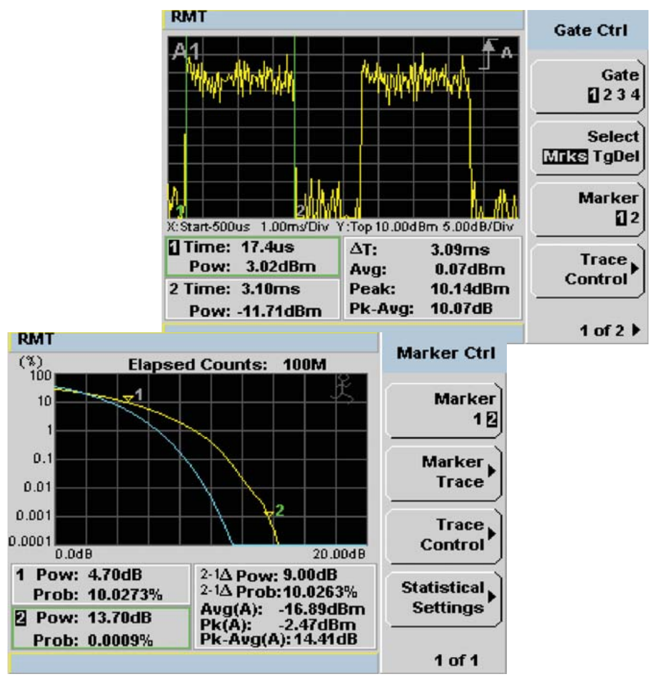
Agilent
N1911A/N1912A P-Series Power Meters
For WiMAX™ Signal Measurements

Demo Guide



Agilent Technologies

The N1911A/12A P-Series power meter makes WiMAX burst signal measurement simpler with its one-button preset

Introduction

This demo guide is designed to help engineers make effective power-time measurements with the P-Series power meters.

Included in this guide are an overview of the WiMAX technology and a step-by-step demonstration of Mobile WiMAX™ (OFDMA) waveform measurements in TDD mode. Power-time and CCDF measurements are covered in various subframes: DL, UL, both DL and UL subframes.

Use the N1911A/12A for Effective WiMAX Burst Signal Measurement

- **Power Versus Time (PvT)**
- **Power Statistical CCDF**

The N1911A/12A P-Series power meters and N1921A/22A wideband power sensors combination can perform fast and accurate measurements of peak/average/peak-to-average ratio power, rise/fall time, maximum/minimum power and CCDF statistical data for wideband signals.

With the P-Series power meters' 30 MHz wide video bandwidth and 100 MSa/s continuous sampling rate, capturing high-burst WiMAX signals is a breeze, even with the signals' fast power transitions.

The P-Series power sensors provide high dynamic range for better sensitivity, enabling reliable measurement of peak and average power. These diode sensors also come with wide frequency ranges up to 40 GHz to easily capture high-frequency WiMAX signals.

Further simplifying measurement set up, the P-Series power meters provide a one-button preset for WiMAX signals so you can effectively capture your desired signal burst faster. With easy steps in this demo guide for PvT and statistical CCDF measurements, you can also evaluate your WiMAX application designs sooner.

WiMAX Overview

Worldwide Interoperability for Microwave Access (WiMAX) is based on wireless transmission methods defined by the IEEE 802.16 standard that offers high-speed data access to large geographical areas, covering a distance up to 20 miles. WiMAX was developed to replace broadband cable networks and to enable mobile broadband wireless access.

The orignal IEEE 802.16 standard offers a 10 GHz – 66 GHz point-to-point system using traditional single carrier modulation with QAM. However, it has little industry adoption.

The IEEE 802.16-2004 [1] standard, 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). The standard contains specifications for licensed and unlicensed BWA operations between 2 GHz and 11 GHz.

The IEEE 802.16-2004 standard specifies Orthogonal Frequency Division Multiplexing (OFDM) as the transmission method for Non-Line-Of-Sight (NLOS) connections to attain a high data rate. OFDM modulation uses up to 256 subcarriers with bandwidths of 1.25 MHz to 28 MHz. Subcarriers are spaced such that they are orthogonal to each other, thus reducing signal interference. The signal bandwidth in the Base Station (BS) can be changed based on transmission distance and signal environment. The network provider may also determine the bandwidths available for users based on various pricing plans. Signal condition and bandwidth requirements determine which modulation will be selected for the individual data burst.

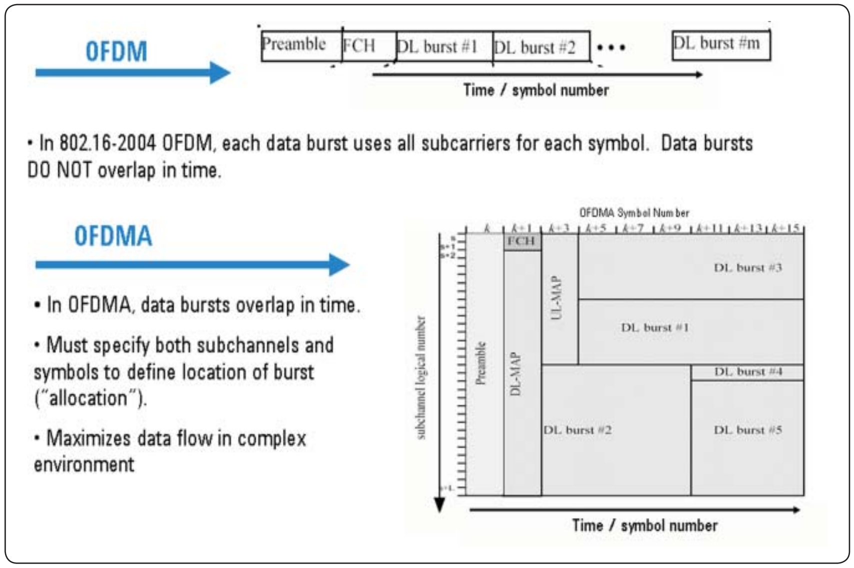


Figure 1. OFDM (fixed) and OFDMA (mobile) frame structures

Table 1. OFDM and OFDMA standards

	Fixed WiMAX (OFDM)		Mobile WiMAX (OFDMA)
Standard	802.16	802.16/802.16-2004	802.16e/802.16-2005
Multiple access	FDD, TDD	FDD, TDD	FDD, TDD, OFDMA
Modulation	single carrier with QAM	OFDM with BPSK, QPSK, 16QAM, 64QAM	OFDMA with BPSK, QPSK, 16QAM, 64QAM
Channel spacing	1.25 MHz to 28 MHz		
FFT size	256		2048 1024, 512, 128
User carriers	200		various
Pilot carriers	8		various
Frequency range	0 to 66 GHz Licensed	2 to 11 GHz Licensed and Unlicensed	< 6 GHz Licensed
Application	NLOS		LOS

Figure 1 shows the OFDM and Orthogonal Frequency Division Multiple Access (OFDMA) frame concepts. In OFDM, the downlink consists of the Preamble (P) followed by a Frame Control Header (FCH) and the subsequent bursts for the respecitve different subscribers. In OFDMA, the bursts are allocated according to a downlink map. The data bursts that overlap the same specifications maximise the data flow in a complex enviroment.

Table 1 is the summary of OFDM and OFDMA standards. The 802.16-2005 standard focuses on the OFDMA layer. OFDMA allows 128, 512, 1024 or 2048 subcarriers in 1.25, 5, 10, 20 or 28 MHz bandwidths respectively.

OFDM/OFDMA Subcarriers

The WiMAX specifications for the 256-carrier OFDM PHY define three types of subcarriers: data, pilot, and null. WiMAX standard specifications for the 200 carriers are used for data and pilot subcarriers. Eight pilot subcarriers are permanently spaced throughout the OFDM spectrum. Therefore, the data subcarriers take up the other 192 active carriers. The remaining 56 potential carriers are nulled and set aside for guard bands and removal of the center frequency subcarriers [2].

Figure 2 shows the comparison standards between Wireless LAN (based on 802.11) and WiMAX (based on 802.16). In WLAN signals, 52 carriers are used, where 48 carriers provide data and four carriers provide pilots. In WiMAX signals, only 200 of the possible 256 carriers are used. These are numbered between –100 to +100. The center frequency carrier (#0) will not be used.

Out of the 200 carriers, 192 of the carriers are used for data, and eight carriers are used for pilots. WiMAX signals can be configured with the bandwidths ranging between 1.25 MHz to 28 MHz. Figure 2 shows an example of a 1.5 MHz-bandwidth signal, where its carriers are spaced at only 6.7 kHz from each other. In WLAN signals, however, the individual subcarriers are spaced at over 300 kHz from each other.

