Keysight Technologies
N9083A & W9083A
Multi-Standard Radio (MSR)
X-Series Measurement Application

Technical Overview

KEYSIGHT TECHNOLOGIES

Multi-Standard Radio (MSR) Measurement Application

The MSR measurement application transforms the X-Series signal analyzers into standard-based MSR base station transmitter testers by adding fast one-button RF conformance measurements to help you evaluate and manufacture your MSR base station and base station components.

The Keysight Technologies, Inc. X-Series is an evolutionary approach to signal analysis that spans instrumentation, measurements, and software. The X-Series analyzers, with upgradeable CPU, memory, disk drives, and I/O ports, enable you to keep your test assets current and extend instrument longevity. Proven algorithms, 100% code-compatibility, and a common UI across the X-Series create a consistent measurement framework for signal analysis that ensures repeatable results and measurement integrity so you can leverage your test system software through all phases of product development. In addition to fixed, perpetual licenses for our X-Series measurement applications, we also offer transportable licenses which can increase the value of your investment by allowing you to transport the application to multiple X-Series analyzers. The MSR measurement application is just one in common library of more than 25 measurement applications.

Technical Overview

- Perform MSR base station transmitter tests on any combination of LTE-FDD, W-CDMA/HSPA/HSPA+, GSM/EDGE/EDGE Evolution, cdma2000, and 1xEV-DO signals
- Perform one-button tests per the 3GPP Release 10 standard (TR/TS 37 series)
- Use hardkey/softkey manual user interface or SCPI remote user interface
- Leverage built-in, context-sensitive help
- Move the application between X-Series signal analyzers with transportable licensing

Real-time spectrum analysis for MSR

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 GSM or LTE-TDD in an MSR signal configuration, and enables identification of interference caused by multiple signals of different radio access technologies transmitted in the same base station RF bandwidth.

- Accurately observe power changes for an MSR 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 performance

Choosing Between X-Series 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 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. Use the 89600 VSA software with a variety of Keysight hardware platforms to pinpoint the answers to signal problems in R&D.

www.keysight.com/find/89600vsa

Multi-Standard Radio (MSR) Technology Overview

The rapid evolution of mobile broadband and the need to deploy next generation cellular technologies alongside legacy deployment has lead to development of multi-standard radio (MSR) base stations. 3GPP defines an MSR base station by the ability of its receiver and transmitter to process two or more carriers in common, active RF components simultaneously in a declared RF bandwidth, where at least one carrier is of a different radio access technology (RAT) than the other carrier(s).

The key drivers behind MSR are coexistence of different technologies in a single network, spectrum "refarming," and cost reduction. MSR allows operators to put spectrum space to a new use, resulting in seamless network migration from the currently deployed 2/3G radio formats to 4G. In terms of cost reduction, using the same base station hardware for multiple technologies reduces the number of sites, site rental costs, and the amount of on-site equipment required.

Traditionally the RF specifications for base station transmitters and receivers have been developed separately for the different RATs. However, in an MSR base station, the base station transmitter and receiver is capable of simultaneously processing multiple carriers of different RATs using common RF hardware, requiring a new set of RF specifications. As such, 3GPP developed a dedicated RF specification for MSR-capable base stations in the 3GPP Release 9 and 10 (TR/TS 37 series).

The operating bands for which MSR base stations are defined are divided into three different band categories (BCs): BC1 for LTE-FDD and W-CDMA operation; BC2 for LTE-FDD, W-CDMA and GSM/EDGE operation; and BC3 for LTE-TDD and TD-SCDMA operation. MSR conformance tests are required when carriers of multiple RATs are being activated. This is done through a set of multi-RAT test configurations (TCs) of contiguous and non-contiguous frequency allocations. Required transmitter measurements in a multi-RAT configuration include channel power, modulation quality (EVM), frequency error, spurious emissions, and operating band unwanted emissions (SEM). Alternatively, ACLR occupied BW and time alignment between transmitter branches are performed in single-RAT configurations, as defined in the TS37.141 conformance requirements.

