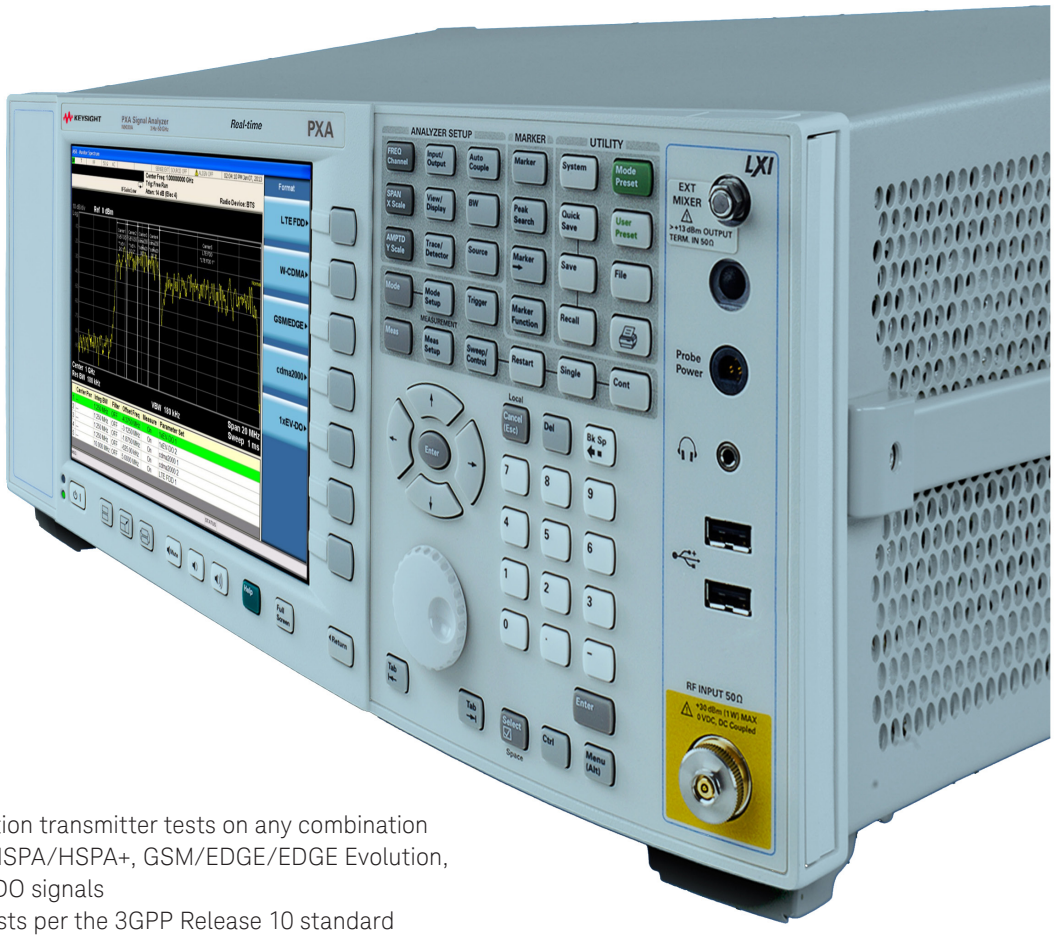
# Keysight Technologies
# N9083EM0D
# Multi-Standard Radio (MSR)
# X-Series Measurement App, Traditional UI

## Technical Overview




- Perform MSR base station transmitter tests on any combination of LTEFDD,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

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.

X-Series measurement applications can help you:

- Gain more insight into device performance with intuitive display and graphs for your application. Select from our library of over 25 different measurement applications.
- Ensure that your design meets the latest standard. Updates are made to the X-Series measurement applications as standards evolve.
- Apply the same measurement science across multiple hardware platforms for consistent measurement results over your design cycle from R&D to production.
- Choose the license structure that meets your business needs. We provide a range of license types (node-locked, transportable, floating or USB portable) and license terms (perpetual or time-based).

## 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

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# 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 N9083EM0D and 89600 VSA software

| 3GPP TS 37.141 Paragraph # | Transmitter test | X-Series N9083EM0D 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<br>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 N9083EM0D measurement application.

