X-parameters in RF_Link Example

What does this example do?
This example contains 2 Data Flow simulation schematics, namely, QPSK and QPSK_VSA. Both of them demonstrate how to bring an actual RF device (in this example; a RF Amplifier) into a system level simulation in SystemVue through the X-parameters characterization of the RF device ("AMP_XParams.mat" file in this example).

Circuit link network with X-parameter device
The W1719 RF System Design Kit is an option to the SystemVue environment that adds an innovative RF system-level simulation engine, and also provides bottom-up verification links for designs originating in Keysight ADS and GoldenGate. The W1719 increases the RF modeling accuracy of the main SystemVue dataflow modeling environment, without sacrificing system-level speed and ease-of-use. It is both a captive RF System Architecture tool in its own right, as well as an easy “RF bridge” for System and Baseband algorithm designers who want “just enough RF.”

Key features

- **Spectrasys** – A spectral domain RF System Architecture simulator that offers compelling simulation and interactive graphical Use Model advantages over circuit tools, math-based block sets for time-domain simulators, vendor “calculator” apps, and spreadsheets. Choose from dozens of pre-programmed measurements and interact directly with graphs.

- **RF Link** – A fast, automated dataflow modeling tool that allows system-level Dataflow simulations to use frequency-domain Spectrasys block diagrams directly, without modification. Account for multiple stages of up and down-conversion, spectral inversion, multiple I/O ports, baseband or modulated carrier ports, thermal and phase noise spectral densities, as well as frequency and power-dependence within the band.

- **ADS X-parameter support** – Use circuit-level nonlinear X-parameters at the system-level, for fast, bottom-up verification of ADS designs or measured devices from vendors. Accounts for complex impedance loading, harmonics, bias, power and frequency dependence. Enable the new Volterra modeling to make 1-tone X-parameter data more accurate for multi-tone large-signal simulations.

- **GoldenGate “Fast Circuit-Envelope” models** – Verify Wireless SoC/RFIC transceivers up to 1,000-100,000 faster at the system level than with Spice, accounting for frequency translation, frequency and power dependence, and memory effects. Fast enough to run coded LTE BER/Throughput simulations or demodulate live on a Keysight 89600B VSA.

- **WhatIF** – An RF Frequency Planning utility for multi-band, wireless front-ends.
Who needs the W1719 RF System Design Kit?

Top-level system architects

The W1719 enables superior Baseband-RF partitioning to identify and reduce margins simultaneously in both areas, while allowing continuous BB-RF co-verification throughout a project lifecycle, from architecture and algorithms all the way to hardware test. Account for Zero IF, leakage terms, non-50 Ω terminations, and other RF effects while interoperating with IP at a variety of levels of abstraction.

Baseband DSP/Math/C++ developers

The unique “RF link” feature allows baseband designers to re-use RF Systems directly and conveniently in their native SystemVue DSP environment, without large computational burden from analog/Spice overhead, detailed RF knowledge, or incompatible formats and spreadsheets. If you have ever used “RF” block sets, but used them in an inappropriate time-domain simulator, you urgently need to evaluate SystemVue with the W1719 option.

RF system architects & spreadsheet users

Get superior diagnostic insight, faster results, higher dynamic range and accuracy, and a much easier Use Model than Spreadsheets, Dataflow simulators, or brute-force circuit simulators (such as Spice or Harmonic Balance). Diagnose opportunities that others miss, and propose practical systems quickly. Then verify with real modulation and baseband coding/decoding, connect directly to enterprise design flows, and follow through into measurement equipment, all in the same environment.

Workgroups, and single power-users

SystemVue unites an electronic system-level (ESL) design flow for multi-disciplined design teams in Layer 1 communications or aerospace/defense, yet also provides a cost-effective united platform that meets the needs of smaller organizations, in which 1 person may perform multiple tasks. Moreover, if you are an RF engineer who faces expanded responsibilities for overall ownership of the physical layer (not just the RF), SystemVue can help with linearization, “throughput”, and other link-level characteristics, while providing a path to baseband hardware design flows.

![ESL Design Flow Diagram](image-url)

Figure 1. The W1719 RF System Design Kit is an optional add-on to SystemVue that enables deeper insights and RF design flow connectivity than would be possible using only a dataflow simulator.
Spectrasys – Block-level RF simulator for RF Architects

RF System Design Kit saves time for RF system architects by accounting for analog effects while providing one-click graphical diagnosis of RF system performance. Key to this is the Spectrasys simulator.