RF Transmitter Tests

An X-Series signal analyzer, along with the MSR measurement application, can perform RF transmitter measurements on MSR base stations and base station components in time, frequency, and modulation domain. BC1 and BC2, along with the different transmitter test configurations, are supported. For BC1, the MSR measurement application analyzes any combination of W-CDMA/HSPA/ HSPA+ and LTE-FDD signals, and, for BC2, it analyzes any combination of GSM/ EDGE/EDGE Evolution, W-CDMA/ HSPA/HSPA+, and LTE-FDD signals.

For base stations supporting both 3GPP and 3GPP2 standards, the MSR measurement application allows a combination of cdma2000/1xEV-DO and 3GPP signals such as LTE-FDD. The MSR carrier allocating algorithm with a preset selection based on test configuration (TC) definitions in TS 37.141 eliminates the need to manually set up the measurements. For the 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, multi-RAT signal, eliminating the need for the wide analysis bandwidth option on the X-Series signal analyzer and thereby reducing the overall test equipment cost.

Standard-based RF transmitter tests

The RF transmitter test requirements for MSR base stations are defined in the TS 37 series of the 3GPP standard. Table 1 shows the required base station RF transmitter tests, along with the corresponding measurement applications.

Table 1. Required BTS RF transmitter measurements and the corresponding measurements in N/W9083A and 89600 VSA software

3GPP TS 37.141 Paragraph #	Transmitter test	X-Series N/W9083A multi-standard radio (MSR) measurement application (Supports BC1 & BC2)	89600 VSA multi-measurement capability[1]
6.2 .1	Base station maximum output power	Channel power	Channel power using band power marker
6.2.2	E-UTRA DL RS power	Conformance EVM	Error summary[2]
6.2.3	UTRA FDD primary CPICH power	Conformance EVM	Code domain power[2]
6.2.4	UTRA TDD primary CCPCH power	Not available (only applied for BC3 BTS)	Code domain power[2]
6.3	Output power dynamics	Conformance EVM	Error summary[2]
6.4	Transmit ON/OFF power	Not available (only applied for BC3 BTS)	Not available
6.5.1	Modulation quality	Conformance EVM	Error summary[2]
6.5.2	Frequency error	Conformance EVM	Error summary[2]
6.5.3	Time alignment error	Conformance EVM	MIMO info table[2]
6.6.1	Transmitter spurious emissions	Spurious emissions	89600 based solutions offer modulation quality measurements. For 1-button, non-demodulation, measurements such as ACLR and spectrum emission mask, the embedded application should be used.
6.6.2	Operation band unwanted emissions	Spectrum emission mask	
6.6.3	Occupied bandwidth	Occupied BW	
6.6.4	Adjacent channel leakage power ratio (ACLR)	ACP Cumulative ACLR (CACLR) for non-contiguous allocation	
6.7	Transmitter intermodulation	ACP	

1. The 89600 VSA multi-measurement capability is a standard feature with 89600 VSA software version 15 or higher. Unlike the N/W9083A, it does not provide presets for MSR as defined by 3GPP Release 9, so the user must manually configure the software for the signal under test. Also, it is not limited to the radio access technologies defined in the 3GPP standard. It can be configured to simultaneously analyze waveforms with any combination of the over 75 standards and modulation types supported by the VSA software.
2. These traces exist within each format. For example, for W-CDMA modulation quality, the user must enable W-CDMA demodulation first, then view EVM metrics under the error summary trace. Similar steps apply for GSM/EDGE and LTE.

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.

These measurements are fully remote controllable via the IEC/IEEE bus or LAN, using SCPI commands. A detailed list of supported measurements is shown in Table 2.

Table 2. List of one-button measurements provided by the N/W9083A measurement application.

