# Agilent
# Infiniium Oscilloscopes
# Performance Guide
# Using 89601A Vector Signal
# Analyzer Software

Product Note

Ultrabroadband vector signal
analyzer measurements using
Agilent Infiniium oscilloscopes.

# Table of contents

# 1 Overview

This product note describes the characteristics, setup and operation of an ultrabroadband vector signal analyzer (VSA) comprised of an Infiniium 54800 series oscilloscope and the 89601A vector signal analyzer software. By taking advantage of the layered architecture and extensive digital signal processing (DSP) routines of the 89601A VSA software, the oscilloscope becomes a new "front end" data acquisition subsystem for the VSA. This hardware-software combination provides up to 1.56 GHz of analysis bandwidth depending on the scope used. See Table 1 for the supported oscilloscope models and the corresponding analysis bandwidths. Appendix A contains suggestions for ultrawideband downconverters.

The 8-bit, high sample rate analog-to-digital converter (ADC) in the Infiniium oscilloscopes produces the large analysis bandwidths shown in Table 1. These bandwidths are capable of providing a spurious-free dynamic range greater than or equal to 40 dB. This is sufficient for 1.5–2% error vector magnitude measurements in most cases. For spectrum measurements with higher dynamic range, a traditional spectrum analyzer should be used.

**Table 1. Infiniium oscilloscopes supported by 89601A VSA software**

| Model | Analysis bandwidth | Max. sample rate | Main Time memory (samples) |
|---|---|---|---|
| 54810A | 0-390 MHz | 1 GSa/s | 32 K |
| 54845A/B | 0-1.56 GHz | 4 GSa/s | 64 K |
| 54846B | 0-2.225 GHz | 8 GSa/s | 64 K |
| 54830B | 0-780 MHz | 2 GSa/s | 2 M (2 M, 4 M, 8 M opt) |
| 54831B | 0-780 MHz | 2 GSa/s | 2 M (2 M, 4 M, 8 M opt) |
| 54832B | 0-1.0 GHz | 4 GSa/s | 2 M (2 M, 4 M, 8 M opt) |

## 1.1  89601A VSA software

The 89601A vector signal analyzer software is the heart of the ultra-broadband VSA. This software provides flexible tools for analyzing and demodulating even the most advanced digital modulations, including those not defined by an established standard.

The VSA makes measurements on signals in the time and frequency domains using either the BB (baseband) or IF Zoom mode. In BB mode, the analysis frequency range is from 0 Hz to the stop frequency. In IF Zoom mode, the analysis frequency range is defined by center frequency and span. There is also an I+jQ mode for analyzing two baseband quadrature channels. Results for any mode can be displayed as magnitude or phase, in I/Q and several other formats.

With the optional digital demodulator, Option AYA, modulation quality measurements in the form of error vector magnitude (EVM) can be made on digital wireless communications signals with bandwidths of hundreds of MHz. In addition, powerful diagnosis capabilities allow you to determine the exact impairments that cause a digitally modulated signal to fail quality standards.

The features of the digital demodulator include variable-block-size signal acquisition, pulse burst edge search, synch word search and a user-controllable adaptive equalizer.

User-selectable filter types include cosine (raised and square-root raised), Gaussian, lowpass and user defined. You can vary the filter alpha/BT shape factor. Supported modulation formats for both burst and continuous carriers include FSK, BPSK, QPSK, OQPSK, DQPSK, $\pi$/4DQPSK, 8PSK, QAM (16 to 256) and MSK.

In addition, the 89601A software provides a signal record feature for later playback and analysis.

## 1.2  Required 89601A software revision

The VSA capabilities described in this product note require 89601A VSA software version 3.0 to operate. See Section 4.7, "Differences from 89610A VSA operation" for capabilities that are different from, or not available with, the ultrabroadband VSA described in this product note.

## 1.3  Required Infiniium scope firmware revision

The 54846B, 54845A/B and 54810A scopes must have firmware version Rev. 3.50 or later. For LAN connection, the firmware must be A.4.0 or later and the following hardware upgrades must be installed:

- If the scope serial number prefix is less than US3844, order hardware/software upgrade E2633-68701.
- If the prefix begins with US3845, order hardware/software upgrade E2633-68703.
- If the prefix begins with US3919, no hardware upgrade is needed.

The 54830B, 54831B, and 54832B firmware must be A.01.03 or later. No hardware upgrade is required for LAN connectivity.

# 2 Software configuration

## 2.1 Installing and launching the 89601A VSA software

Install the 89601A VSA software by following the instructions on the Install Wizard. Select **Install VSA Software**. When the Installation options window opens select Full Installation with LAN and GPIB I/O.

For detailed software installation instructions, see the *Agilent Technologies 89600 Series Vector Signal Analyzers Installation and Service Guide* (part number 89600-90015), included on the installation CD.

# 3 Hardware configuration

## 3.1 I/O between computer and scope

Connect the scope and the computer as shown in Figure 1a or 1b. There are two options for the connection, GPIB and LAN. Refer to Appendix B for more information on the LAN cable, the GPIB cable and the GPIB interface cards.

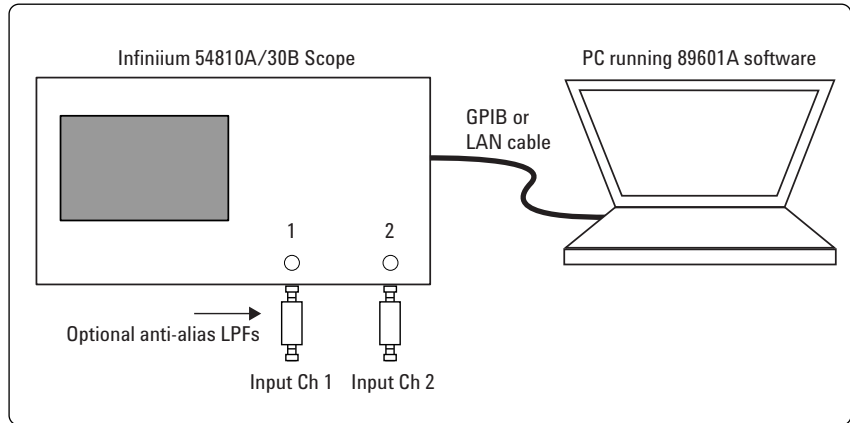LAN is recommended with deep memory scopes (54830B/54831B/54832B).



