Keysight Technologies
Mobile WiMAX™ X-Series Measurement Application
N9075A & W9075A

Technical Overview

KEYSIGHT TECHNOLOGIES

Introduction

- Mobile WiMAX™ RF transmitter measurements
- Single-channel matrix A modulation analysis and pilot-based matrix B (wave 2) analysis
- One-button tests with pass/fail limits per Mobile WiMAX standard
- Hardkey/softkey manual user interface and SCPI remote user interface
- Built-in context sensitive help
- Transportable license between X-Series signal analyzers

Mobile WiMAX Measurement Application

The Mobile WiMAX measurement application transforms the X-Series signal analyzers into standard-based Mobile WiMAX transmitter testers by adding fast one-button power and modulation measurements to help you design, evaluate, and manufacture your Mobile WiMAX devices, based on IEEE 802.16e-2005 and WiBro. When the Keysight Technologies, Inc. N9030A PXA or N9020A MXA signal analyzer has optional baseband IQ inputs, Option BBA, each of the RF and analog baseband IQ signals of Mobile WiMAX can be measured to compare signal quality.

The Mobile WiMAX measurement application is just one in a common library of more than 25 measurement applications in the Keysight X-Series. The Keysight 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 to you transport the application to multiple X-Series analyzers.

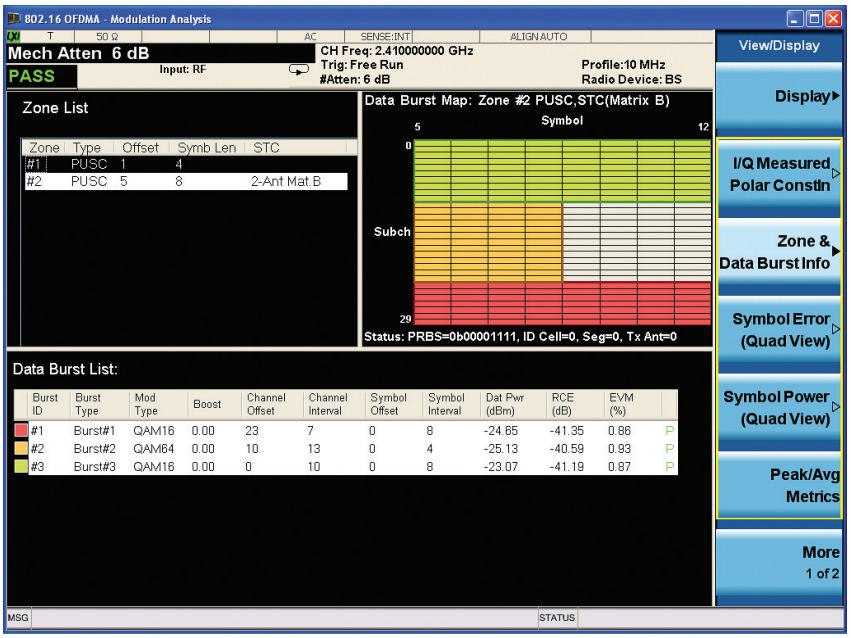

Figure 1. Single-Input pilot-based EVM measurement of matrix B signal.

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 online today: www.keysight.com/find/X-Series_trial

Mobile WiMAX Overview

The IEEE 802.16e-2005 standard, often referred to as Mobile WiMAX, defines the physical layer (PHY) and medium access control (MAC) protocol for products that extend broadband wireless access (BWA) from the local area network (LAN) to the metropolitan area network (MAN). The standard contains specifications for licensed and unlicensed BWA operating between 2 and 11 GHz. The term OFDMA used to describe this new technology means orthogonal frequency division multiple access and it distinguishes the system from OFDM technologies such as Fixed WiMAX or 802.11 WLAN. The standard includes an OFDMA PHY layer with sub-channelization that allows the time and frequency resources to be dynamically allocated among multiple users across the downlink (DL) and uplink (UL) sub-frames. It uses a combination of TDD and OFDMA for downlink and uplink signaling and multiple user access. The unique features within the TDD/OFDMA frame provide frequency diversity, frequency reuse, and cell segmentation which improve the performance against fading and inter-cell interference.