GSM/EDGE/EDGE Evolution	W-CDMA/HSPA/HSPA+	LTE-FDD	cdma2000[3]	1xEV-DO[3]
Conformance EVM results				
RMS 95th %ile EVM Average RMS EVM Maximum RMS EVM Average peak EVM Maximum peak EVM Symbol position of the peak EVM Average RMS magnitude error Maximum RMS magnitude error Average RMS phase error Maximum RMS phase error Average frequency error Maximum frequency error Average absolute peak phase error Maximum absolute peak phase error Average I/Q origin offset Amplitude droop error Maximum I/Q origin offset Trigger to TO Timing offset of AM/PM path Detected TSC Detected mod scheme	RMS EVM Peak EVM Rho Magnitude error Phase error Frequency error Peak code domain error I/Q origin offset Time offset CPICH power over a slot Total power over a slot Channel number Number of active channels First slot number DPCCH slot format PRACH preamble signature	EVM EVM peak Data EVM 3GPP-defined QPSK EVM 3GPP-defined 16QAM EVM 3GPP-defined 64QAM EVM RS EVM Frequency error IQ offset IQ gain imbalance IQ quad error IQ timing skew Common tracking error Symbol clock error Time offset Channel power RS Tx power OFDM symbol Tx power Reference signal Rx power Reference signal Rx quality Received signal strength indicator Sync correlation Sync type CP length mode Cell ID Cell ID group/sector RS-OS/PRS	RMS EVM Peak EVM Rho Magnitude error Phase error Frequency error Peak code domain error I/Q origin offset Time offset Channel number Number of active channels	RMS EVM Peak EVM Rho Magnitude error Phase error Frequency error I/Q origin offset Max MAC inactive channel power Max data active channel power Min data active channel power Number of active channels Pilot offset Preamble length MAC index
Channel power				
Occupied BW[1]				
ACP				
Spectrum emission mask				
Spurious emissions				
Monitor spectrum[2]				
Power stat CCDF[2]				
IQ waveform[2]				

1. Occupied BW is not provided for each carrier separately. It is a composite value for all carriers within the measurement span.
2. These are general purpose measurements for quick examination of a signal under test.
3. cdma2000 and 1xEV-DO are not part of 3GPP MSR definition, therefore conformance test per 3GPP TS 37 does not apply to these two radio formats.

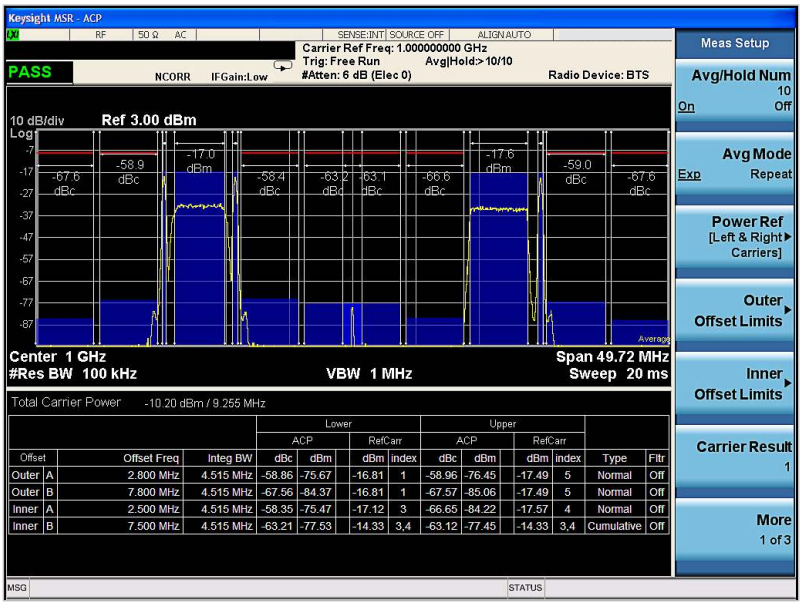
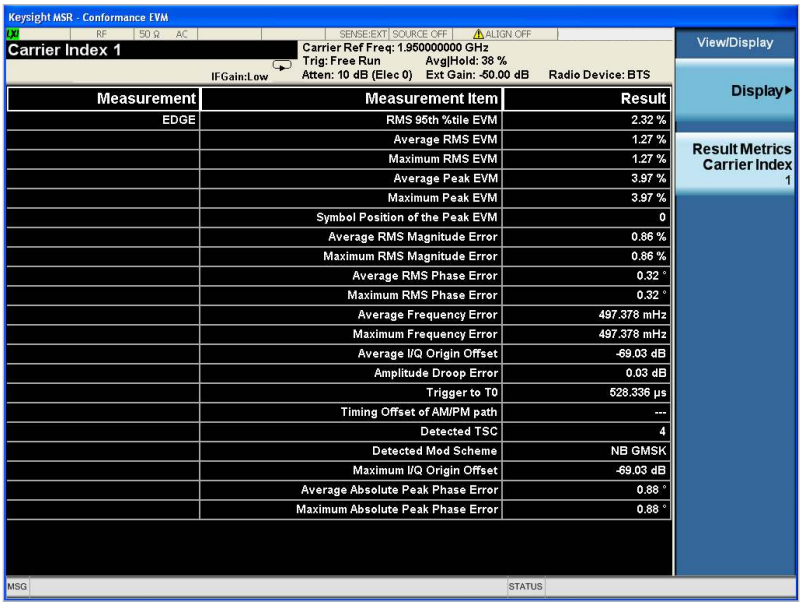


