Component Test Measurement (aka Channel Quality Measurement) 89600 VSA Software

Options 89601201C (Previously as 89601200C), 89601202C and 89601203C

Key Features

- Make group delay measurements using a simple wideband multi-tone stimulus signal
- Import and export the multi-tone stimulus definition from and to Keysight's N7621B Signal Studio
- Calibrate the input stimulus with measured signal data
- Perform simple and repeatable phase and magnitude channel response analysis
- Select from more than 40 Keysight measurement platforms and 400 instrument models to meet your specific design and test goals
- Component test measurement now is part of the 89600 VSA software Option 8960120xC for basic vector signal analysis and hardware connectivity
- Support the advanced component test feature for statistical computation mode to allow you compute the channel response relative to a measured stimulus which requires ordering Option 89601CSDC of stimulus response signal analysis with the feature code 89601CTMC included to enable this advanced feature)
- Support the advanced component test feature for homodyne modulator/demodulator testing to make separate measurement of I/Q impairment portion of channel response which requires ordering option 89601CSDC of stimulus response signal analysis with the feature code 89601CTMC included to enable this advanced feature)
- 89600 VSA introduces three tiered options from VSA2025 U1 release with three different tiered options as 89601201C (Advanced), 89601202C (Standard), and 89601203C (Essential) to cover the capabilities with different Center Frequency (CF), Intermediate Frequency (IF) bandwidth, baseband IQ (BBIQ) bandwidth, and measurement channel limitation (See 5992-4210EN for more details)
- The legacy Option 89601200C as basic core and hardware connectivity can continue to work as advanced tier which has the same capabilities as 89601201C advanced tier

Component Test Measurement
(aka Channel Quality Measurement)

The 89600 VSA software tiered Options 89601200C/89601201C/202C/203C for channel component test measurements accelerate satellite payload testing with a wideband test approach for group delay. Satellite system design engineers can input a multi-tone stimulus to their device, then make quick and easy relative group delay measurements within an instrument span of up to 4 GHz using the UXA signal analyzer, and even wider bandwidth measurements with Keysight oscilloscopes and digitizers. 8960120xC option for component test measurements allows R&D engineers to measure and diagnose problems for signals generated on the test bench, as well as live signals over the air.

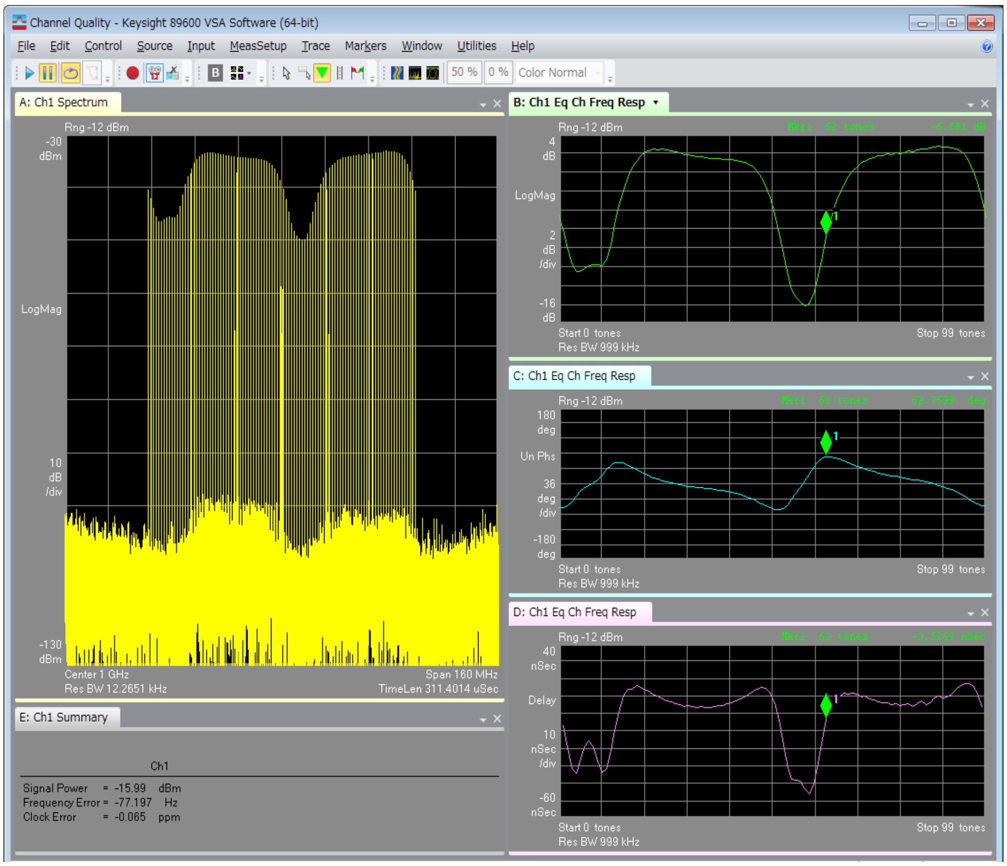


Figure 1. Each tone of a 100 MHz wide multi-tone signal is shown in Trace A (in yellow). Channel frequency response traces are shown to the right, in magnitude, phase and group delay.

Try Before You Buy!

Download the 89600 VSA software and use it free for 30 days to make measurements with your analysis hardware, or use our recorded demo signals.

Request your free trial license today: www.keysight.com/ find/89600_trial

Key Benefits of Options 89601200C/89601201C/202C/203C for Component Test Measurements

- Active channels can be notched out of the stimulus signal
- Source and receiver can be in different physical locations
- Works well with frequency-translating devices
- Measurement algorithms compensate for LO drift

Scalable Measurements Across Various Hardware Platforms

The 89600 VSA software provides seamless connectivity with over 300 Keysight instrument models, enabling a wide variety of solutions to fit the price, form factor, performance, and capabilities needed for your test environment. For example, some series of oscilloscopes enable very high bandwidth phase coherent measurements across multiple channels. On the other hand, much better dynamic range is achieved with some X-Series analyzers. For test environments where space comes at a premium, PXI-based solutions can offer a modular form factor.

Please visit www.keysight.com/find/89600_hardware for more information of 89600 VSA supported hardware.

