

# Agilent EEsof EDA

W1911 WiMAX Baseband Verification Library

W1913 WiMAX Baseband Exploration Library

*Baseband PHY Libraries for SystemVue*

Datasheet

## Turbocharge Your WiMAX™ PHY Design Process

*“How do you really know that your adaptation of WiMAX is still interoperable with the standard?”*

The W1911EP/ET and W1913ET WiMAX baseband PHY libraries save time, reduce engineering effort and accelerate the maturity of baseband physical layer (PHY) designs for next-generation WiMAX systems. They enable system architects, algorithm developers and baseband hardware designers to investigate, implement and verify their Layer 1 WiMAX signal processing designs in the presence of meaningful RF and test. The libraries give the user piece of mind that a PHY meets or exceeds real-world performance requirements from the Institute of Electrical and Electronic Engineers (IEEE) standards for 802.16e (Mobile WiMAX™).

**The W1911EP/ET WiMAX baseband verification library** provides measurement-hardened “golden reference” models that accelerate the PHY design and verification process. The library puts reliable Agilent measurement know-how at the front of the design process, where it improves the actual design, instead of only characterizing nonconformity after the fact. It can be used as a

parameterized reference design to create internal test vectors at the block level, or to fill in gaps to complete a fully-coded working PHY, so that system-level performance can be continuously monitored.

**The W1913ET WiMAX baseband exploration library** unlocks access to algorithmic source code for the W1911 library. It allows users to explore the 802.16e standard interactively, probe inside algorithms with a debugger and modify the intellectual property (IP) in order to precisely test any level of abstraction. With source code, users gain a dramatic head start toward working user equipment, base station or proprietary PHY adaptation, saving up to an engineering-year worth of effort in terms of modeling, regression scripting and throwaway reference IP. Agilent provides a high-quality, independent reference that works with RF and offers a seamless transition into test.

Both the W1911 and W1913 support IEEE 802.16e-2005 (SystemVue 2009.05).



**Agilent Technologies**

# W1911EP/ET WiMAX Baseband Verification Library

*Why should I buy the W1911 golden reference verification library?*

**1. Reliable start.** Start with proven simulation models as independent, measurement-hardened “golden reference” standards. Learn the standard quickly and have complete control of PHY performance through model parameterization.

**2. Unique RF-aware IP development environment.** Produce high-performance baseband PHYs that are ready for the real world. SystemVue puts superior access to RF simulation and test equipment at the point of creation, along with all the native polymorphism, debuggers and vendor-neutral hardware design you have come to expect from traditional signal-processing tools.

**3. Early and continuous verification.** Use Agilent modeling expertise and measurement connectivity to complete a virtual working PHY on the very first day. Easily verify the latest frequency division duplex (FDD) and time division duplex (TDD) innovations—either at the block-level or the link-level—and, using any mixture of implementations:

- Algorithmic IP (block level, .m-file, C++)
- Fixed-point and VHDL hardware instantiations
- Working hardware with baseband/RF test equipment

**4. Synergy with measurements.** Beyond design, SystemVue is able to create sophisticated hybrid simulations/measurements that overcome difficulties with incomplete early support of emerging standards by commercial test equipment (e.g., BER/BLER waterfall curves), and physical availability of systems, probes and interfaces (e.g., DigRF).