Figure 1. Cumulative adjacent channel leakage power ratio (CACLR) measurement on a non-contiguously allocated GSM/EDGE + W-CDMA/ HSPA + LTE-FDD MSR signal.



Measurement	Measurement Item	Result
EDGE	RMS 95th %tile EVM	2.32 %
	Average RMS EVM	1.27 %
	Maximum RMS EVM	1.27 %
	Average Peak EVM	3.97 %
	Maximum Peak EVM	3.97 %
	Symbol Position of the Peak EVM	0
	Average RMS Magnitude Error	0.86 %
	Maximum RMS Magnitude Error	0.86 %
	Average RMS Phase Error	0.32 °
	Maximum RMS Phase Error	0.32 °
	Average Frequency Error	497.378 mHz
	Maximum Frequency Error	497.378 mHz
	Average I/Q Origin Offset	-69.03 dB
	Amplitude Droop Error	0.03 dB
	Trigger to T0	528.336 µs
	Timing Offset of AM/PM path	---
	Detected TSC	4
	Detected Mod Scheme	NB GMSK
	Maximum I/Q Origin Offset	-69.03 dB
	Average Absolute Peak Phase Error	0.88 °
	Maximum Absolute Peak Phase Error	0.88 °

Figure 2. MSR error summary trace showing EVM and frequency error, plus additional error metrics.

Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
15.00 kHz	215.0 kHz	60.00 kHz	-26.71	(-14.21)	-10.02 M	-26.24	(-13.74)	10.02 M
215.0 kHz	1.015 MHz	30.00 kHz	-33.45	(-20.95)	-10.52 M	-35.04	(-22.54)	10.54 M
1.015 MHz	1.500 MHz	30.00 kHz	-42.17	(-17.67)	-11.28 M	-41.93	(-17.43)	11.17 M
1.500 MHz	10.50 MHz	1.000 MHz	-26.56	(-15.06)	-20.05 M	-26.54	(-15.04)	13.66 M
10.50 MHz	20.00 MHz	1.000 MHz	-26.84	(-11.84)	-24.97 M	-26.93	(-11.93)	27.29 M
40.00 MHz	50.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

Figure 3. MSR spectrum emissions mask (SEM) measurement for BC2: GSM/EDGE + W-CDMA/ HSPA + LTE-FDD with full limit mask according to 3GPP TS 37.141.