Figure 2. 89600 VSA Option 8960120xC for component test measurements offers scalable RF and bandwidth performance to meet your specific application needs. Use the software with Keysight X-Series signal analyzers, including the UXA with up to 1 GHz real-time bandwidth. For much wider signal bandwidths, you can leverage Keysight Infiniium oscilloscopes or the M9703B AXIe wideband digitizer.

Why Use a Multi-Tone Stimulus Model?

Traditionally, characterizing component test figures of merit such as group delay has been done using network analyzers with precise methods and cable connections. Design engineers face increasing challenges when it comes to characterizing magnitude, phase, and group delay in passive, active, and frequency-translating devices over ever-wider bandwidths. On the other hand, the multi-tone stimulus test approach offers a simpler test setup and more stable group delay measurements, and thus has been broadly adopted by satellite system engineers. The 89600 VSA software's component test measurement provides many ways to look at a wideband relative channel response, with a set of features for defining multi-tone signals, tracking drifts in frequency, phase, and amplitude. It also offers one-button stimulus definition update and fixed equalization response update functions to quickly eliminate measurement system frequency response variability, so you can focus on and troubleshoot aberrations in the DUT frequency response.

Measurement Example

To highlight the use of this equalizer, we present measured data on a cable at 28 GHz. Often, system impairments such as broadband IQ mismatch and IF gain (un)flatness prevents accurate measurement of a low-loss cable. But by looking at the difference between a straight-through calibration measurement and the actual Device Under Test (DUT), we can isolate the frequency response of just the cable alone. Thanks to built-in algorithms in the VSA, these equalizer corrections may be applied quickly and conveniently, as will be shown below.

First, a multitone signal was created using Keysight's Multitone Distortion Signal Creation bundle (part of the Signal Studio software). With this tool, you can create a multitone signal definition specifying the number of tones, tone spacing (Hz), phase distribution (random, constant, parabolic), center frequency, and amplitude. This stimulus definition can serve as the VSA reference channel response against which you can compare measured signals captured with your receiver front end (signal analyzer or oscilloscope, for example). The resultant waveform file was downloaded to an M8190A Arbitrary Waveform Generator (AWG). The channel 1 and 2 modulation outputs of the AWG were connected to the wideband analog I and Q inputs of an E8257D PSG signal generator. Other vector signal generators like the MXG or EXG may also be used. The resultant 28 GHz modulated RF signal was sent to an N9040B UXA signal analyzer, although any broadband receiver (like an oscilloscope) with appropriate frequency range may be used. The measurement block diagram is shown in Figure 3.

Figure 3. Measurement block diagram showing the interconnection between the Signal Studio software, AWG, PSG signal generator and UXA signal analyzer.

First, we measure a through connection, assumed to be lossless. Using the component test measurement personality of the 89600 VSA software, we observe the channel frequency response in different formats such as log magnitude (dB), linear magnitude, unwrapped phase (deg), group delay (ns), real (I), or imag (Q). In hardware, it is challenging to create a perfectly uniform amplitude series of tones across a 1 GHz spectrum at 28 GHz. Thus, the measured channel frequency response is the measurement system impairment, as shown in Figure 4.

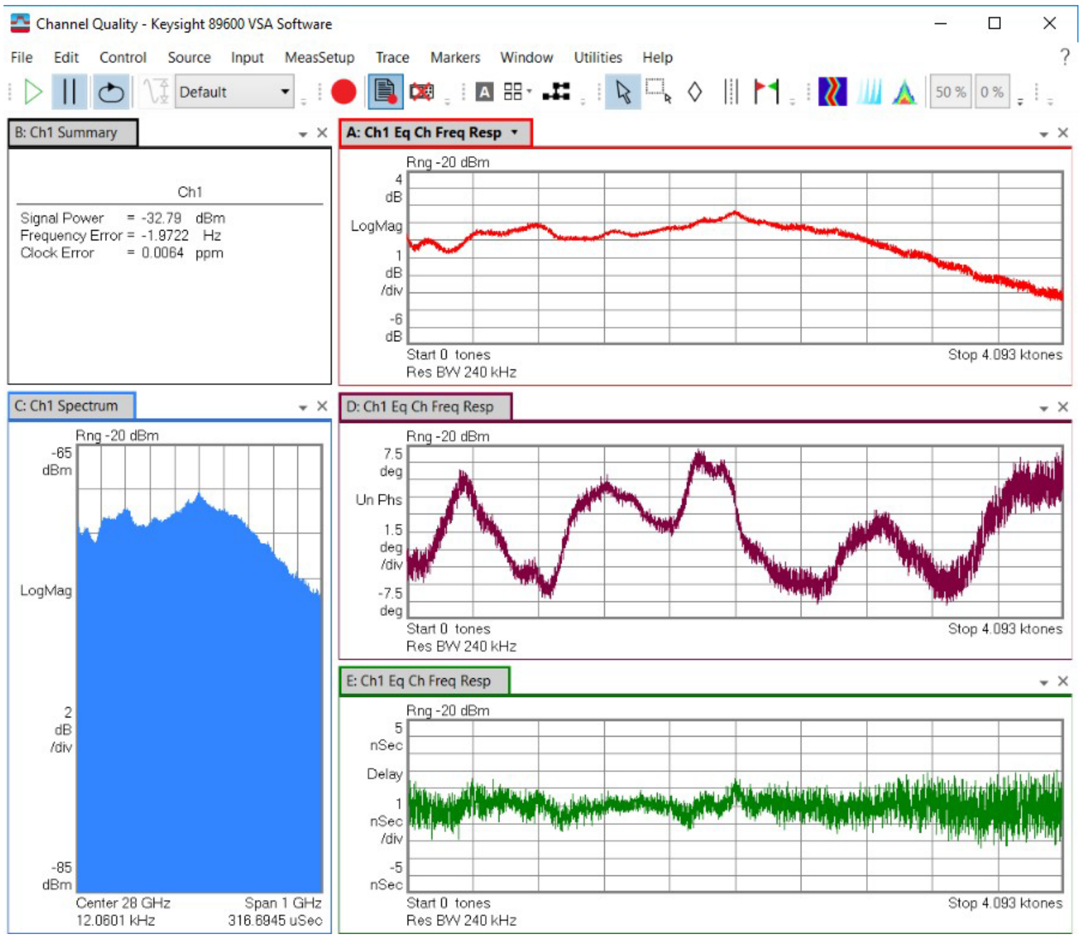


Figure 4. Measurement of a through connection, exposing measurement system impairments across the 1 GHz bandwidth. Trace C shows the densely packed tones in blue. Trace A shows the amplitude variations across tones. Trace D shows the unwrapped phase response and trace E shows the group delay.

