Agilent EEsof EDA

- **W1910 LTE Baseband Verification Library**
- **W1912 LTE Baseband Exploration Library**

Baseband PHY Libraries for SystemVue

Datasheet

Turbocharge Your 3GPP LTE PHY Design Process

*How do you really **know** that your algorithm is interoperable with the latest version of 3GPP LTE? How do you track an **evolving** standard?*

The W1910EP/ET and W1912ET LTE baseband PHY libraries save time, reduce engineering effort and accelerate the maturity of baseband PHY designs for next-generation 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE) systems. They enable system architects, algorithm developers and baseband hardware designers to investigate, implement and verify their Layer 1 3GPP LTE signal processing designs in the presence of meaningful RF and test. The libraries give the user piece of mind that a physical layer (PHY) meets or exceeds real-world performance requirements from the European Telecommunications Standards Institute (ETSI).

The W1910EP/ET LTE Baseband Verification Library provides measurement-hardened "golden reference" models that accelerate the 3GPP LTE 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 W1912ET LTE baseband exploration library unlocks access to algorithmic source code for the W1910 library. It allows users to explore the 3GPP LTE 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 a working LTE UE, eNodeB 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 W1910 and W1912 support LTE version 8.5 (SystemVue 2009.05).
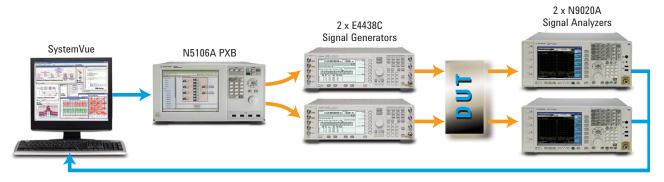
Agilent Technologies

Figure 1. The W1910 library can interact with the Agilent VSA software, PXB baseband source and other test equipment to perform difficult measurements (e.g., fully-coded BER curves for TD-LTE, with MIMO and channel/fading models enabled), offering a huge advantage for baseband designers.

W1910EP/ET LTE Baseband Verification Library

Why should I buy the W1910 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), time division duplex (TDD) and MIMO 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 simulation/measurements that overcome difficulties with incomplete early support of emerging standards by commercial test equipment (e.g., coded MIMO BER/BLER waterfall curves), and physical availability of systems, probes and interfaces (e.g., DigRF).

The W1910EP/ET verification library includes:

- Over 60 specification-compliant, low level LTE PHY building blocks
- ETSI specified channel-model profiles, including MIMO
- High level source and receiver models for both uplink and downlink
- Model support for both TDD and FDD modes, and control channels
- Example test benches for PHY evaluation of coded BER, throughput, transmit EVM, CCDF, and 2x2 MIMO
- Full documentation on models and examples
- Ability to reuse encrypted waveform files (.wfm) exported from the N7624B *Signal Studio for 3GPP LTE* software as simulation sources
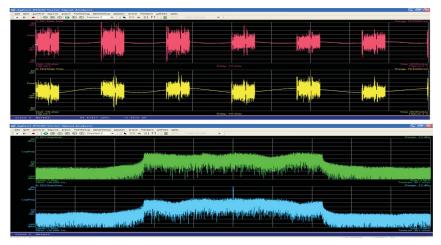

Figure 2. The W1910 was used to produce these frames of fully-coded TD-LTE, with MIMO and channel/fading models enabled.

W1910EP/ET requirements

- The W1910EP/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.

- W1910EP is available as a perpetual software license with an annual support or as a cost-effective time-based license with 0% residual.
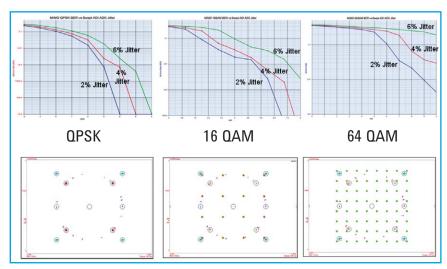

Figure 3. The W1910 library allows link-level studies, such as this MIMO BER waterfall study vs. ADC clock jitter, for three PHY modes.