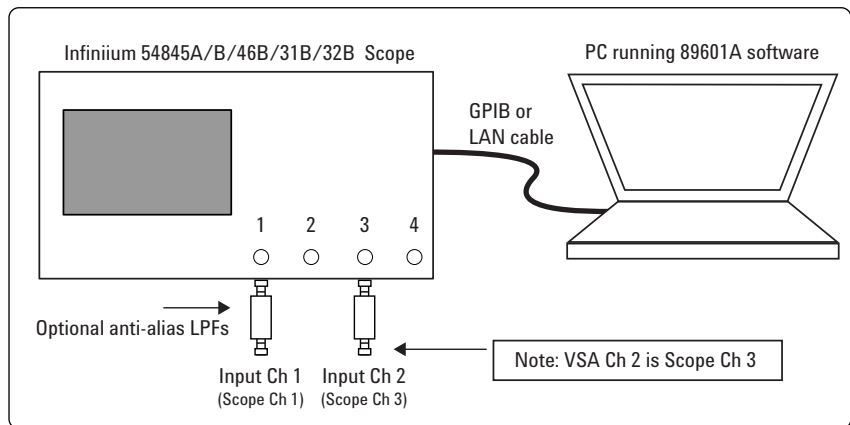**Figure 1a. Equipment connections for 54810A and 54830B scopes**



**Figure 1b. Equipment connections for 54845A/B, 54831B, and 54832B scopes**

### 3.1.1 GPIB installation

Install the GPIB interface card according to its instructions. Verify that the Agilent I O Libraries are installed and the revision number is K.01 or greater. (The I O Libraries can be installed during the installation of the 89600 series software.) You can check the revision number from the IO icon in the lower right toolbar on the desktop. Select **I O**, then **About Agilent IO Libraries Control**.

Verify that the GPIB interface is active and configured by selecting the **I O toolbar**, then **I O Config**. If a GPIB interface does not appear on the right-hand box, select the GPIB interface from the left-hand box and click **OK**.

Run VISA Assistant to confirm that the instrument shows up in the list of instruments by clicking on the **IO** icon, then click **Run VISA Assistant** (or **Start, Programs, Agilent I O Libraries, VISA Assistant**). The instrument should be listed in the left side of the VISA Assistant window as something like <VISA Interface Name>::18::INSTR. (The VISA Interface Name will be GPIB0 or something similar.)

If the scope doesn't appear in VISA Assistant, try removing the GPIB interface and re-installing it. To do this, click the **I O** icon, then **Run I O Confide**. In the right-hand box, highlight the GPIB interface and click **Remove**. Select the GPIB interface from the left-hand box and click **OK**. Check VISA Assistant until the scope appears.

### 3.1.2   LAN interface installation

Ensure that the IP addresses for your computer and scope are compatible, then configure the LAN (local area network) interface by following the steps below. The IP address consists of four groups of numbers separated by periods (for example, 192.192.192.25).

1. If your computer is connected to a local area network, have your network administrator assign an IP and Gateway address for the scope that will work with your computer.

2. Set the scope's IP address: With a mouse connected to the scope before power-up, click on the mouse icon, then click **File, Network, Properties, Configuration**. Scroll down to the TCP/IP icon that shows your scope's Ethernet card. Select it and click **Properties**. Select the **IP Address** tab and select **Specify an IP address**. Enter the IP and Gateway address assigned by the administrator. Click **OK, OK**.

3. Determine the scope's Remote SICL Address Name: With the scope's keyboard connected, press **Ctrl+Esc**. Use the scope's mouse to navigate to the IO Library. Select **Start, Programs, Agilent I O Libraries, I O Config**. Select **VISA LAN Client** and **Configure**. Note the VISA GPIB interface's SICL Address Name. For example, VISA Name **GPIB0** may have SICL Address Name **hpib7** or **gpib7**. This name will be used in step 9c.

NOTE:  If a keyboard in not available, try both **hpib7** and **gpib7** for the Remote SICL Address Name in step 9c.

4. If your computer is not on a local area network and you will be connecting directly to the scope using a crossover cable, perform these steps:

    a. Determine the IP address for your computer by clicking **Start, Run**. Type **cmd** and click **OK**. At the DOS prompt, type **ipconfig** and press **Enter**. If an IP address is listed, leave it and continue with step b. If an IP address is not listed, go to step c.

b. Set the IP address on the scope so that the first three sections of the IP address are the same as that of the computer, and the last section is 1 greater. (For example, if the computer IP address is 192.192.192.25, set the scope's IP address to 192.192.192.26.) To change the scope's IP address, press **System, Config I O, IP address**, type the new address using the number keypad, and press **Enter**. Continue with step 5.

c. Find the IP address for the scope by following step 2 above. Set the IP address for the computer so that the first three sections are the same as for the scope, and the last section is one lower. (For example, if the IP address of the scope is 10.10.10.10, set the computer address to 10.10.10.9.) For Windows NT®, right-click **Network Neighborhood**, click **Properties, Protocols, TCP/IP Protocol, Properties, Specify an IP address**. For Windows® 2000, right-click **My Network Places**, click **Properties**, right-click **Local Area Network**, click **Properties, Internet Protocol (TCP/IP), Properties, Use the following IP address**. Type the address in the box, using periods (.) to separate the sections.

d. Click in the **Subnet Mask** box. Accept the default numbers that appear. Click **OK** and close all dialog boxes.

e. Reboot your computer.
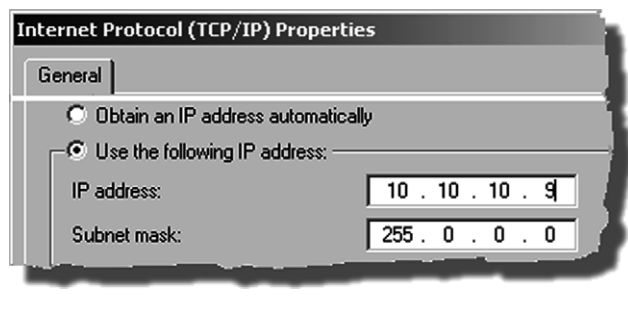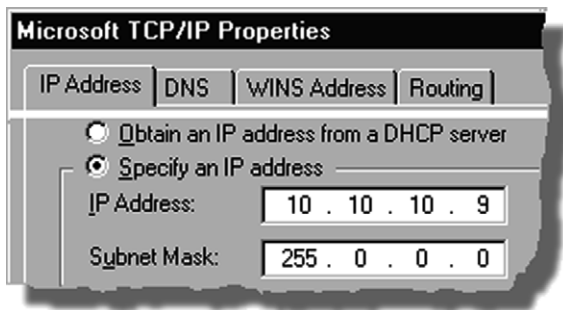
5. Be sure that both the scope and your computer are connected to the LAN, or connect a crossover cable between the computer and the scope.

6. Run the Agilent IO Libraries IO configuration tool on the computer. Click the **IO** icon in the task bar, then click **Run IO Config** (or click **Start, Programs, Agilent IO Libraries, IO Config**). A list of installed interfaces will appear.

7. Remove any previously installed interfaces. The names should appear as:

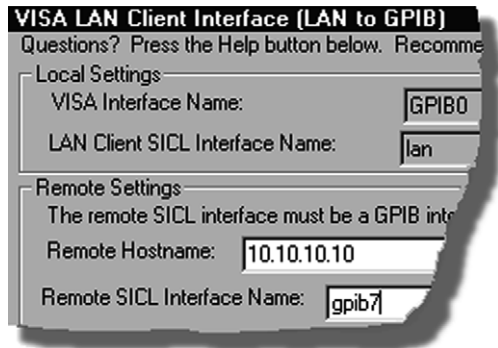| SICL name | VISA name |
|-----------|-----------|
| lan       | n/a       |
| n/a       | GPIB1     |

8. Setup the LAN Client.

   a. Click **LAN Client, Configure**.
   b. Leave the default selections in the LAN Client dialogue box.
   c. Remember the name in the SICL Interface Name box.
   d. Click **OK**.