If we replace the through connection with the DUT connection (in this case a cable), the resultant measured channel response is not discernible from the system impairments, as shown in Figure 5.

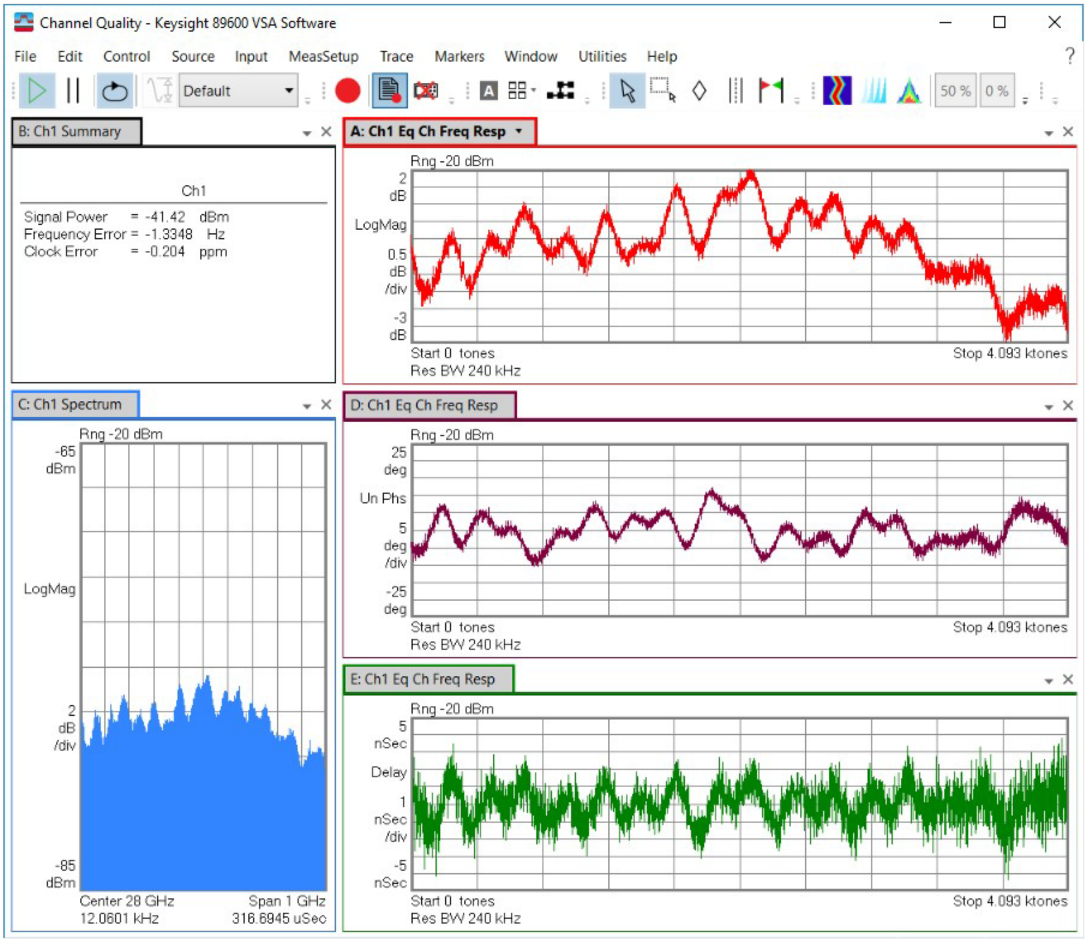


Figure 5. Measured response of system impairments and DUT. Note it is difficult to distinguish between the system impairments in figure 4 and this measurement.

Equalization and Measurement Corrections

We need to compensate for the system impairment frequency response and make subsequent measurements with this correction in place. Fortunately, the VSA enables a convenient way to do this using the “ Component Test Properties” dialogue box, shown in Figure 6.

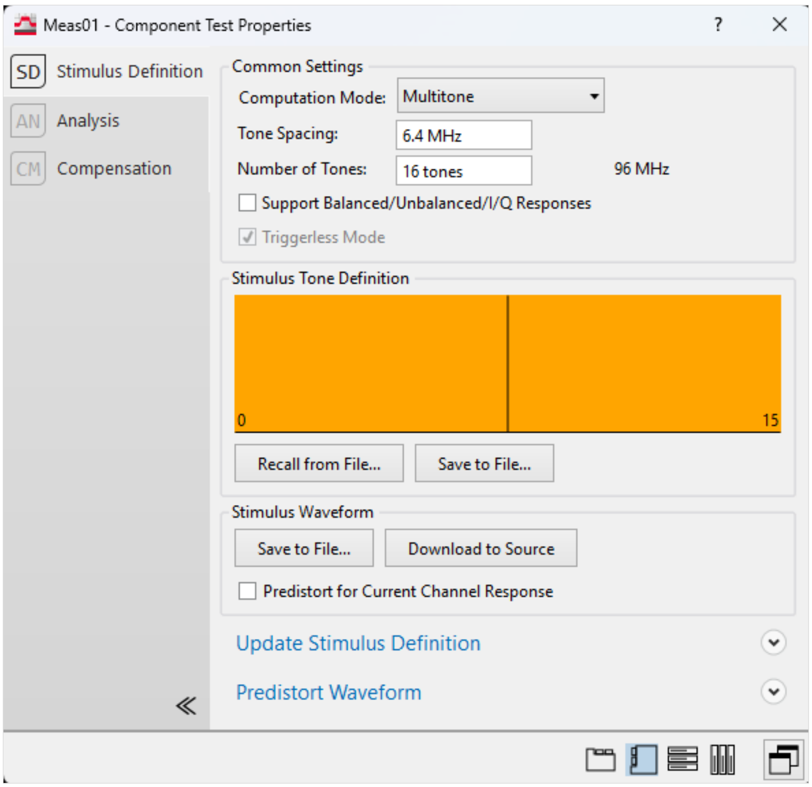


Figure 6. Component Test Properties dialog box. We observe 4094 tones spaced 240 kHz apart, giving an overall bandwidth of 982.32 MHz.

