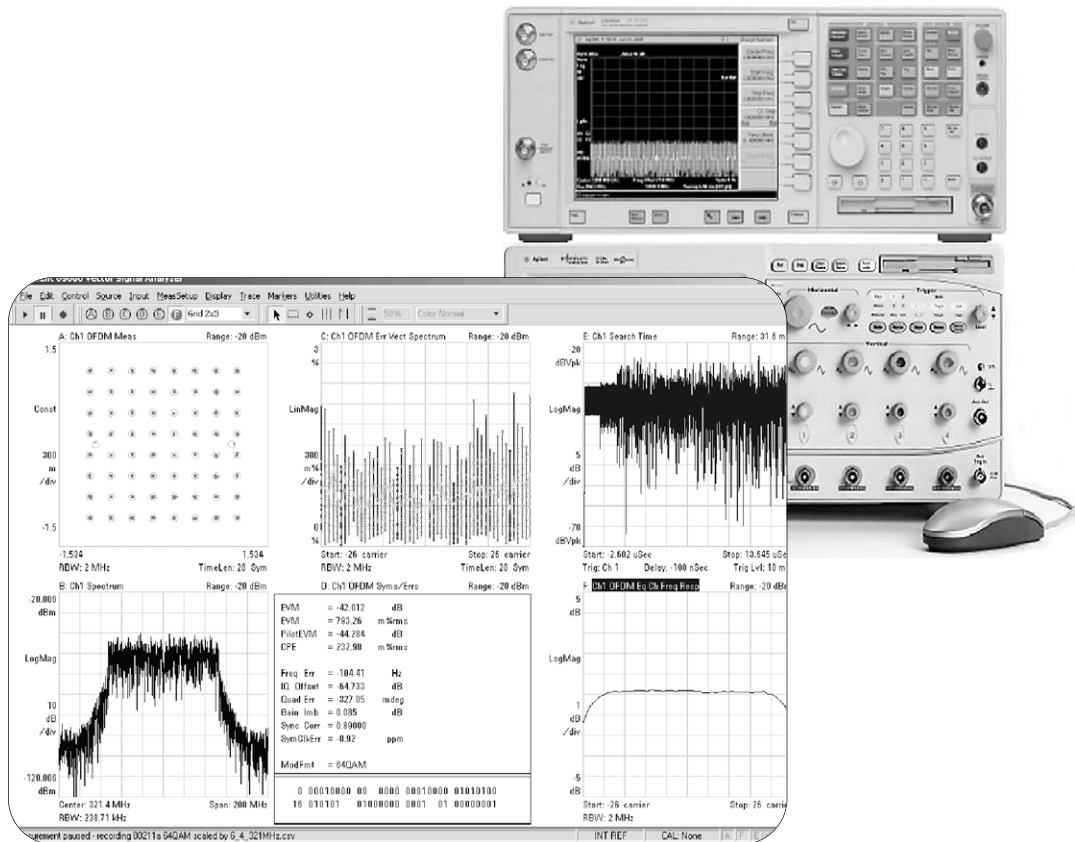


# Wideband (up to 250 MHz) RF and Baseband Transmitter Modulation Analysis using the Agilent 89600 Vector Signal Analysis Software

## Application Note



Perform advanced analysis of wideband transmit and receive designs with a flexible and cost-effective Agilent test solution. Applications include wideband and satellite communications, radar system design, and ultra-wideband applications.



The combination of the PSA Series spectrum analyzer, Infiniium oscilloscope and 89600 VSA software gives you the industry's most versatile wideband measurement system. Make RF and baseband measurements using consistent analysis methods, and link the results directly back into PHY simulations running on Agilent EEsof's Advanced Design System.

