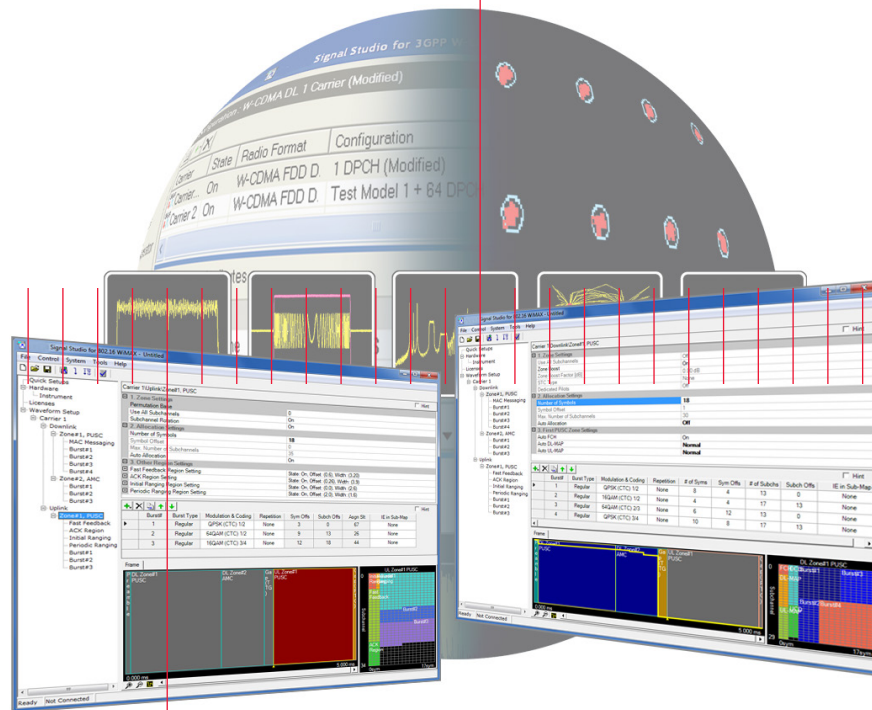# Keysight Technologies
Signal Studio for Mobile WiMAX™ N7615B

Technical Overview

– Create Keysight validated and performance optimized Mobile WiMAX and WiBro reference signals compliant to the IEEE 802.16 WirelessMAN-OFDMA PHY standards

– Test components with single- and multi-carrier signals

– Configure downlink and uplink channel parameters for testing space-time coding (STC) and MIMO features, as well as new features in the IEEE 802.16-2009 (formerly 802.16Rev2) standard such as cyclic delay diversity (CDD) and FDD/H-FDD frames

– Accelerate the signal creation process with a user interface based on parameterized and graphical signal configuration and tree-style navigation

KEYSIGHT
TECHNOLOGIES

Simplify Mobile WiMAX Signal Creation

Keysight Technologies, Inc. Signal Studio software is a flexible suite of signal-creation tools that will reduce the time you spend on signal simulation. For Mobile WiMAX, Signal Studio's performance-optimized reference signals—validated by Keysight—enhance the characterization and verification of your devices. Through its application-specific user-interface you'll create standards-based and custom test signals for component, transmitter, and receiver test.

Component and transmitter test

Signal Studio's basic capabilities use waveform playback mode to create and customize waveform files needed to test components and transmitters. Its user-friendly interface lets you configure signal parameters, calculate the resulting waveforms and download files for playback. The applications for these partially-coded, statistically correct signals include

— Parametric test of components, such as amplifiers and filters
— Performance characterization and verification of RF sub-systems

Receiver test

Signal Studio's advanced capabilities enable you to create fully channel-coded signals for receiver bit-error-rate (BER) or packet-error-rate (PER) analysis. Applications include

— Performance verification and functional test of receivers, during RF/baseband integration and system verification
— Coding verification of baseband subsystems, including FPGAs, ASICs, and DSPs

Apply your signals in real–world testing

Once you have set up your signals in Signal Studio, you can download them to a variety of Keysight instruments. Signal Studio software complements these platforms by providing a cost-effective way to tailor them to your test needs in design, development and production test.