For data transmission the standard defines a set of adaptive modulation and coding rate configurations that can be used to trade off data rate for system robustness under various wireless propagation and interference conditions. When the radio link quality is good, the WiMAX system can use a higher-order modulation scheme (more bits/symbol) that will result in more system capacity. When link conditions are poor due to problems such as signal fading or interference, the WiMAX system can change to a lower modulation scheme to maintain an acceptable radio link margin. The allowed modulation types are binary phase shift keying (BPSK), quadrature phase shift keying (QPSK), 16 quadrature amplitude modulation (16QAM), and 64QAM.

The WiMAX Forum™ is comprised of industry experts whose charter is to bring the IEEE 802.16 standard to the marketplace and to create the process for certification and inter-operability between equipment vendors. The WiMAX Forum tests operational performance based on the standard through the use of radio and protocol conformance test documentation. Subsets of system features are known as profiles, which specify the mandatory and optional features from the 802.16 standard required for baseline functionality and interoperability. The choice of profiles has been driven by spectrum availability, regulatory constraints, and market demand. The WiMAX Forum specifies a series of protocol and radio conformance tests (RCT) for compliance and interoperability between various equipment manufacturers. Certification test houses, such as AT4 Wireless in Spain and Telecommunications Technology Association (TTA) in Korea, were among the first to be approved by the WiMAX Forum to provide conformance testing to the WiMAX profile specifications.

In order to support increased range, link reliability, and throughput, several advanced features are supported in wave 2. These include DL/UL adaptive modulation and coding (DL/UL AMC zones), beamforming, space time coding (STC) or matrix A, 2x2 MIMO with vertical encoding or matrix B, and collaborative spatial multiplexing-uplink (CSM). The use of 2 antennas for transmission and 1 for reception gives the notation 2x1, and the use of 2 antennas for transmission and 2 for reception gives the notation 2x2. Matrix A and matrix B zones may be transmitted by a base station with two transmit antennas. In the downlink subframe, the preamble is followed by the first zone–a mandatory PUSC zone that contains the FCH, the DL-MAP, and the UL-MAP. The preamble and first zone are transmitted only by antenna 0. Antenna 1 is generally expected to be inactive during this time, but becomes active with the first matrix A or matrix B zone in the subframe.

RF Transmitter Tests

The X-Series signal analyzers along with the Mobile WiMAX measurement application, perform transmitter measurements on BS and MS devices in time, frequency and modulation domains. Mobile WiMAX signals with zone types PUSC, FUSC, OPUSC, OFUSC, and AMC can be analyzed. Additionally, modulation analysis can be done on matrix A signals and pilot-based modulation analysis can be done using a single input on matrix B signals.

Standard-based RF transmitter tests

The RF transmitter test and air interface requirements for product certification of base stations and mobile devices by the WiMAX Forum are defined in the WiMAX Forum Mobile Radio Conformance Test and additional requirements for mobile stations are defined in the WiMAX Forum Mobile Radio Requirement Testing. Table 2 shows the required base station RF transmitter tests along with the corresponding measurement applications. Note some MS tests require the use of a base station emulator (BSE) and some BS tests require the use of a mobile station emulator (MSE). This aspect is not included in the tables.

Table 1. Required mobile station transmitter measurements and the corresponding measurements in N/W9075A and 89601B-B7Y.

RCT test #	Transmitter test	N/W9075A 802.16 OFDMA measurement (WiMAX/WiBro)	89601B-B7Y 89601B for mobile and fixed WiMAX
MS-12.1	MS transmitter modulation and coding, cyclic prefix and frame duration timing	Modulation analysis	EVM
MS-13.1	MS transmit ranging support	Transmit power	Can be performed using band power marker
MS-15.1	MS transmit power dynamic range and relative step accuracy	Channel power	Can be performed using band power marker
MS-16.1	MS transmit power control support	Channel power	Can be performed using band power marker
MS-17.1	MS transmitter spectral flatness	Modulation analysis	EVM
MS-18.1	MS transmitter relative constellation error	Modulation analysis	EVM
MS-19.1	MS transmit synchronization	Modulation analysis	EVM
MS-20.1	MS transmit/receive switching gap	Modulation analysis (PER not included)	EVM (PER not included)
MS-24.2	MS transmit collaborative MIMO	Modulation analysis	EVM
MS-25.2	MS transmit beamforming support	Subchannel rotation on/off analysis supported (PER not included)	EVM (PER not included)

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/89600

RF Transmitter Tests (continued)

Table 2. Required mobile station transmitter measurements and the corresponding measurements in N/W9075A per WiMAX Forum Mobile Radio Requirement Testing Draft-T25-005-R010v03-B.