While WiMAX signals have significantly more subcarriers and data in each symbol, they do not have a significantly higher data rate than WLAN signals. That's because in OFDM, when the carriers become more closely spaced, the symbol period must be increased proportionately to maintain the orthogonality of the individual carriers.

A longer symbol period means a higher resistance towards channel impairment such as multipath fading, thus, it is more advantageous to use more closely spaced carriers with the proportionately longer symbol period. This advantage allows WiMAX signals to transmit data more effectively over long distances and in NLOS, compared to WLAN signal.

In OFDMA mode, various subscribers can be served simultaneously by assigning each subscriber a specific carrier group (subchannelization) that carries the data intended for that subscriber (see Figure 3).

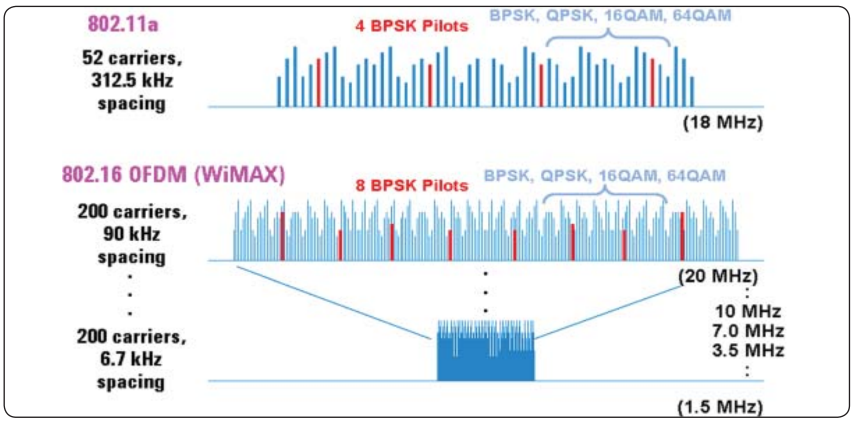


Figure 2. 802.11a WLAN versus 802.16 WiMAX standards

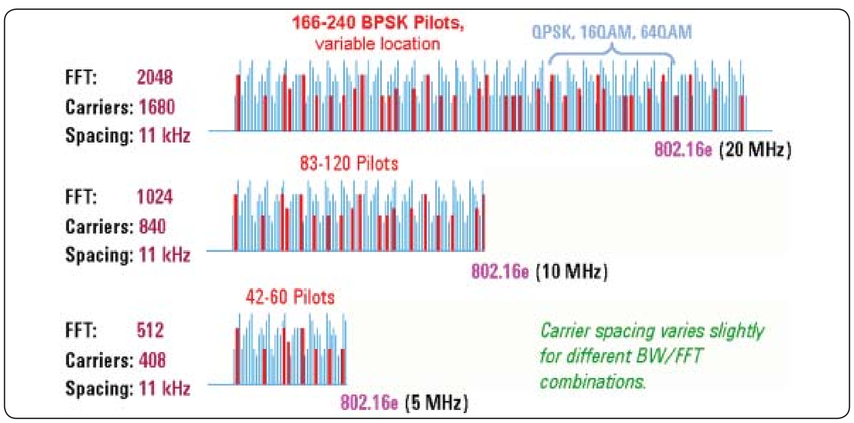


Figure 3. 802.16e OFDMA Mobile WiMAX

802.16 Concept: Subchannelization

Subchannelization is an optional capability that can be supported by subscriber and Base Stations (BS). Figure 4 shows the Uplink subchannelization. One subchannel contains 12 carriers. The OFDM WiMAX has 192 active data carriers, so there are 16 subchannels in total. They are allocated in various combinations for the creation of 31 different configurations to be assigned to a user. (Details on subchannelization can be found in [1], Table 213 for OFDM.)

In the most basic operation, all 16 subchannels (all 192 carriers) are assigned to a single user. In the most complex configuration, 16 users are assigned to one subchannel. The downlink symbol would still contain all 192 carriers, but each individual user's data would only have 12 carriers. For uplink, all 16 users would transmit signals simultaneously, so their signals will arrive at the BS at the same time and with approximately the same power.

It is important to align the subscriber's station time, frequency, and amplitude so that the BS can receive, demodulate and decode informations from 16 different transmitters simultaneously.

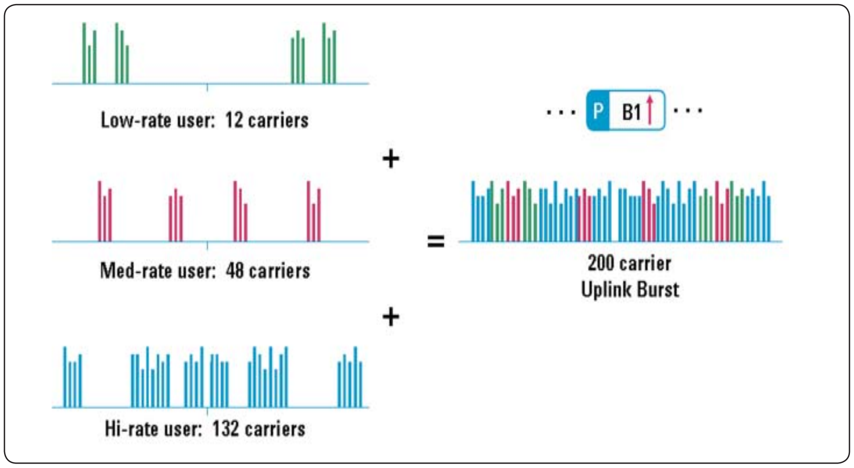


Figure 4. Uplink Subchannelization

Modulation Type

The IEEE 802.16-2004 standard defines a set of adaptive modulation and coding (AMC) rate configuration that can be used to trade-off data rates for system robustness under various wireless propagation and interference conditions. When the radio link quality is good, the WiMAX system can use higher-order modulation schemes (more bits or 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 lower modulation schemes 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 [2].

Duplexing Techniques

WiMAX systems can be deployed as Time Division Duplexing (TDD), Frequency Division Duplexing (FDD), or Half-Duplex FDD (see Figure 5).

In the TDD configuration, the BS and subscriber equipment transmit on the same RF frequency, but at a different time. The Downlink (DL) subframe is transmitted by the BS, followed by a short gap called Transmit/Receive Transition Gap (TTG), whereas the Uplink (UL) subframe is transmitted by the individual subscriber. The subscribers are accurately synchronized so that their transmissions do not overlap each other as they arrive at the BS. There is another short gap called the Receive/Transmit Transition Gap (RTG) after the Uplink subframe is allocated before the BS can start transmitting again.

A Downlink subframe always begins with a Preamble (P), followed by a Header (H), and one or more downlink bursts of data. The downlink bursts are generally made up of multiple symbols within the burst. Within each burst, the modulation type is constant, but the modulation type can change from burst to burst. “Robust” bursts such as BPSK and QPSK must be transmitted first, followed by less robust modulation types (QAM). The order of the robust burst, from most to less robust is BPSK, QPSK, 16QAM, followed by 64QAM. Each UL subframe is preceded by a Preamble, called a “short Preamble”, which allows the BS to synchronize with each subscriber on its own.

In the FDD configuration, the downlink and uplink frames are identical to the TDD, but they are transmitted on separate RF frequencies and overlap each other at a specific time. No TTG or RTG gaps are required in this FDD mode.

The Half-Duplex FDD configuration combines the characteristics of FDD and TDD. However, the BS and subscriber equipment transmit on different frequencies like FDD, and at different times like TDD.

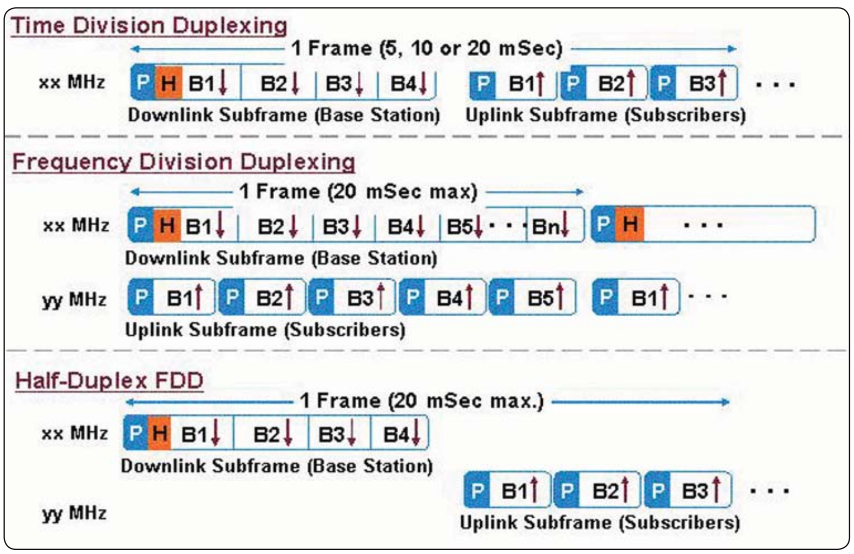


Figure 5. Various duplexing techniques (TDD, FDD and H-FDD)

Output Power

Power level transmission is an important IEEE 802.16 conformance specification. It is defined as the time-averaged power over the useful period of a UL or DL subframe burst. Peak-to-average power can also be obtained during this period. To make accurate and stable measurements, it is important to be able to capture the desired complete subframe consistently within the fixed timeframe. This can be achieved by applying proper time-triggering mechanisms such as trigger level, holdoff and delay that are available in the P-Series power meters.