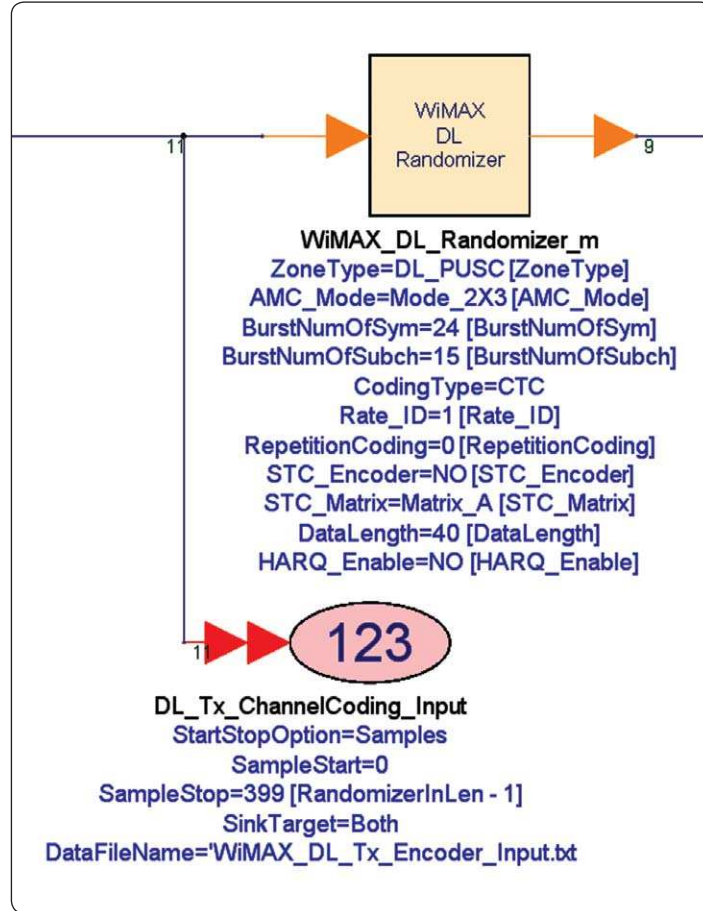


Figure 1. The W1911 library provides working reference PHYs as highly parameterized, user-configurable algorithmic references. In this screen capture, test vectors are captured to ASCII files along the signal-processing chain for later comparison.

*The W1911EP/ET verification library includes:*

- Over 75 specification-compliant, low level WiMAX PHY building blocks
- High-level source and receiver models for both uplink and downlink
- Example test benches for PHY evaluation of coded BER and transmit CCDF
- Full documentation on models and examples
- Ability to reuse encrypted waveform files (.wfm) exported from the N7613A *Signal Studio for WiMAX 2004* and N7615B *Signal Studio for 802.16 WiMAX* software as simulation sources

*W1911EP/ET requirements*

- The W1911EP/ET requires only the W1461BP/BT SystemVue 2009 environment. Any SystemVue 2009 configuration is therefore suitable.
- SystemVue 2009 runs on both 32- and 64-bit versions of Windows XP®/Vista. Network-licensed configurations are especially affordable.
- W1911EP is available as a perpetual software license with an annual support, or as a cost-effective time-based license with 0% residual (W1911ET).

# W1913ET WiMAX Baseband Exploration Library

Compared to the W1911, what does the W1913 add that will improve my design process?

- **Algorithmic confidence.** Proven, modifiable source code gives you an independent, self-documenting algorithmic reference library that enables you to quickly understand and interpret key IEEE 802.16e algorithmic relationships.
- **Precise control.** Control and script every detail, create exact test vectors and even single-step your way through operations with an integrated debugger.
- **Speed to insight.** Troubleshoot more quickly and concentrate more on your baseband design than on evaluating/configuring reference IP.

What will I receive with a W1913ET 'source code' product?

The W1913 is a superset of the W1911 library, but is a time-limited product. It provides the compiled blocks of the W1911 and adds an additional source code model to each block. The polymorphism of SystemVue allows you to choose either a simulation model for each individual block, your own custom modification, or a C++ model.

Both the W1911 and W1913 support both IEEE 802.16-2004 and IEEE 802.16-2005 (SystemVue 2009.05).

The W1913ET WiMAX baseband exploration library includes:

- 12-month license of the W1911ET WiMAX baseband verification library
- Modifiable source-code overlay to each compiled block (math language .m-file format)
- Source-code license, updates and technical support for 12 months
- Ability to generate precisely-configured WiMAX test vectors, and easily create scripted verification regression suites
- Standards-compliant verification testbenches

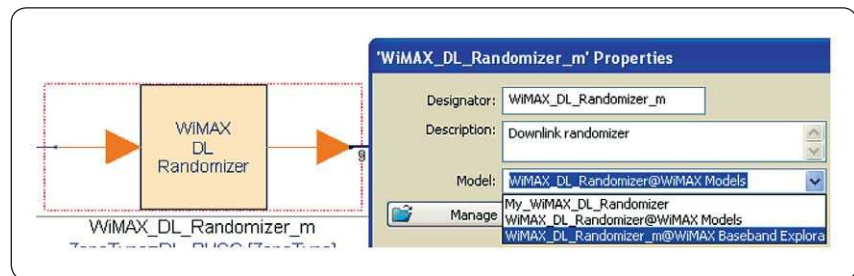


Figure 2. The W1913ET library uses SystemVue's polymorphism to provide a source-code model to each of the W1911EP/ET blocks.