9. Set up the VISA LAN Client:

   a. Click **VISA LAN Client, Configure**.
   b. Enter the scope's IP address in the Remote Hostname box. (To find the IP address for the scope, follow step 2.)
   c. Change the Remote SICL Interface Name to **hpib7** or **gpib7**, whichever was found in step 3.

NOTE: If a keyboard in not available to find the name in step 3, try both **hpib7** and **gpib7** for the Remote SICL Address Name in step 9c.

   d. Confirm that the entry in the LAN Client SICL Interface Name box matches the interface name that you noted in step 6.
   e. Remember the VISA Interface Name.
   f. Click **OK**, **OK**.

**LAN Client**
Questions? Press the Help button below. Recommended default values are shown.
SICL Interface Name: lan
VISA Interface Name: TCPIP0
Logical Unit: 30
Server Timeout: 120
Client Timeout Delta: 25
☑ Log Errors
Default Protocol
⦿ AUTO (autom

**VISA LAN Client Interface (LAN to GPIB)**
Questions? Press the Help button below. Recomme
Local Settings
VISA Interface Name: GPIB0
LAN Client SICL Interface Name: lan
Remote Settings
The remote SICL interface must be a GPIB int
Remote Hostname: 10.10.10.10
Remote SICL Interface Name: gpib7

10. Run VISA Assistant to confirm that the instrument shows up in the list of instruments.

    a. Click the **IO** icon, then click **Run VISA Assistant**. (or **Start, Programs, Agilent I O Libraries, VISA Assistant**.) The instrument should be listed in the left side of the VISA Assistant window as something like <VISA Interface Name>::18: :INSTR. (The VISA Interface Name will be GPIB0 or something similar.) If the instrument is listed, continue with step d. Otherwise, continue with the next step.

    b. If the instrument does not appear in the list, verify that cables are connected and power is on. Run VISA Assistant again. If the instrument appears in the list, continue with step d. Otherwise, continue with the next step.

    c. If the instrument still does not appear in the list, run **I O Config** again and remove the interfaces you added. Then repeat steps 6 and 7, and run VISA Assistant again.

    d. Close VISA Assistant.

## 3.2 Anti-alias filters and alias-exposure-free mode

The ultrabroadband VSA can be configured to be essentially alias free by using the Full Rate sampling mode and installing an external lowpass filter on the scope input. See Section 4.2 for a description of the sampling modes.

**Table 2. External lowpass filters**

| Scope model | Cutoff | | Part number |
|---|---|---|---|
| 54845A/B, 54832B | 1.2 GHz | Mini-Circuits[1] | LP-1200 |
| 54830B, 54831B | 900 MHz | Mini-Circuits | LP-900 |
| 54810A | 550 MHz | Mini-Circuits | LP-550 |

Use BNC-f to SMA-m and SMA-f to BNC-m adapters to connect the filter's SMA connectors to the scope's BNC connectors.

## 3.3 Selecting the Infiniium scope hardware as the ADC for the VSA

The final step in configuring the ultrabroadband VSA is to select the Infiniium scope as the ADC the software will use. To select an Infiniium scope as the "front end" data acquisition system (ADC1) for the VSA software, click on **Utilities, Hardware** and make selections from the **Hardware** menu as shown below. Only valid scope models detected by the I/O software will be available in the **Hardware** menu. Select a sampling mode by clicking **Configure**, **Sample Mode**, **Edit** in the Select Hardware ADC dialog box.

**Hardware**

| | |
|---|---|
| **Simulate Mode** | **OFF** (unchecked) |
| **ADC1** | **HP/Agilent Infiniium Series Scopes** |
| **Configure** | |
| **Sample Mode** | **Full Rate, Minimize or Maximize** |

See Sections 4.2 and 5 for a discussion of the tradeoffs for the various sampling modes.

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1. Mini-Circuits, Inc., 1-800-654-7949, www.minicircuits.com.

# 4 Operation

## 4.1 Basic operation

Operation of the ultrabroadband VSA is substantially the same as that of the 89610A VSA. See the following sections for some differences or special configurations. There is an online Tutorial and Getting Started Guide under the **Help/Roadmap** toolbar in the 89601A software.

**NOTE: DO NOT adjust any controls on the scope's front panel. All scope operation is controlled by the software. The scope controls cannot be locked, and adjusting them may cause the software to give errors.**

**NOTE:** Calibrate the scope periodically by following its calibration instructions. With a mouse connected to the scope at power on, select **Utilities/Calibrate** and follow the displayed instructions.

## 4.2 Sampling modes: Full Rate, Maximize and Minimize

### Full Rate mode
When the **Sample Mode** is set to **Full Rate** using the **Utilities/Hardware/ HP/Agilent Infiniium Series Scope/ Configure/Sample Mode/Edit** menu path, the scope sample rate is fixed at the maximum for each scope model according to Table 3.

**Table 3. Sample rates of Infiniium scopes in Full Rate mode.**

| Infiniium model | Full sample rate |
|---|---|
| 54846B | 8 GSa/s |
| 54845A/B, 59832B | 4 GSa/s |
| 54810A | 1 GSa/s |
| 54830B/31B | 2 GSa/s |

With the addition of the anti-alias lowpass filter described above, this mode is free of alias exposure zones. This means that no signal anywhere in the range of the VSA's center frequency will alias upon the desired signal and corrupt the measurement.

There is a trade-off when using this mode. The memory in the 54810A and 54845A, limits the measurement time, or **Main Time**, to 32 and 16 µs, respectively. The 54830B, 54831B, and 54832B slopes have deeper memories allowing longer record lengths. If a longer **Main Time** (or **Result Length** for digital demodulation) is needed for more resolution in the frequency domain, go to the **Configure** menu, click on **Sample Mode/Edit** and select either **Maximize** or **Minimize** from the drop-down menu. The **Main Time** limit for any sample rate is shown in the operating region curves below.

Note: Any limitation to **Main Time** (or **Result Length**) will be indicated by the inability of the software to increase the **Main Time or decrease RBW** when **Number of Frequency Points** is increased.

### Maximize mode
When the **Sample Mode** is set to **Maximize**, the sample rate is set by the software to the largest value possible for proper sampling with the selected center frequency/span combination. In this mode, sometimes called IF subsampling, the sample rate is selected to ensure no alias foldover in the desired center frequency/span region.

Depending on the center frequency/ span combination, the IF subsample rate can be less than the full sample rate available in the scope. When it is much less than the full rate, significant increases in **Main Time** are possible. As for the **Full Rate** mode, any limitation of the **Main Time** for proper sampling will be indicated by the inability of the software to increase the **Main Time** when **Number of Frequency Points** is increased.

This mode allows operation in the middle values of **Main Time** (as shown by the operating region curves in Section 5) with the penalty of some alias exposure zones.