## Key Features

This combination:

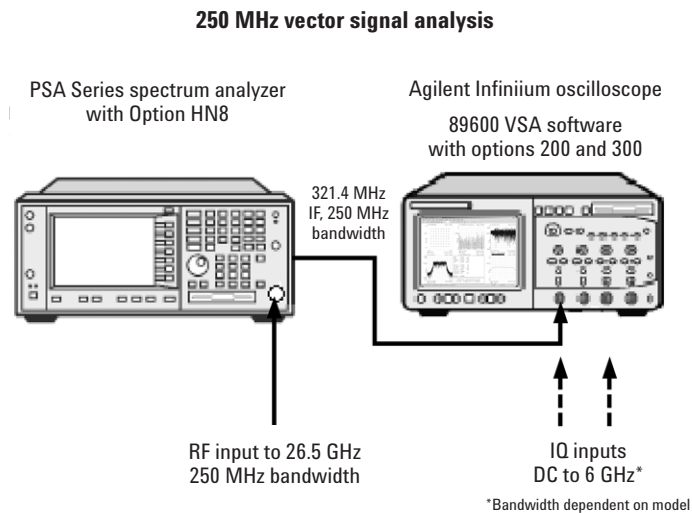
- Provides wideband communications and radar systems analysis from baseband to RF.
  - Up to 250 MHz demodulation bandwidth at RF (3.05 GHz to 26.5 GHz)
  - Up to 6 GHz IQ demodulation bandwidth at baseband
  - Troubleshoot zero IF (ZIF) operation
  - Differential IQ measurements
  - Receiver EVM measurements
- Offers highly advanced modulation analysis capability on both RF and baseband signals using Agilent's 89600 vector signal analysis software.
  - Up to 24 digital demodulators, with 8 filters, including user-defined
  - Easy-to-use time-gated signal analysis
  - Flexible display formatting, including spectrograms for tracking frequency and amplitude behavior of signals, particularly those with poor-signal-to-noise ratio and frequency hopping signals
  - Time-capture for analyzing signals or transients off-line
- Enables industry-leading general purpose spectrum analysis capability using the PSA Series of spectrum analyzers.
  - Excellent speed, dynamic range, and accuracy
  - All-digital IF provides fast FFT-based or traditional swept analog measurements
- Allows you to run the VSA software either inside the Infiniium oscilloscope for an integrated solution, or on an external PC for data-sharing, and off-line for remote analysis.
- Offers advanced calibration support via the VSA software fixed equalizer, providing high accuracy measurements right across the measurement band (calibration dependent on reference calibration signal).
- Enables you to move effortlessly between the simulated and real world using the power and connectivity of Agilent's VSA software, using Agilent's EEsof Advanced Design System software.
  - Use Agilent's connected solutions for prototyping solutions: feed ADS simulations into real hardware for signal generation, or feed real hardware outputs into an ADS simulation
- Measures advanced receiver characteristics, using the same equipment with the addition of an appropriate source.

## Solution Overview

The system consists of the following Agilent products:

- Agilent PSA Series high performance spectrum analyzer, with Option HN8 (wideband IF output).
- Compatible Agilent Infiniium oscilloscope.
- 89600 vector signal analysis software, with options 200 (basic vector signal analysis) and 300 (hardware connectivity)

For examples of how to use this solution in test configurations, see Figures 5 and 6.



**Figure 1. Measurement setup for making measurements on signals with up to 250 MHz bandwidth. The RF input is fed into the PSA Series high performance spectrum analyzer with Option HN8 wideband IF output. Or, feed differential IQ baseband inputs directly into the Infiniium oscilloscope.**

## System Calibration

The down-conversion path can be calibrated using channel equalization, a method used by receivers to compensate for channel imperfections.

## Background

The 89600 VSA software provides a fixed equalization feature, which you can use to reduce imperfections in the measurement channel. To use this feature, a known good signal is used to characterize a channel and create an equalization function. Because the channel imperfections are stable and will not change for subsequent measurements (key assumption), you can use fixed equalization to compensate for them. Using this compensation as part of the measurement system allows more accurate characterization of the DUT performance.

The fixed equalization feature in the 89600 VSA software will store the downconverter performance (i.e., the spectrum analyzer IF output) and automatically remove its effect from the measurement before displaying the results.

Fixed equalization applies a fixed FIR equalization filter (constructed from the frequency response data stored in a data register) to the data, along with time corrections for the channel.

The FIR filter is defined by its frequency response rather than by its impulse response.

The frequency response measurement is performed with a source generating a noise-like signal, which has a bandwidth greater than the signal of interest.

For more information, check the help text of the 89600 VSA software, available with the demo version of the software.

