101.5 dBm typ)	–94.5 (–99.5 dBm typ)	–92.5 (–96.5 dBm typ)
Accuracy			
– Relative	± 0.06 dB	± 0.13 dB	± 0.13 dB
– Absolute	± 0.62 (± 0.20 dB 95%)	± 0.88 (± 0.27 dB 95%)	± 1.15 (± 0.31 dB 95%)
Spurious emissions			
Dynamic range, relative	88.8 (92.1 dB typ)	81.3 (82.2 dB typ)	76.9 (77.4 dB typ)
Sensitivity, absolute	–88.5 (–91.5 dBm typ)	–84.5 (–89.5 dBm typ)	–82.5 (–86.5 dBm typ)
Accuracy (attenuation = 10 dB)	± 0.19 dB (95%)	± 0.29 dB (95%)	± 0.38 dB (95%)
– Frequency range	20 Hz to 3.6 GHz	20 Hz to 3.6 GHz	9 kHz to 3.6 GHz
– Frequency range	± 1.08 dB (95%) 3.5 GHz to 8.4 GHz	± 1.17 dB (95%) 3.5 GHz to 8.4 GHz	± 1.22 dB (95%) 3.5 GHz to 7.0 GHz
– Frequency range	± 1.48 dB (95%) 8.3 GHz to 13.6 GHz	± 1.54 dB (95%) 8.3 GHz to 13.6 GHz	± 1.59 dB (95%) 6.9 GHz to 13.6 GHz
Occupied bandwidth			
Minimum power at RF input	–30 dBm (nom)		
Frequency accuracy	± 10 kHz (RBW = 30 kHz, Number of points = 1001, Span = 10 MHz)		
Modulation analysis			
Input range	Signal level within one range step of overload		
OSTP/RSTP [1]			
Absolute accuracy	± 0.21 dB (nom)	± 0.27 dB (nom)	± 0.30 dB (nom)
EVM floor for downlink (OFDMA) [2]			
Signal bandwidth			
– 5 MHz	0.34% (–49.3 dB) 0.28% (–51.2 dB) nom	0.36% (–48.8 dB)	0.68% (–43.3 dB)
– 10 MHz	0.35% (–49.1 dB) 0.31% (–50.3 dB) nom	0.36% (–48.8 dB)	0.68% (–43.6 dB)
– 20 MHz	0.39% (–48.1 dB) 0.34% (–49.5 dB) nom	0.40% (–47.9 dB)	0.72% (–43.0 dB)
EVM floor for downlink (OFDMA) with Option BBA			
Signal bandwidth			
– 5 MHz	0.18% (–54.8 dB) nom	0.18% (–54.8 dB) nom	
– 10 MHz	0.18% (–54.8 dB) nom	0.18% (–54.8 dB) nom	
– 20 MHz	0.18% (–54.8 dB) nom	0.18% (–54.8 dB) nom	
EVM accuracy for Downlink (OFDMA) [3]			
EVM range: 0 to 8%	± 0.3% nom	± 0.3% nom	± 0.3% nom
EVM floor for uplink (SC-FDMA) [2]			
Signal bandwidth			
– 5 MHz	0.31% (–50.1 dB) 0.21% (–53.5 dB) nom	0.35% (–49.1 dB)	0.66% (–43.6 dB)
– 10 MHz	0.32% (–49.8 dB) 0.21% (–53.5 dB) nom	0.35% (–49.1 dB)	0.66% (–43.6 dB)
– 20 MHz	0.35% (–49.1 dB) 0.22% (–53.2 dB) nom	0.40% (–47.9 dB)	0.70% (–43.0 dB)

1. The accuracy specification applies when EVM is less than 1% and no power boost is applied on reference signal.
2. For MXA and EXA instruments with serial number prefix ≥ MY/SG/US5233 and ≥ MY/SG/US5340, which ship standard with N9020A-EP2 and N9010A-EP3. Refer to the LTE section in the MXA and EXA specification guides for more information: www.keysight.com/find/mxa_specifications; www.keysight.com/find/exa_specifications.
3. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. Refer to specification guide for information on calculating the errors due to the floor.

Key Specifications (continued)

Description	PXA	MXA	EXA
Frequency error			
Lock range	± 2.5 x subcarrier spacing = 37.5 kHz for default 15 kHz subcarrier spacing (nom)		
Accuracy	± 1 Hz + tfa [1] (nom)		
Time offset [2]			
Absolute frame offset accuracy	± 20 ns	± 20 ns	± 20 ns
Relative frame offset accuracy	± 5 ns (nom)	± 5 ns (nom)	± 5 ns (nom)
MIMO RS timing accuracy	± 5 ns (nom)	± 5 ns (nom)	± 5 ns (nom)

1. tfa = transmitter frequency x frequency reference accuracy.
2. The accuracy specification applies when EVM is less than 1% and no power boost is applied for resource elements.

Ordering Information

Software licensing and configuration

Choose from two license types:

- Fixed, perpetual license:
  This allows you to run the application in the X-Series analyzer in which it is initially installed.
- Transportable, perpetual license:
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The table below contains information on our fixed, perpetual licenses. For more information, please visit the product web pages.