Alias exposure zones are those bands of frequencies that, if occupied by an unwanted signal, will alias down into the frequency span of interest and corrupt the measurement. However, **Maximize** mode will spread the out-of-band alias exposure zones away from the desired signal to the greatest degree.

Exposure zones will not be a problem with the majority of measurements of clean, single-signal devices. However, devices with multiple signals or spurious signals could cause problems. See Section 6.1 to find out how to determine if there are any unwanted signals at frequencies that can alias down into the frequency span of the measurement.

While operating in **Maximize** mode caution must be exercised under measurement conditions that change the record length. Changes to record length generally result in changes to the scope's sample rate that, in turn, cause changes in the alias exposure regions, which can adversely affect measurement results.

In addition to changing "Main Time Length" (or "Result Length" in digital modulation analysis operation), here are some other measurement situations that may change record length:

- When taking a recording the 89600 software will generally change the acquisition length to match the desired record length. This may be significantly different from the acquisition length used to set up the recording.
- When entering digital modulation analysis from "Demod Off" the acquisition length is generally changed significantly.
- When changing search length during a digital modulation analysis measurement.
- When changing RBW in non-demod operation. RBW changes have a direct impact on "Main Time Length".

As stated earlier, the primary way to avoid alias problems in these measurement situations is to ensure that the measured signal is band-limited to the frequencies of interest. If this is not possible, then the Alias Checker macro should be utilized to ensure that any alias components do not negatively affect your measurement results.

**Minimize mode**

When the **Sample Mode** is set to **Minimize**, the scope's sample rate is set to the smallest value possible for proper IF subsampling with the current center frequency/span combination. Depending on the center frequency/span combination, the IF subsample rate can be less than the full sample rate available in the scope. When it is much less than the full rate, significant increases in **Main Time** are possible.

**Minimize** mode gives the largest values of **Main Time** on the operating region curves. However, it produces less spreading of the out-of-band alias exposure zones. Use **Minimize** if there are no out-of-band signals and the longest **Main Time** values are desired.

## 4.3 Special trigger modes: traditional low duty cycle hold-off

The trigger parameter *hold-off* has two modes in the VSA software: **Burst** and **Low Duty Cycle**. In the **Burst** mode, hold-off is defined as an amount of time that a pulsed carrier must be off before a trigger event can occur (see the interactive Help tool). The **Burst** mode is selected under **Hardware/HP/Agilent Infiniium Series Scopes/Configure/ Hold-off Type/ Burst,Hi Duty Cycle.** The **Burst** mode definition is optimized for high duty cycle communications bursts and is different from the traditional definition of hold-off for low duty cycle pulses. For low duty cycle pulses, hold-off is defined as a dead time after the trigger event during which no additional trigger events can occur.

To activate the traditional **Low Duty Cycle** pulse hold-off mode, click **Utilities/Hardware/HP/Agilent Infiniium Series Scopes/ Configure/Hold-off Type/Low Duty Cycle, Hold-off**. Enter a time that is longer than the expected duration of the input pulse.

See the interactive Help tool for a complete description of the high duty cycle hold-off. See the scope's Help tool for a description of the traditional low duty cycle hold-off. To activate the traditional **Low Duty Cycle** pulse hold-off mode, click **Hardware/HP/Agilent Infiniium Series Scopes/Configure/Hold-off Type/Low dc Hold-off**. Enter a time that is longer than the expected duration of the input pulse.

## 4.4 Special trigger modes: custom trigger commands

The Infiniium scopes have extensive trigger conditioning and pattern capability. To take advantage of any mode not covered in the ultrabroad-band VSA personality, a custom trigger mode is available. Click **Utilities/ Hardware/HP/Agilent Infiniium Series Scopes/Configure/Channel Trigger Type/Edit** and select **Custom** from the drop-down menu. You can then enter the SCPI commands for specific triggering modes using the custom trigger command entry box. Click **Utilities/ Hardware/HP/Agilent Infiniium Series Scopes/Configure/Custom Trigger Commands/Edit**. Enter the sequence of SCPI trigger commands in the dialog box. Use a semicolon to separate the commands. The commands will be transmitted to the scope upon clicking the last **OK** box when closing the **Configure** windows.

## 4.5 Disabling the scope display

The control and display of the oscilloscope signal is accomplished by the software. However, the scope display can be viewed by using the **Hardware/ HP/Agilent Infiniium Series Scopes/ Configure/Enable Display Updates** menu path to disable or enable the scope waveform display.

## 4.6 Changing the preset conditions

The preset conditions can be changed for the scope by entering SCPI commands in the **Hardware/HP/ Agilent Infiniium Series Scopes/Configure/ User SCPI Preset** menu path. Separate commands with a semicolon. Verify that any commands do not conflict with the normal operation of the software.

## 4.7 Differences from 89601AA VSA operation

- No **Magnitude Trigger** (however, **Channel Trigger** is available)
- Possible limitation of movement on the operating region curve to avoid alias corruption of the measured signal. This depends on the settings of **Center Frequency, Span, Sample Mode** and **Number of Frequency Points**. There is also potential interference due to the alias products of out-of-band signals. (See Section 6.)
- No built-in wideband calibrator. The frequency response corrections are determined from factory data.

# 5 Time and frequency span operating region

This discussion is based on concepts covered in Product Note 89400-12, *Understanding Time and Frequency Domain Interactions in the HP 89400 Series Vector Signal Analyzers* (literature number 5962-9217EN). This product note is included in the installation documentation under the **Program Files/Agilent/89600 VSA/Help** directory**.**

The product note outlines the trade-offs between the measurement setup parameters **Span** and **Main Time**. The interactions are summarized in two forms: equations and an operating region curve below. The operating region curve gives **Main Time** as a function of the current **Span** and **Number of Frequency Points** settings. The **Main Time** parameter is called **Result Length** in the **Digital Demod** measurement mode.

The operating region curves for the ultrabroadband VSAs are different from those of the VSAs of Product Note 89400-12 (the 89410A and 89610A) because the **Main Time** may be limited for some sample rate, center frequency and span combinations. The differences are due to three hardware characteristics of the ultrawideband ADCs in the Infiniium scopes:
- a much higher sampling rate
- the lack of a hardware decimator, which means the decimation must be performed by the software from same-length records taken at much higher sampling rates
- limited memory capacity.

## 5.1 The relationship of Main Time, Span and Sample Rate

The record length, or **Main Time** of a measurement is shown in the lower right corner of a Spectrum or Time display window. This is the length of time the scope sampled the input waveform for the measurement. These samples are transferred to the DSP and measurement algorithms running on the software.

Maximum **Main Time** length is normally adjusted by setting **Number of Frequency Points** in the **MeasSetup/ ResBW** menu **ResBW Coupling is** set to **Auto**, and **ResBW Mode** is set to **Arbitrary** or **1-3-10**. The **Main Time** tab can then be used to set **Main Time** up to this maximum limit. This setup keeps **Main Time** maximized and within the DSP requirements.