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

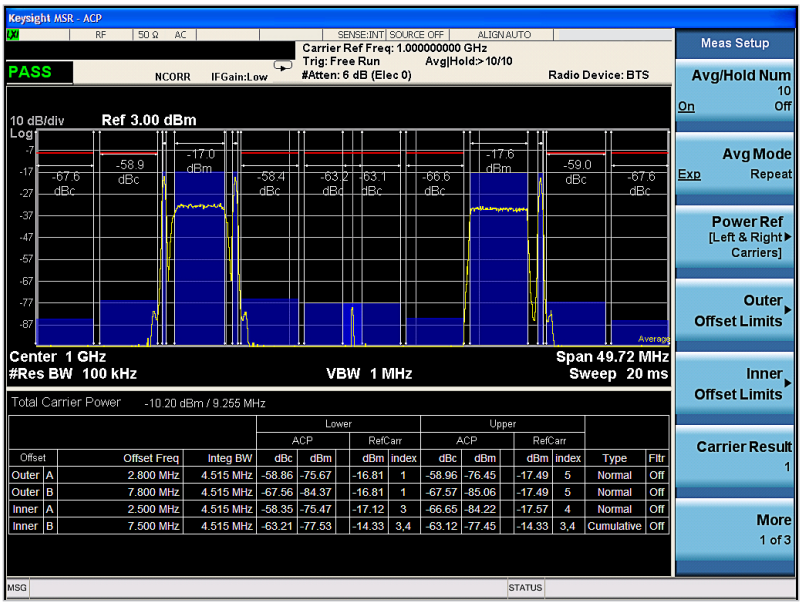


Figure 1. Cumulative adjacent channel leakage power ratio (CACLR) measurement on a non-contiguously allocated GSM/EDGE + W-CDMA/HSPA + LTE-FDD MSR signal.

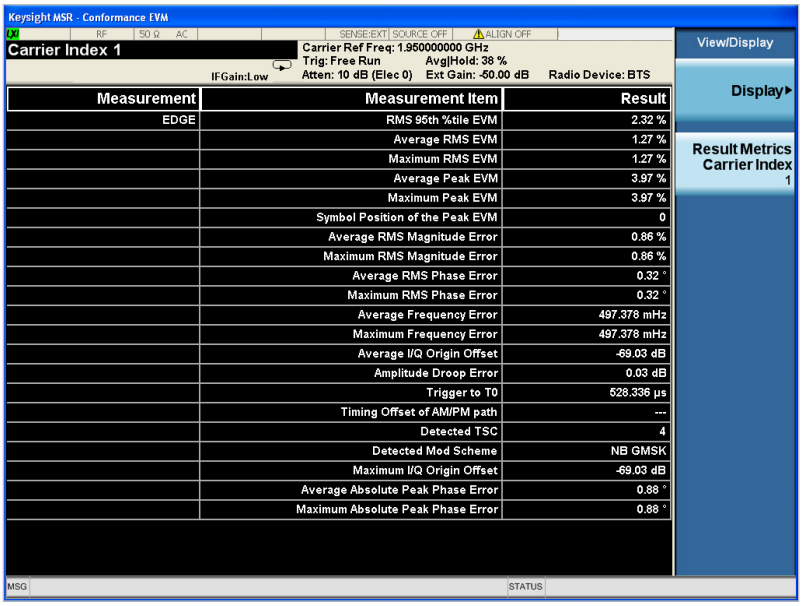


Figure 2. MSR error summary trace showing EVM and frequency error, plus additional error metrics.