— Vector signal generators

  — X-Series: MXG and EXG
  — PSG
  — ESG
  — First-generation MXG
  — PXIe M9381A

— EXT wireless communication test set

— PXB baseband generator and channel emulator

— 16800/16900 Series logic analyzers

— DigRF exerciser module

— M9252A DigRF host adapter

— SystemVue simulation software
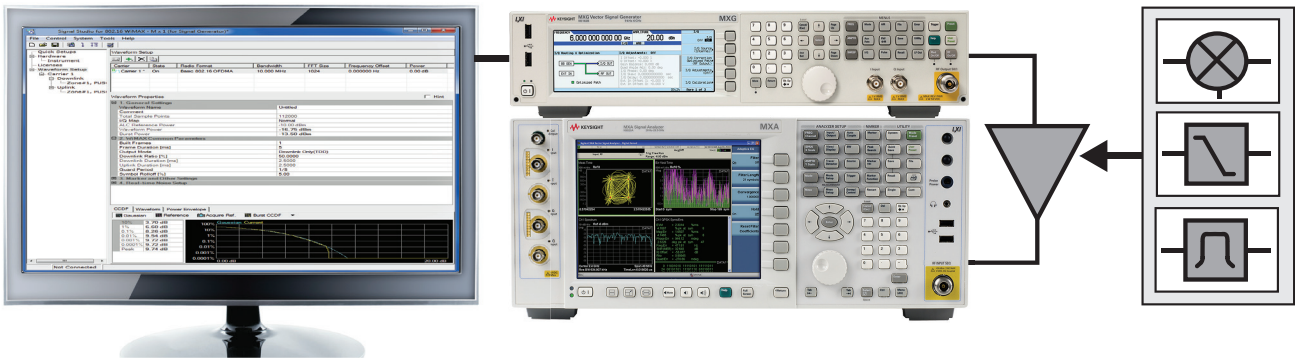
Component and Transmitter Test

Figure 1. Typical component test configuration using Signal Studio's basic capabilities with a Keysight X-Series signal generator and an X-Series signal analyzer

Signal Studio's basic capabilities enable you to create and customize Mobile WiMAX waveforms to characterize the power and modulation performance of your transmitter or receiver components. Easy manipulation of a variety of signal parameters, including channel bandwidth, FFT size, frame duration, guard period, and modulation type, simplifies signal creation.

– Create spectrally-correct signals for ACLR, channel power, spectral mask, and spurious testing

– Configure TDD or FDD downlink or uplink frames

– Configure single or multi-carrier waveforms, with each carrier having its own settings for bandwidth, frequency offsets, power, and preamble index/cell ID

– Set parameters such as channel power, number of symbols of data, and modulation type (QPSK, 16QAM, 64QAM) for modulation verification and analysis, such as EVM tests

– View CCDF, spectrum, power envelope, and time domain graphs to investigate the effects of various settings on these parameters
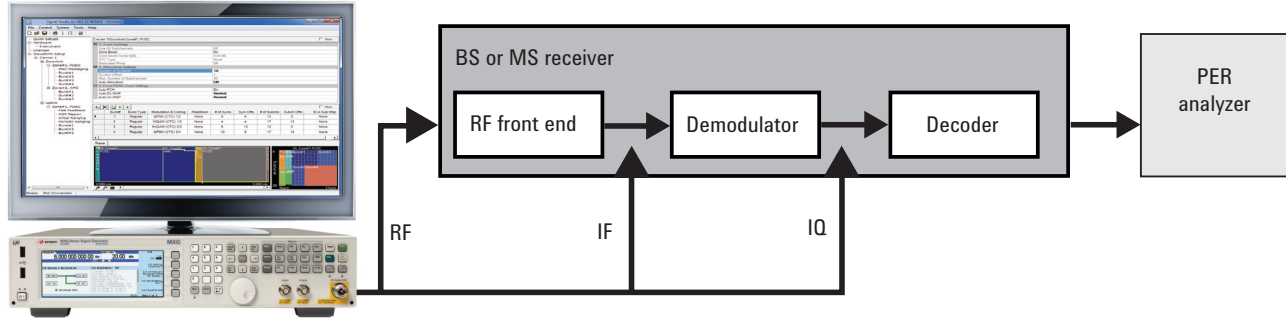
Receiver Test

Figure 2. Generate fully channel-coded signals to evaluate the PER of your receiver with Keysight X-Series signal generators and Signal Studio's advanced capabilities.

Signal Studio's advanced capabilities provide additional features to help you create 802.16e OFDMA standard-compliant frame structures for testing receiver designs in all stages of development. Set the output mode to build frames that are TDD, FDD, or FDD/H-FDD for downlink or uplink only. Create multiple bursts and MAC PDUs and configure the PDUs individually using standard data patterns or user-defined data. The MAC PDU parameters include MAC PDU mode (with or without header and CRC), CID, data type, and data length. Each data burst can be fully coded with convolutional coding (CC) or convolutional turbo coding (CTC), randomization, and interleaving. You also have the flexibility to configure individual burst parameters, such as modulation type and rate, repetition coding, and power boosting.

