Keysight Technologies

W1902 Digital Modem Library

Simulation Reference Library for Satellite and Military Communication Architects, Baseband Algorithm Researchers, and Component Verifiers in R&D

Data Sheet

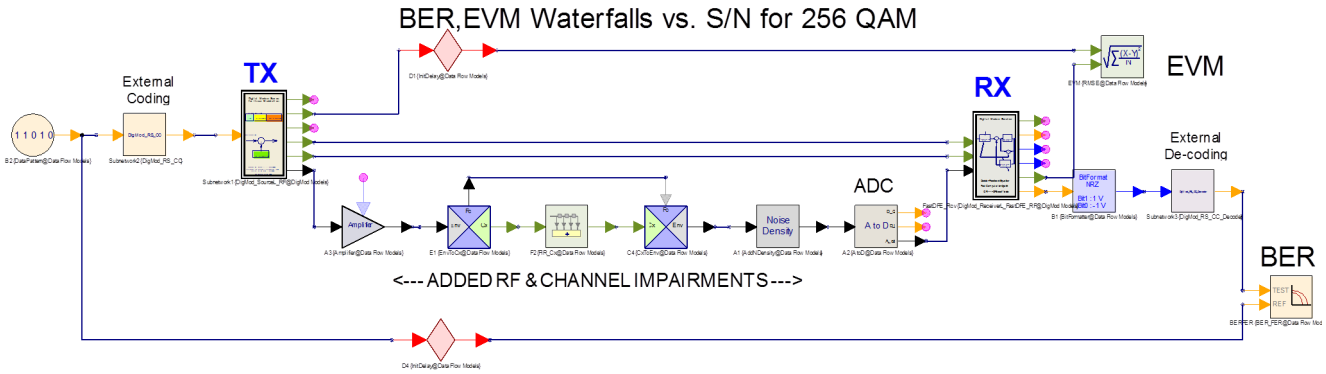

Figure 1. The W1902 Digital Modem Library supports 40 essential modulation/demodulation formats. Framing and spread spectrum functions are also supported for many of these formats, allowing communication designers to quickly analyze BER performance of satellite and military radio links.

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Introduction

The W1902EP/ET Digital Modem Library is a simulation add-on for SystemVue that enables transmit, receive, and Bit-Error-Rate (BER) analysis for 40 digital modulation formats used in satellite, military and commercial wireless communication systems. Additionally, the W1902 provides framing, Direct-Sequence Spread Spectrum (DSSS), and reference receiver designs for 18 of the linear modulation formats. The library enables higher design productivity, reduces verification effort, and supports a model-based design approach across the entire communications design cycle—from algorithm to implementation to hardware verification—using wideband test equipment.

Productivity and flexibility for A/D applications

Even though military and satellite communication networks are being upgraded to newer high-capacity and low-latency formats, many communication designers continue to invest project overhead time to maintain personal simulation blocksets and tools.

- The W1902 Digital Modem Library reduces this overhead and streamlines the verification effort by providing a reliable, Commercial Off-the-Shelf (COTS) reference for common modulation formats.
- The W1902 also connects easily to test equipment and other RF design tools, which enables the higher level of system simulation accuracy needed for RF/FPGA co-design, digital pre-distortion, and test equipment support for today's wider bandwidths.
- SystemVue enables the easy import of intellectual property in C++, MATLAB, and HDL formats, allowing the additional modeling details required by classified, secure and academic research applications to be easily accommodated.

Who should use the SystemVue Digital Modem Library?

System-level architects, baseband algorithm designers, and RF component designers can use the W1902 Digital Modem Library to perform early R&D validation of communication system architectures, components and DSP algorithms. The W1902 also provides a convenient modeling platform for custom applications and proprietary communication links.

The SystemVue environment is also scriptable, links to RF design tools such as Keysight Technologies, Inc. Advanced Design System (ADS), and connects to high-performance test equipment, providing both flexibility and consistency across a full product lifecycle.

Key applications

- Satellite communication, including ground-space, space-space and deep-space
- Military communication and secure backhaul
- Academic research
- Extended test equipment support for specialized modulation formats
- Component validation, using either simulation or the latest wideband test equipment

Key benefits

- Higher productivity, through a trusted IP reference on an open modeling environment
- Lower project overhead, scripting, verification, and NRE
- Faster time to deployment, through superior RF-DSP co-design in SystemVue

What is included?