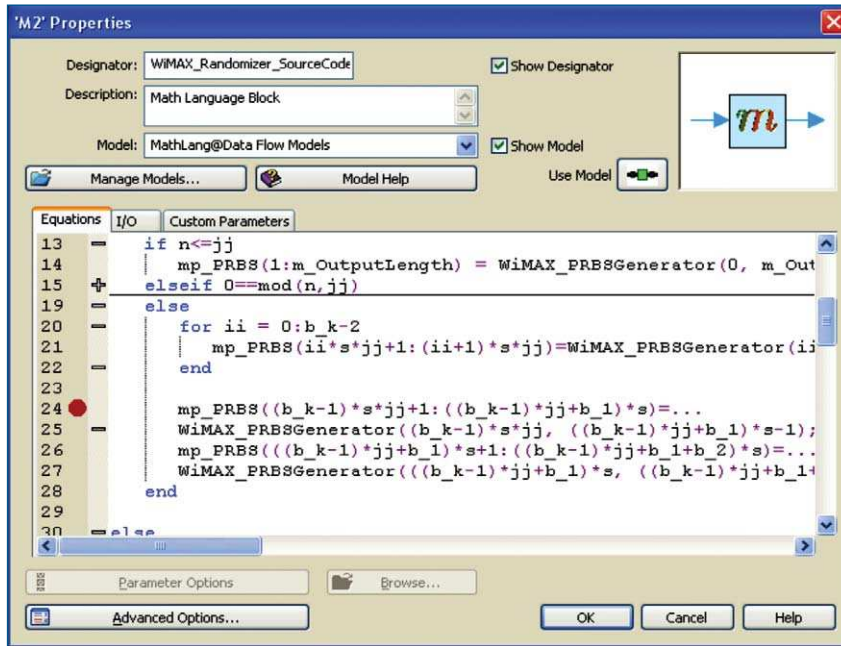


Figure 3. The W1913ET library provides source code in the popular math language .m format, which can be executed and debugged natively within SystemVue. The entire SystemVue environment can be scripted, not just the models.

*“How do you currently debug algorithms without a working reference PHY, with believable RF and real world measurements?”*

### How do I evaluate the W1913ET library?

A source-code sample is provided for your inspection, along with related documentation, in the Examples\ Baseband Exploration directory of the standard installation of SystemVue 2009.05. The product web page,

<http://www.agilent.com/find/eesof-systemvue-wimax-baseband-exploration-library>

provides additional links to applications, whitepapers, videos, webinars, and success stories.

Request an evaluation of SystemVue:

<http://www.agilent.com/find/eesof-systemvue-evaluation>

### W1913ET requirements

- The W1913ET requires only the W1461BP/BT SystemVue 2009 environment, which includes all necessary languages, debuggers and blocksets. Any SystemVue 2009 configuration is therefore suitable.
- The underlying compiled verification library (W1911ET) is provided with the W1913ET for the duration of access to the source code.
- SystemVue runs on both 32- and 64-bit versions of Windows XP®/Vista.
- The W1913ET is an IP product. Additional license terms apply.

## Technical Specifications (W1911 and W1913)

The IEEE 802.16e-2005 standard, often referred to as Mobile WiMAX, specifies air interfaces for broadband wireless access (BWA) systems. The W1911/13 WiMAX baseband PHY libraries enable the user to easily create waveforms that comply with the WirelessMAN-OFDMA PHY in the IEEE 802.16e-2005 standard. The libraries also provide transmitter measurements (e.g., spectrum, CCDF, etc...) and receiver measurements (e.g., BER).

### *Standards support*

Both the W1911/13 WiMAX baseband PHY libraries support the following 802.16e standards (SystemVue 2009.05).

- IEEE 802.16-2004 standard, part 16: "Air Interface for Fixed Broadband Wireless Access Systems," section 8.4 WirelessMAN-OFDMA PHY, October 1, 2004
- IEEE 802.16e-2005 standard, amendment 2 for "Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands and Corrigendum 1," part 16: "Air Interface for Fixed Broadband Wireless Access Systems," section 8.4 WirelessMAN-OFDMA PHY, February 2006
- P802.16 Rev2/D4, April 2008
- WiMAX Forum® Mobile Radio Conformance Tests (MRCT) (Revision 2.0.0), December 2007

### **Baseband sources (downlink and uplink)**

- Configure TDD/FDD frames for downlink and uplink, and downlink FDD frame with two DL subframes
- Flexible configuration of zones, bursts and MAC PDUs
- 512, 1024 or 2048 FFT sizes
- FCH, DL-MAP, UL-MAP, DCD, UCD, and compressed DL/UL MAP automatically generated in downlink
- PUSC, FUSC, OFUSC, and AMC permutation zone for downlink and PUSC, OPUSC and AMC permutation zone for uplink
- Standards-based, raw or fully-coded data
- Channel coding: CC (convolutional coding) and CTC (convolutional turbo coding)
- HARQ bursts are supported for both downlink and uplink
- Flexible configuration of ranging, fast-feedback and HARQ-ACK channels in uplink source

### **Baseband receivers (downlink and uplink)**

- 512, 1024 or 2048 FFT sizes with variable bandwidths
- CC decoding with soft decision (with channel state information (CSI))
- CTC decoding with soft decision (with channel state information (CSI))
- 3 transport block allocations (MCS index, transport block size and target code rate).