Although **Main Time** can be adjusted directly by the **MeasSetup/Time** menu, it cannot be greater than the limit imposed by the **Number of Frequency Points** line on the operating region chart. See the Help Oline tool for a complete discussion.

Note: The maximum **Main Time** length can be found as follows:

The relationship between the param-eters is shown below:

$$Max\ Main\ Time = \frac{Number\ of\ Frequency\ Points}{Span}$$

$$where\ Span = \frac{Sample\ Rate}{1.28}\ \ (for\ IF\ Zoom\ mode)$$

$$Max\ Main\ Time = \frac{1.28\ x\ Number\ Frequency\ Points}{Sample\ Rate}$$

where *Sample Rate* = current sample rate computed by the software for alias-free measurents

Maximum Main Time may be further limited by scope memory depth.

## 5.2 Operating region curves for Infiniium 54810A, 54845A and 54846B scopes

For the Infiniium 54810A, 54845A, and 54846B the fixed 32 K- or 64 K-point memory, respectively limits the **Main Time** record length to about 64 and 16 µs, in the **Full Rate** sampling mode.

The operating region for the full-rate mode is represented by the lowest of the scopes sample rate (heavy dashed) curves in figures 2 and 3. For example, for the 54810A, the full rate curve is labeled 1 GS/s. The alias exposure free zone (shown as a shaded region on the curves) lies below the full rate curve.

In addition to the full-rate operating region, these curves show the operating regions for the **Maximize** and **Minimize** modes. Also shown are the points at which the scope changes sample rates while in these modes.

The range of time record lengths for a given span is represented by an imaginary vertical line that runs from the minimum span (heavy solid) line at the bottom to the number of frequency points (light dashed) line at the top. As the record length changes the scope's sample rate also changes at each of the scope's sample rate (heavy dashed) curves is crossed.

The range of span for a given time record length (or conversely RBW) is represented by an imaginary horizontal line that runs from the minimum span (heavy solid) at the left to the number of frequency points (light dashed) line at the right.

To maintain the record length, as the span changes the scope's sample rate also changes as each of the scope's sample rate (heavy dashed) curves is crossed. Note that the heavy solid line at the far upper right represents the absolute maximum span/time record length combination that can be achieved by the scope based on its hardware implementation.

To increase the **Main Time** beyond the alias free-zone limit, select **Utilities/Hardware/HP/Agilent Infiniium Series Scopes/Configure/Sample Mode/Edit** and either **Maximize** or **Minimize** from the drop-down menu.

In the **Maximize** or **Minimize** sampling mode, the time limit is increased, and alias-free operation is not possible. This means signals outside the measurement span of the desired signal may alias down into this span and corrupt the measurement. Of course, the frequency of an unwanted signal would have to be within the alias exposure zone for this to happen.

This will not be a problem with the majority of measurements of clean, single-signal devices. However, devices with multiple signals or spurious signals could cause aliasing problems. Section 6 describes how to perform a check to see if there are any unwanted signals that can alias down into the measurement span.
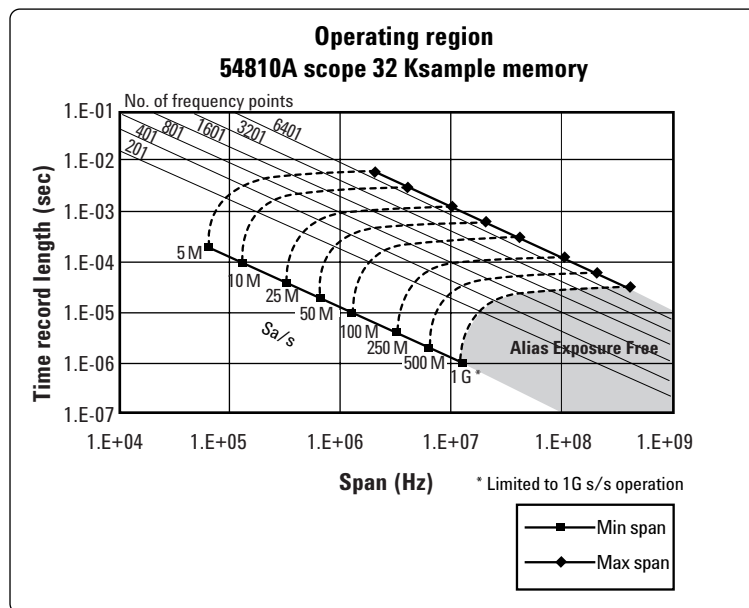


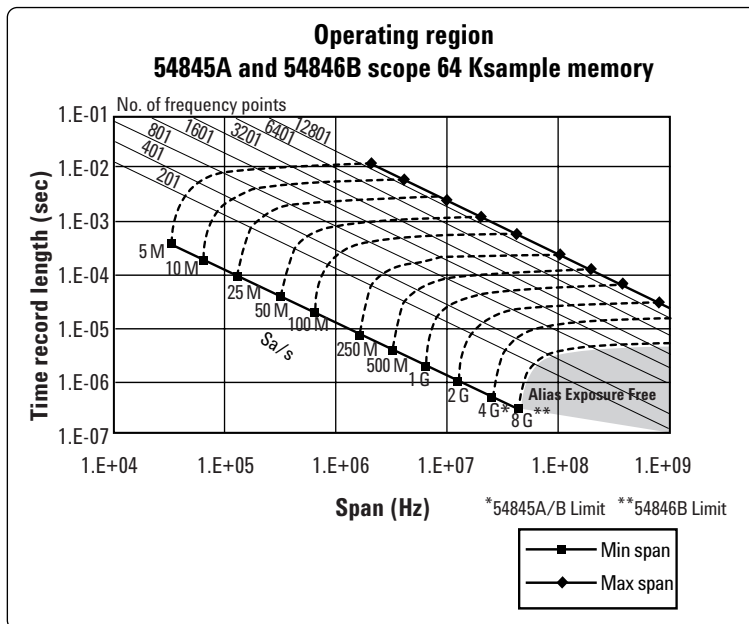**Figure 2. Operating region for 54810A scope**



**Figure 3. Operating region for 54845A/B scope**

## 5.3 Operating region curve for the Infiniium 5483XB scopes

The Infiniium 54830/31/32B scopes have deep memory, which allows greater movment on the operating region curve for the **Full Rate** sampling mode Table 4 shows the limits on **Main Time** for various memory options.

The operating region curve for the 548330/31/32B scopes are shown in Figures 4, 5, and 6.