N9080B LTE/LTE-Advanced FDD measurement application

Model-Option	Description	Additional information
N9080B-1FP	LTE FDD measurement application, fixed perpetual license	
N9080B-1TP	LTE FDD measurement application, transportable perpetual license	
N9080B-2FP	LTE-Advanced FDD measurement application, fixed perpetual license	Requires 1FP
N9080B-2TP	LTE-Advanced FDD measurement application, transportable perpetual license	Requires 1TP

Note: N9080B application requires Windows 7 operating system in X-Series signal analyzers. For more information, see hardware configuration below.

N9082B LTE/LTE-Advanced TDD measurement application

Model-Option	Description	Additional information
N9082B-1FP	LTE TDD measurement application, fixed perpetual license	
N9082B-1TP	LTE TDD measurement application, transportable perpetual license	
N9082B-2FP	LTE-Advanced TDD measurement application, fixed perpetual license	Requires 1FP
N9082B-2TP	LTE-Advanced TDD measurement application, transportable perpetual license	Requires 1TP

Note: N9082B application requires Windows 7 operating system in X-Series signal analyzers. For more information, see hardware configuration below.

Hardware configuration

N9030A PXA signal analyzer

Description	Model-Option	Additional information
3.6, 8.4, 13.6, 26.5, 43, 44, or 50 GHz frequency range	N9030A-503, -508, -513, -526, -543, -544, or -550	One required
Operating system, Windows Embedded Standard 7	N9030A-W7X	Required; ships standard on new instruments
Analog baseband IQ (BBIQ) inputs	N9030A-BBA	Required for analog baseband measurement
25, 40, 85, or 160 MHz analysis bandwidth	N9030A-B25, -B40, -B85, -B1X	One required; LTE-Advanced demodulation is sequential so > 25 MHz bandwidth is not required; LTE-Advanced TDD transmit on/off power measurement is the only measurement that requires bandwidth wide enough to cover the full aggregated bandwidth
Precision frequency reference	N9030A-PFR	Recommended
Electronic attenuator, 3.6 GHz	N9030A-EA3	Recommended
Preamplifier, 3.6, 8.4, 13.6, 26.5, 43, 44, or 50 GHz	N9030A-P03, -P08, -P13, -P26, -P43, -P44, or -P50	One recommended

N9020A MXA signal analyzer

Description	Model-Option	Additional information
3.6, 8.4, 13.6, or 26.5 GHz frequency range	N9020A-503, -508, -513, or -526	One required
Operating system, Windows Embedded Standard 7	N9020A-W7X	Required; ships standard on new instruments
Analog baseband IQ (BBIQ) inputs	N9020A-BBA	Required for analog baseband measurement
25, 40, 85, 125, or 160 MHz analysis bandwidth	N9020A-B25, -B40, -B85, -B1A, -B1X	One required; LTE-Advanced demodulation is sequential so > 25 MHz bandwidth is not required; LTE-Advanced TDD transmit on/off power measurement is the only measurement that requires bandwidth wide enough to cover the full aggregated bandwidth
Precision frequency reference	N9020A-PFR	Recommended
Electronic attenuator, 3.6 GHz	N9020A-EA3	Recommended
Preamplifier, 3.6, 8.4, 13.6, or 26.5 GHz	N9020A-P03, -P08, -P13, or -P26	One recommended

N9010A EXA signal analyzer

Description	Model-Option	Additional information
3.6, 7.0, 13.6, 26.5, 32, or 44 GHz frequency range	N9010A-503, -507, -513, -526 , 532, or 544	One required
Operating system, Windows Embedded Standard 7	N9010A-W7X	Required; ships standard on new instruments
25, 40 MHz analysis bandwidth	N9010A-B25, B40	One required; LTE-Advanced demodulation is sequential so > 25 MHz bandwidth is not required; LTE-Advanced TDD transmit on/off power measurement is the only measurement that requires bandwidth wide enough to cover the full aggregated bandwidth
Precision frequency reference	N9010A-PFR	Recommended
Electronic attenuator, 3.6 GHz	N9010A-EA3	Recommended
Preamplifier, 3.6, 7.0, 13.6, 26.5, 32, or 44 GHz	N9010A-P03, -P07, -P13, -P26 -P32, or -P44	One recommended

Related Literature

Description	Publication number
N9080B LTE/LTE-Advanced FDD Measurement Application Measurement Guide	N9080-90008
N9082B LTE/LTE-Advanced TDD Measurement Application Measurement Guide	N9082-90004
3GPP Long Term Evolution: System Overview, Product Development, and Test Challenges, Application Note	5989-8139EN
Introducing LTE-Advanced, Application Note	5990-6706EN
Stimulus-Response Testing for LTE Components, Application Note	5990-5149EN
Measuring ACLR Performance in LTE Transmitters, Application Note	5990-5089EN
TD-LTE E-UTRA Base Station Transmit ON/OFF Power Measurement Using a Keysight X-Series Signal Analyzer, Application Note	5990-5989EN
User's and Programmer's Reference Guide is available in the library section of the N9080A, W9080A, N9082A and W9082A product pages.	

Web

Product pages:
- www.keysight.com/find/N9080B
- www.keysight.com/find/N9082B

X-Series measurement applications:
- www.keysight.com/find/X-Series_Apps

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