## WiMAX baseband block set

The W1911EP/ET verification library provides over 75 highly-parameterized primitive blocks that are combined for convenience into 10 to 20 additional higher-level reference designs to achieve fully-coded uplink and downlink configurations. Use them as algorithmic references to compare test vectors at any point in the signal processing chain or to complete a working PHY. The W1913ET library provides a source-code overlay for the most critical primitives and is regression-tested for identical performance.

Channel coding/decoding	Modulation/demodulation	Multiplex
<ul style="list-style-type: none"> <li>• CRC Coder*</li> <li>• DL CC*</li> <li>• DL CC Decoder</li> <li>• DL CTC*</li> <li>• DL CTC Decoder</li> <li>• DL Deinterleaver*</li> <li>• DL Derandomizer*</li> <li>• DL Derepetition*</li> <li>• DL FEC*</li> <li>• DL FECDecoder*</li> <li>• DL Interleaver*</li> <li>• DL Randomizer*</li> <li>• DL Repetition*</li> <li>• DL SubcarrRandomizer</li> <li>• Puncturer</li> <li>• UL CC*</li> <li>• UL CC Decoder*</li> <li>• UL CTC *</li> <li>• UL CTC Decoder</li> <li>• UL Deinterleaver*</li> <li>• UL Derandomizer*</li> <li>• UL Derepetition*</li> <li>• UL FEC</li> <li>• UL FECDecoder</li> <li>• UL Interleaver*</li> <li>• UL Randomizer*</li> <li>• UL Repetition*</li> <li>• UL SubcarrRandomizer*</li> <li>• ViterbiDecoder</li> </ul>	<ul style="list-style-type: none"> <li>• UL FreqSync</li> </ul> <p><b>MIMO source</b></p> <ul style="list-style-type: none"> <li>• MidambleGen</li> </ul> <p><b>Signal Source</b></p> <ul style="list-style-type: none"> <li>• DCD</li> <li>• DL MAP</li> <li>• DL PowerAdjust</li> <li>• DL ZonePerm*</li> <li>• DLFP</li> <li>• MACHeader*</li> <li>• Preamble*</li> <li>• SymWindow</li> <li>• UCD</li> <li>• UL ACK</li> <li>• UL FFB</li> <li>• UL MAP</li> <li>• UL PowerAdjust</li> <li>• UL Ranging</li> <li>• UL ZonePerm*</li> <li>• UL ZonePerm Rect</li> <li>• ULMAP Full</li> </ul> <p><b>Source</b></p> <ul style="list-style-type: none"> <li>• DL Source</li> <li>• UL Source</li> </ul> <p><b>Signaling</b></p> <ul style="list-style-type: none"> <li>• MACPDU</li> </ul>	<ul style="list-style-type: none"> <li>• Commutator</li> <li>• Distributor</li> <li>• DL BurstWoFEC</li> <li>• DL DemuxBurst*</li> <li>• DL DemuxFrame*</li> <li>• DL DemuxOFDMSym*</li> <li>• DL MuxBurst**</li> <li>• DL MuxOFDMSym*</li> <li>• UL BurstWoFEC</li> <li>• UL BurstWoFEC</li> <li>• UL BurstWoFEC</li> <li>• UL DemuxFrame</li> <li>• UL DemuxOFDMSym*</li> <li>• UL MuxBurst</li> <li>• UL MuxOFDMSym*</li> </ul> <p><b>Receiver</b></p> <ul style="list-style-type: none"> <li>• DL ChEstimator</li> <li>• DL Demapper*</li> <li>• DL FrameSync</li> <li>• DL FreqSync</li> <li>• DL Receiver</li> <li>• UL ChEstimator</li> <li>• UL Demapper*</li> <li>• UL FrameSync</li> <li>• UL FreqSyncFraction</li> <li>• UL FreqSyncInteger</li> <li>• UL Receiver</li> </ul> <p><b>Testing</b></p> <ul style="list-style-type: none"> <li>• DataPattern</li> </ul>

\* W1913ET provides source code for this primitive

# Testbench Samples

## Testbench 1: downlink channel-coding test vector for Mobile WiMAX SISO system

### WiMax\_Downlink\_ChannelCoding\_m.vsw

This workspace allows generation of critical channel coding test vectors for WiMax Downlink source generation. Test points can be added between required coding algorithm blocks to create “golden reference” vectors for use in other programs for algorithm verification or with actual HW to validate design and prototype.