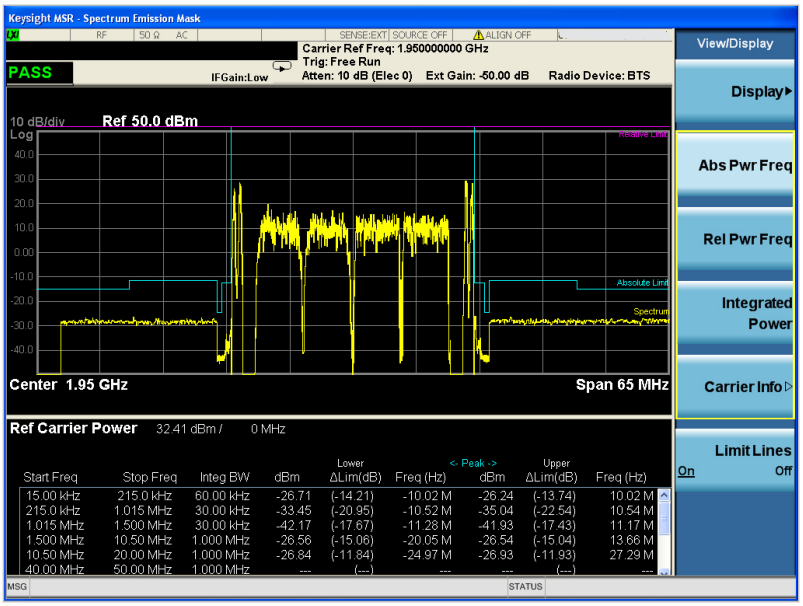


Figure 3. MSR spectrum emissions mask (SEM) measurement for BC2: GSM/EDGE + W-CDMA/HSPA + LTE-FDD with full limit mask according to 3GPP TS 37.141.

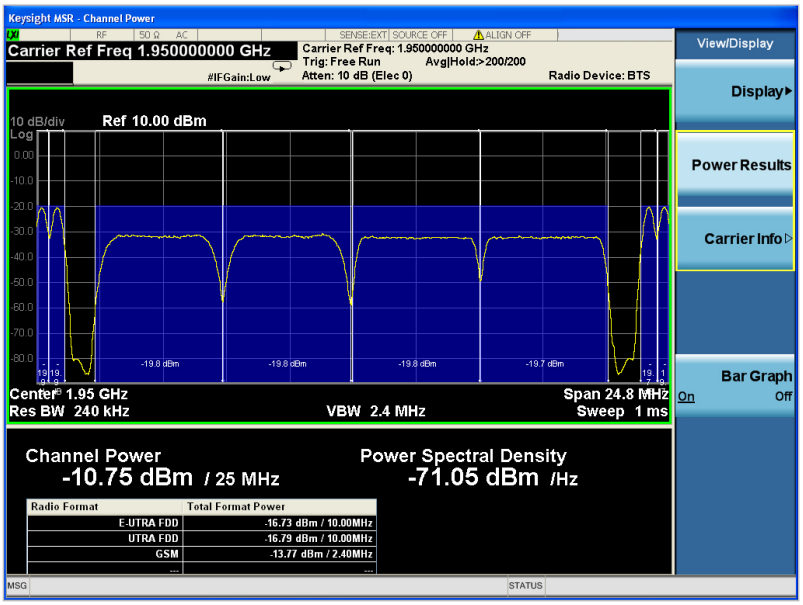


Figure 4. MSR channel power measurement showing the measured power of each carrier.

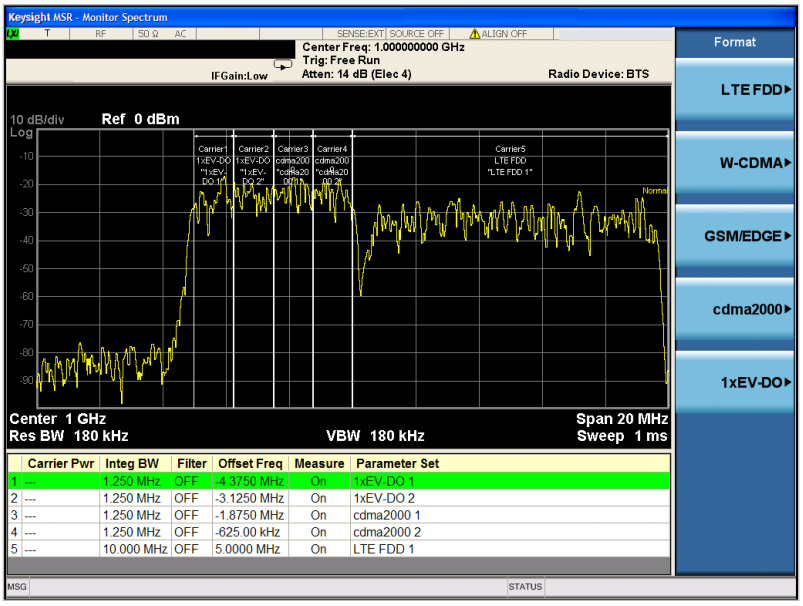


Figure 5. MSR monitor spectrum trace showing general information about each carrier.