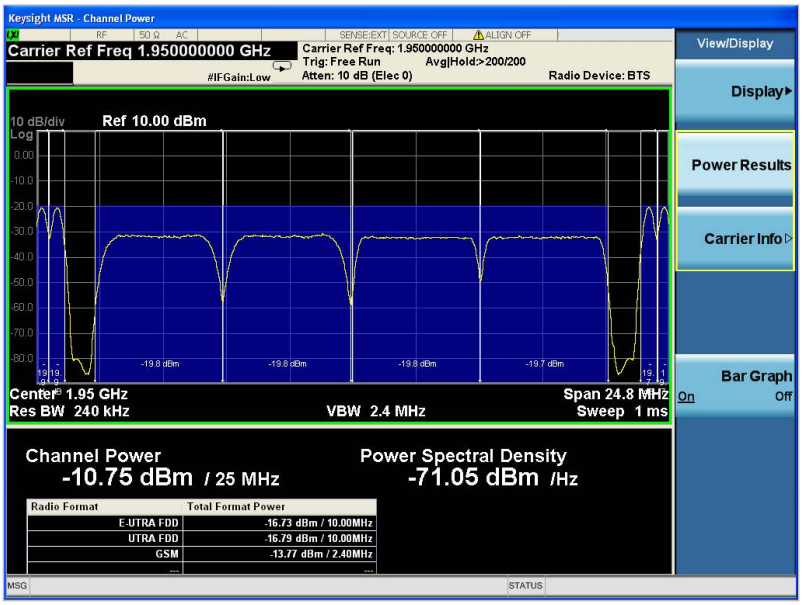


Figure 4. MSR channel power measurement showing the measured power of each carrier.

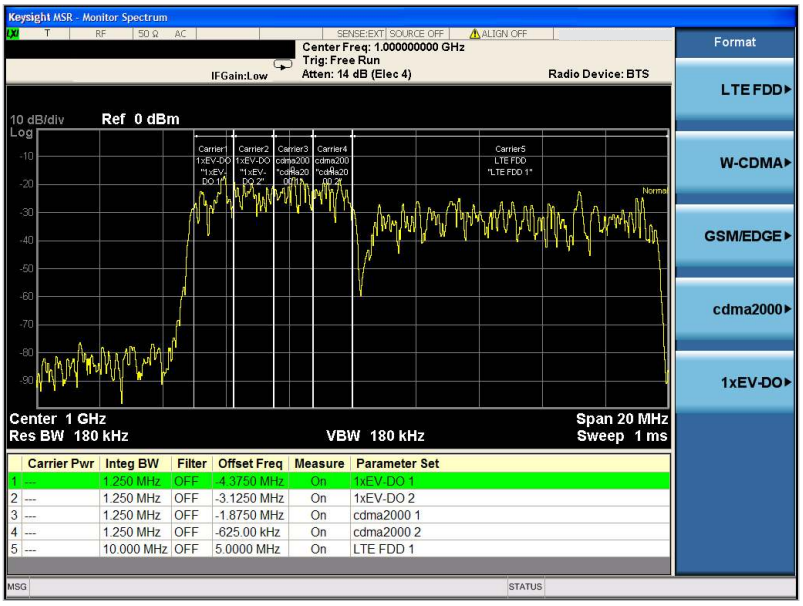


Figure 5. MSR monitor spectrum trace showing general information about each carrier.