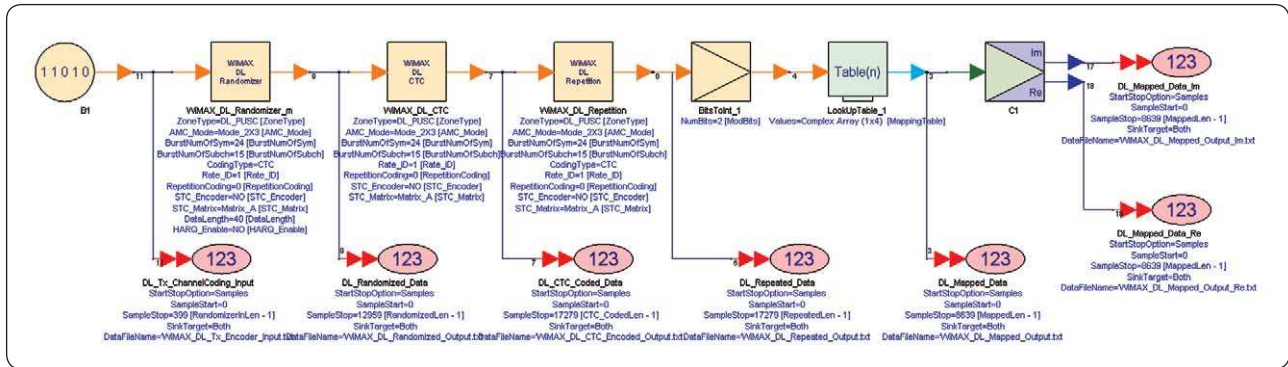


Figure 4. Testbench to create test vectors to test individual baseband blocks in a WiMAX downlink

*“Even if you design in another environment, SystemVue accelerates Algorithm and Hardware verification, and covers both Block-level and Link-level with fading and RF”*

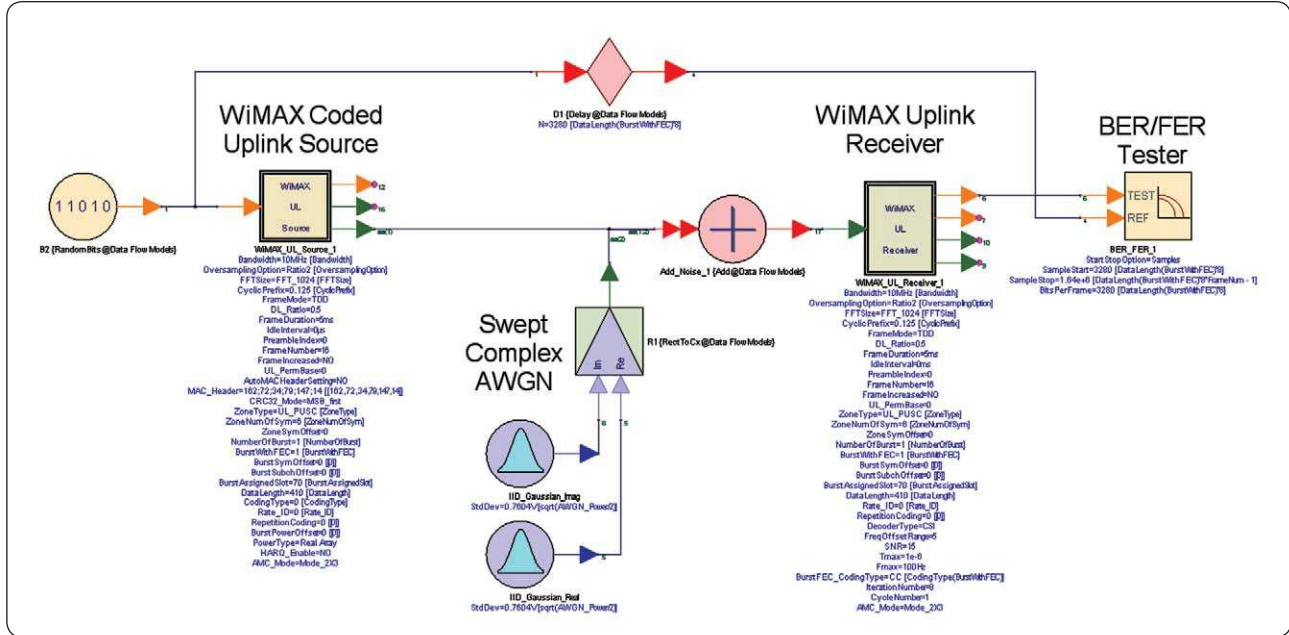


Figure 5. Simulation to calculate Bit or Block Error Ratio (BER/BLER) versus swept EbNo for a WiMAX uplink.