The stimulus definition would normally come from the signal creation software’s ideal multi-tone definition or statistical definition (added with VSA2026). But due to the measured system impairments, we may redefine the stimulus definition by hitting the ‘Update’ button shown in Figure 6. Subsequent measurements are compensated by the stored frequency response. Since the hardware connections have not changed, the resulting channel frequency response is perfectly flat in amplitude and phase, with zero group delay, as shown in Figure 7.

Two computation modes for stimulus are supported

- Multitone mode as the traditional – this is computed based on orthogonal tone correlation
- Statistical mode (added in VSA2026) – this uses the signa statistics instead of tone-by-tone correlation which provides more general results for non-ideal or wideband signals. It provides two kinds of references with ideal stimulus or measured stimulus

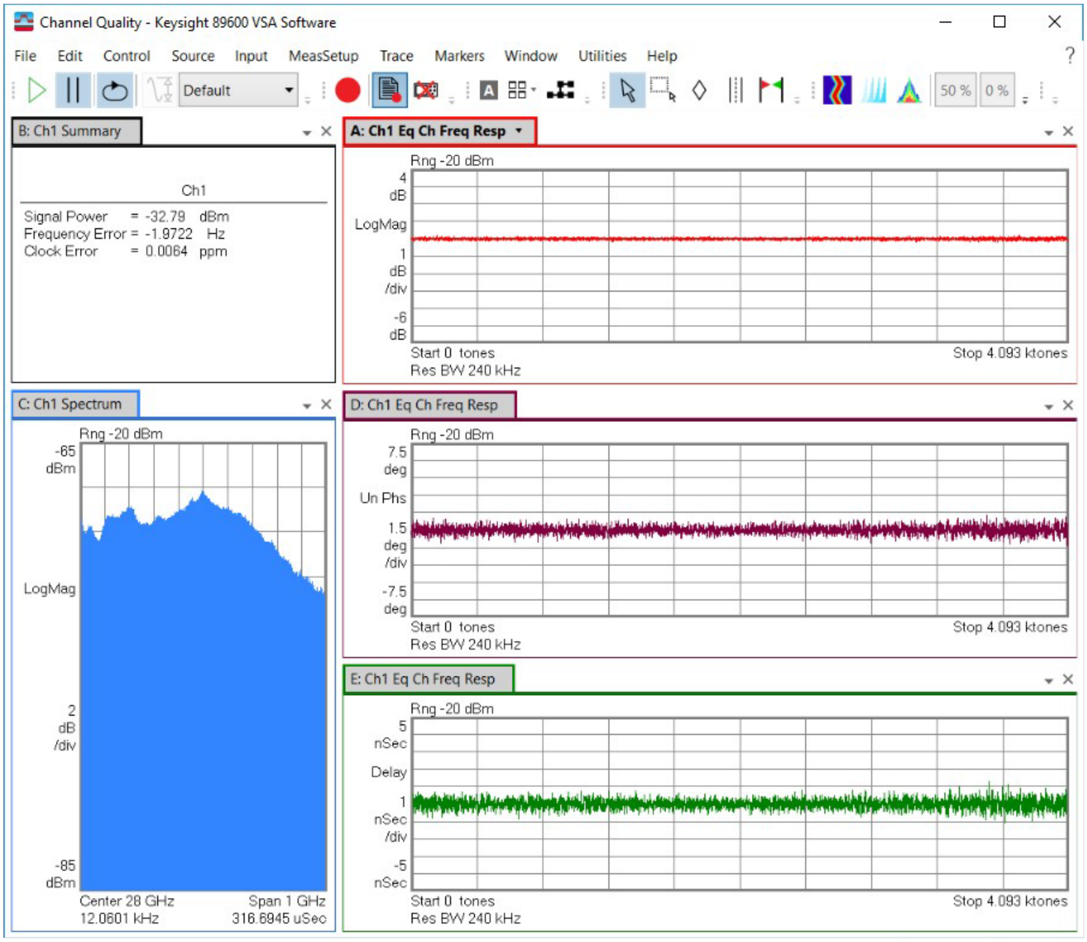


Figure 7. Channel frequency response measurement after equalization, showing flat log magnitude, phase and group delay.

With the updated stimulus definition, we may measure the channel frequency response of a cable, as shown in Figure 8. This would have been impossible had we not corrected for the system impairments. The data show a ripple in measured amplitude response, or standing wave ratio, caused mostly by the difference in mismatch loss between the through-line cable and our device-under-test cable.

The 89600 VSA software provides multiple mechanisms for applying vector correction and compensation models to measurements. These include measurement specific functionality (as described previously for the Channel Quality measurement), as well as general purpose correction features. For more information about the general purpose features, please refer to the User Corrections or Fixed Equalization topics in the 89600 VSA help.