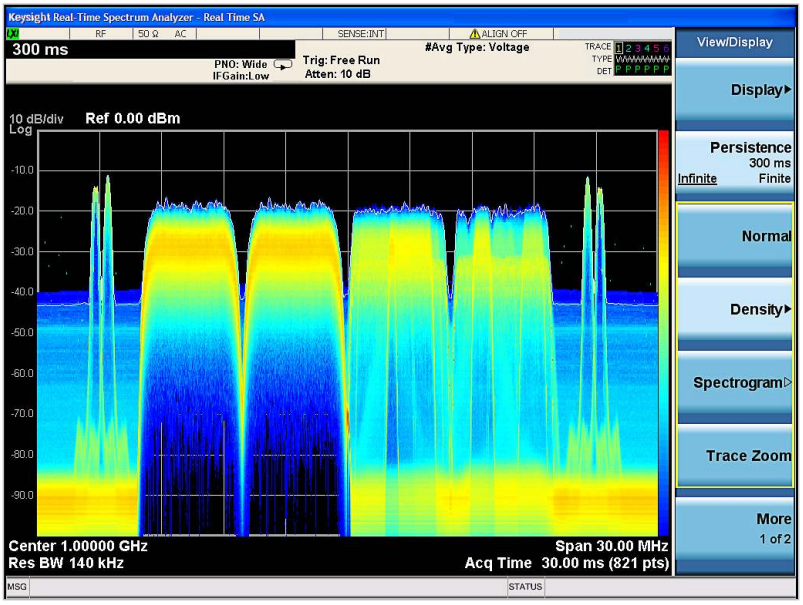


Figure 6. Real-time view of MSR signal using the RTSA option on the PXA or MXA signal analyzers.

Key Specifications

Definitions

- Specifications describe the performance of parameters covered by the product warranty.
- 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.
- PXA and EXA specifications apply to analyzers with frequency options of 526 and lower. For analyzers with higher frequency options, specifications are not warranted but performance will nominally be close to that shown in this section.

Note: Data subject to change

Description	PXA	MXA	EXA	CXA
Channel power				
Minimum power at RF input	–50 dBm (nom)			
Power accuracy (95% confidence)	± 0.19 dB	± 0.23 dB	± 0.27 dB	± 0.61 dB
Occupied bandwidth				
Minimum power at RF input	–30 dBm (nom)			
Frequency accuracy	± (Span/1000) (nom)			
Power statistics CCDF				
Histogram resolution	0.01 dB			
Spurious emissions				
Accuracy (Attenuation = 10 dB)	± 0.19 dB (95%)	± 0.29 dB (95%)	± 0.38 dB (95%)	± 0.81 dB (95%)
Frequency range	20 Hz to 3.6 GHz	20 Hz to 3.6 GHz	20 Hz to 3.6 GHz	100 Hz to 3 GHz
	±1.08 dB (95%)	± 1.17 dB (95%)	± 1.22 dB (95%)	± 1.80 dB (95%)
Frequency range	3.5 GHz to 8.4 GHz	3.5 GHz to 8.4 GHz	3.5 GHz to 7.0 GHz	3.0 GHz to 7.5 GHz
	± 1.48 dB (95%)	± 1.54 dB (95%)	± 1.59 dB (95%)	
Frequency range	8.3 GHz to 13.6 GHz	8.3 GHz to 13.6 GHz	6.9 GHz to 13.6 GHz	N/A
Conformance EVM[1] (all values are nominal)				
GSM/EDGE[2]				
EVM, rms - floor (EDGE)	0.6%	0.6%	0.7%	0.7%
Phase error, rms - floor (GSM)	0.5°	0.5°	0.6°	0.6°
W-CDMA[2]				
Composite EVM - floor	1.5%	1.5%	1.6%	1.6%
LTE-FDD[2]				
EVM floor for downlink (OFDMA)[3]				
Signal bandwidth				
5 MHz	0.44% (–47.1 dB)	0.49% (–46.1 dB)	0.66% (–43.6 dB)	0.72% (–42.8 dB)
10 MHz	0.36% (–48.8 dB)	0.41% (–47.7 dB)	0.66% (–43.6 dB)	0.67% (–43.4 dB)
20 MHz	0.38% (–48.4 dB)	0.43% (–47.3 dB)	0.65% (–43.7 dB)	0.72% (–42.8 dB)

1. Signal level is within one range step of overload. The specifications for floor do not include signal-to-noise impact which may decrease by increasing number of carriers. The noise floor can be estimated by DANL + 2.51 + 10 x log10(MeasBW), where DANL is the displayed average noise level specification in dBm and MeasBW is measurement bandwidth at receiver in Hz.
2. Applies when carrier spacing is 600 kHz for GSM/EDGE, 5 MHz for W-CDMA, and equal to the signal bandwidth for LTE-FDD, and each carrier power of adjacent channels is ≤ the carrier power of the tested channel for EVM.
3. EVM numbers for MXA is for instruments with serial number prefix ≥ MY/SG/US5233 (those instruments ship standard with N9020A-EP2 as the identifier). Refer to the LTE chapter of the MXA specification guide for specification on other MXAs: www.keysight.com/find/mxa_specifications.