The P-Series power meters' trigger level is typically set at auto-level. Trigger holdoff ensures that the acquisition will not occur until the holdoff time has passed and a valid trigger is found. This is very useful for burst signals that have amplitude variations because these variations can cause false triggering.

Trigger delay allows measurements of different signals. By just changing the delay setting of the power meter, you can make power measurements of the next subframe.

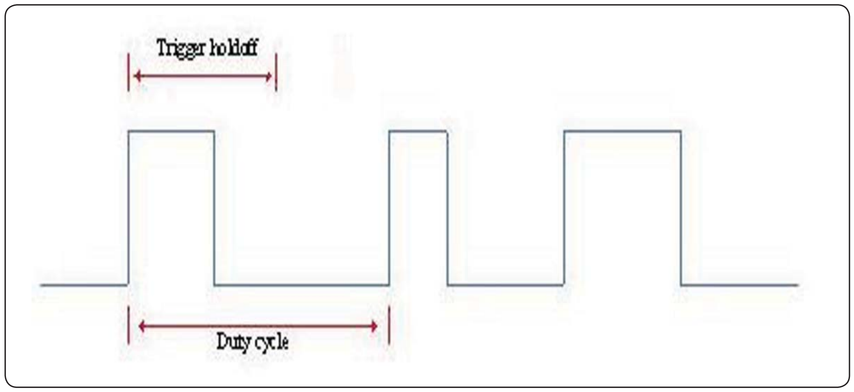


Figure 6. WiMAX burst power profile (without constant duty cycle)

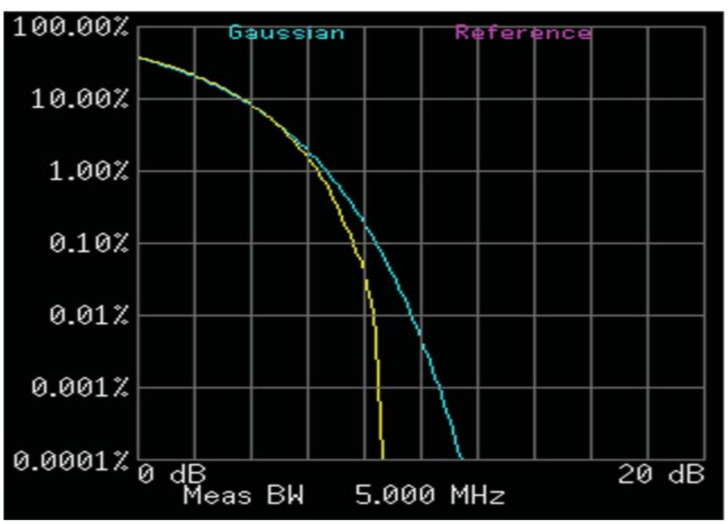


Figure 7. CCDF plot: Y axis represents the percentage of time the signal power is at or exceeds the power specified by the X axis

CCDF

The Complementary Cumulative Distribution Function (CCDF) is a plot of probability versus Peak-to-Average Ratio (PAR), which characterizes the power statistics of a signal. CCDF is one of the important measurements in designing WiMAX power amplifiers that must be capable of handling high PAR signal exhibits while constantly maintaining good adjacent channel leakage performance.

The CCDF plot is primarily used in the wireless communications market for evaluating multicarrier power amplifier performance. It provides a measurement of the percentage of time where the PAR is at or exceeds a specific power level.

Demonstration Preparation

This demonstration focuses on Mobile WiMAX (OFDMA) signal measurements over LAN.

The following instruments and software are used in this demo guide:
- E4438C ESG vector signal generator[1]
- N1911A/N1912A P-Series power meters
- N1921A/N1922A P-Series wideband power sensors
- N7615A/B Signal Studio software[2]

The Signal Studio is a Windows®-based utility that simplifies the creation of standard or customized WiMAX waveforms. With the Signal Studio software, the desired Mobile WiMAX waveform can be configured. Waveform parameters are then input to the ESG.

To update instrument firmware and software, visit:
- www.agilent.com/find/esg
- www.agilent.com/find/mxg
- www.agilent.com/find/wideband_powermeters
- www.agilent.com/find/signalstudio

Product type	Description
ESG Vector Signal Generator	• E4438C firmware revision C.04.60 or later • Frequency range option: 503 or 506 • Baseband generator option: 601 or 602
P-Series Power Meters	N1911A or N1912A firmware revision A.03.01 or later
P-Series Wideband Power Sensors	N1921A or N1922A
Signal Studio software	N7615B Version 1.8.2.0 or later
Controller PC	Installed with the N7615B Signal Studio software (to generate and input the WiMAX signal into the ESG) Refer to online documentation for installation and setup.

1 Alternatively, you can use the N5182A MXG vector signal generator, firmware revision 1.10 or later, frequency range option: 503 or 506, and baseband generator option: 651 or 652.
2 The N7615A/B is for Mobile WiMAX signal measurements. For Fixed WiMAX signal measurements, the N7613A/B can be use.

Demonstration Preparation (continued)

Connecting the PC, ESG and P-Series Instructions

1. Connect the PC to the E4438C ESG via a LAN cable.
2. Launch the Agilent Connection Expert application (Agilent IO Libraries Suite) and verify successful connection of the ESG.
3. Connect the P-Series power meter and sensors as shown in Figure 8.

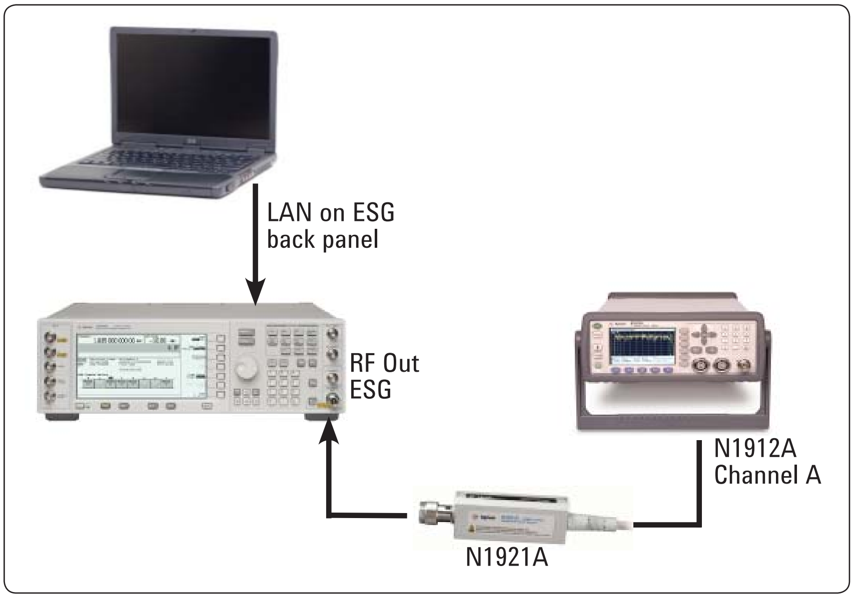


Figure 8 P-Series and ESG setup diagram

Establishing a communication link to the ESG

Keystrokes surrounded by [ ] represent front panel keys of the instruments, while keystrokes surrounded by { } represent softkeys.