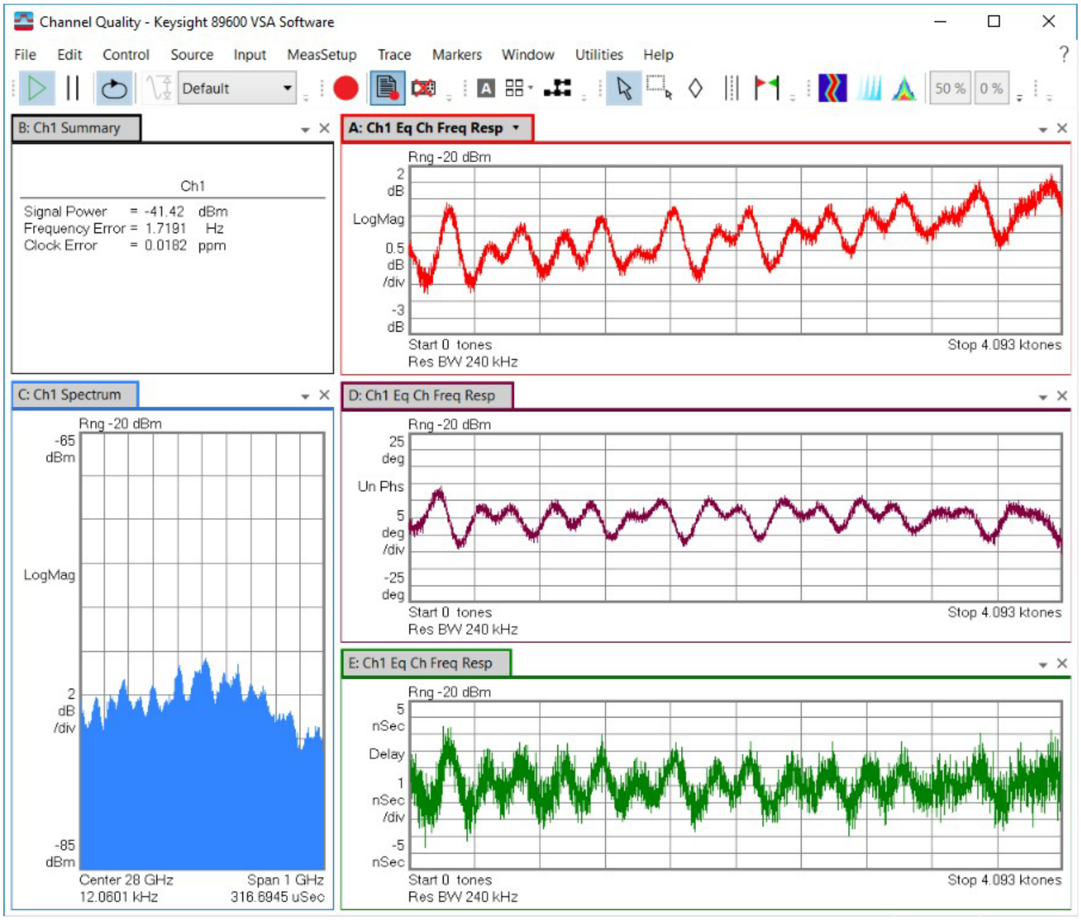
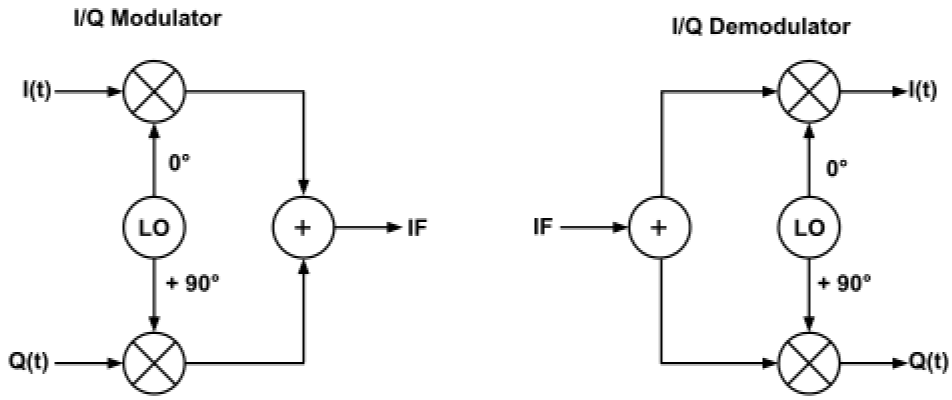


Figure 8. Corrected measured frequency or channel response of the DUT (cable).

Homodyne System Characterization and Correction

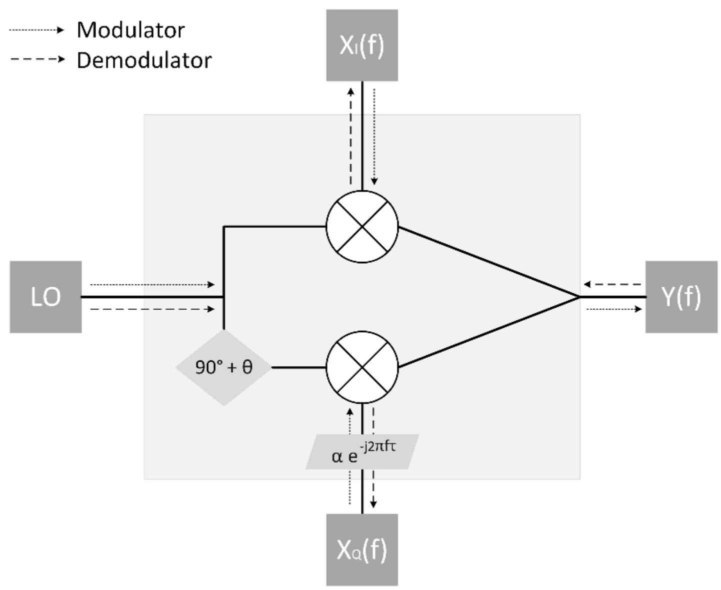


In modern high-frequency communications, homodyne architecture offers valuable simplicity and efficiency but create unique measurement challenges. As bandwidths expand and carrier frequencies climb into millimeter-wave bands, the limitations of traditional static IQ correction become increasingly apparent. The 89600 VSA software with Option 89601200C/89601201C/202C/203C for basic vector signal analysis and hardware connectivity and Option 89601CSDC for stimulus response signal analysis together can provide a powerful solution by characterizing and correcting frequency-dependent distortions across your entire signal bandwidth.

Beyond static parameter compensation

Traditional IQ imbalance correction focuses on three static scalar parameters:

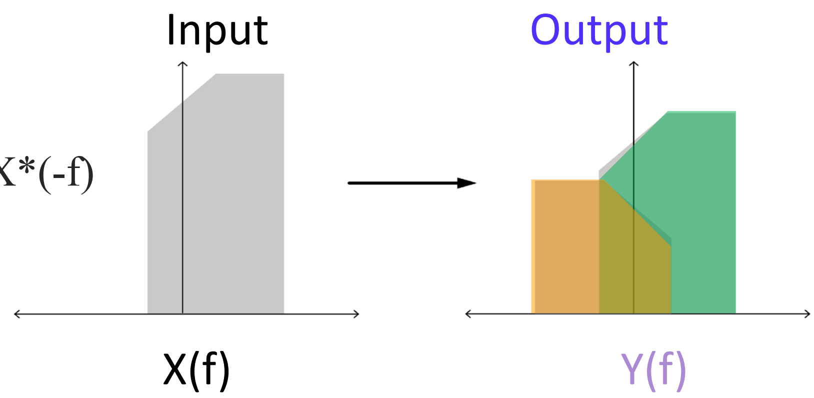
- Amplitude imbalance (α)
- Time skew (τ)
- Quadrature phase error (θ)