**Testbench 2: uplink channel-coding  
BER Testing Mobile WiMAX  
SISO system**

This workspace provides the swept BER and BLER vs. SNR measurements, with fully-coded transmit/receive chain and added noise for a downlink link-level test. The scripting to generate the EbNo curves is already configured and can be modified. Test vectors can be captured at any location along the signal processing chain or sent to/from actual test equipment. Additional channel and RF effects may also be added (not shown).

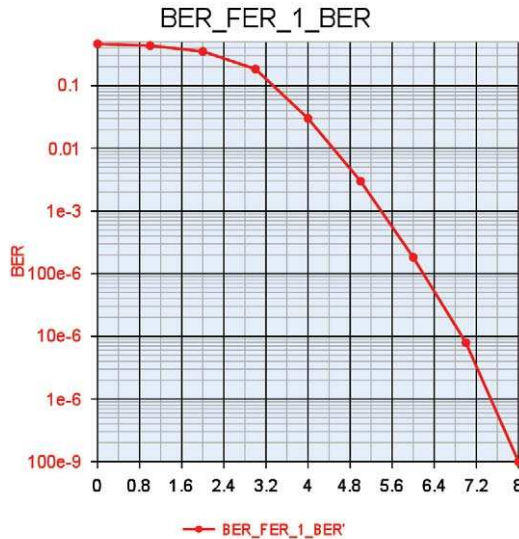


Figure 6. Display of the BER in the AWGN channel, with QPSK 1/2 averaged over 500 frames.

### Testbench 3: WiMAX Downlink Source Creation and channel-coding

This workspace provides full downlink channel coding, channel multiplexing, modulation, and filtering to produce an IEEE compliant baseband and/or RF signal. The workspace can be used for downlink PHY verification both for baseband algorithm design and RF block design.