Instructions	Keystrokes
On the ESG:	
1. Set the instrument to its default settings.	Press [Preset]
2. Check the IP address.	Press [Utility] {GPIB/RS-232/LAN} {LAN Setup} • if connecting to a network, press {LAN Config} {DHCP} • if direct-connecting from PC to ESG, press {LAN Config } {Manual}, e.g. {IP address 192.168.100.1}
3. Run the Signal Studio for 802.16 WiMAX.	Double-click on the 802.16 WiMAX shortcut on the desktop or access the program via Windows start menu.
4. Verify that the software is communicating with the instrument via LAN TCP/IP link.	From the {System} pull-down menu at the top of the Signal Studio program window, select {Change Hardware Connections} {Next}, select [LAN] and enter the host name or IP address of the ESG in the address area. Finally, click {Test I/O Connection} {Next}.
5. The software should return a "success" connection status.	• If connection is successful, click {Finish}. • If connection is not successful, verify the instrument connection and the IP address or TCP/IP link again.

DL Profile in TDD Mode

Profile setting

Most parameters are in their default settings when Signal Studio is launched. Values in **bold** indicate modified parameters.

Instructions	Software operations
On the Signal Studio software:	
1. Set the basic parameters of the signal at center frequency 3.5 GHz, amplitude at 0 dBm. Turn RF output and ALC ON.	Click **Signal Generator** on the left of the Explorer menu. • Instrument model number = E4438C Select [Preset] at the top of the selection menu. • Frequency = **3.5 GHz** • Amplitude = **0 dBm** • RF Output = On • ALC = On
2. Configure waveform setup.	Click **Waveform Setup**. Under **Waveform Properties**, set the parameters as follows: • Built frames = 1 • Frame duration = 5 ms • Output mode = **Downlink only (TDD)** • Downlink Ratio (%) = 50.0000 • Downlink duration (ms) = 5.0000 • Uplink duration (ms) = 0.0000 • Guard period = 1/8 • Symbol rolloff = 5.0 %
3. Configure test signal.	Click **Carrier 1**. Under **Waveform Setup** on the left of the Explorer menu. Carrier 1: • State = On • Radio format = advanced 802.16 OFDMA • BW = 10 MHz • FFT size = 1024 • Frequency offset = 0 Hz • Power = 0.00 dB Reference specifications: 802.16e-2005 with PRBS Method Cor1/D3. Single-carrier with 10 MHz bandwidth, 1024 FFT size and 28/25 n.
4. Create a single-carrier signal that includes downlink only.	Click **Downlink** and set the following parameters: • Preamble index = 0 • Group bitmax = 111111 [Binary], 3F [Hex] • Number of symbols = **20** • Symbol offset = 1 • Max number of subch = 30
5. Configure Zone No. 1, PUSC.	Select Zone No. 1 PUSC MAC messaging and set the following parameters: • Zone boost = Off • Number of symbols = 20 • Auto allocation = On • Auto FCH = On • Auto DL-MAP = Off • Auto UL-MAP = Off

DL Profile in TDD Mode (cont.)

Profile setting (cont.)

Instructions	Software operations
6. Configure MAC messaging.	• Auto DL-MAP = Off • Modulation and coding = QPSK (CC) 1/2 • Repetition coding = None
7. Configure Burst No. 1.	Select Burst No. 1 and set the following parameters: • Modulation and coding = QPSK (CC) 1/2 • Repetition coding = None • Power boost = 0 dB • Data Length (Bytes) = **1000**
8. Download signal to ESG.	On the menu bar, go to **Control > Generate and Download**. If you encounter any errors, refer to Signal Studio's online help.
9. Save file setting for future use.	**File > Save As... > OFDMA_Demo.scp** (Insert the file name of your choice)
10. Export waveform file for future use.	**File > Export Waveform Data > OFDMA_Demo.wfm** (Insert the file name of your choice)

DL Profile in TDD Mode (cont.)

PvT Measurement

Power versus time (PvT) measurement examines the time domain burst structure over certain subframes.

The P-Series power meters' real-time markers allow users to move the markers manually to measure the desired subframe burst.

In IEEE 802.16, there is no specific definition for power. Thus, users are required to specify the design of the frame based on their measurements.

Figure 9 shows the PvT graph for an entire WiMAX burst signal within a frame duration of 5 ms (refer to waveform setup on Page 10).

The Signal Studio under Downlink step shows a frame duration of 5 ms (see Figure 10). Moving the cursor around the frame zone reveals the time duration and power level of the Preamble, DL, TTG, UL and RTG as seen below:

- Preamble = 0.104 ms / 1 sym
- DL = 2.06 ms / 20 sym(s)
- TTG = 0.34 ms
- UL = 1.85 ms / 18 sym(s)
- RTG = 0.648 ms

The Preamble region (Figure 10) shows 0 dB. In DL zone, there are three different power levels:

i) –3.98 dB when the FCH and Burst 1 is ON (right after the Preamble)
ii) –4.46 dB when only Burst 1 is ON
ii) –10.27 dB from the end of Burst 1 to the end of the DL zone.

Measuring DL PvT

Instructions	Keystrokes
On the P-Series power meter:	
1. Select WiMAX preset.	[Preset], Press [or] key to choose {WiMAX}. [Select], {Confirm}.
2. Set trace display.	[Disp], {Disp Type}, {Trace}.
3. Set trigger holdoff at 4 ms.	[Trig/Acq], {Settings}, {1 of 2}, {Hold-off 4 ms}.
4. Expand the window. Change the scale. Move the marker to measure frame duration (see Figure 9).	[ ], {Trace Control}, {X Start -400 µs, X Scale 600 µs and Y Scale 10 dB} {Gate Control}, press [ ] to allocate marker 2 and [ ] to allocate marker 1.

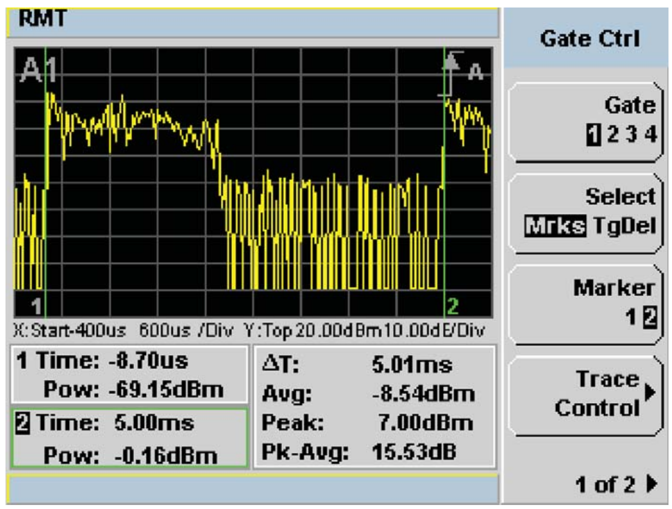


Figure 9. WiMAX waveform duration at 5 ms for DL in TDD mode. In the P-Series power meters, green lines (Gate1 and Gate2) are used to highlight the burst structure of the WiMAX profile.

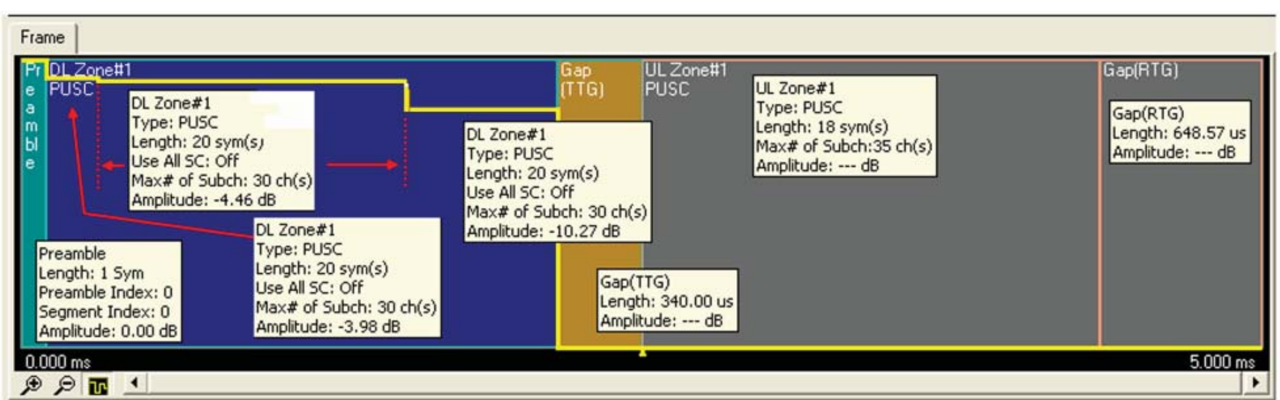


Figure 10. Frame duration (5 ms) of DL waveform captured with Signal Studio

Measuring Preamble and DL PvT

Instructions	Keystrokes
On the P-Series power meter:	
1. Measure Preamble at 104 µs duration (see Figure 11).	{Trace Control}, {X Start –200 µs and X Scale 300 µs}. {Gate Control}. Press [ ] to allocate marker 2 and [ ] to allocate marker 1.
2. Measure DL with only Burst 1 ON (see Figure 12).	Press [ ] to allocate marker 2 and [ ] to allocate marker 1.