Reference Transmitter	Reference Receiver

– Modulation for 18 modulation formats [1]
– Oversampling and filtering [1]
– Framing [user-definable length, modulation, data]
  – Guard interval
  – Idle interval
  – Preamble
  – Payload
– DSSS spreading (user-definable)
  – Provides noise immunity, security, and signal processing gain
– Waveform and data I/O
  – Input data from simulation or file I/O
  – Output complex modulated waveform to simulation, file I/O or test equipment
  – Additional outputs for framing, preamble and other functions
– Coding support (external only)
  – Users are free to add coding, error correction, and other C++, MATLAB, and HDL blocks outside the digital modem source
– Impairments
  – Users can add or sweep a wide range of RF impairments and channel models outside the digital modem source
	– De-modulation for 18 modulation formats [2,3]
	– Filtering, synchronization and re-sampling [2,3]
	– Corrections applied:
	  – Carrier frequency offset (e.g., Doppler)
	  – IQ phase rotation
	  – IQ imbalance
	  – AGC re-normalization
	– Adaptive equalization
	  – Linear Equalizer (LE) and Decision Feedback Equalizer (DFE)
	  – Adaptive algorithms (RLS, LMS, RLS/LMS)
	  – Fractional-Space Equalizer (FSE) for both LE and DFE
	  – MMSE-DFE (fast computation DFE)
	– Maximum Likelihood Sequence Detector (MLSE)
	– Rake combiner for DSSS
	– Frame synchronization using both correlation and differential correlation algorithms
	– Carrier frequency synchronization and frequency tracking algorithm using PLL
	– Waveform and data I/O
	  – Input complex modulated waveform from simulation, file I/O or test equipment
	  – Additional inputs for framing, preamble, etc.
	  – Output data bits, constellation
	– Measurements and pre-configured templates
	  – BER vs. Eb/N0 or SNR sweeps
	  – EVM
	  – System-level verification

1. 40 total modulation formats are supported outside the reference transmitter source. Also, some raw modulation features (source only) are available using the "DigitalMod" source included in the core SystemVue environment. This free source does not provide framing, DSSS or demodulation.
2. The W1902 supports 40 total demodulation formats. The reference receiver supports 18 of them.
3. Some dynamic visualization features are available using the Keysight 89600 VSA software, option AYA. The 89600 VSA does not provide framing, DSSS or demodulated data output.

Formats supported

Linear Modulation Formats		Differential and Nonlinear Modulation formats	
16-QAM	Star 16-QAM	DBPSK	EDGE-8PSK
32-QAM	Star 32-QAM	π/2 DBPSK	D8PSK
64-QAM	BPSK	DQPSK	π/8 D8PSK
128-QAM	QPSK	π/4 DQPSK	
256-QAM	8-PSK	OQPSK	2FSK
512-QAM	16-PSK	SOQPSK-TG	4FSK
1024-QAM	16-APSK	SOQPSK-MIL*	8FSK
2048-QAM	32-APSK	IJF-OQPSK	16FSK
4096-QAM	Custom APSK	FQPSK	MSK
		EFQPSK	GMSK
		CQPSK	M-ary CPM
		π/4-CQPSK	Multi-h CPM*

*some limitations apply

– Provides full reference source/receiver, including Mod/Demod, Filtering, Framing, DSSS, Synchronization, AGC, Adaptive EQ
– Enables BER and EVM measurements, even with test & measurement waveforms.

– Provides Modulation/Demodulation primitives
– User provides Synchronization and other receiver algorithms necessary for robust BER