RCT test #	Transmitter test	Band class	Measurement/support in N/W9075A
2.1.1.2.1	MS transmitter spectral mask	1.B	SEM measurement per tables 6, 7 of 2.1.1.2.1.6
2.1.1.2.2	MS transmitter spurious emission (conducted)	1.B	Spurious emission per procedure 2.1.1.2.2.6
2.1.1.3.1	MS transmitter spectral mask	3.A	SEM measurement per tables 16, 17 of 2.1.3.1.1.6
2.1.3.1.2	MS transmitter spurious emission (conducted)	3.A	Spurious emission per procedure 2.1.3.1.2.6.1, 2.1.3.1.2.6.2, and 2.1.3.1.2.6.3
2.1.5.1.1	MS transmitter spectral mask	5.A	SEM measurement per tables 38, 39, 40 of 2.1.5.1.5
2.1.1.2.2	MS transmitter spurious emission (conducted)	5.A	Spurious emission per procedure 2.1.5.2.6

Table 3. Required base station transmitter measurements and the corresponding measurements in N/W9075A and 89600 VSA software per WiMAX Forum Mobile Radio Conformance Tests Release 1.0 Revision 2.1.0.

RCT test #	Transmitter test	N/W9075A 802.16 OFDMA measurement (WiMAX/ WiBro)	89601B-B7Y 89601B for mobile and fixed WiMAX
BS-07.1	BS transmitter modulation and coding	Modulation analysis	EVM
BS-08.1	BS transmitter cyclic prefix, symbol timing, and frame duration timing	Modulation analysis	EVM
BS-09.1	BS transmit preambles	Modulation analysis	EVM
BS-10.1	BS transmitter power range	Channel power	Can be performed using band power markers
BS-11.1	BS transmitter spectral flatness	Modulation analysis	EVM
BS-12.1	BS transmitter relative constellation error	Modulation analysis	EVM
BS-13.1	BS synchronization	Modulation analysis	EVM
BS-16.1	BS receive/transmit switching gaps	Modulation analysis (PER not included)	EVM (PER not included)
BS-17.2	BS AMC receive and transmit operation	Modulation analysis	EVM
BS-19.2	BS transmit MIMO processing	Modulation analysis (PER not included)	EVM (PER not included)
BS-20.2	BS transmitter beamforming	Modulation analysis (MSE not included)	EVM (MSE not included)

Measurement details

All of the RF transmitter measurements as defined by the IEEE 802.16e standard, as well as a wide range of additional measurements and analysis tools, are available with a single keystroke. 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 4.

Table 4. One-button measurements provided by the N/W9075A measurement application.

X-Series measurement application	N9075A	W9075A
Channel power	●	●
Adjacent channel power (ACP)	●	●
Spectrum emission mask (SEM)	●	●
Spurious Emission	●	●
Occupied bandwidth (OBW)	●	●
Power vs time	●	●
Power Statistic CCDF	●	●
Monitor spectrum	●	●
IQ waveform	●	●
Modulation analysis	●	●
RCE (EVM) peak, rms	●	●
Pilot RCE	●	●
Unmodulated RCE	●	●
Preamble RCE	●	●
RSSI	●	●
Preamble boosting	●	●
Preamble errors (phase)	●	●
Preamble PCINR R1, R3	●	●
Frequency error	●	●
IQ offset	●	●
IQ timing skew	●	●
IQ quad error	●	●
IQ gain imbalance	●	●
Subcarrier flatness (relative, absolute)	●	●
Symbol clock error	●	●
Sync correlation	●	●
Time offset	●	●
Constellation	●	●
Data burst list and map display	●	●
Symbol error vs subcarrier, vs symbol	●	●
Symbol power vs subcarrier, vs symbol	●	●

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 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