Even if you design in another environment, Agilent SystemVue can still offer virtual LTE verification of work in progress, at the block level, or at the link level with RF & Fading effects, and live measurements.
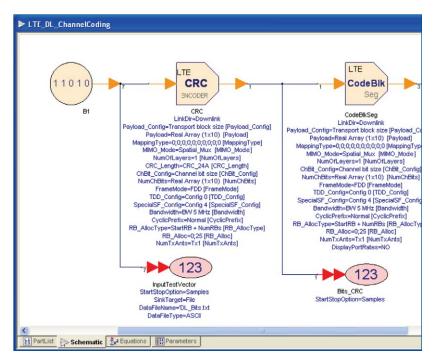

Figure 4. The W1910 library provides working reference PHYs as highly parameterized, user-configurable algorithmic references. In this screen capture, test vectors are captured to ASCII files along the signal-processing chain for later comparison.

Did you know? An Agilent hardware division saved 3 months with this product. Learn more. **http://cp.literature.agilent.com/litweb/pdf/5990-3671EN.pdf**
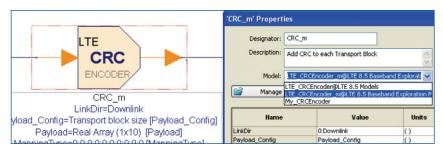
Figure 5. The W1912ET library uses SystemVue's polymorphism to provide a source-code model to each of the W1910EP/ET blocks.

W1912ET LTE Baseband Exploration Library

Compared to the W1910, what does the W1912 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 ETSI-specified 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 the W1912ET 'source code' product?

The W1912 is a superset of the W1910 library, but is a time-limited product. It provides the compiled blocks of the W1910 and adds a second-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 W1910 and W1912 support LTE version 8.5 (SystemVue 2009.05).

The W1912ET LTE baseband exploration library includes:

- 12-month license of the W1910ET LTE 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 LTE test vectors and easily create scripted verification regression suites

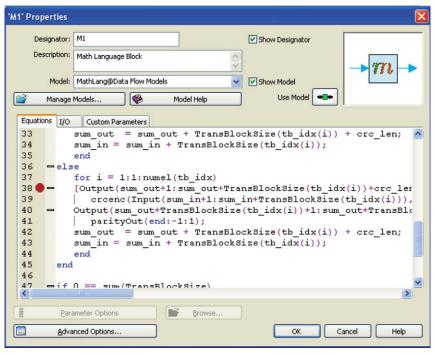- Standards-compliant verification testbenches

4

Figure 6. The W1912ET 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 I evaluate the W1912ET 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-lte-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)**

W1912ET requirements

- The W1912ET 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 library (W1910EP/ET) is included and is not required.

- SystemVue runs on both 32- and 64-bit versions of Windows XP®/Vista.

- The W1912ET is an IP product. Additional license terms apply.

Technical Specifications (W1910 and W1912)

Both the W1910/12 LTE baseband PHY libraries support **3GPP LTE revision 8.5** (SystemVue 2009.05). Updates to these libraries are issued quarterly (approximately), to remain current with the "long term evolution" of the standard.

- 3GPP TS 36.211 v8.5.0, "Physical Channels and Modulation" (Dec 2008)

- 3GPP TS 36.212 v8.5.0, "Multiplexing and Channel Coding" (Dec 2008)

- 3GPP TS 36.213 v8.5.0, "Physical Layer Procedures" (Dec 2008)

Downlink baseband MIMO sources and receivers

- FDD-LTE and TD-LTE

- Full coding and decoding procedures for DL-SCH

- Turbo coding/decoding with LOG-MAP, MAX-LOGMAP and SOVA algorithms

- All control channels (PCFICH, PHICH, PDSCH, PDCCH, and PBCH)

- Downlink power allocation according to TS 36.213

- 3 resource-block allocations (StartRB+NumRBs, RB indices (1D) and RB indices (2D))

- 3 transport-block allocations (MCS index, transport block size and target code rate)