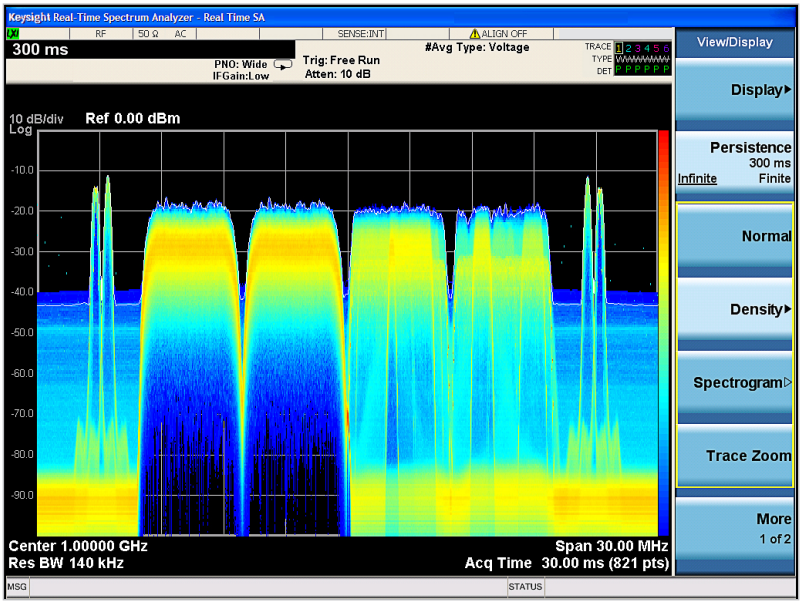


Figure 6. Real-time view of MSR signal using the RTSA option on the PXA or MXA signal analyzers.

# 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 |
| 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 | 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.

Benchtop:

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**

PXIe:

VSA up to 6 GHz: **www.keysight.com/find/m9391a**
VSA up to 50GHz: **www.keysight.com/find/m9393a**
VXT: **www.keysight.com/find/m9421a**
CXA-m: **www.keysight.com/find/cxa-m**

# Ordering Information

## Flexible licensing and configuration

- **Perpetual:** License can be used in perpetuity.
- **Time-based:** License is time limited to a defined period, such as 12-months.
- **Node-locked:** Allows you to use the license on one specified instrument/computer.
- **Transportable:** Allows you to use the license on one instrument/computer at a time. This license may be transferred to another instrument/computer using Keysight's online tool.
- **Floating:** Allows you to access the license on networked instruments/computers from a server, one at a time. For concurrent access, multiple licenses may be purchased.
- **USB portable:** Allows you to move the license from one instrument/computer to another by end-user only with certified USB dongle, purchased separately.
- **Software support subscription:** Allows the license holder access to Keysight technical support and all software upgrades

## You Can Upgrade!

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

UP GRADE

## Multi-Standard Radio (MSR) measurement application (N9083EM0D)

| Model | Software License Type | Support Contract | Support Subscription (12-month) [2] |
|---|---|---|---|
| N9083EM0D-1FP | Node-locked perpetual | R-Y5C-001-A[2] | R-Y6C-001-L[2] |
| N9083EM0D-1FL | Node-locked 12-month | R-Y4C-001-L[1] | Included |
| N9083EM0D-1TP | Transportable perpetual | R-Y5C-004-D[2] | R-Y6C-004-L[2] |
| N9083EM0D-1TL | Transportable 12-month | R-Y4C-004-L[1] | Included |
| N9083EM0D-1NP | Floating perpetual | R-Y5C-002-B[2] | R-Y6C-002-L[2] |
| N9083EM0D-1NL | Floating 12-month | R-Y4C-002-L[1] | Included |
| N9083EM0D-1UP | USB portable perpetual | R-Y5C-005-E[2] | R-Y6C-005-L[2] |
| N9083EM0D-1UL | USB portable 12-month | R-Y4C-005-L[1] | Included |