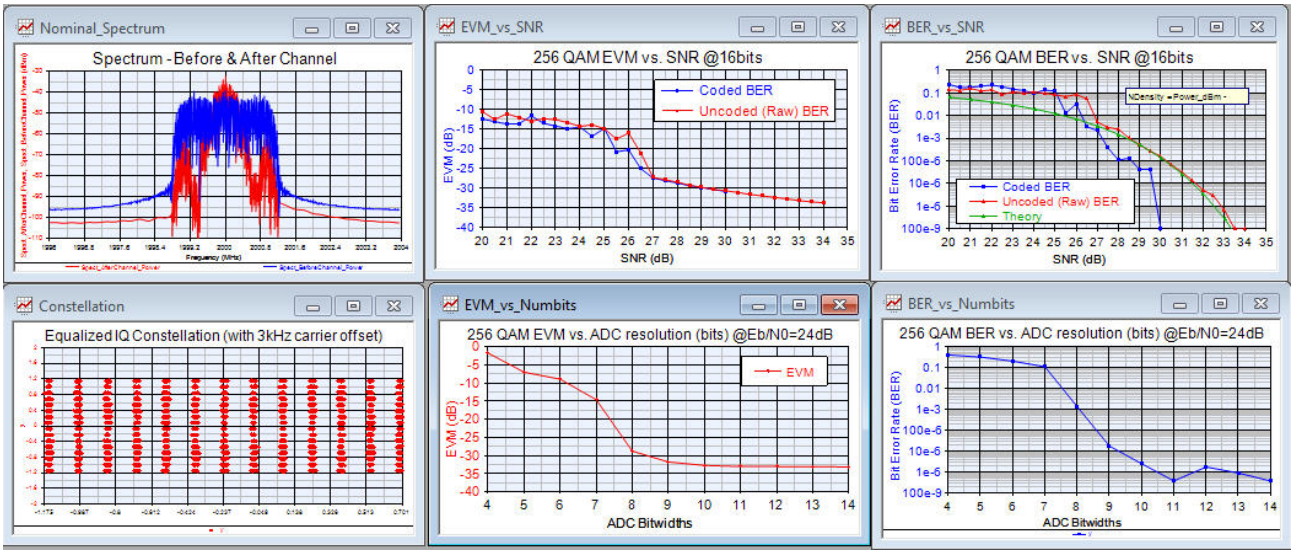

Figure 2. In this example, the W1902 library is used to analyze a 256-QAM communication link having amplifier nonlinearities, finite ADC resolution, AWGN receiver noise, and simple channel effects (see Figure 1). For enhanced realism, the same analysis can also work with RF test equipment in the verification loop.