## Procedure

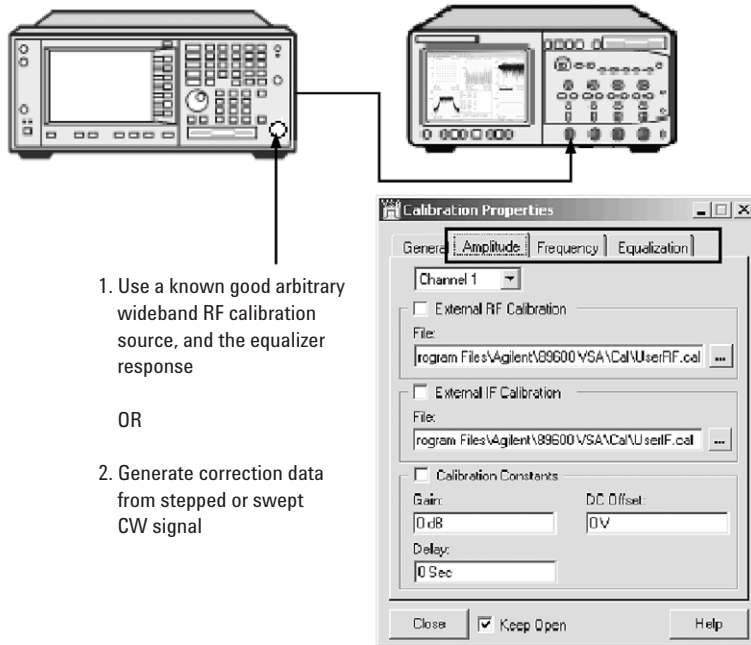
Performing a fixed equalization calibration using the setup provided below in Figure 2 is simple. The first step is to connect the source output to the RF input of the PSA. Then, use the following procedure for setting up the 89601 VSA software hosted in the Infiniium scope:

- In Trace | Data, select **Ch Frequency Response**. This will show the frequency response of the measurement channel.
- In File | Copy Trace, select **D1** to store the channel frequency response. Select OK to close the dialog box.
- In Utilities | Fixed Equalization, select **Channel 1** and register **D1**. Check-mark **Fixed Equalization**. Close the dialog box.
- Re-start the measurement and notice the equalized channel frequency response is now nearly flat. The fixed equalizer is compensating for the channel imperfections.

### Calibration source suggestions

*Equalizer-based calibration:*  
Agilent 81132A pulse generator creating a PRBS signal at > 100 Mbps rate, driving a wideband mixer such as Marki M9-05401N

*Swept CW calibration:*  
Agilent PSG for swept amplitude calibration



**Figure 2. Measurement setup for generating fixed equalization calibration data. This product note describes the first method. See the 89600 VSA software help text for information on generating correction data via a stepped or swept CW signal.**

Within the span and at the center frequency of the signal of interest, the frequency response should be near 0 dB, and should appear stable. See Figures 3 and 4 for examples of frequency response before and after calibration.

The calibration is finished and the real DUT is ready to be connected. Figures 5 and 6 show the DUT connection in an example configuration.

# Fixed Equalization Calibration Examples

Below are some example plots of system flatness, with and without correction.



Figure 3. Un-corrected output from PSA Option HN8 showing 300 MHz wide span, with 0.5 dB per division