For easy burst configuration, the software includes an auto-allocation feature which automatically selects a valid combination of symbol and subchannel settings. You can choose regular data bursts or HARQ bursts.

Mobile station receiver testing

– Add downlink PUSC, FUSC, or AMC zones

– Automatically generate FCH, DL-MAP, UL-MAP, DCD, and UCD for downlink frame

– Choose normal or compressed MAP, or sub-DL-UL-MAPs in the first DL-PUSC zone

– Automatic or manual setting of DIUC and UIUC values

– Test MIMO using Matrix A (space-time coding) or Matrix B (2x2 MIMO)

Base station receiver testing

– Configure uplink PUSC, OPUSC, AMC, or sounding zones

– Add an initial or periodic ranging region, or a fast feedback region to transmit user-defined data bits, with automatic data wrapping around these special regions

– Test MIMO using uplink collaborative spatial multiplexing (1x2 MIMO)

For STC/MIMO testing, the Signal Studio software can generate the waveforms for the unfaded signal at the transmit antennas. The software also allows you to incorporate SISO or MIMO fading effects in the waveform for receiver testing. Various channel fading models are provided in the Signal Studio software, including ITU Pedestrian A and B, Vehicular A and B, Vehicular A with long channel, and the correlated MIMO channel models used for the Mobile WiMAX Radio Conformance Tests. Static multipath fading with up to 20 paths can also be applied. Long waveform files containing multiple frames with embedded fading provide a simple solution for testing STC/MIMO receivers without the added expense of channel emulation hardware.
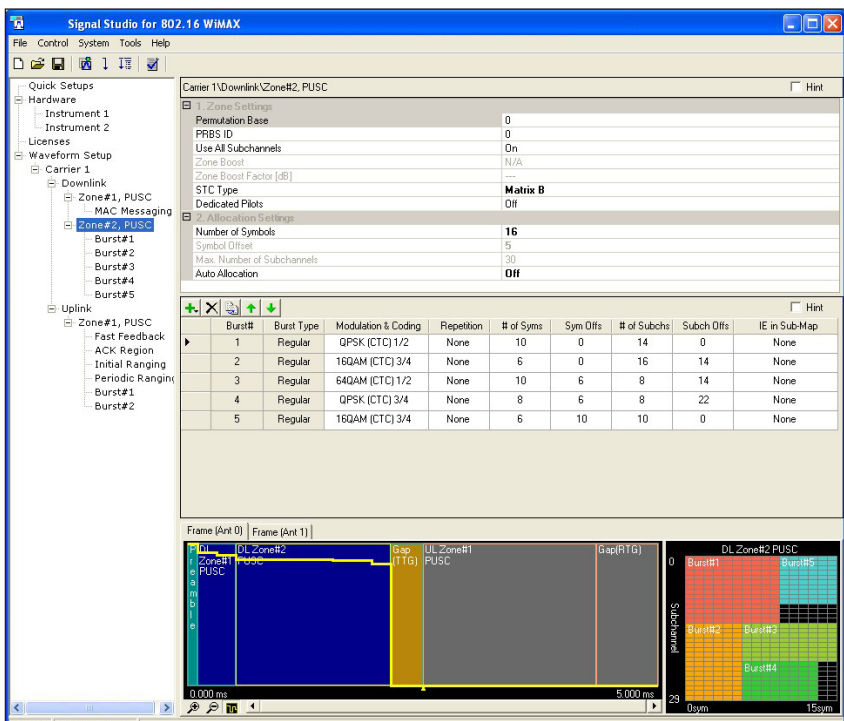

Figure 3. Navigate through the frame elements using the software's tree view in the left panel to quickly customize OFDMA waveforms with multiple zones and data bursts.