**Table 4. Time limits versus scope memory**

## Main time limits (µs)

| Memory sample points | 2 M(std) | 4 M(opt) | 8 M(opt) | VSA bandwidth (MHz) |
|---|---|---|---|---|
| **Scope** | | | | |
| 54830B | 1,000 | 2,000 | 4,000 | 0-780 |
| 54831B | 1,000 | 2,000 | 4,000 | 0-780 |
| 54832 | 500 | 500 | 1,000 | 0 to 1000 |
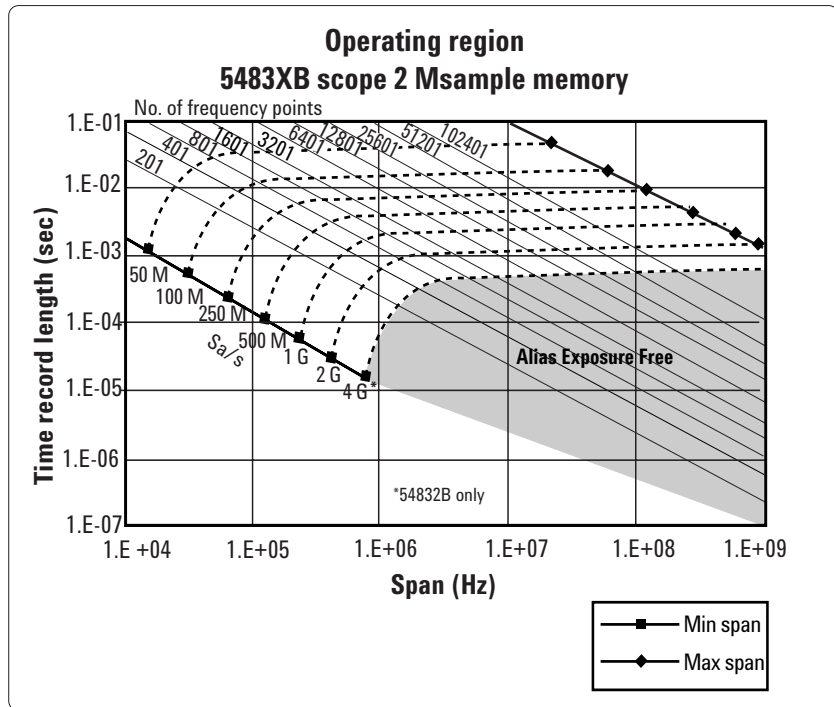


Figure 4. Operating region for 2 M point memory for 5483XB scopes

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**Operating region**
**5483XB scope 4 Msample memory**

No. of frequency points
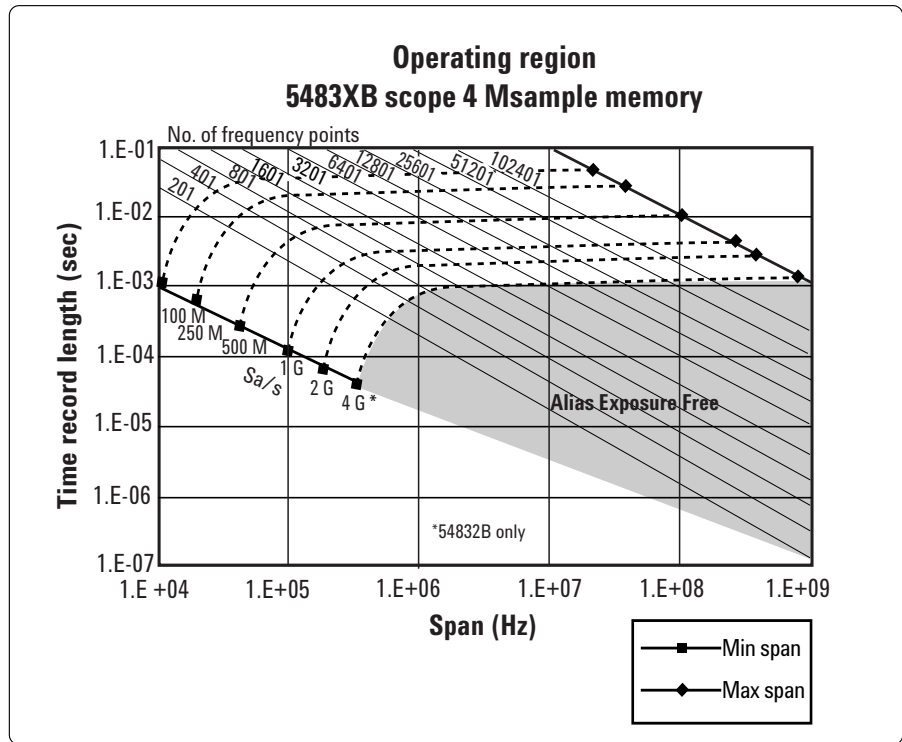
*Figure 5. Operating region for 4 M point memory for 5483XB scopes*

**Operating region**
**5483XB scope 8 Msample memory**

No. of frequency points
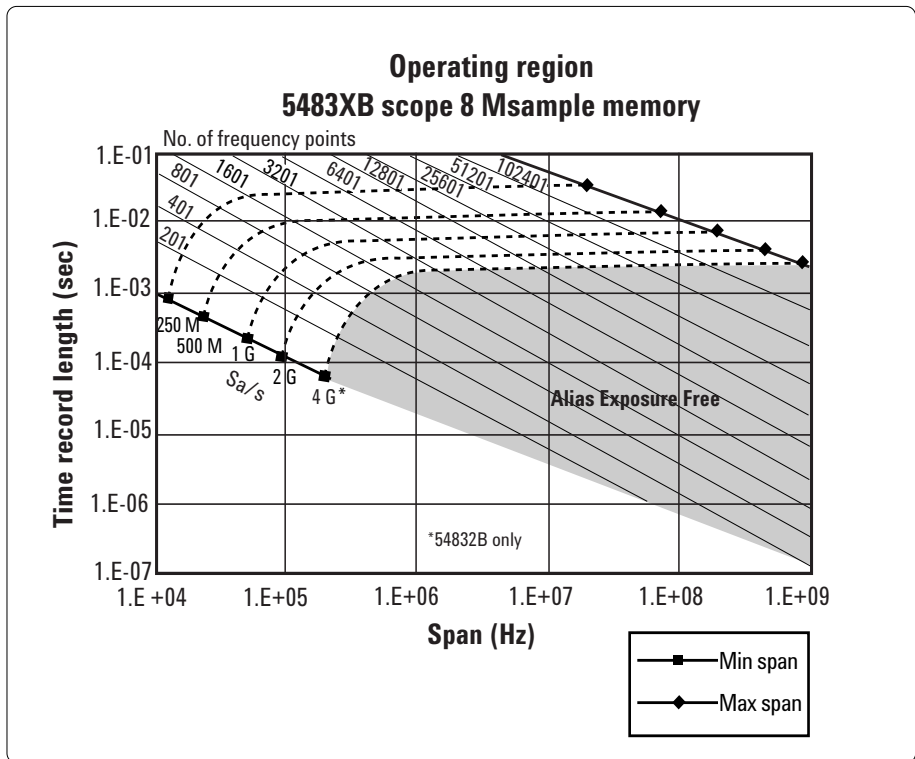
*Figure 6. Operating region for 8 M point memory for 5483XB scopes*

# 6 Out-of-band alias exposure zones

As mentioned above, the **Maximize** and **Minimize** sampling modes increase the maximum **Main Time** length at the expense of possible aliasing of out-of-band signals into the frequency span of the measurement. The spectrum ranges subject to the alias conversion are called alias exposure zones. To determine if any out-of-band signals exist in the exposure zones, run the Alias Exposure Zone Checker macro.