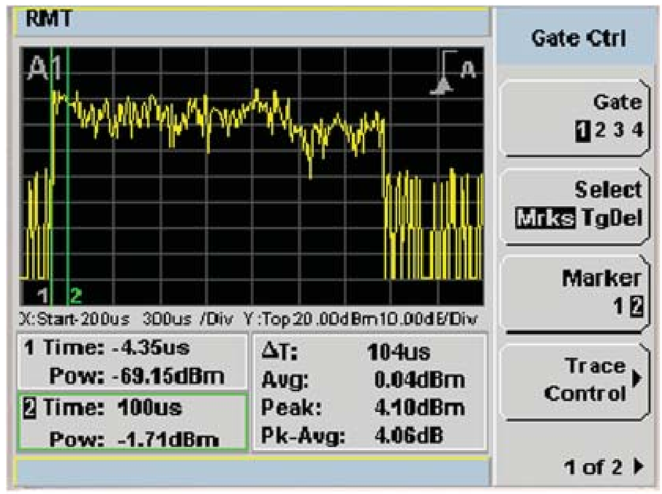


Figure 11. Preamble duration at 104 µs and average power is measured at 0.04 dBm, which is close to 0 dBm of input power (see ESG setup on Page 10)

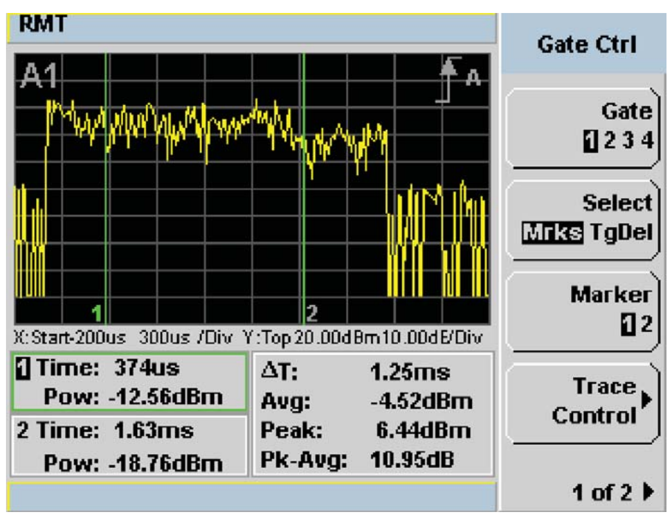


Figure 12. DL average power measures –4.52 dBm at 1.25 ms where only Burst 1 is ON. Referring to Figure 11, the Preamble (P) has a 3 dB boost above the DL or nominal level of the rest of the signals. At times, bursts can be boosted above 0 dB as well.

Measuring TTG, UL and RTG PvT

Instructions	Keystrokes
On the P-Series power meter:	
Measure the TTG, UL and RTG at 2.84 ms duration (see Figure 13).	Press [ ] to allocate marker 2 and [ ] to allocate marker 1.

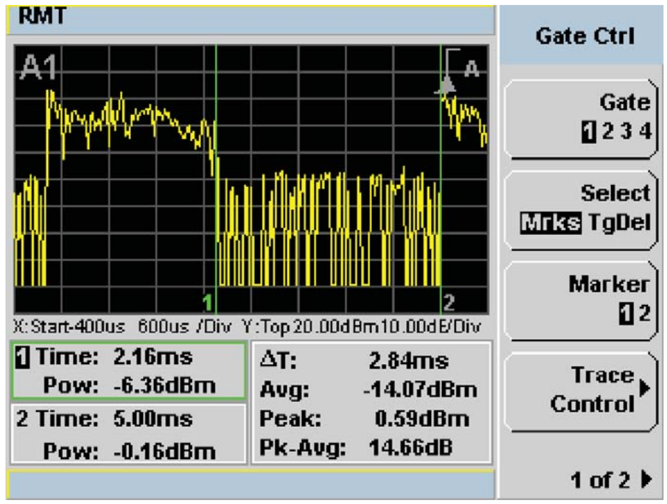


Figure 13. TTG, UL and RTG at 2.84 ms duration

DL Profile in TDD Mode (cont.)

Power Statistics CCDF Measurement
Prior to measurement, a reference trace is set and compared with the Gaussian noise trace.

CCDF is generally measured with data that is as random as possible to match the Gaussian Curve. The CCDF waveform provides statistics of the input signal, analyzed over 1 s asynchronously to any features of the signal. 100 MHz samples are histogrammed in real time so we can have the statistics on 100 million samples.

The P-Series power meters provide waveform CCDF measurements in graphical and table formats (see Figures 14 and 15). The Preamble and Header portion of the waveform are fixed data, thus causing the yellow line curve on the CCDF plot to extend past the Gaussian Curve and therefore, displaying a very high PAR (see Figure 14).

Referring to Figures 16 and 17, the Signal Studio under Waveform Setup shows that the CCDF plot and the table to the left of the CCDF plot display the calculated peak-to-average values. The blue line represents the Gaussian noise and the yellow line represents the input signal. Click the Waveform CCDF or Burst CCDF button to toggle between the calculation types.

Instructions	Keystrokes
On the P-Series power meter:	
1. Set acquisition to "Free Run"	[Trig/Acq], {Acqn A}, {Free Run}.
2. Measure CCDF in trace format	[Disp], {Disp Type}, {1 of 2}, {CCDF Trace}.
3. Set trace scale to 20 dB	{Trace Control}, {Scale/Div 2dB}.
4. Set up Gaussian noise and expand the display (see Figure 14)	{Trace Display}, {Gaussian}, [ ].
5. Set CCDF in table format and expand the display (see Figure 15)	[Disp], {Disp Type}, {1 of 2}, {CCDF Table}, [ ].

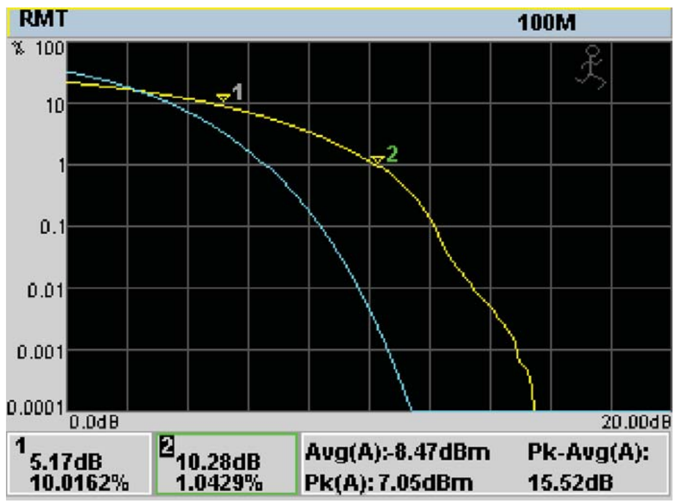


Figure 14. CCDF graphical format. The yellow line is the input signal. The blue reference line is the band-limited Gaussian noise curve. Marker 1 and Marker 2 indicate 10% and 1% of time at a specified power measurement.