Features Summary

Feature/Parameter	Component & transmitter testing	Receiver testing	
	Basic waveform playback mode	Advanced waveform playback mode	
	802.16 OFDMA	802.16 OFDMA	802.16Rev2 OFDMA
Waveform properties:			
WiMAX system parameters setup	■	■	■
Marker settings	■	■	■
Baseband quadrature angle and gain balance	■	■	■
Noise setup	■	■	■
Multi-carrier waveform generation	■	■	■
Add one or more zone types	■	■	■
Modulation: QPSK, 16QAM, 64QAM	■	■	■
Data pattern bit offset	■		
Data length based on number of symbols	■		
Data source type: S(QPSK), S(16QAM), S(64QAM), PN9, PN15, user defined	■	■	■
Reference specification:			
802.16-2004/Cor1/D2	■	■	■
802.16-2004/Cor1/D3	■	■	■
802.16Rev2	■	■	■
Carrier settings: MAC CRC order, PRBS method, frame number increment on/off		■	■
RMS power information display	■	■	■
Edit MAC message settings: include DCD/UCD, allow DCD/UCD to be in separate bursts from DL-MAP and UL-MAP		■	■
Choose FEC coding type and rate: raw, CC, CTC		■	■
Configure MAC PDUs for each burst		■	■
Specify MAC PDU data length in bytes		■	■
Configure data bursts in each zone:			
Regular DL and UL data burst		■	■
UL collaborative SM burst		■	■
DL/UL HARQ bursts (Chase combining)		■	■
DL/UL HARQ bursts (incremental redundancy)			■
Fading emulation included in waveform data: static multi-path, mobile SISO and MIMO fading, and dual 1x2 MIMO for UL collaborative SM		■	■
User-defined channel correlation matrix			■
New AMC zone types: 1x6, 3x2, 2x6			■
Downlink			
Group Bitmask	■	■	■
AMC physical bands bitmap	■	■	■
Include FCH, DL-MAP, UL-MAP:			
FCH, normal or compressed DL-MAP and UL-MAP		■	■
Sub-DL-UL-MAP in first DL-PUSC zone		■	■
DL-MAP IE for STC, UL-MAP IE for collaborative multiplexing		■	■
Support STC and MIMO:			
2 antennas STC (Matrix A) in DL-PUSC zone		■	■
2x2 MIMO (Matrix B) in DL-PUSC		■	■
Mixed Matrix A and B bursts in same zone			■
STC/MIMO in AMC zones			■
Dedicated pilots for DL-PUSC and DL-AMC zones		■	■
Cyclic delay diversity (CDD) for 2 antennas			■
FDD/H-FDD output modes			■

Features Summary

Feature/Parameter	Component & transmitter testing	Receiver testing	
	Basic waveform playback mode	Advanced waveform playback mode	
	802.16 OFDMA	802.16 OFDMA	802.16Rev2 OFDMA
Uplink			
Subchannels and AMC physical bands bitmap	■	■	■
Uplink ranging region		■	■
Initial/handover ranging (2 symbols)		■	■
Periodic ranging/BW request (1 symbol)		■	■
Uplink fast feedback region:			
Fast feedback channel allocation using CQICH allocation IE		■	■
Fast feedback, 4 bits		■	■
Enhanced fast feedback, 6 bits		■	■
MIMO fast feedback, 3 bits		■	■
ACK, 1 bit		■	■
Collaborative spatial multiplexing (SM) in UL-PUSC zone		■	■
Subchannel rotation on/off for UL-PUSC zone		■	■
UL sounding zone and sounding message		■	■

Supported Standards and Test Configurations

IEEE publication	Date
802.16-2004	2004
P802.16-2004/Cor1/D2 and D3	2005
802.16e-2005	2006
802.16Rev2/D6	2008

Performance Characteristics

Definitions

Characteristic value:
Non-warranted value based on testing during development phase of this product. The majority of instruments tested met this value.

Performance range:
Non-warranted value based on testing during development phase of this product. All instruments tested performed within this range.

The following performance characteristics table shows the error vector magnitude (EVM) results for each instrument listed. The results are applicable for both non-MIMO configuration and STC/MIMO (Matrix A and Matrix B) configurations. Waveform parameter settings are shown below.

Multiple DL-PUSC waveforms were used with different settings:

— Bandwidths/FFTs = 5 MHz/512, 10 MHz/1024

— Burst length = 30 symbols, 5 ms frame length

— Modulation types = QPSK and 64 QAM

— Symbol rolloff = 2.78% (5 MHz BW), 5.56% (10 MHz BW)

— Power level = −20 dBm (Option 1EA = +8 dBm)

