

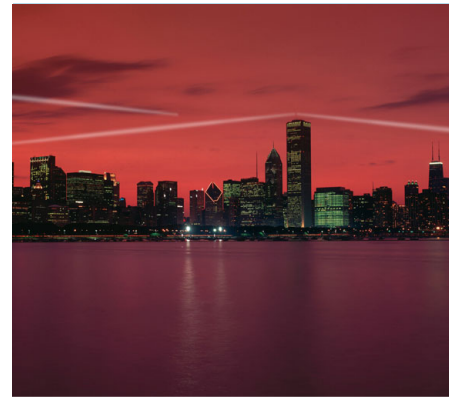
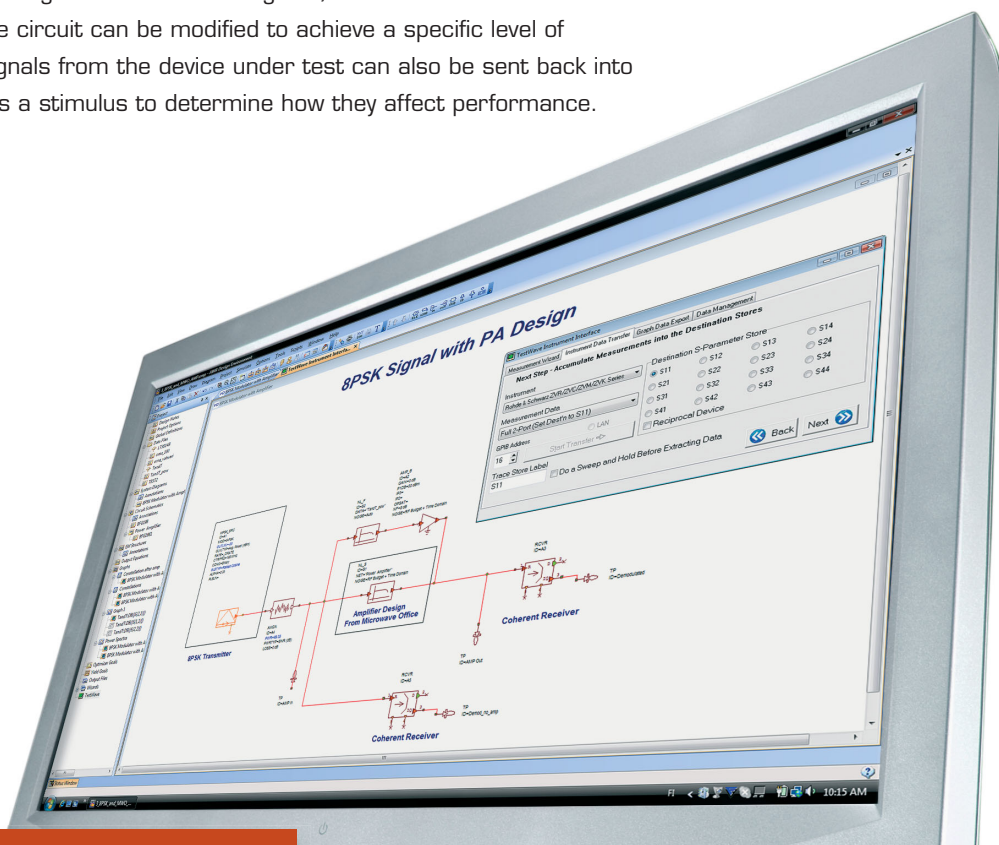
INTRODUCTION

When simulating a complete subsystem such as a wireless communication device or radar receiver, the quality of measurement data becomes essential to ensure that the finished product meets or exceeds the demands the system will encounter in service. The measurement data can be used to make changes to the system early in the design process, when those changes can be realized in the least amount of time and at the lowest cost. However, this can be accomplished only if there is a direct link between the system being simulated and the measurement equipment itself—that is, when there is “hardware in the loop.” AWR’s Visual System Simulator™ (VSS) combined with its TestWave™ software provides an end-to-end communications system simulation environment that makes this possible.

The TestWave software physically connects VSS to actual test and measurement equipment through VISA, GPIB, LAN, or RS-232 connections. This level of integration enables system simulation, test signal generation, and measurement verification to become an integral part of the entire design flow process. Designers can perform trade-off studies to optimize a circuit using data obtained from actual test equipment. The VSS/TestWave user interface imports signals, manages data, and directly controls the test equipment, sending commands and receiving responses. During the simulation, the block configures the test equipment, passes variables to the instruments, and takes measurement data from the instruments for use in the analysis.