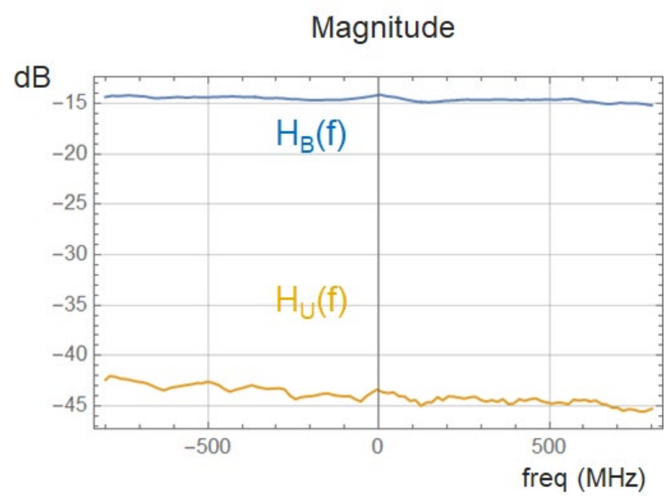
While adequate for narrowband applications, this scalar-based approach becomes increasingly impractical for wideband or high-frequency applications. The fundamental problem: these parameters vary significantly across frequency, making "trial-and-error" optimization ineffective and unable to completely remove distortion effects.

The 89600 VSA software solves this problem by implementing a frequency-dependent system model.

$$Y(f) = H_B(f)X(f) + H_U(f)X^*(-f)$$



Where:



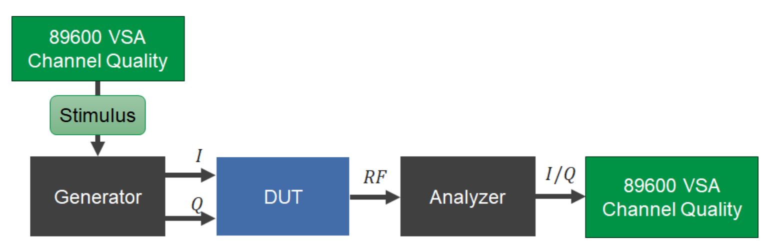
- **H_B(f)** represents the balanced response (capturing everything but I/Q impairments, such as impedance mismatches and reflections)
- **H_U(f)** represents the unbalanced response (specifically capturing effects of IQ impairments)
- *X*(-f)* is the conjugate of the frequency-flipped version of the input signal

Precision measurement workflow

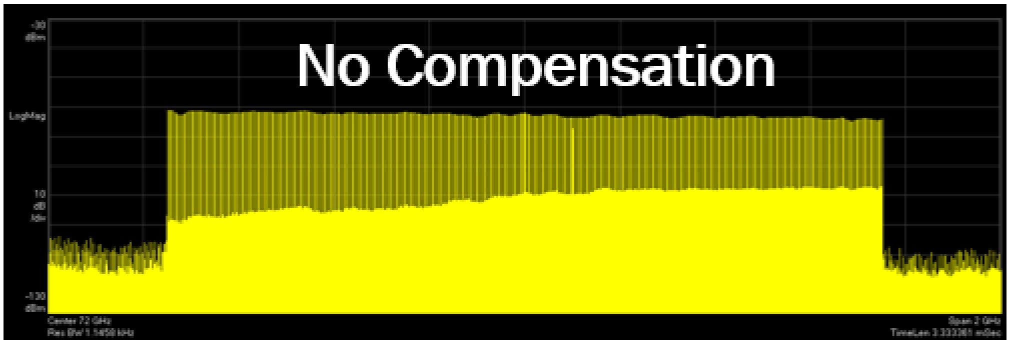
The component test software provides a streamlined workflow that separates characterization from correction:

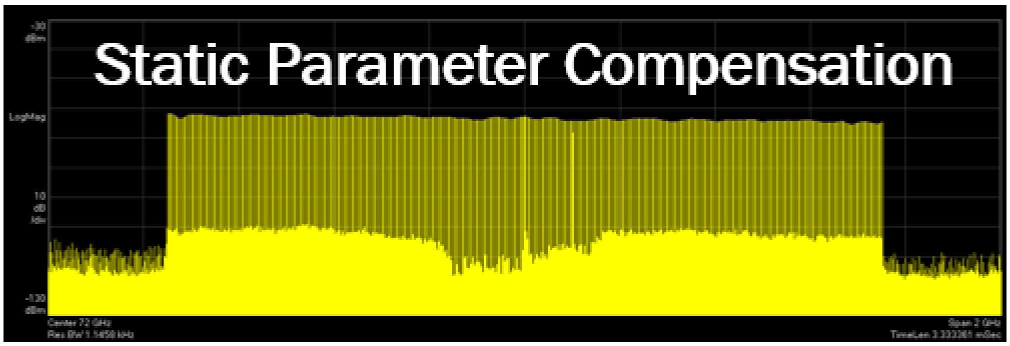
Characterize your Homodyne system

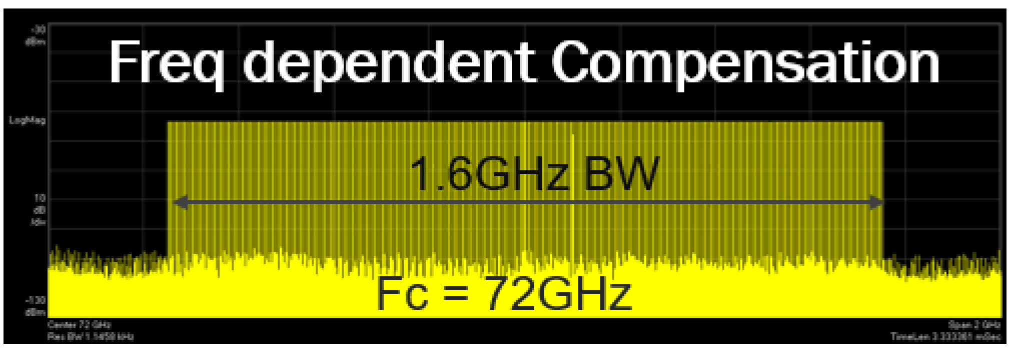
1. **Configure stimulus** - Generate a multi-tone calibration signal covering your bandwidth of interest with precisely controlled tone spacing and phase relationships



2. **Measure system response** - Transmit the calibration signal through your device under test and analyze the frequency domain response
3. **Calculate transfer functions** - The software automatically computes both balanced (H_B) and unbalanced (H_U) frequency response functions







Apply correction

1. **Predistort your signals** - Apply computed correction to any arbitrary waveform using the inverse I and Q system responses
2. **Validate performance** - Measure the EVM and spectral improvements of your corrected signals

The same methodology works for both homodyne transmitters and receivers, providing a consistent characterization approach across your entire RF system chain. For devices with programmable filters, you can even export the inverse I and Q responses directly as filter taps.