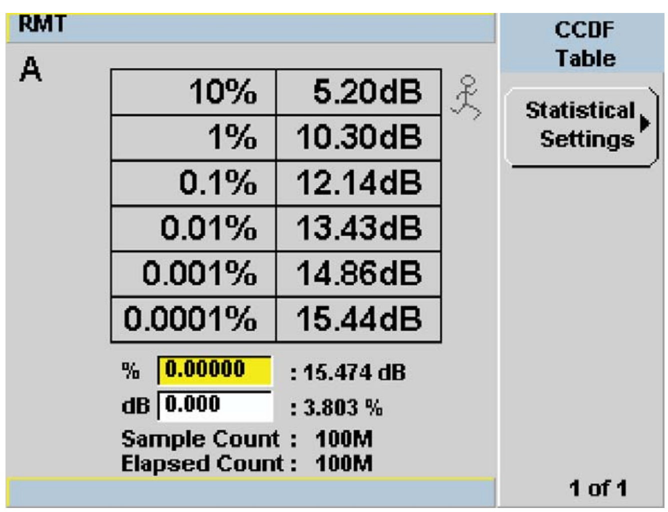


Figure 15. CCDF table format

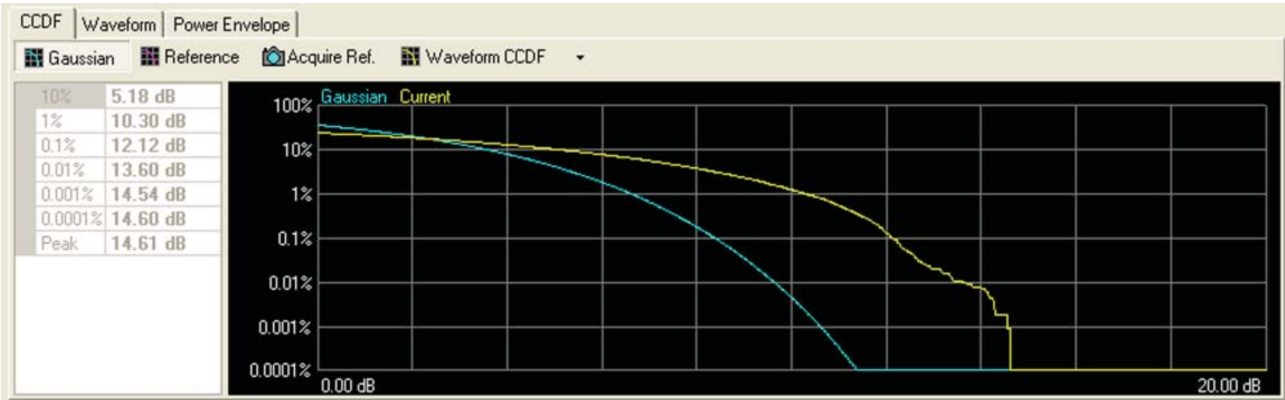


Figure 16. **Waveform CCDF** calculates CCDF and peak-to-average ratio using the entire waveform, including portions where the data is at zero (no signal).

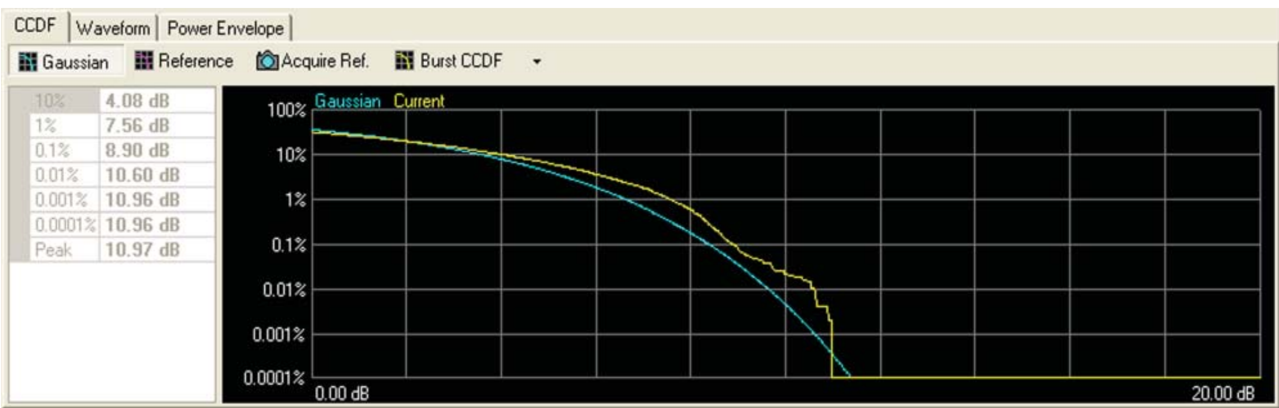


Figure 17. **Burst CCDF** calculates the entire waveform using only the actual signal instead of the whole waveform.

UL Profile in TDD Mode

Profile setting

Instructions	Software operations
On the Signal Studio software:	
1. Configure waveform setup.	Click **Waveform Setup**. Under **Waveform Properties**, set the parameters as follows: • Built frames = 1 • Frame duration = 5 ms • Output mode = **Uplink only (TDD)** • Downlink Ratio (%) = 50.0000 • Downlink duration (ms) = 5.0000 • Uplink duration (ms) = 0.0000 • Guard period = 1/8 • Symbol rolloff = 5.0 %
2. Configure Uplink Burst No. 1.	Select Burst No. 1 and set the following parameters: • Modulation and coding = QPSK (CC) 1/2 • Repetition coding = None • Power boost = 0 dB • Data Length (Bytes) = **1000**
3. Download signal to ESG.	On the menu bar, go to **Control > Generate and Download**.

UL Profile in TDD Mode (cont.)

PvT Measurement

The Signal Studio under Uplink step shows a frame duration of 5 ms (see Figure 19). The frame duration setting is the same as the DL profile setup but the Uplink region will show –0.15 dB when only UL Burst 1 is ON.

Measuring UL PvT

Instructions	Keystrokes
On the P-Series power meter:	
1. Select WiMAX preset.	[Preset], Press [or] key to choose {WiMAX}. [Select], {Confirm}.
2. Set trace display.	[Disp], {Disp Type}, {Trace}.
3. Set trigger holdoff 4 ms.	[Trig/Acq], {Settings}, {1 of 2}, {Holdoff 4 ms}
4. Expand the window. Change the scale. Move the marker to measure 5 ms waveform duration (see Figure 18).	[ ], {Trace Control}, {X Start 1.5 ms, X Scale 600 μs and Y Scale 10 dB}, {Gate Control}. Press [ ] to allocate marker 2 and [ ] to allocate marker 1.

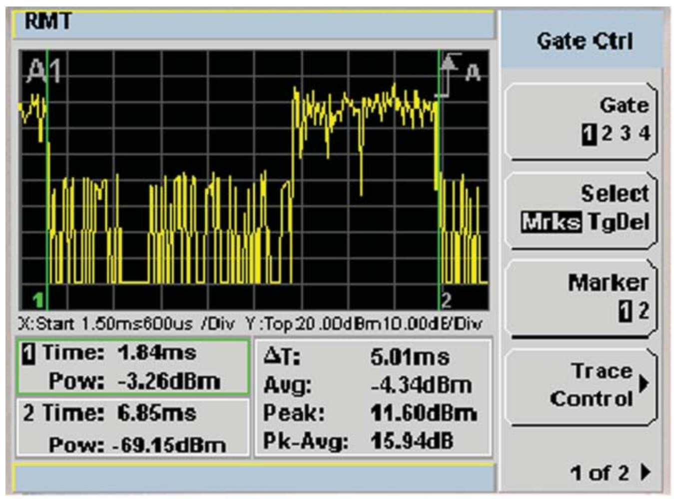


Figure 18. WiMAX waveform duration at 5 ms for UL in TDD mode

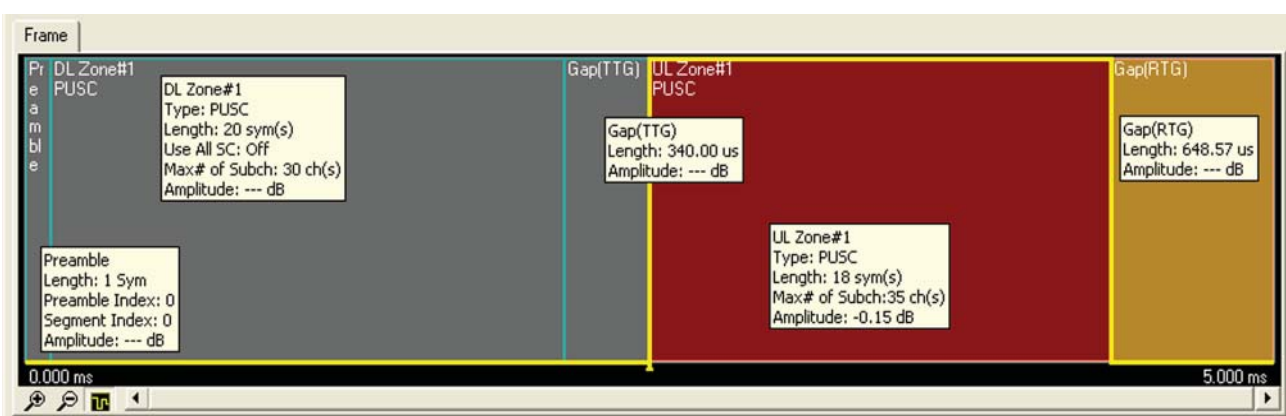


Figure 19. Frame duration (5 ms) of UL waveform captured with Signal Studio

Measuring UL average power

Instructions	Keystrokes
On the P-Series power meter:	
Measure UL at 1.83 ms duration (see Figure 20).	Press [ ] to allocate marker 2 and [ ] to allocate marker 1.