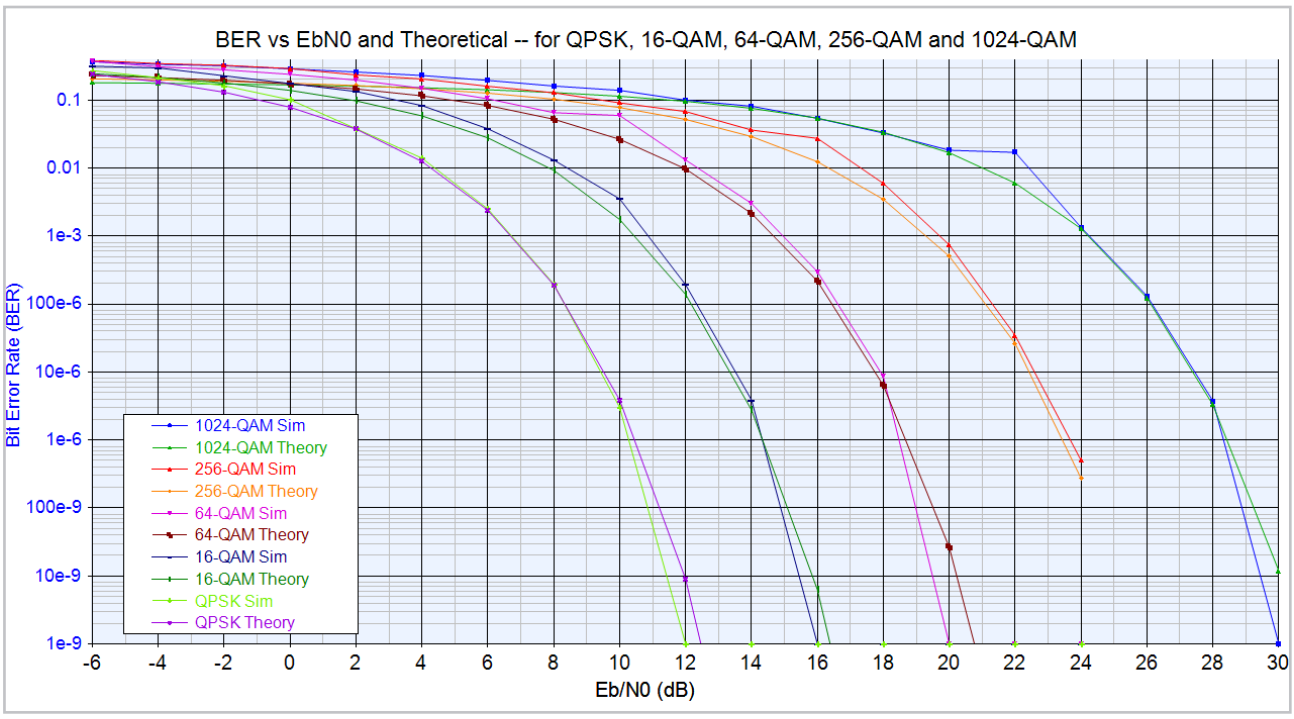

Figure 3. The W1902 library provides reliable signal processing references that approach the theoretical performance of various modulation formats. Under non-ideal conditions, the W1902 is also a reference receiver that corrects for carrier offset frequency (due to doppler shift or a mistuned receiver), synchronization, IQ rotation/mismatch, and other impairments, just as a finished radio would do.

Configuration

The W1902 Digital Modem Library can be added as an option to any W146x-series SystemVue environment or bundle.

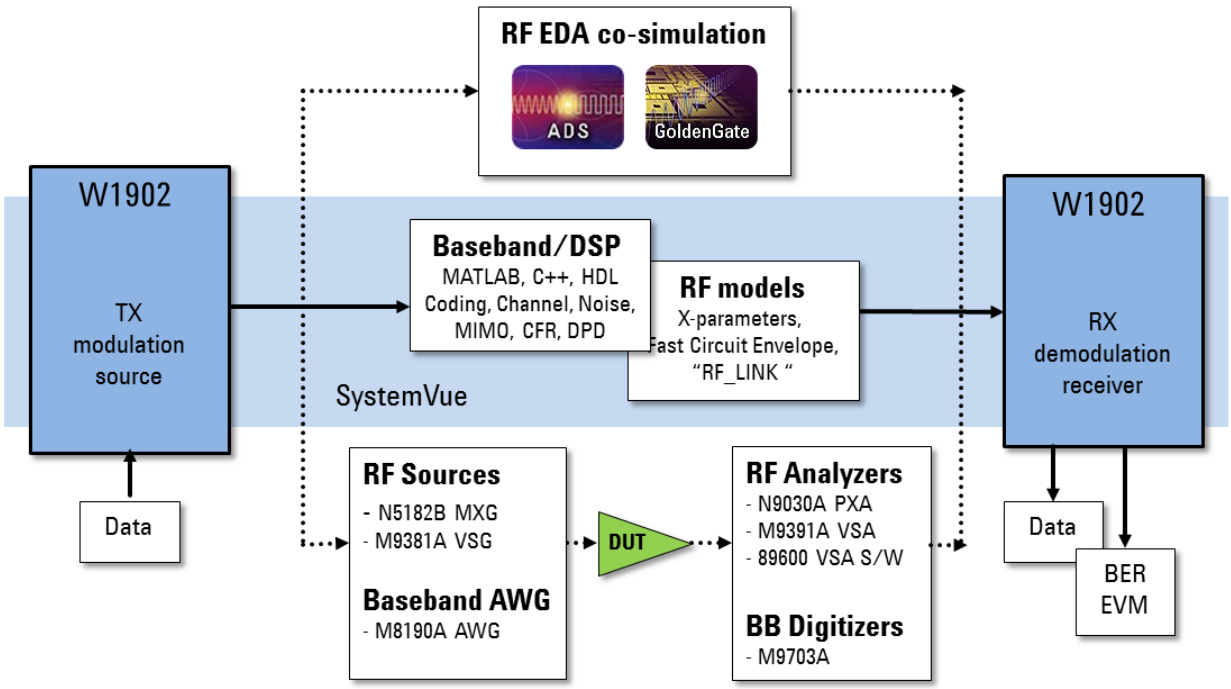

Figure 4. The W1902 Digital Modem Library can be used with other Keysight design software and test instruments.

Complementary Keysight software (such as Keysight I/O libraries, Command Expert, and the 89600 VSA with option 300) is often used to connect SystemVue to families of Keysight test equipment, including AWGs, digitizers, RF sources, RF analyzers, and others. SystemVue offers a convenient modeling and verification platform that can be used in the R&D environment, in the test lab, or shared over a network.

For more information

For more detailed application information, refer to:
www.keysight.com/find/eesof-systemvue-digital-modem
www.keysight.com/find/eesof-systemvue-videos
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