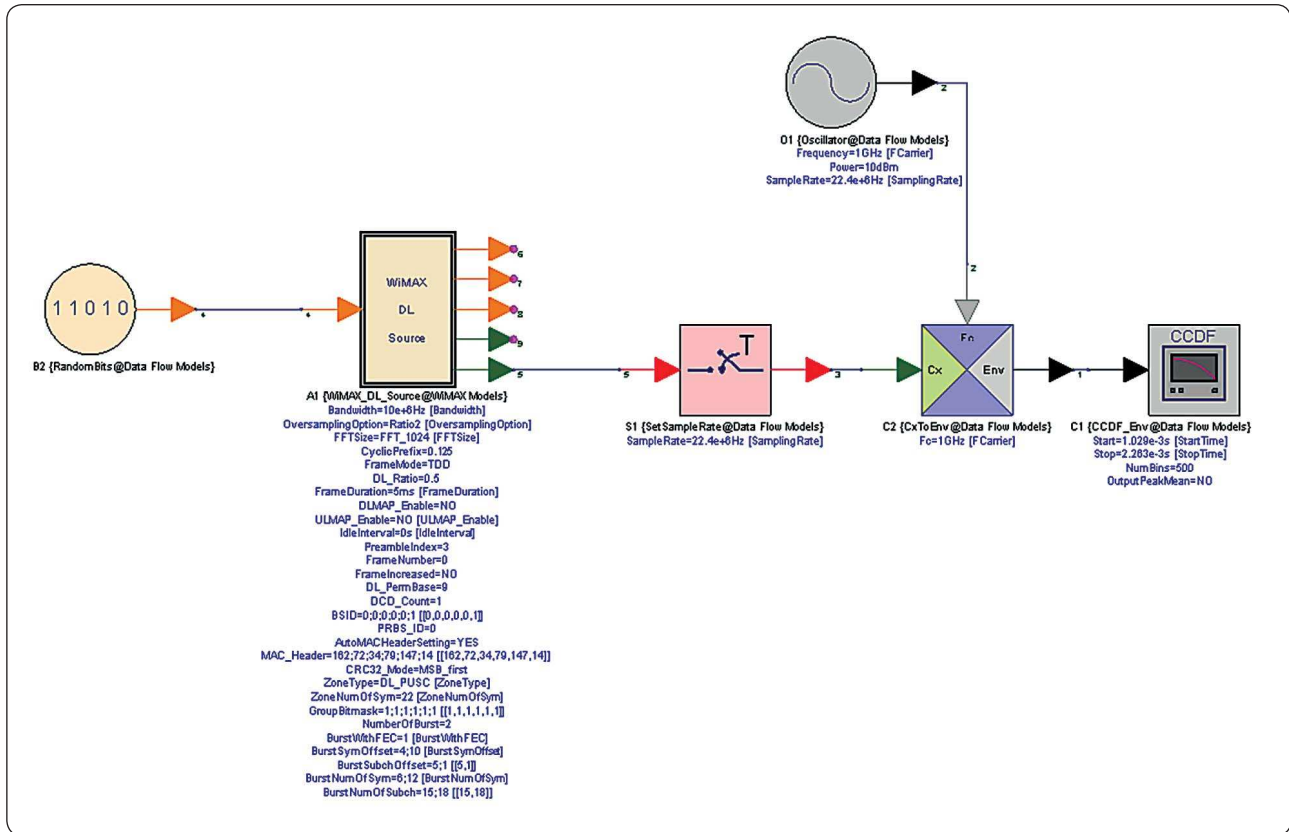


Figure 7. WiMAX downlink source generation for CCDF and Spectrum.

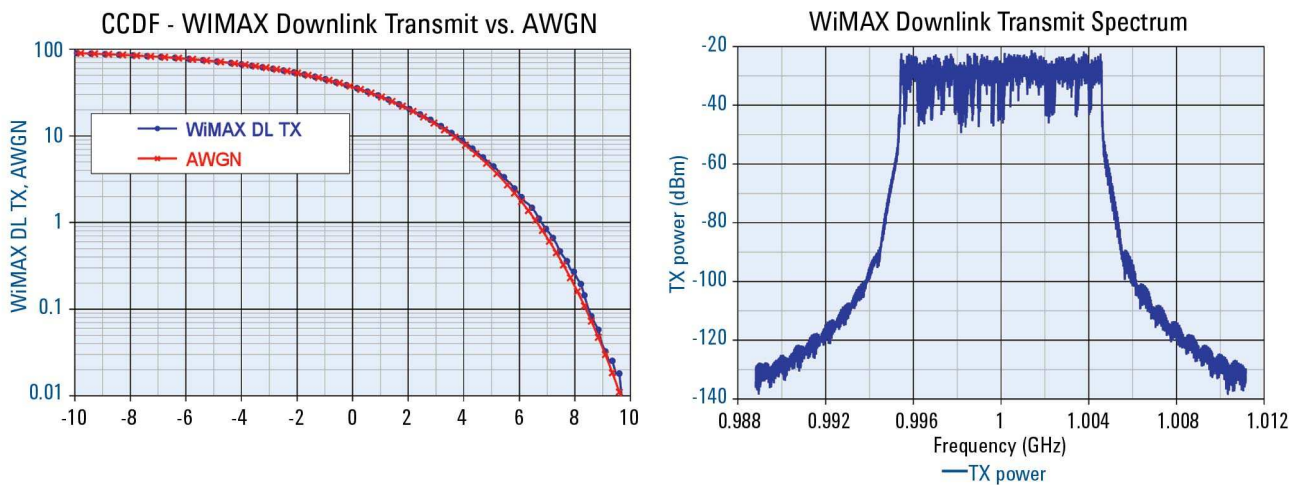


Figure 8. WiMAX downlink transmit vs. AWGN and WiMAX downlink transmit spectrum measurements.