- Coded MIMO downlink signal sources for 1, 2 or 4 antennas, with precoder/de-precoder and LayerMapper/LayerDemapper

- Downlink receivers for 1, 2 or 4 antennas. SISO, SIMO (1x2 and1x4) and MIMO (2x2, 4x2 and 4x4) solutions are provided

Uplink baseband sources and receivers

- FDD-LTE and TD-LTE

- Turbo coding/decoding

- PUSCH hopping

- PRACH

- PUCCH

- SRS

- Uplink power allocation

- 3 resource-block allocations (StartRB+NumRBs, RB indices (1D) and RB indices (2D))

- 3 transport-block allocations (MCS index, transport block size and target code rate)

- Convolutional turbo coding (CTC), rate matching, convolutional coding (CC), and randomizer

- Channel estimation with MMSE and linear algorithms

- Physical signals such as primary synchronization signal (PSS), secondary synchronization signal (SSS), pilot, and Zadoff-Chu sequences

LTE 8.5 baseband block set

The W1910/12 LTE baseband PHY libraries for SystemVue provide over 100 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.

Channel Coding

- CodeBlkDeseg*
- CodeBlkSeg*
- ConvCoder*
- CRCDecoder*
- CRCEncoder*
- DeScrambler*
- DL ChannelCoder
- DL ChannelDecoder
- RateDematch*
- RateMatch*
- Scrambler*
- TurboCoder*
- TurboDecoder*
- UL ChannelCoder
- UL ChannelDecoder
- UL ChDeInterleaver*
- UL ChInterleaver*
- UL ControlInfoEncoder *

Measurement

- BER FER
- DL EVM Sink
- UL EVM Sink

MIMO PreCoder

- DL MIMO Deprecoder *
- DL MIMO LayDemapDeprecoder
- DL MIMO LayerDemapper*
- DL MIMO LayerMapper*
- DL MIMO LayMapPrecoder
- DL MIMO Precoder*
- PHICH Deprecoder*

- PHICH LayDemapDeprecoder
- PHICH LayerDemapper*
- PHICH LayerMapper*
- PHICH LayMapPrecoder
- PHICH Precoder*

Modulation

- Demapper*
- DL OFDM Demodulator
- DL OFDM Modulator
- Mapper*
- MIMO Mapper
- PHICH Demodulator*
- PHICH Modulator*
- SCFDMA Demodulator
- SCFDMA Modulator
- SpecShaping*
- SS MIMO Demod
- UL DFT

Source

- DL MIMO 2Ant Src
- DL MIMO 4Ant Src
- DL Src
- UL Src

Multiplex

- BusFork2
- DL DemuxFrame*
- DL DemuxOFDMSym*
- DL DemuxSlot*
- DL MIMO DemuxCIR
- DL MuxFrame*
- DL MuxOFDMSym*
- DL MuxSlot*
- UL DemuxFrame*
- UL DemuxSCFDMASym*
- UL DemuxSlot*
- UL MuxFrame*
- UL MuxSCFDMASym*
- UL MuxSlot*

Receiver

- DL MIMO 2Ant Rcv
- DL MIMO 4Ant Rcv
- DL Receiver
- UL Receiver

Signaling

- BCH Gen
- DL CFI*
- DL DCI CRC*
- DL DCI Gen*
- DL DCI RateMatch*
- DL HI*
- PBCH CRC*
- PBCH RateMatch*
- PBCH Scrambler*
- PCFICH Scrambler*
- PDCCH Interleaver*
- PDCCH Mux*
- PDCCH Scrambler*
- UL PUCCH*

Sync Equalization

- DL ChEstimator*
- DL MIMO FrameSync
- DL MIMO FreqSync
- DL TimeFreqSync 1Ant
- DL TimeFreqSync 2Ant
- DL TimeFreqSync 4Ant
- IQ Offset
- UL ChEstimator*
- UL FrameSync
- UL FreqSync
- UL TimeFreqSync

Sync Signal

- DL Pilot*
- PSCH*
- RACH
- RACH HalfCarrierShift*
- RACH PrmGen*
- RACH SubcMapping*
- SSCH*
- UL CAZAC*