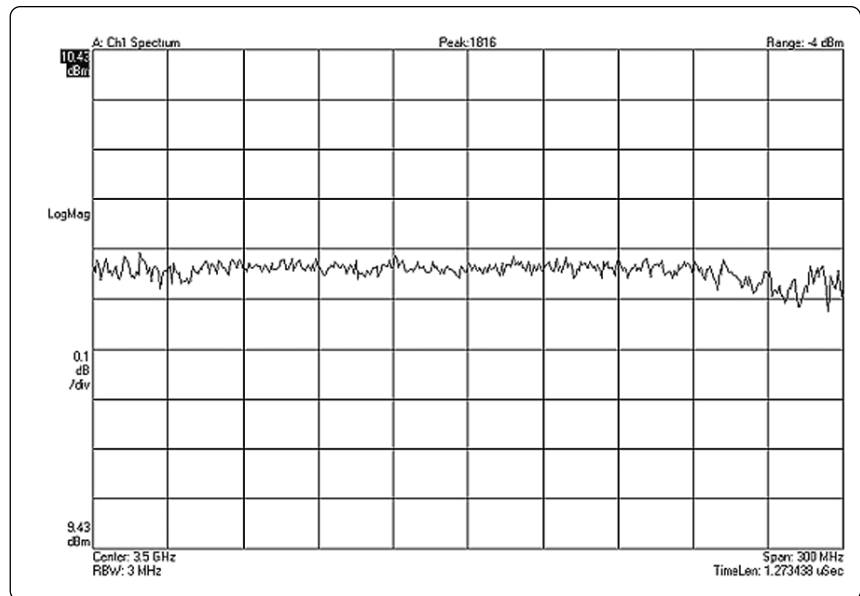


Figure 4. Same 300 MHz wide span using fixed equalizer correction, with 0.1 dB per division. Notice the dramatic increase in improved flatness.