# Channel coding/decoding measurements

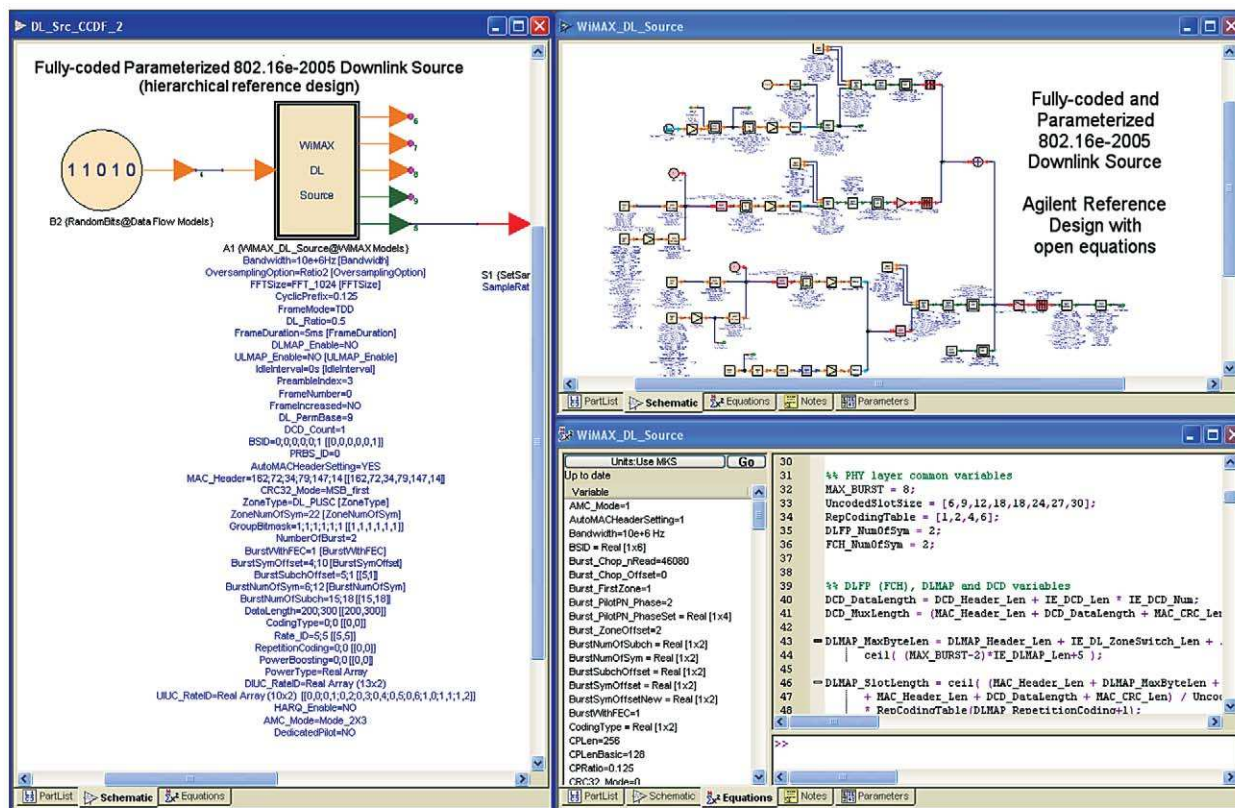


Figure 9. Channel coding/decoding measurements with the WiMAX baseband verification libraries.

The following channel coding/decoding measurements are performed for Mobile WiMAX SISO systems:

- Swept BER and PER measurement on AWGN for both downlink and uplink
- Channel-coding test vectors with intermediate stages for both downlink and uplink
- Channel-decoding test vectors with intermediate stages for both downlink and uplink

*“Save time and reduce engineering costs by re-using the same Agilent toolset, from Exploration to Hardware implementation to live Test.”*

[www.agilent.com](http://www.agilent.com)

[www.agilent.com/find/eesof-systemvue](http://www.agilent.com/find/eesof-systemvue)

For more information on Agilent Technologies' products, applications or services, please contact your local Agilent office. The complete list is available at:

[www.agilent.com/find/contactus](http://www.agilent.com/find/contactus)

#### Americas

Canada	(877) 894-4414
Latin America	305 269 7500
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
Thailand	1 800 226 008

#### Europe & Middle East

Austria	01 36027 71571
Belgium	32 (0) 2 404 93 40
Denmark	45 70 13 15 15
Finland	358 (0) 10 855 2100
France	0825 010 700*
	*0.125 €/minute
Germany	07031 464 6333
Ireland	1890 924 204
Israel	972-3-9288-504/544
Italy	39 02 92 60 8484
Netherlands	31 (0) 20 547 2111
Spain	34 (91) 631 3300
Sweden	0200-88 22 55
Switzerland	0800 80 53 53
United Kingdom	44 (0) 118 9276201

Other European Countries:

[www.agilent.com/find/contactus](http://www.agilent.com/find/contactus)

Revised: October 1, 2008

"WiMAX," "Mobile WiMAX" and "WiMAX Forum" are trademarks of the WiMAX Forum.

Windows is U.S. registered trademarks of Microsoft Corporation.

Product specifications and descriptions in this document subject to change without notice.

© Agilent Technologies, Inc. 2009

Printed in USA, August 6, 2009

5990-4422EN



**Agilent Technologies**