Supported devices and radio bands

Device type	Standard
BS, MS	802.16e-2005

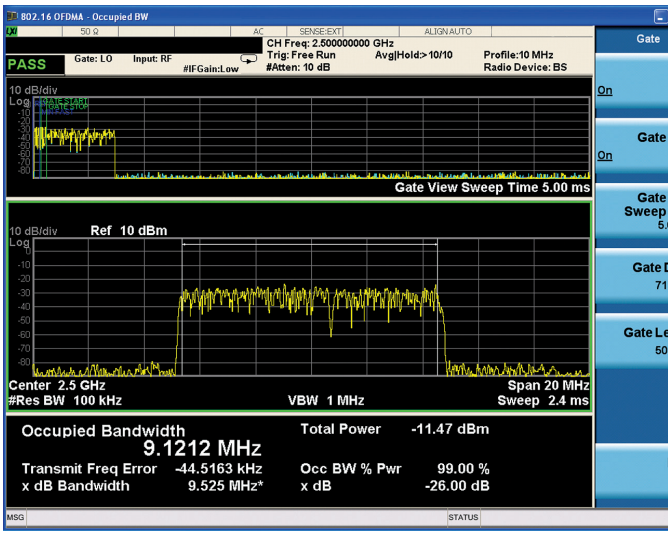

Figure 2. Time-gated occupied bandwidth measurement.

Figure 3. Modulation analysis results and metrics.

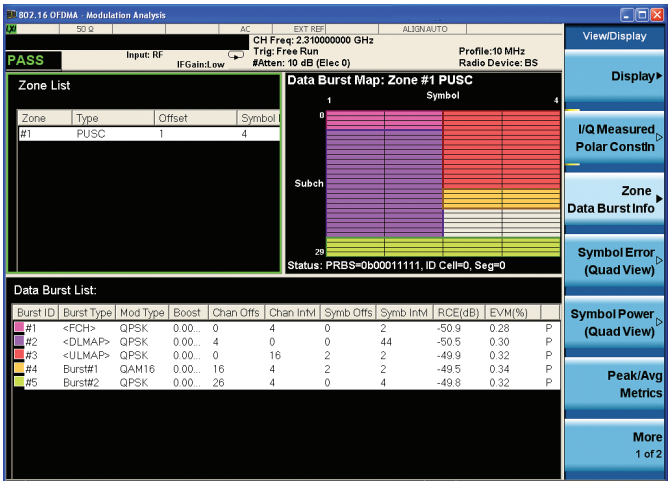

Figure 4. Modulation analysis views and auto-detected DL-MAP.

Performance specifications

Description	PXA	MXA	EXA	CXA
Modulation analysis				
RCE (EVM) floor, RF input				
10 MHz BW profile				
CF ≤ 3 GHz	–50 dB	–49 dB1		–40 dB (nom, CF < 3.6 GHz)
3 GHz < CF < 3.6 GHz	–50 dB (nom)	–49 dB (nom)1	–42 dB (nom)	
RCE (EVM) floor, analog baseband IQ input				
10 MHz BW profile		–48 dB (nom)		
Adjacent channel power accuracy				
MS				
10 MHz offset	± 0.14 dB	± 0.16 dB	± 0.17 dB	± 0.40 dB
20 MHz offset	± 0.26 dB	± 0.47 dB	± 0.83 dB	± 1.55 dB
BS				
10 MHz offset	± 0.17 dB	± 0.60 dB	± 1.22 dB	± 1.77 dB
20 MHz offset	± 0.33 dB	± 0.64 dB	± 1.33 dB	± 2.25 dB
Channel power				
Minimum power at RF input	–35 dBm (nom)	–35 dBm (nom)	–35 dBm (nom)	–35 dBm (nom)
Absolute power accuracy 20 to 30 °C, Attenuation = 10 dB	± 0.63 dB	± 0.82 dB	± 0.94 dB	± 1.33 dB
90% confidence absolute power accuracy 20 to 30 °C, Attenuation = 10 dB	± 0.19 dB	± 0.23 dB	± 0.27 dB	± 0.61 dB
Measurement floor	–81.7 dBm (nom) at 10 MHz BW	–79.7 dBm (nom) at 10 MHz BW	–75.7 dBm (nom) at 10 MHz BW	–74.7 dBm (nom) at 10 MHz BW
Spectrum emission mask				
Dynamic range, relative	82.5	77.4	72.3	70
5.05 MHz offset 10 MHz BW	85.4 (typ)	82.8 (typ)	78.8 (typ)	75 (typ)
Sensitivity, absolute	–98.5 dBm	–94.5 dBm	–89.5 dBm	–88.5 dBm
5.05 MHz offset 10 MHz BW	(–101.5 dBm typ)	(–99.5 dBm typ)	(–95.5 dBm typ)	(–94.5 dBm typ)
Accuracy				
Relative	± 0.05 dB	± 0.12 dB	± 0.11 dB	± 0.11 dB
Absolute 20 to 30 °C	± 0.62 dB (± 0.20 dB 95% confidence)	± 0.88 dB (± 0.27 dB 95% confidence)	±1.05 dB (± 0.31 dB 95% confidence)	± 1.53 dB (± 0.65 dB 95% confidence)
Spurious emissions				
Accuracy				
Frequency range				
20 Hz to 3.6 GHz	± 0.19 dB (95% confidence)	± 0.29 dB (95% confidence)	± 0.38 dB (95% confidence)	± 0.81 dB (95% confidence, 100 kHz to 3 GHz)
3.5 to 8.4 GHz	± 1.08 dB (95% confidence)	± 1.17 dB (95% confidence)	± 1.22 dB (95% confidence)	± 1.80 dB (95% confidence, 3 to 7.5 GHz)
8.3 to 13.6 GHz	± 1.48 dB (95% confidence)	± 1.54 dB (95% confidence)	± 1.59 dB (95% confidence)	NA