## 6.1 Setting up the Alias Exposure Zone Checker

Follow this procedure for setting up the Alias Exposure Zone Checker:

1. Start the VSA application.

2. Click on **Utilities, Macros, Recall**. Navigate to the **Examples\Macros** subdirectory in the directory where you installed the VSA application (for example, C:\Program Files\Agilent\89600 VSA\Examples\Macros). Select **RecallSetupAfterAliasCheck** and **AliasCheck** files, and click OK.

Right click on the top of the VSA application. You will see a popup showing the various toolbars. Select the **Macros** toolbar. This will make the alias checker icons appear on your VSA application toolbar.

## 6.2 Using the Alias Exposure Zone Checker

The Alias Exposure Zone Checker calculates the frequencies of the alias exposure zones for any combination of center frequency, span and scope sample rate. It then measures the power in each zone and compares it to the power of the desired signal in the span of the measurement setup at the time the checker was started. An unwanted signal in an exposure zone is a source of interference if it is larger than the desired signal's amplitude minus 40 dB. This -40 dBc threshold is approximately the same level as the quantization errors in the scope's 8-bit digitizer, and represents the limit of the scope's dynamic range. The -40 dBc level is sufficient for 1 – 2 % EVM measurements.

Launch the checker macro by using the tool path **Utilities/Macros/Alias Checker** or click its icon (shown below) on the bottom of the tool bar.

When the macro stops, a full-span spectrum trace (Figure 7) will appear in Trace A (green). It shows the desired  signal plus any unwanted signals.  Superimposed is an orange Trace C showing boxes for each exposure zone frequency range. Any unwanted signal falling inside the zone box is a source of alias interference. If the height of any box is higher than the green reference line, the power in that zone is greater than the –40 dBc threshold of interference.

Click **Yes** in the checker dialog box to return to the original measurement setup. Click **No** for further examination of the out-of-band signals. You can return to the original measurement setup by clicking the Recall Setup After Alias Check macro icon.
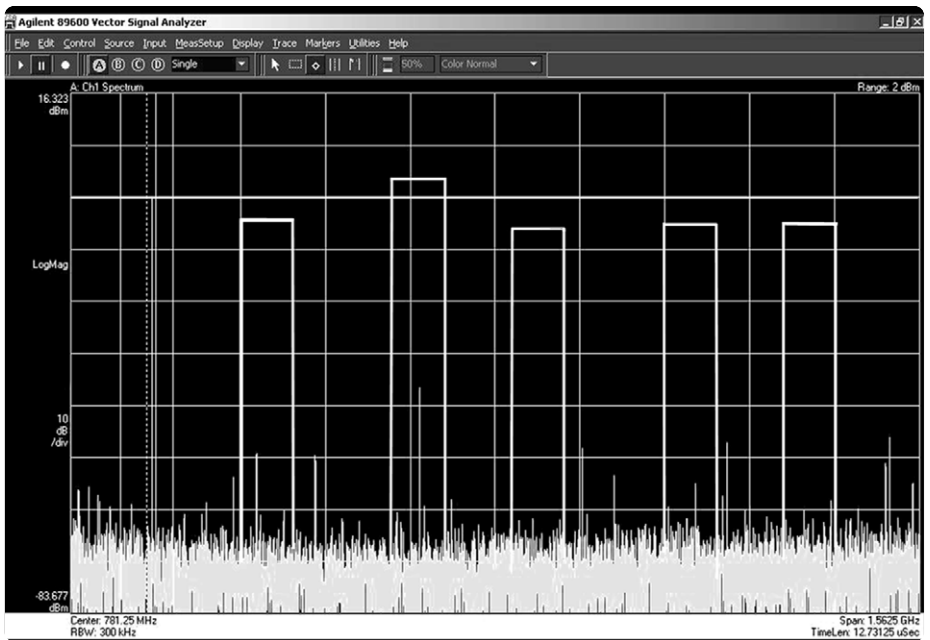


Figure 7.  Alias Exposure Zone Checker results. The desired signal is at 150 MHz and an out-of-band signal is at –35 dBc and 642 MHz. The unwanted signal in the 2nd alias zone is 5 dB above the –40 dBc threshold line.

When no alias zones exist because the current sampling mode is alias free, no orange zone boxes will appear. In addition, the message **No Alias Zones Detected! Restore Initial Settings?** will appear (see Figure 8).
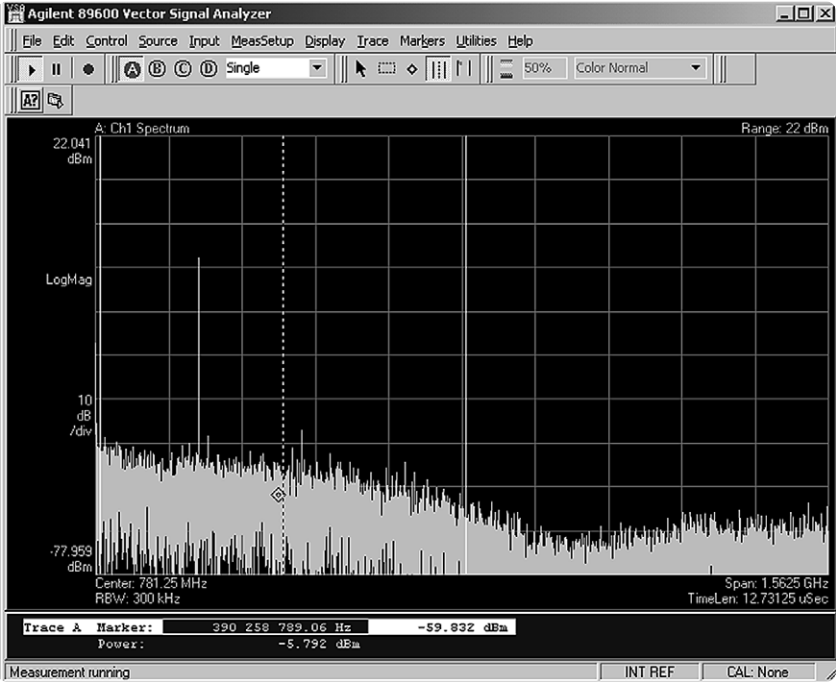