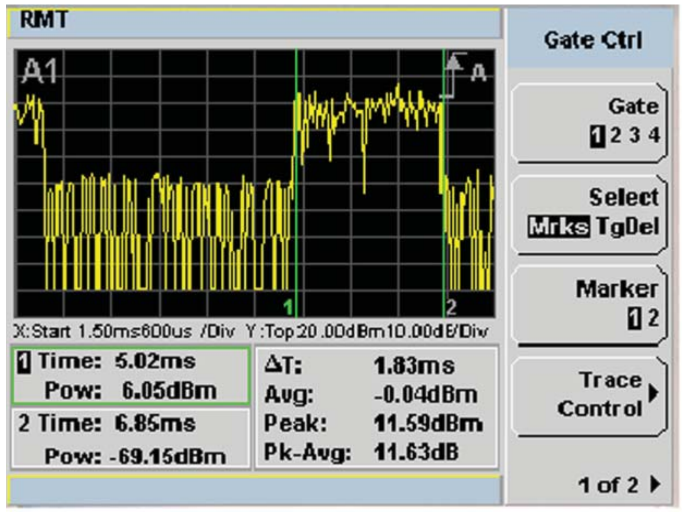


Figure 20. UL average power measures –0.04 dBm at 1.83 ms duration

Measuring RTG, Preamble, DL and TTG PvT

Instructions	Keystrokes
On the P-Series power meter:	
Measure RTG, Preamble, DL and TTG at 3.16 ms duration (see Figure 21).	Press [ ] to allocate marker 2 and [ ] to allocate marker 1.

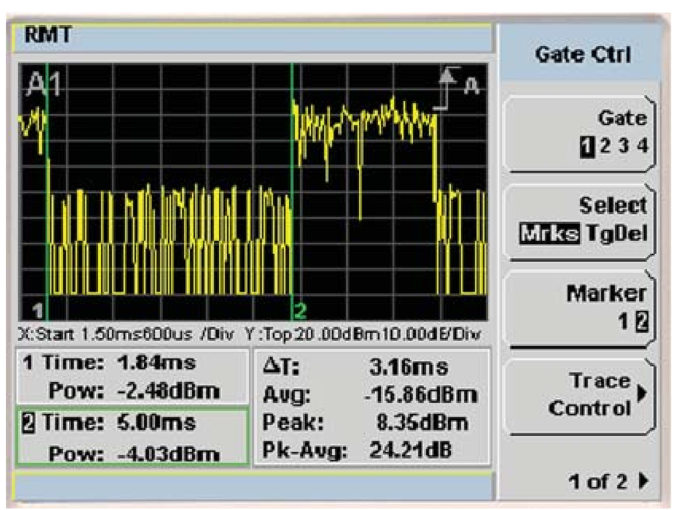


Figure 21. RTG, Preamble, DL and TTG at 3.16 ms duration

DL and UL profile in TDD mode

Profile setting

Instructions	Software operations
On the Signal Studio software:	
1. Configure waveform setup.	Click **Waveform Setup** to see the setup of the fundamental waveform signal. Under **Waveform Properties**, you can set WiMAX common parameters as follows: • Built frames = 1 • Frame duration = 5 ms • Output mode = **Both DL and UL (TDD)** • Downlink Ratio (%) = 50.0000 • Downlink duration (ms) = 5.0000 • Uplink duration (ms) = 0.0000 • Guard period = 1/8 • Symbol rolloff = 5.0 %
2. Configure the number of signals in Uplink to make the RTG a longer period	Click **Uplink** and set the following parameters: • Number of symbols = **15** • Symbol offset = 0 • Max number of subchs = 35
3. Download signal to ESG.	On the menu bar, go to **Control > Generate and Download**.

DL and UL profile in TDD mode (cont.)

PvT Measurement

The Signal Studio under Downlink step shows the frame duration of 5 ms (see Figure 23). Moving the cursor around the frame zone shows the time duration and power level of the Preamble, DL, TTG, UL and RTG as shown below:

- Preamble = 0.104 ms / 1 sym
- DL = 2.06 ms / 20 sym(s)
- TTG = 0.34 ms
- UL = 1.53 ms / 15 sym(s)
- RTG = 0.957 ms

Preamble region shows 0 dB. In DL zone there are three different power levels:

i) –3.98 dB when the FCH and Burst 1 is one (right after the Preamble)

ii) –4.46 dB when only Burst 1 is ON

ii) –10.27 dB from the end of Burst 1 to the end of the zone. (Same as DL waveform setup)

The UL zone shows two different power levels:

i) –4.45 dB when only Burst 1 is ON

ii) –4.58 dB from the end of Burst 1 to the end of the UL zone.

Measuring DL and UL PvT

Instructions	Keystrokes
On the P-Series power meter:	
1. Select WiMAX preset.	[Preset], press [ ] or [ ] key to choose {WiMAX}. [Select], {Confirm}.
2. Set trace display.	[Disp], {Disp Type}, {Trace}.
3. Set trigger holdoff at 4 ms.	[Trig/Acq], {Settings}, {1 of 2}, {Holdoff 4 ms}.
4. Expand the window. Change the scale. Move the marker to measure 5 ms waveform duration. Once the complete waveform on the screen is within 5 ms for markers 1 and 2, stop the triggering (see Figure 22).	[ ], {Trace Control}, {X Start –400 µs, X Scale 600 µs and Y Scale 310 dB}, {Gate Control}. Press [ ] to allocate marker 2 and [ ] to allocate marker 1 within 5 ms time duration. [Run/Stop]

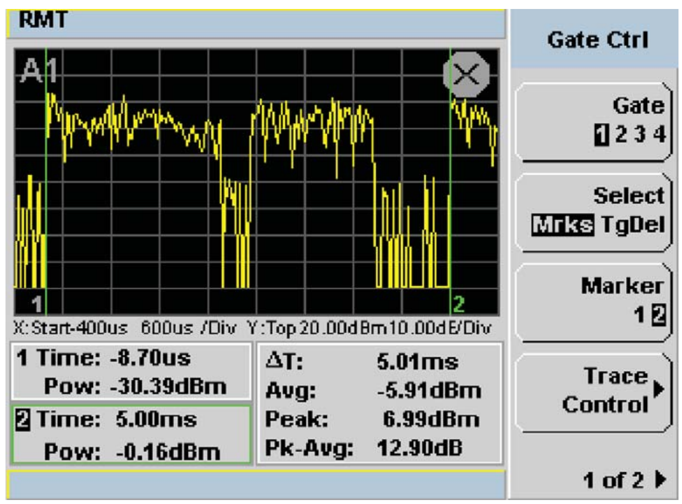


Figure 22. WiMAX waveform duration at 5ms for both DL and UL in TDD mode

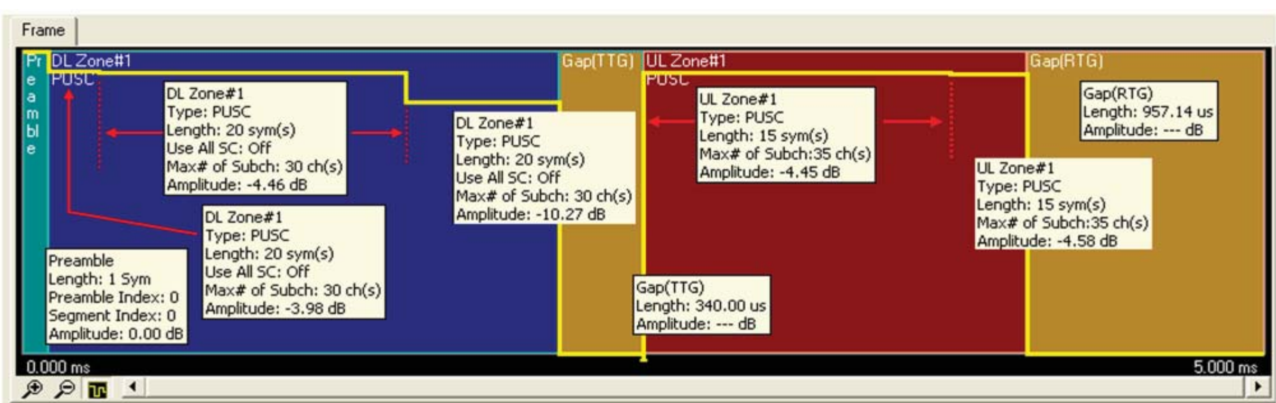


Figure 23. Frame duration (5 ms) of DL and UL waveforms captured with Signal Studio

Measuring Preamble PvT

Instructions	Keystrokes
On the P-Series power meter:	
Measure the Preamble at 104 µs duration (See Figure 24).	Press [] to allocate marker 2 and [] to allocate marker 1.