For engineers working on next-generation communications systems, these capabilities translate directly into higher data rates, improved spectral efficiency, and more reliable performance — even in the most demanding millimeter-wave applications. The 89600 VSA software's frequency-dependent characterization provides the precision required to push beyond the limitations of traditional approaches, helping you deliver cutting-edge RF system performance when it matters most.

Software Features

Stimulus Definition

Recall from File…	Select a saved multi-tone definition (.txt) file to recall. File format (.txt) is compatible with N7621B “Signal Studio for Multi-tone Distortion” exported multi-tone definitions or N7621APPC/E7621APPC Signal Generation for multitone and Noise Power Ratio (NPR) with Embedded GUI Application exported multi-tone definitions
Computation Mode	Multitone or Statistical (Statistical mode requires the 89601CTMC feature code included with the 89601CSDC option for stimulus response signal analysis)
Reference	For statistical computation mode, choose from Ideal or Measured Stimulus
Tone spacing	Tone spacing in Hz for the current multi-tone definition
Number of tones	Number of tones in the multi-tone definition.
Advanced component test	Support balanced/unbalance/I/Q response and Triggerless Mode for homodyne modulator/demodulator testing (requires 89601CTMC feature code from 89601CSDC option)
Recal from File..	Recall a multi-tone definition (.txt) file.
Save to File..	Save or export a multi-tone definition (.txt) file.
Update stimulus definition	Updates the definition of tones within the current multi-tone definition. Provides options to update from predefined settings or from the current measurement.
Predefined	Defines stimulus tones based on Amplitude and Phase settings, with options for Constant, Parabolic, or Random phase distribution.
From current measurement	Updates the definition of tones based on the current multi-tone measurement. Useful for evaluating different tone notching scenarios or switching between multiple multi-tone signal definitions.
Active/Inactive	Determines which tones in the current definition are active or inactive based on the current measurements and the Detection Threshold value.
Detection threshold	Specifies the tone power level (relative to peak tone power level) to consider a tone as active when auto-detecting tone active/inactive status from the measured waveform.
Magnitude	Replaces the magnitude of all tones in the multi-tone definition to reflect the current measurement results.
Phase	Replaces the phase of all tones in the multi-tone definition to reflect the current measurement results.
Save to File...	Saves a waveform based on the current Multi-tone Stimulus tone definition. This waveform can then be downloaded to a signal generator using PathWave Signal Generation (PWSG) – Advanced Waveform Utility (AWU).

Download to Source	Downloads the stimulus waveform directly to a connected signal generator while preserving other source settings. When used with multi-channel sources, the same waveform is downloaded to all enabled channels.
Predistort for current channel response	Option to precompensate the waveform for the current channel response before downloading or saving. Enables verification that the channel response is being compensated by the computed inverse response.
Predistort waveform	Used to compensate a provided waveform file for the currently measured channel response and save it as another file. Particularly useful for predistorting modulated signals to compensate for IQ impairments.
Input waveform	Opens a dialog to select an input waveform file for predistortion. Only single channel input waveforms are supported.
Output waveform	Opens a dialog to select the destination file path for the predistorted output waveform.
Mode	Specifies how to handle filter settling during predistortion with three options: Circular (for periodic waveforms that repeat), Linear (for bursted waveforms, with truncated settling), or Linear with settling present (keeps settling points but creates longer waveform).
Predistort	Button that applies predistortion to the waveform by reading the input waveform, predistorting it according to the selected mode, and saving to the output waveform path. The channel response is resampled to match the input waveform.
Analysis	
Copy response	Copies the channel response for the selected path to Data Registers. When combined with the Fixed Equalization feature, this simplifies differential channel response measurements or updating the measurement reference plane for the analyzer.
Ch[N] (Destination data register)	Selects the Data Register(s) (D1 to D64) for the channel response to be copied from the specified measurement channel(s). Enables relative channel response measurements when used with Fixed Equalization.
Analysis interval	Sets the amount of time (in seconds) to process for each component test measurement. The number of repetitions of the stimulus signal (periods) is calculated and displayed to the right. A longer analysis interval may be helpful when analyzing relatively noisy signals.
Compute unbalanced response	Determines whether to compute the unbalanced channel response (in addition to the balanced channel response, which is always computed). Enables additional metrics and trace results for measuring IQ impairments, including IQ Offset, IQ Gain Imbalance, IQ Quadrature Error, and IQ Time Skew.
Triggerless mode	Special mode for unbalanced response measurements that affects how the measurement processes the input data when no external trigger is available.

Compensation	
Timing adjust	Allows for compensation of the difference between the sample clock of the measured signal and the sample clock expected from the stimulus definition. Helps correct for minor differences between the transmitter's sample rate and the measurement hardware's sample rate. Even small clock errors (1-3 ppm) can degrade channel response results.
Coarse frequency estimation	When selected, attempts to perform frequency offset compensation prior to the component test measurement. Disabling this capability may increase stability and speed of measurements but reduces the tolerance of frequency offset for the component test measurements.
Frequency offset	When selected, enables frequency offset compensation for component test measurements. The analyzer corrects the acquired time data for frequency offset before calculating the channel response. If the center frequency of the multitone stimulus signal varies by more than half of the tone spacing, Coarse Frequency Estimation may need to be enabled.
Phase drift	When selected, enables phase drift compensation for component test measurements. The analyzer corrects the acquired time data for phase drift within the Analysis Interval before calculating the channel response.
Gain drift	When selected, enables gain drift compensation for component test measurements. The analyzer corrects the acquired time data for gain drift within the Analysis Interval before calculating the channel response.
Smoothing interval	Sets the phase and gain drift compensation smoothing interval in seconds. The number of repetitions of the stimulus signal (periods) is calculated and displayed to the right. The allowed values for this property may be quantized based on the period of the stimulus.