For example, a baseband I/Q waveform data generated by a transmitter with VSS software can be sent to an external vector signal generator to stimulate a device used in the circuit. The output of the device can then be passed to a vector signal analyzer and the results compared with those in the VSS simulation. Using these results as a guide, values of the device or other elements of the circuit can be modified to achieve a specific level of performance. The signals from the device under test can also be sent back into the VSS simulation as a stimulus to determine how they affect performance.

TestWave instrument interface is easy to set-up and use.



Hardware in the Loop

Visual System Simulator and TestWave Software Integrate Measurement Data into the Design Process

Measurements made with modulation analyzers, vector signal analyzers, vector network analyzers, and other instruments can be incorporated directly into the simulation. Dedicated blocks within the VSS system diagram automate the transfer of data between real-world measurements and the simulation to make the process simple. TestWave includes an instrument interface wizard as seen in Figure 1 that is accessible from within the Microwave Office® software, which enables dynamic exchange of data between the instruments and the simulations being executed. Industry-standard data formats for S-parameters, I-V data, amplifier compression curves, and many other characteristics are supported.

As the following examples illustrate, VSS/TestWave software enables communications systems to be designed to deliver their highest possible performance by integrating the once distinct domains of simulation and measurement.

A TYPICAL VSS/TESTWAVE SETUP

In Figure 2, VSS generates a signal and passes it through a power amplifier. The signal can be any of any type, including the latest cellular, WiMAX, and WiFi communication standards, and the analysis can be as simple as a spectral display or the evaluation of an error vector magnitude (EVM) measurement. First, the signal generator clock and vector signal analyzer clock must be synchronized. Second, a cable must be connected to the signal generator, allowing it to be triggered by the software. On the Parameters tab of the “Element Options” dialog box in the VSS/TestWave block, the designer selects the instruments that will be connected and enters their GPIB or LAN addresses.

In the next example (Figure 3), a C-band linear FM chirp signal with a bandwidth of 20 MHz illustrates how VSS and TestWave software work together. The signal is generated within VSS using an FM modulator and a sawtooth waveform. This signal is “ideal” in that it has no RF impairments. The signal is passed through a coupler so it can be used as a local oscillator in the receive path and an isolator is placed before the power amplifier under test. A VSS behavioral amplifier can first be used to verify the functionality of the system. If the goal of the analysis is also to include a specific power amplifier product, a VSS/TestWave block can be substituted for the behavioral model.

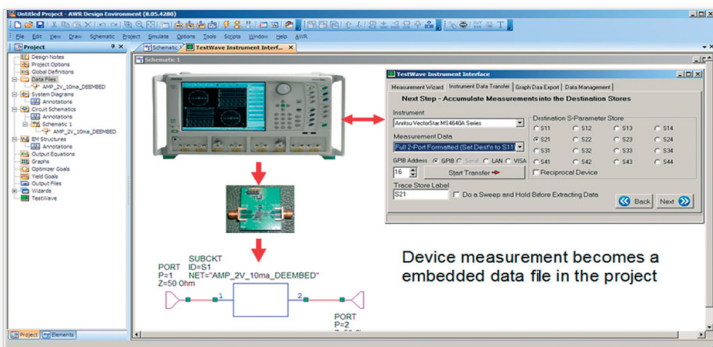


Figure 1. VSS/TestWave block in the system diagram allows VSS to directly communicate with Rhode & Schwarz instruments to perform a hardware-in-loop simulation.

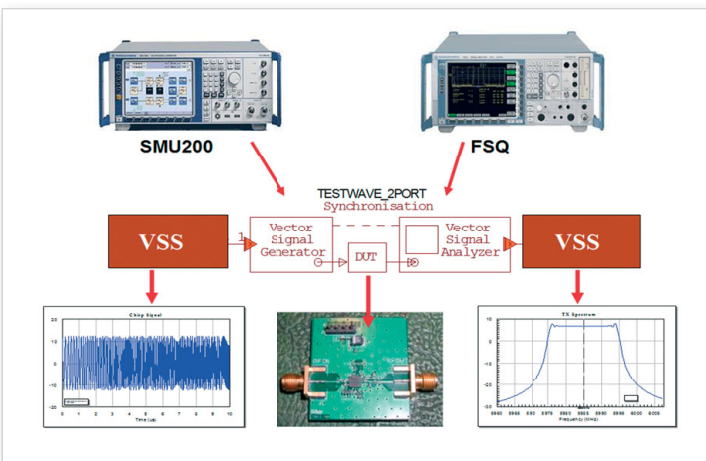


Figure 2. An example of VSS employed to generate a signal and pass it through a power amplifier.