## One month software support subscription extensions [3]

| Model | Description |
|---|---|
| R-Y6C-501[3] | 1-month of software support subscription for node-locked license |
| R-Y6C-502[3] | 1-month of software support subscription for floating license |
| R-Y6C-504[3] | 1-month of software support subscription for transportable license |
| R-Y6C-505[3] | 1-month of software support subscription for USB portable license |

1. All time-based X-Series measurement application licenses includes a 12-month support contract which also includes the 12-month software support subscription as same duration.
2. Support contract must bundle software support subscription for all perpetual licenses in the first year. All software upgrades and Keysight support are provided for software licenses with valid support subscription.
3. After the first year, software support subscription may be extended with annual or monthly software support subscription extensions for perpetual licenses.

## Try Before You Buy!

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## Hardware Configurations

To learn more about compatible platforms and required configurations, please visit: www.keysight.com/find/X-Series_apps_platform

## Software Models & Options

To learn more about X-Series measurement application licensing, model numbers and options, please visit: www.keysight.com/find/X-Series_apps_model

# Hardware Configuration

For optimizing the Multi-Standard Radio (MSR) measurement application, Keysight recommends a minimum level of instrument hardware functionality at each instrument performance point. Supported instruments include:

Benchtop:

- PXA N9030A
- MXA N9020A
- EXA N9010A
- CXA N9000A

## N90x0A X-Series signal analyzer

| Capability | Instrument Option | Benefit |
|---|---|---|
| Analysis bandwidth | 10 or 25 MHz as default or higher | **Required**: Wider analysis bandwidth options such as 25/40/85/160 MHz can be selected depending on the specified signal analyzer model |
| Precision frequency reference | -PFR | **Recommended**: For enhanced frequency accuracy and repeatability for lower measurement uncertainty |
| Electronic attenuator | -EA3 | **Recommended**: Fast and reliable attenuation changes ideal for manufacturing without the wear associated with mechanical attenuators up to 3.6 GHz in 1 dB steps |
| Pre-amplifier | 3.6 GHz (-P03) or higher | **Recommended**: For maximizing the measurement sensitivity |
| Fine resolution step attenuator | -FSA | **Recommended**: Useful for maximizing useable dynamic range to see signals |
| Analog baseband I/Q inputs | -BBA on PXA and MXA only | **Optional**: To extend measurements at baseband if required by device under test |

# Related Literature

| Description | Publication number |
|---|---|
| N9083A & W9083A Multi-Standard Radio (MSR) Measurement Application Measurement Guide | N9083-90002 |
| 3GPP Long Term Evolution: System Overview, Product Development, and Test Challenges, Application Note | 5989-8139EN |
| Designing and Testing 3GPP W-CDMA Base Transceiver Stations (Including Femtocells), Application Note 1355 | 5980-1239E |
| Concepts of High Speed Downlink Packet Access: Bringing Increased Throughput and Efficiency to W-CDMA, Application Note | 5989-2365EN |
| Understanding GSM/EDGE Transmitter and Receiver Measurements for Base Transceiver Stations and their Components, Application Note | 5968-2320E |
| Measuring EDGE Signals – New and Modified Techniques and Measurement Requirements, Application Note 1361 | 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:
**www.keysight.com/find/N9083D**

X-Series measurement applications:
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X-Series signal analyzers:
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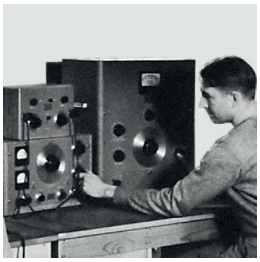

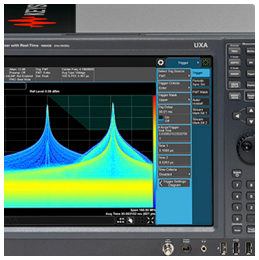

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www.keysight.com/find/N9083D

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at:
www.keysight.com/find/contactus

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