Measurement Results, Available In the Main VSA Window

Channel N	Acquisition time, Auto correlation, CCDF, CDF, Correction, Instantaneous Spectrum, PDF, PSD, Raw main time, Spectrum. Standard signal analysis traces available for each measurement channel.
Component test	Channel Frequency Response (log mag, linear mag, wrap phase, unwrap phase, group delay, separate for I and Q components), Inverse channel response, Instantaneous channel frequency response, Stimulus definition, Summary, Tracking response, Coherence, EQ Channel Capacity, Inst Coherence, Inst Eq Channel Capacity, Stimulus Source Frequency Response (Frequency, Impulse, Tracking Response)
Cross channel NxM	Cross Channel Measurements (Coherence, Cross Correlation, Cross Spectrum, Frequency Response, and Impulse Response), only available with multi-channel hardware configuration. Enables analysis of relationships between different measurement channels.

Graph	AM/AM, AM/PM, Gain Compression, Stimulus Time, Response Time, Delta EVM Time. Provides graphical representations of stimulus-response relationships for amplifier/transmitter characterization.
Summary	Signal Power, Frequency Error, Clock Error, Phase Offset/channel (Ch1 as reference), Time Offset/channel (Ch1 as reference), IQ Offset, IQ Quad Error, IQ Gain Imbalance, IQ Time Skew

Key Specifications

This technical overview provides nominal performance specifications for the software when making measurements with the specified platform[1]. Nominal values indicate expected performance or describe product performance that is useful in the application of the product. For a complete list of specifications refer to the measurement platform literature.

General

Frequency	Depends on connected hardware platforms
Trigger types	Free run, external, IF magnitude, frequency mask2
Tone spacing	Depends on connected hardware bandwidth and selected number of tones
Number of tones	2 to 131702

1. Data subject to change.
2. Frequency mask is included with RT1 and RT2 real-time spectrum analysis licenses. It works with UXA, PXA, and MXA X-Series signal analyzers with required hardware. Refer to instrument configuration guides for more detail.

Ordering Information

Software Licensing and Configuration

Flexible licensing and configuration

- **Perpetual:** License can be used in perpetuity.
- **Time-based:** License is time limited to a defined period, such as 12-months.
- **Node-locked:** Allows you to use the license on one specified instrument/computer.
- **Transportable:** Allows you to use the license on one instrument/computer at a time. This license may be transferred to another instrument/computer using Keysight's online tool.
- **Floating:** Allows you to access the license on networked instruments/computers from a server, one at a time. For concurrent access, multiple licenses may be purchased.
- **USB portable:** Allows you to move the license from one instrument/computer to another by end-user only with certified USB dongle, purchased separately.
- **Software support subscription:** Allows the license holder access to Keysight technical support and all software upgrades

Licenses Ordering Information

Option	Title	Description
89601200C (Legacy) 89601201C/89601202C/89601203C (New)	Basic vector signal analysis and hardware connectivity	(One Required) This option provides the foundational vector signal analysis functionality and hardware connectivity necessary for WLAN signal analysis.
89601201C (or 89601200C)	Basic vector signal analysis and hardware connectivity	Advanced vector signal analysis all-inclusive with no frequency, bandwidth limits, up to 64 channels.
89601202C	Basic vector signal analysis and hardware connectivity	Standard vector signal analysis up to 55 GHz center frequency, 2.16 GHz bandwidth, and up to 4 channels support.
89601203C	Basic vector signal analysis and hardware connectivity	Essentials tier up to 8 GHz center frequency, 160 MHz bandwidth, single measurement channel and VSA instance.
89601CSDC	Digital demodulation analysis	Demodulate captured IQ signal with Digital Demod, Custom IQ, or Flex Frame measurements

Software License Types and Terms

Software License Type	Software License	Support Subscription
Node-locked perpetual	SW1000-LIC-01	SW1000-SUP-01
Node-locked time-based	SW1000-SUB-01	Included
Transportable perpetual	SW1000-LIC-01	SW1000-SUP-01
Transportable time-based	SW1000-SUB-01	Included
Floating perpetual (single site)	SW1000-LIC-01	SW1000-SUP-01
Floating time-based (single site)	SW1000-SUB-01	Included
Floating perpetual (regional)	SW1000-LIC-01	SW1000-SUP-01
Floating time-based (regional)	SW1000-SUB-01	Included
Floating perpetual (worldwide)	SW1000-LIC-01	SW1000-SUP-01
Floating time-based (worldwide)	SW1000-SUB-01	Included
USB portable perpetual	SW1000-LIC-01	SW1000-SUP-01
USB portable time-based	SW1000-SUB-01	Included

For time-based licenses, KeysightCare support is included. For perpetual licenses, KeysightCare support subscription may be purchased using the following model numbers. For example, a one-month

One Month Software Support Subscription Extensions

Support Subscription	Description
SW1000-SUP-01	Perpetual KeysightCare support (1 month to 60 months)
SW1000-B2S	Back to KeysightCare support fee (Perpetual support only, one time fee) Minimum of 12 months required for a renewal

You can upgrade!

All 89600 VSA Software options can be added after your initial purchase and are license-key enabled. For more information, please refer to www.keysight.com/find/89600_upgrades

Keep Your 89600 VSA Up-to-Date

With rapidly evolving standards and continuous advancements in signal analysis, the 89600 VSA software with valid 89601200C, 89601201C, 89601202C or 89601203C KeysightCare support subscription can offers you the advantage of immediate access to the latest features and enhancements available for 89600 VSA software. Refer the VSA Configuration Guide (5990-6386EN) for more details.

Additional Resources

Literature

- 89600 VSA Software, Brochure, literature number 5990-6553EN
- 89600 VSA Software, Configuration Guide, literature number 5990-6386EN
- 89600 VSA Software basic vector signal analysis and hardware connectivity option with 89601200C, 89601201C, 89601202C, 89601203C Technical Overview, literature number 5992-4210EN

Web

- www.keysight.com/find/89600_trial