EVM performance characteristics

Carrier frequency		N5172B EXG/ N5182B MXG (with Option UNV and 1EA)	N5162A/N5182A MXG (with Option UNV)	N5162A/N5182A MXG (with Options UNV and 1EA)	E4438C ESG	E8267D PSG[1]	M9381A
2.5 GHz	Characteristic value[2]	−56.1 dB (0.16% rms)	−48.5 dB (0.4% rms)	−48.0 dB (0.4% rms)	−48.5 dB (0.4% rms)	−48.1 dB (0.4% rms)	−53.5 dB (0.21% rms)
	Performance range[3]	−59.8 to −55.9 dB (0.10 to 0.16% rms)	−51.2 to −48.4 dB (0.27 to 0.38% rms)	−53.6 to −48.4 dB (0.21 to 0.38% rms)	−51.4 to −48.0 dB (0.27 to 0.40% rms)	−52.4 to −47.4 dB (0.24 to 0.43% rms)	−54.8 to −53.3 dB (0.18 to 0.22% rms)
3.5 GHz	Characteristic value[2]	−53.2 dB (−0.22% rms)	−46.0 dB (0.5% rms)	−46.0 dB (0.5% rms)	−46.0 dB (0.5% rms)	−48.9 dB (0.4% rms)	−48.6 dB (0.37% rms)
	Performance range[3]	−57.9 to −53.0 dB (0.13 to 0.22% rms)	−48.6 to −45.7 dB (0.37 to 0.52% rms)	−50.8 to −46.2 dB (0.29 to 0.49% rms)	−50.2 to −44.7 dB (0.31 to 0.58% rms)	−42.7 to −48.3 dB (0.23 to 0.38% rms)	−49.7 to −48.2 dB (0.33 to 0.39% rms)

1. *Performance characteristics are based on PSG signal generators with the standard pulse modulation Option E8267D-UNU. EVM performance may degrade with the narrow pulse modulation Option E8267D-UNW, so Option E8267D-UNW is not recommended for use with the N7615B.*

2. *Non-warranted value based on testing during development phase of this product. The majority of instruments tested met this value.*

3. *Non-warranted range based on testing during development phase of this product. All instruments tested performed within this range.*

Ordering Information

Hardware configurations

To learn more about compatible hardware and required configurations, please visit: www.keysight.com/find/
SignalStudio_platforms

PC requirements

A PC is required to run Signal Studio. www.keysight.com/find/
SignalStudio_pc

Software licensing and configuration

Signal Studio offers flexible licensing options, including:

- **Fixed license**: Allows you to create unlimited I/Q waveforms with a specific Signal Studio product and use them with a single, specific platform.
- **Transportable/floating license:** Allows you to create unlimited I/Q waveforms with a specific Signal Studio product and use them with a single platform (or PC in some cases) at a time. You may transfer the license from one product to another.
- **Waveform license:** Allows you to generate up to 545 user-configured I/Q waveforms with any Signal Studio product and use them with a single, specific platform.

The table below lists fixed, perpetual licenses only; additional license types may be available. For detailed licensing information and configuration assistance, please refer to the Licensing Options web page at www.keysight.com/find/SignalStudio_licensing

N7601B Signal Studio for cdma2000/1xEV-DO

Model-Option	Description
Connectivity	
N7615B-1FP	Connect to E4438C ESG
N7615B-2FP	Connect to E8267D PSG
N7615B-3FP	Connect to N5182/62 MXG, N5172 EXG
N7615B-6FP	Connect to N5106A PXB
N7615B-7FP	Connect to Keysight simulation software
N7615B-8FP	Connect to E6607 EXT
N7615B-9FP	Connect to M9381A and M9252A
N7615B-R7L	Connect to 16800/16900/N5343A
Capability	
N7615B-EFP	Basic Mobile WiMAX
N7615B-QFP	Advanced Mobile WiMAX
N7615B-RFP	Advanced Mobile WiMAX 802.16 Updates
N7615B-R7Z	Basic Mobile WiMAX for 16800/16900/N5343A
N7615B-R89	Advanced Mobile WiMAX for 16800/16900/N5343A
N7615B-R8A	Advanced Mobile WiMAX 802.16 Updates for 16800/16900/N5343A

Additional Information

Websites

Access the comprehensive online documentation, which includes the complete software HELP file and configuration guide
www.keysight.com/find/n7615b
www.keysight.com/find/SignalStudio

Signal generators—www.keysight.com/find/sg

E6607 EXT wireless communications test set—www.keysight.com/find/ext

Logic analyzers—www.keysight.com/find/logic

DigRF modules—www.keysight.com/find/rdx

Literature

WiMAX Concepts and RF Measurements, Application Note, 5989-2027EN
Signal Studio Software, Brochure, 5989-6448EN

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