Spectrasys overcomes key limitations of spreadsheets, math & DSP engines, circuit simulators, and their limited model sets, which miss these analog effects entirely, or make problems very difficult to isolate and diagnose. This allows RF system designers to identify and correct poor architecture choices early in the design, before commitments are made to the frequency plan, board area, layout, bill of materials, and performance.

With more than 100 pre-defined system measurements, and dozens of power and voltage-based behavioral models, designers do not need to spend time writing homegrown code, when they can use a dedicated, graphical tool designed for the RF system design task. High-quality designs can be produced quickly, saving prototyping cycles, costly troubleshooting, and project risk.

Figure 2. Spectrasys accounts for complex mismatch, bi-directional propagation, nonlinearities, frequency response, leakage terms, continuous spectrums from DC to millimeter waves, and tracks individual signal and noise contributors. These can be inspected interactively in seconds, directly from the graphs.
WhatIF – RF Frequency Planner

The W1719 also provides the “WhatIF” frequency planning tool. WhatIF helps wireless system architects choose a set of Intermediate Frequencies (IFs) that maximize system performance with a minimum of filtering and design margin for multi-band RF receivers. It reduces the frequency planning task from weeks of analysis down to an afternoon using an interactive, graphical approach. It accounts for tuned bandwidths, spurs and intermodulated frequencies.

Comparison with Genesys Spectrasys

Of the capabilities of the W1719, the basic Spectrasys simulator and WhatIF utility are also available as options to the Keysight Genesys environment. If you primarily design analog/RF circuits, are able to approximate performance using CW tones, or have a low percentage of signal processing content, you may wish to look at the Genesys version of Spectrasys and WhatIF.

If your communications or defense systems contain both RF and signal processing content, require modulation analysis, such as EVM, BER, spectral regrowth, or CCDF, or you need to connect to test equipment, wireless standards references, or interactive baseband modeling, then W1719 RF System Design Kit within SystemVue is the clear choice.
Using RF Architectures at Higher System-Levels

SystemVue offers “RF Link”, a behavioral modeling feature that allows both Baseband/MATLAB engineers and RF Architects to collaborate from the same design files, but using the simulation tools most comfortable to their respective disciplines.

RF system architects typically work in the frequency domain, using analog simulators such as Spectrasys that account more easily for mismatch, leakages, phase noise, distortion and intermodulation spurs in the spectral domain. System and baseband algorithm designers tend to work in the time domain (or modulated envelope/carrier domain), for modeling dynamic behaviors with modulated signal types. “RF Link” is a key SystemVue technology that bridges the gap between these types of users.

RF Link converts the accurate frequency-domain RF system results into computationally fast dataflow models in seconds, at run-time. RF systems are profiled for 3 characteristics: nonlinear transfer curve at the carrier’s center frequency; the small-signal frequency response across the instantaneous modulation bandwidth; and the noise spectral density, including phase and thermal noise sources. This is done for each RF frequency “regime” along the main RF signal path, accounting separately for each stage of frequency conversion, and spectral inversions that may occur (ie – each RF path is literally broken into sub-paths, separated at the frequency translators and mixers). This accurate approach also allows measured and simulated X-parameters (from the Advanced Design System) to roll up easily to Spectrasys, and then to the higher system level.

Unlike more mathematical approaches, the W1719 directly incorporates work-in-progress from RF EDA design tools as well as real-life measurements, resulting in both credible accuracy and high computational speed.

Figure 4. “RF Link” models bandpass RF architectures accurately in the time-domain. This enables System Architects, MATLAB algorithm modelers, and RF Architects to use the same tool for cross-validation, saving time and reducing license usage.
Figure 5. "RF Link" allows RF architectures to be validated at the system level using actual 5G, Radar, Satellite, and measurement waveforms. This enables superior proposals, achievable design margins, and earlier cross-validation with baseband architectures.
Configurations

The W1719 RF System Design Kit can be added to any SystemVue Environment.

The W1719 is already included in these SystemVue bundles:
- W1464 SystemVue RF System Architect
- W1465 SystemVue System Architect
- W1467 SystemVue Array Architect

Many power amplifier designers interested in this product will also be interested in:
- W1716 SystemVue Digital Pre-Distortion Builder

Phased Array designers may be interested in upgrading their existing W1719:
- To add W1720 Phased Array Beamforming Kit, or
- To upgrade to W1467 SystemVue bundle (includes W1461, W1719, W1720)

More Information

For more information about SystemVue, please visit us on the web:

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