# Example Test Configurations

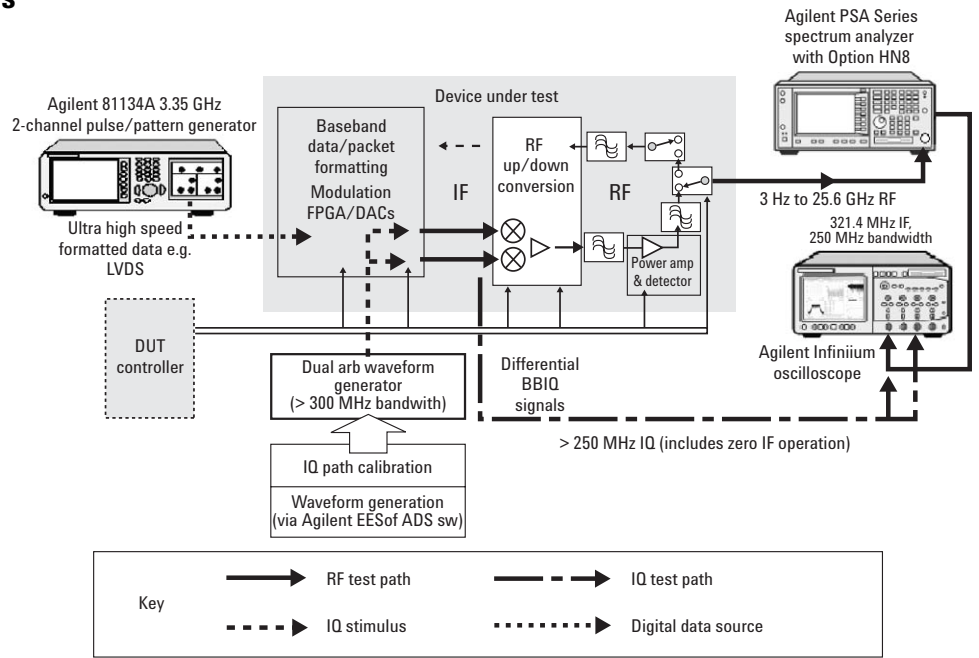


Figure 5. Transmitter test configuration

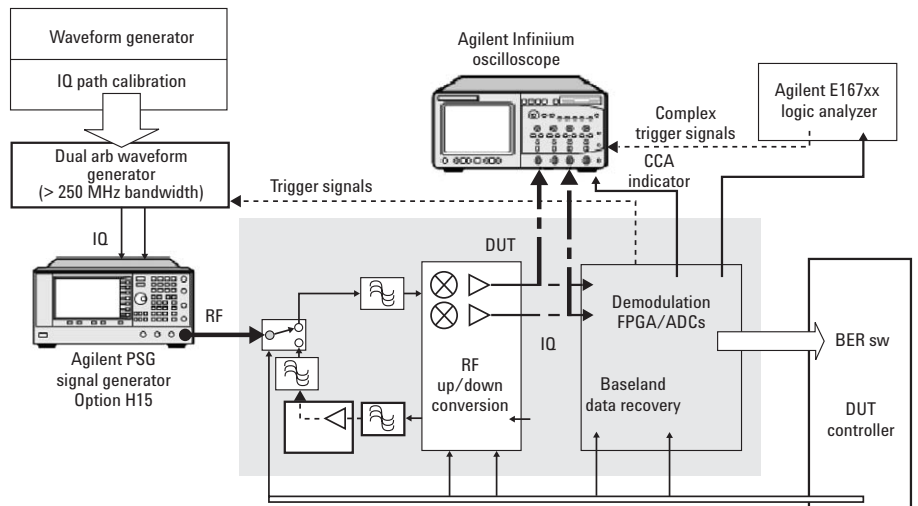


Figure 6. Receiver test configuration

## Additional Configuration Information

PSA Series spectrum analyzer model	Frequency range	Required option
E4440A	3 Hz to 26.5 GHz	* Option HN8 pre-selector bypass for wideband IF output
E4443A	3 Hz to 6.7 GHz	
E4445A	3 Hz to 13.2 GHz	
E4446A*	3 Hz to 44 GHz	
E4448A*	3 Hz to 50 GHz	

\*Pre-selector bypass available only for frequencies below 26.5GHz

Infiniium oscilloscope	Analysis bandwidth	Maximum sampling rate	Standard memory depth (samples)	Optional memory depth (samples)*
54830B/D	0 to 780 MHz	2 GSa/s	2M	4M, 8M
54831B/D	0 to 780 MHz	2 GSa/s	2M	4M, 8M
54832B/D	0 to 1 GHz	4 GSa/s	2M	4M, 8M
54853A	0 to 2.5 GHz	20 GSa/s	256K	1M @ 20 GSa/s 32M @ < 2 GSa/s
54854A	0 to 4 GHz	20 GSa/s	256K	1M @ 20 GSa/s 32M @ < 2 GSa/s
54855A	0 to 6 GHz	20 GSa/s	256K	1M @ 20 GSa/s 32M @ < 2 GSa/s

\*Maximum memory depth recommended

	Required options	Recommended options*
<b>89600 vector signal analysis software</b> Includes models 89601A, 89601AN, 89601N12	Option 200 basic vector signal analysis	* AYA vector modulation analysis
	Option 300 Hardware Connectivity	* B7R WLAN modulation analysis * B7N 3G modulation analysis * 105 link to ADS * B7S 802.16 modulation analysis

\* See 89600 VSA software product literature for additional options.

## Related Literature

*E4440A PSA Series Spectrum Analyzers Brochure*, literature number 5980-1283E

*E4440A PSA Series Spectrum Analyzers Data Sheet*, literature number 5980-1284E

*89600 Vector Signal Analyzer Software 89601A/89601AN/89601N12 Data Sheet*, literature number 5989-1786EN

*89600 Vector Signal Analyzer Software 89601A/89601AN/89601N12 Technical Overview*, literature number 5989-1679EN

*Hardware Measurement Platforms for The Agilent 89600 Series Vector Signal Analyzer Software Data Sheet*, literature number 5989-1753EN

*Infiniium 54830 Series Oscilloscopes Brochure*, literature number 5988-3788EN

*Agilent Infiniium Oscilloscopes Performance Guide Using 89601A Vector Signal Analyzer Software Application Note*, literature number 5988-4096EN

*RF Testing of Wireless LAN Products Application Note 1380-1*, literature number 5988-3762EN

*IEEE 802.11 Wireless LAN PHY Layer (RF) Operation and Measurement Application Note 1380-2*, literature number 5988-5411EN

*Spectral Analysis Using a Deep-Memory Oscilloscope Fast Fourier Transform (FFT). Application Note 1383-1*, literature number 5988-4368EN

*Equalization Techniques and OFDM Troubleshooting for Wireless LANs Application Note AN 1455*, literature number 5988-9440EN

*Extended Calibration Using the Agilent 89600 Vector Signal Analyzer Application Note 1443*, literature number 5988-7814EN

## Related Web Resources

For more information, visit: [www.agilent.com/find/89600](http://www.agilent.com/find/89600)

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Contacts revised: 9/17/04

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Printed in USA, December 10, 2004  
5989-0872EN



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