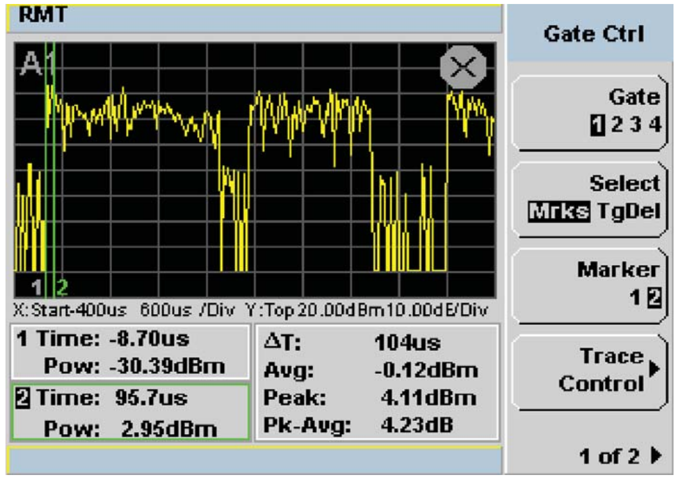


Figure 24. Preamble average power measures –0.12 dBm at 104 µs duration

Measuring DL PvT

Instructions	Keystrokes
On the P-Series power meter:	
Measure the DL duration with only Burst 1 ON (See Figure 25).	Press [] to allocate marker 2 and [] to allocate marker 1.

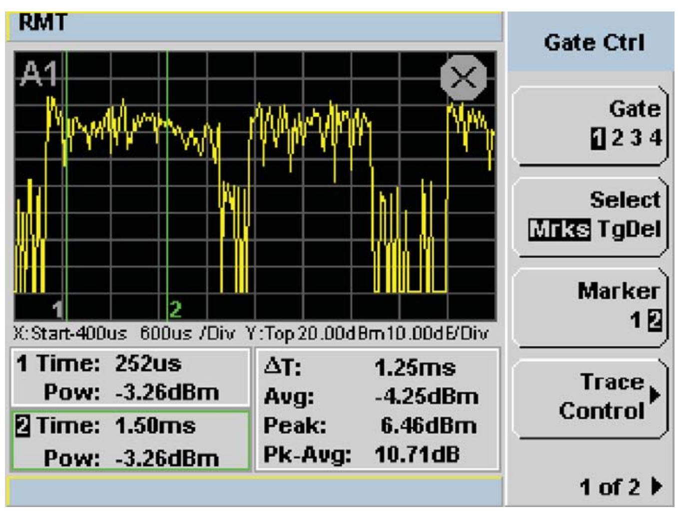


Figure 25. DL average power measures –4.25 dBm at 1.25 ms duration where only Burst 1 is ON

Measuring UL PvT

Instructions	Keystrokes
On the P-Series power meter:	
Measure UL duration with only Burst 1 ON (See Figure 26).	Press [ ] to allocate marker 2 and [ ] to allocate marker 1.

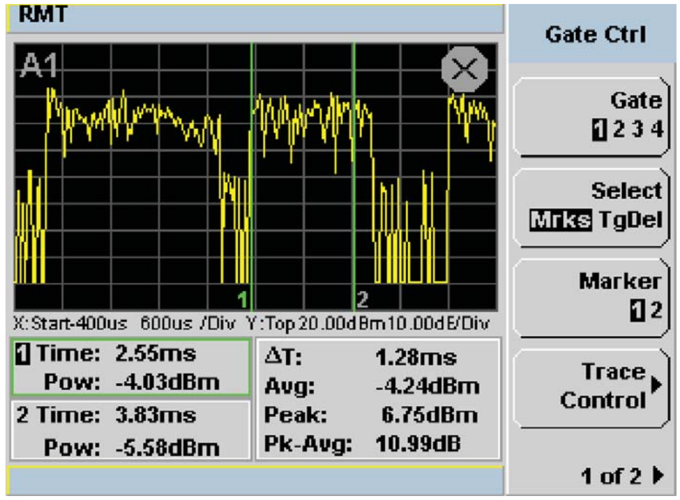


Figure 26. UL average power measures –4.24 dBm at 1.28 ms duration where only Burst 1 is ON

Measuring TTG PvT

Instructions	Keystrokes
On the P-Series power meter:	
Measure the TTG at 339 µs duration (See Figure 27).	Press [ ] to allocate marker 2 and [ ] to allocate marker 1.

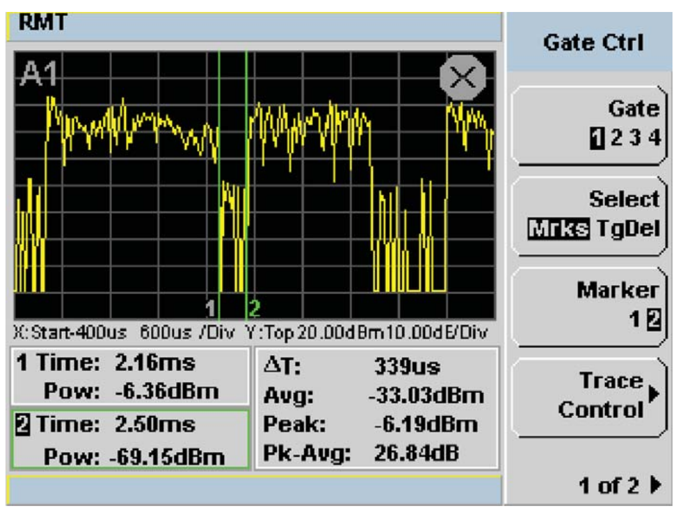


Figure 27. TTG at 339 µs duration

Measuring RTG PvT

Instructions	Keystrokes
On the P-Series power meter:	
Measure the RTG at 965 μs duration (see Figure 28).	Press [] to allocate marker 2 and [] to allocate marker 1.

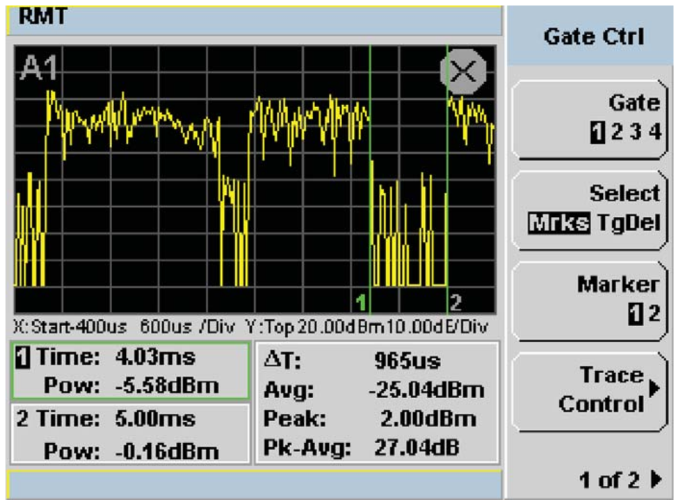


Figure 28. RTG at 965 μs duration

Ordering Information

Product type	Model number
P-Series Power Meters	N1911A or N1912A
P-Series Wideband Power Sensors	N1921A or N1922A

For further information, refer to:
P-Series Power Meters and Power Sensors Configuration Guide, 5989-1252EN

Product Web Site

For the most up-to-date and complete application and product information, visit our product web site at:

www.agilent.com/find/wideband_powermeters

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www.agilent.com/find/wimax

References

[1] Institute of Electrical and Electronics Engineer, Inc, IEEE Std 802.16-2004; IEEE Standard for Local and metropolitan area network; part 16; Air Interface for Fixed Broadband Wireless Access Systems, Section 8.3 Wireless MAN-OFDM PHY, Oct. 1, 2004

[2] Agilent Technologies, WiMAX Concepts and RF Measurement, IEEE 802.16-2004 WiMAX PHY layer operation and measurement, Application Note, Literature Number 5989-2027EN, Jan. 5, 2005

[3] Agilent Technologies, WiMAX Frequency and Time Parameter Table, Application Note, Literature Number 5989-2274EN, Jan. 20, 2005

Related Literatures

[1] P-Series Power Meters and Power Sensors Configuration Guide, Literature Number 5989-1252EN

[2] P-Series Power Meters and Sensors, Technical Overview, Literature Number 5989-1049EN

[3] N1911A/N1912A P-Series Power Meters and N1921A/N1922A Power Sensors Data Sheet, Literature Number 5989-2471

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(fax) 0800 286 331

Other Asia Pacific Countries:
(tel) (65) 6375 8100
(fax) (65) 6755 0042
Email: tm_ap@agilent.com
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