* *W1912ET provides source code for this primitive*

Testbench Samples

Testbench 1: downlink channel coding/decoding test vector

3GPP_LTE_DL_ChannelCoding_BER

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).
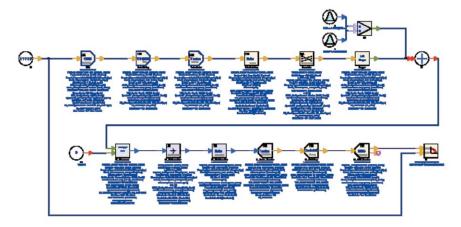
Figure 7. LTE PHY Coding/Decoding example for BER validation of critical Layer1 algorithms.
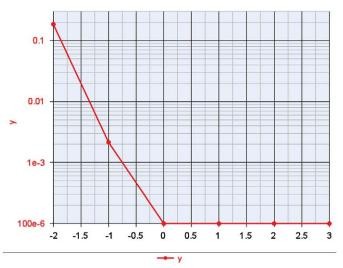
Figure 8. B2_BER
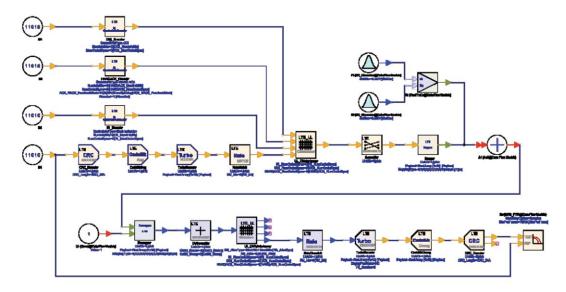
Figure 9. LTE_UL_ChannelCoding_BER_m: provides the swept BER and BLER VS SNR

Testbench 2: 3GPP_LTE_UL_ChannelCoding.wsv

This example workspace demonstrates the 3GPP LTE uplink FDD channel coding, channel decoding and swept BER and BLER vs. SNR measurements. Note that additional control channels are added in, along with complex noise, to generate EbNo waterfalls.
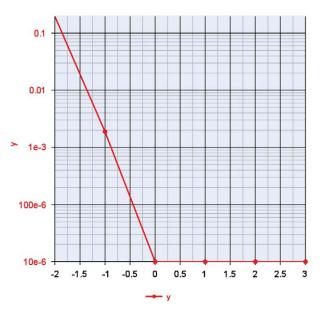
Figure 10. BER display (QPSK, 1/3 coding rate)

Testbench 3: 3GPP_LTE_DL_MIMO_BER.wsv

This example workspace demonstrates the 3GPP LTE downlink FDD MIMO channel simulations for a 2x2 antenna configuration. System performance is measured using swept BER and BLER vs. SNR measurements. This example can be modified easily to allow for TDD MIMO systems to be evaluated as well as expanded to include 4x4 MIMO antenna configurations.
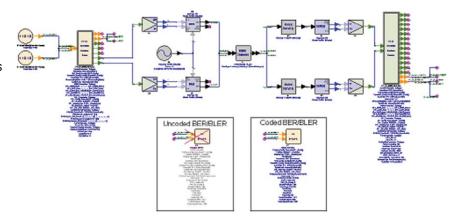
Figure 11. Evaluation of full LTE 2x2 MIMO system performance for both FDD and TDD downlink with swept EbNo measurement of BER/BLER.
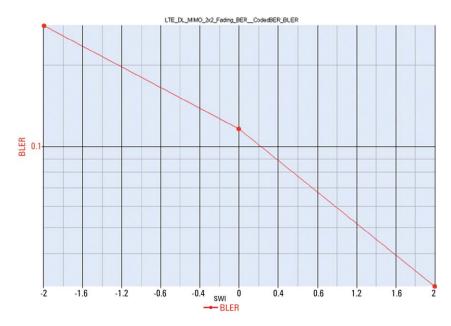
Figure 12. LTE Downlink 2x2 MIMO BER"

Agilent Technologies