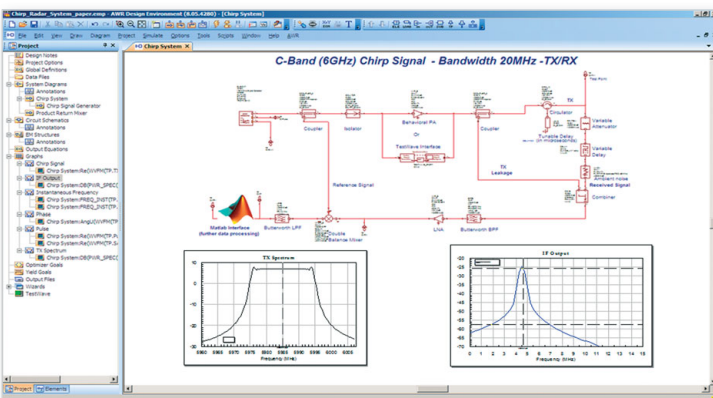


Figure 3. System diagram of a VSS linear FM chirp waveform.

VSS/TestWave software automatically takes the signal from the spectrum analyzer and passes it through a series of VSS behavioral models, adding delay, attenuation, and a phase component to simulate reflections (multipath). As the design matures, actual S-parameters of an antenna or a VSS antenna model (including parameters such as gain, directivity, and effective area) can be introduced as well. The received signal is passed through a filter and low-noise amplifier and is translated to an IF frequency. After this, the designer can send the signal to a VSS Matlab® block for further processing via co-simulation. In short, VSS generates the desired signal and simulates RF impairments while also including the performance of a physical device in the simulation environment.

EXAMPLES TELL THE STORY

VSS/TestWave can be a valuable tool when evaluating the performance of radar systems that typically employ pulsed signals. Signals of short pulse duration provide greater range resolution, and signals with high peak power detect objects at longer ranges. However, since the shorter the pulse duration of the transmitted signal, the weaker the received signal, pulse compression techniques are used to provide a combination of acceptable range resolution and reduced signal power, while at the same time adding complexity to the transmitter and receiver. A radar signal with a short-duration pulse has its power spread over time, an effect similar to that of spread spectrum techniques, using Barker codes and complementary codes that spread the signal energy. The received signal is processed by a filter that compresses the long-duration pulse to produce pulse durations of $1/B$, where B is the bandwidth of the transmitted signal. VSS can create a complementary-coded pulse radar signal and display the corresponding transmitted signal. The VSS/TestWave interface can download this signal to an arbitrary waveform generator. The corresponding matched filter at the receiver is shown in Figure 4 along with the complete complementary-coded radar system.

In Figure 5, VSS software generates 32QPSK signals that are passed to a TestWave source block that automatically loads an arbitrary waveform, which can be passed to a power amplifier. VSS software makes it possible to create many different scenarios that involve complicated modulated signals along with interferers and adjacent channels. Its suite of measurements can be used to analyze adjacent channel power ratio (ACPR), EVM, complimentary cumulative distribution function (CCDF), carrier to noise and interference ratio (CNIR), bit error rate (BER), and eye diagrams, among others. All of these parameters can be evaluated using VSS/TestWave software and various instruments to generate, display, and analyze performance of the system as changes are made within the simulation.

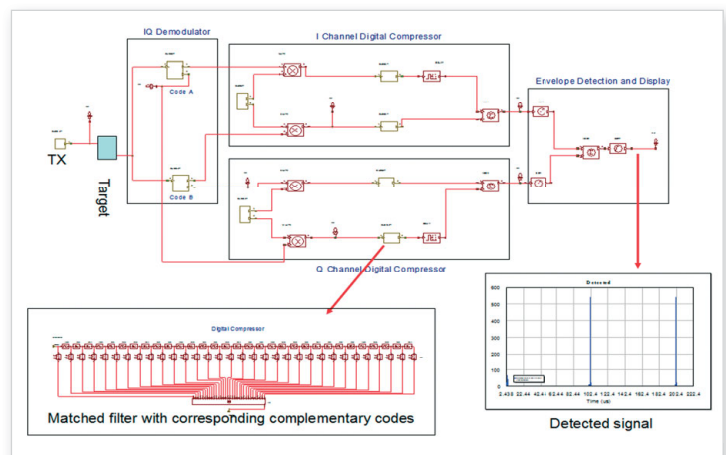


Figure 4. Complementary-coded pulse radar system in VSS.