1. For instruments with serial number prefix ≥ MY/SG/US5233, which ship standard with N9020A-EP2 as the identifier. Refer to the 802.16 OFDM chapter of the MXA specification guide for specifications on the other MXAs. For MXA, phase noise optimization is set to fast tuning.

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 online today: www.keysight.com/find/X-Series_trial

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

N9075A & W9075A Mobile WiMAX X-Series measurement application

Description	Model-Option		Additional information
	PXA, MXA, EXA	CXA	
Mobile WiMAX	N9075A-2FP	W9075A-2FP	

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
Analysis bandwidth to 25 MHz	N9030A-B25	Required
Analog baseband IQ (BBIQ) inputs	N9030A-BBA	Required for analog baseband measurement
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
Analysis bandwidth to 25 MHz (standard option)	N9020A-B25	Required
Analog baseband IQ (BBIQ) inputs	N9020A-BBA	Required for analog baseband analysis
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
Analysis bandwidth to 25 MHz (standard option)	N9010A-B25	Required
Precision frequency reference	N9010A-PFR	Recommended
Fine step attenuator	N9010A-FSA	Recommended
Electronic attenuator, 3.6 GHz	N9010A-EA3	Recommended
Preamplifier, 3.6, 7.0, 13.6, or 26.5 GHz	N9010A-P03, -P07, -P13, or -P26	One recommended

N9000A CXA signal analyzer

Description	Model-Option	Additional information
3.0, 7.5, 13.6, or 26.5 GHz frequency range	N9000A-503, -507, -513, or -526	One required
Analysis bandwidth to 25 MHz	N9000A-B25	Required
Precision frequency reference	N9000A-PFR	Recommended
Fine step attenuator	N9000A-FSA	Recommended
Preamplifier, 3.0, 7.5, 13.6, or 26.5 GHz	N9000A-P03, -P07, -P13, or -P26	One recommended

You Can Upgrade!

Options can be added after your initial purchase.

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

myKeysight

www.keysight.com/find/mykeysight
A personalized view into the information most relevant to you.

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.

Three-Year Warranty

www.keysight.com/find/ThreeYearWarranty
Keysight's commitment to superior product quality and lower total cost of ownership. The only test and measurement company with three-year warranty standard on all instruments, worldwide.

www.keysight.com/go/quality
Keysight Technologies, Inc.
DEKRA Certified ISO 9001:2008
Quality Management System

Keysight Channel Partners

www.keysight.com/find/channelpartners
Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

www.keysight.com/find/n9075a
www.keysight.com/find/w9075a
www.keysight.com/find/89600
www.keysight.com/find/x-series_apps
www.keysight.com/find/x-series
www.keysight.com/find/wimax

Related Literature

N9075A and W9075A, Demonstration Guide, literature number 5990-5930EN

Mobile WiMAXTM PHY Layer (RF) Operation and Measurement, Application Note, literature number 5989-8309EN

IEEE 802.16e WiMAX OFDMA Signal Measurements and Troubleshooting, Application Note 1578, literature number 5989-2382EN

N9075A & W9075A 802.16 OFDMA Measurement Application Measurement Guide, Part Number N9075-90013

User's and Programmer's Reference Guide is available in the library section of the N9075A and W9075A product pages.

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

Americas

Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

Europe & Middle East

Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	800 000154
Sweden	0200 882255
Switzerland	0800 805353 Opt. 1 (DE) Opt. 2 (FR) Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:
www.keysight.com/find/contactus
(BP-09-23-14)

KEYSIGHT TECHNOLOGIES

Published in USA, August 3, 2014
5989-5353EN
www.keysight.com