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

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

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:** This allows you to run the application in the X-Series analyzer in which it is initially installed, plus it may be transferred from one X-Series analyzer to another.

Try Before You Buy!

Free 30-day trials of X-Series measurement applications provide unrestricted use of each application's features and functionality on your X-Series analyzer. Redeem a trial license on-line today:

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You Can Upgrade!

Options can be added after your initial purchase.

All of our X-Series application options are license-key upgradeable.

The table below contains information on our fixed, perpetual licenses. For more information, please visit the product web pages.

N9083A & W9083A multi-standard radio (MSR) X-Series measurement application

Description	Model-Option		Additional information
	PXA, MXA, EXA	CXA	
MSR	N9083A-1FP	W9083A-1FP	Required
LTE-FDD	N9080A-1FP	W9080A-1FP	Required for LTE-FDD
W-CDMA	N9073A-1FP	W9073A-1FP	Required for W-CDMA
HSPA	N9073A-2FP	W9073A-2FP	Required for HSPA; 2FP requires 1FP
HSPA+	N9073A-3FP	W9073A-3FP	Required for HSPA+; 3FP requires 1FP and 2FP
GSM/EDGE	N9071A-2FP	W9071A-2FP	Required for GSM/EDGE
EDGE Evolution	N9071A-3FP	W9071A-3FP	Required for EDGE Evolution; 3FP requires 2FP
cdma2000	N9072A-2FP	W9072A-2FP	Required for cdma2000
1xEV-DO	N9076A-1FP	W9076A-1FP	Required for 1xEV-DO

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
25, 40, 85, or 160 MHz analysis bandwidth	N9030A-B25, -B40, -B85, or -B1X	One required for analysis over 10 MHz, such as 20 MHz LTE signals
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
25, 40, 85, 125, or 160 MHz analysis bandwidth	N9020A-B25, -B40, -B85, -B1A, or -B1X	One required for analysis over 10 MHz, such as 20 MHz LTE signals
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
25 or 40 MHz analysis bandwidth	N9010A-B25 or -B40	One required for analysis over 10 MHz, such as 20 MHz LTE signals
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
Fine step attenuator	N9010A-FSA	Recommended

N9000A CXA signal analyzer

Description	Model-Option	Additional information
3.6 or 7.0 GHz frequency range	N9000A-503, or -507	One required
25 MHz analysis bandwidth	N9000A-B25	One required for analysis over 10 MHz, such as 20 MHz LTE signals
Precision frequency reference	N9000A-PFR	Recommended
Preamplifier, 3.6 or 7.0 44 GHz	N9000A-P03 or -P07	One recommended
Fine step attenuator	N9000A-FSA	Recommended

Related Literature

N9083A & W9083A Multi-Standard Radio (MSR) Measurement Application Measurement Guide, part number N9083-90002

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

Designing and Testing 3GPP W-CDMA Base Transceiver Stations (Including Femtocells), Application Note 1355, literature number 5980-1239E

Concepts of High Speed Downlink Packet Access: Bringing Increased Throughput and Efficiency to W-CDMA, Application Note, literature number 5989-2365EN

Understanding GSM/EDGE Transmitter and Receiver Measurements for Base Transceiver Stations and their Components, Application Note, literature number 5968-2320E

Measuring EDGE Signals – New and Modified Techniques and Measurement Requirements, Application Note 1361, literature number 5980-2508EN

User's and Programmer's Reference Guide is available in the library section of the N9083A and W9083A product pages.

Web

Product page:
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www.lxistandard.org
LAN eXtensions for Instruments puts the power of Ethernet and the Web inside your test systems. Keysight is a founding member of the LXI consortium.

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