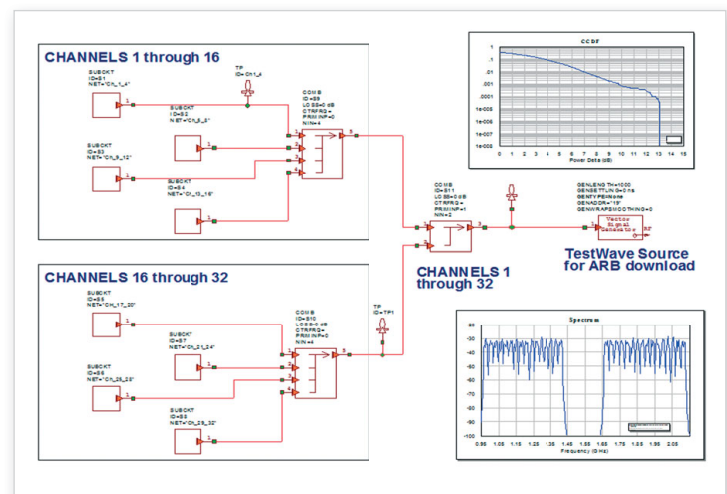


Figure 5. These 32QPSK signals were generated in VSS along with a CCDF measurement.

SUMMARY

The unique capabilities of VSS software for simulation of complete communication and radar systems are significantly enhanced by TestWave's ability to bring actual test equipment "into the loop." This makes it possible to "fine-tune" the performance of a system to meet required specifications at every stage of the simulation process using information based on actual measurements, rather assumptions and numerous arbitrary "tweaks" that consume valuable time. The result is a process that considerably reduces risk and enables greater performance achievement from virtually any design.

TESTWAVE SOFTWARE CAPABILITIES IN A NUTSHELL

Supports	Network analyzers, spectrum analyzers, modulation analyzers, oscilloscopes
Chart Types	Cartesian- linear and log, polar, Smith, admittance Smith, eye diagram, vector modulation (Cartesian, polar, rotated), constellation, Nichols, antenna polar
Graph Data Formats	Linear magn, Log magn, re/im, VSWR, phase, group delay, unwrapped phase
Data Storage	16 complex trace stores, arbitrary number of points (limited by available system memory). Each store has a trace label, trace notes and data analysis table.
Markers	Up to 20 markers and/or delta markerslabel, trace notes and data analysis table.
Limit Lines	Up to 50 arbitrary line segments for limits testing
Scaling	Up to 2 independent vertical scales
Numerical	Electrical delay, smoothing, magnitude/ phase offset, magnitude slope
Trace Maths	+, -, /, x, log, magn, phase, square-root, anti-log, group delay, derivative, mismatch loss factor, Rollet's stability factor K, stability factor B, maximum unilateral power gain, maximum available gain, maximum stable gain, Z0 renormalization, number of bit differences, maximum value, minimum value, standard 3- or 4-port to mixed-mode S-parameters, timebase delay, smoothing, wraparound smoothing, complex reflection to VSWR, dB reflection to VSWR, mW to dBm, dBm to mW
Data Editing	Edit, cut, copy and paste traces in the table view
Measurement Templates	Copy attributes from previous measurements such as limits, markers, annotation, graticule
Integrated Interfaces	OLE2 linking and embedding server (for Word, PowerPoint, etc) :- double-click in the document to begin editing. COM (ActiveX Automation) and DDE server (for automated operation with test system software)
File Formats: (all bi-directional)	SoftPlot (*.SPT), MIPlot (*.MPT), AWR Design Environment (Touchstone) (*.S1P.. S4P), spreadsheet (*.CSV), tab delimited (*.TXT), MathCad (*.PRN), Citifile (*.F??,D??)

INSTRUMENTS SUPPORTED BY VSS/TESTWAVE SOFTWARE

Visit <http://www.awrcorp.com/TestWave-Supported-Instruments/> for up-to-date list of supported T&M instruments or contact AWR directly to make a specific query.



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