**Figure 8. Alias checker results when no zones are detected. No orange alias zone boxes appear.**

When the original center frequency/ span is inadvertently tuned to an alias response of a signal whose frequency is not the center frequency, the checker will attempt to suggest the signal's frequency. The checker results at the desired center frequency location (box formed by white solid and dashed lines) will show no signal, and a large signal will appear in one of the zones, as shown in Figure 9. Further, all zone boxes will be well above the green threshold line.
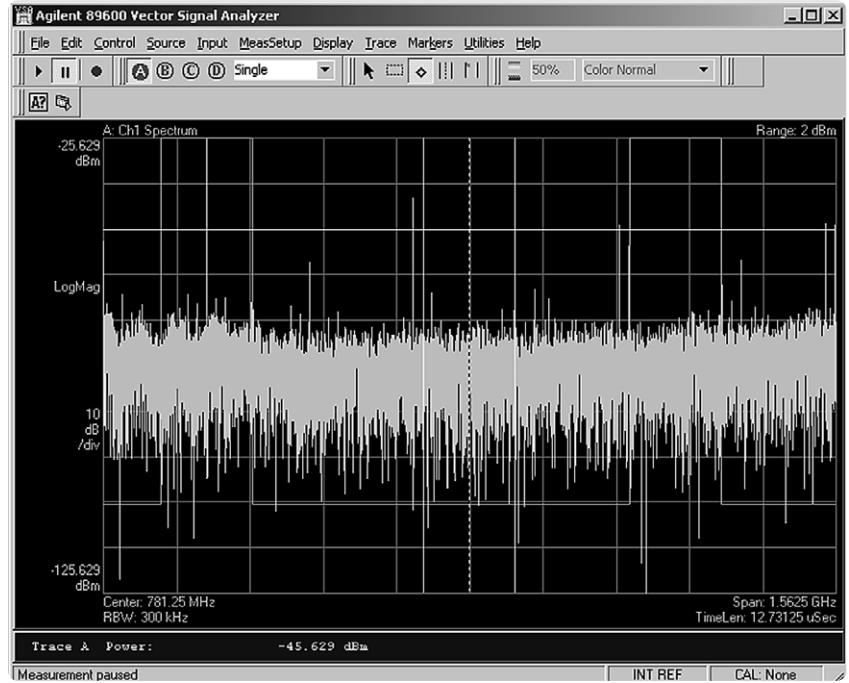


**Figure 9. Alias checker results when the center frequency is originally tuned to an alias product. The checker shows no signal at the desired frequency (white solid/ dashed box) and large zone boxes at the zones containing the desired signal.**

# Appendix A
Downconverting RF
and microwave signals
into the range of the
Infiniium oscilloscopes

External components with
wide bandwidths can be used to
downconvert signals into the range
of the ultrabroadband VSAs.

The 89601A VSA software can
account for the mixing equation of the
external downconverter. While the
downconverter cannot be controlled
by the software, the downconverter's
input center frequency, IF bandwidth,
external bandwidth and IF mirroring
can be taken into account by using
the **Utilities/Calibration/External
Frequency** menu picks. See the Help
text for further details on using the
external frequency tool.
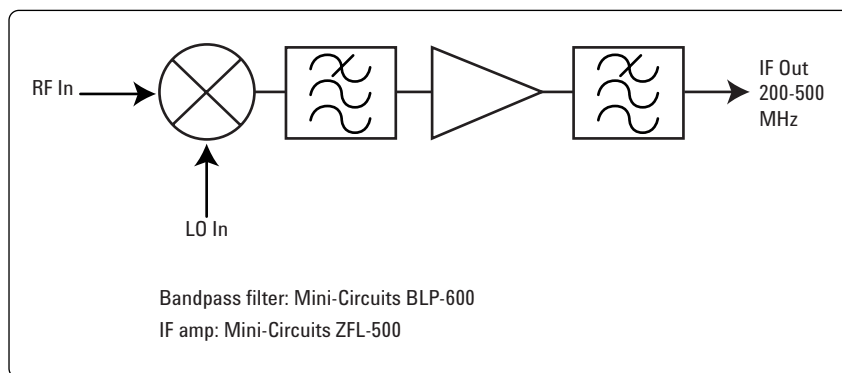


**Figure 10.  Block diagram of suggested downconverter.  See Table 4 for further details.**

**Table 5. External wideband downconverter details**

| RF range | Mixer | LO | IF amp | Remarks |
|---|---|---|---|---|
| 0 – 390, 780 or 1560 MHz (see Table 1) | | None | None | Use scope Ch 1 or Ch 3 (VSA Ch 2) |
| 0.2 – 6 GHz | Marki [2] M2-0006MA | 16 – 19 dBm $F_{LO} = F_{RF} - F_{IF}$ | Mini-Circuits [3] ZFL-500 $F_{IF} = 200 - 500$ MHz | Mxr: CL = 8 dB, TOI = 18 dBm, Amp: gain = 20 dB, NF = 5.5 dB, TOI = +18 dBm |
| 5 – 40 GHz | Marki M9-0540IN | 3 – 17 dBm $F_{LO} = F_{RF} - F_{IF}$ | As above | Mxr: CL = 8 dB, TOI = 16 dBm |
| 26.5 – 40 GHz | Agilent 11970A | 15 dBm $F_{LO} = (F_{RF} - F_{IF})/8$ F=0-1 GH$_3$ | As above | 8th harmonic waveguide mixer. Mxr: CL = 22 dB, TOI = 15 dBm |
| 33 – 50 GHz | Agilent 11970Q | 15 dBm $F_{LO} = (F_{RF} - F_{IF})/10$ $F_{IF}$=0-1 GH$_3$ | As above | 10th harmonic waveguide mixer. Mxr: CL = 24 dB, TOI = 15 dBm |

# Appendix B
Cables and I/O cards
for connecting a PC
to an Infiniium scope

**Table 6. PC interfaces and connection cables**

| Description | Part number | Notes |
|---|---|---|
| PCMCIA GPIB card | 778034-02 | For laptop PCs. Comes with 2-meter GPIB cable. Available from National Instruments. |
| PCI GPIB interface card | 82350 | For desktop PCs. Requires GPIB cable (10833A). Available from Agilent. |
| 1-meter GPIB cable | 10833A | Available from Agilent. |
| LAN cross-over cable | 8121-0545 | Available from Agilent. |

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2.  Marki Microwave, **http://www.markimicrowave.com/m9-0540.htm**; Telephone: 408-778-4200, FAX: 408-778-4300, 215 Vineyard Court, Morgan Hill, CA 95037
3.  Mini-Circuits, Inc., 1-800-654-7949, 44-1252-83600, **http://www.minicircuits.com.**

## Appendix C
## PC requirements to run 89601A software

The 89601A requires a PC connected via GPIB or LAN I/O to the Infiniium scope. Either a laptop or desktop PC may be used as long as it meets or exceeds the following minimum requirements [4]:

- \> 300 MHz Pentium or AMD-K6 256 MB RAM (512 MB recommended for use with 1 MB memory 54830 scopes)
- 4 MB video RAM (8 MB recommended) hard disk with 100 MB of available space

- Microsoft® Windows 2000 or NT 4.0 (service pack 5, or greater required)
- CD ROM drive (can be provided via network access), 3.5 inch floppy disk drive (can be provided via network access)
- GPIB interface

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4. For best immunity from electrostatic discharge (ESD), use a desktop PC.

## For more information

For more product literature visit
www.agilent.com/find/89600

## Related literature

Agilent 89600 Vector Signal Analyzers,
installation CD, literature number
5980-1989E

Agilent Technologies 8900 Series
Vector Signal Analyzers Installation
and Service Guide, part number
8900-90015

Understanding Time and Frequency
Domain Interactions in the Agilent
Technologies 89400 Series Vector
Signal Analyzers, literature number
5962-9217EN

**Agilent Technologies**