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

Application Note

Ultra-broadband vector signal
analyzer measurements using
Agilent Infiniium oscilloscopes.

Agilent Technologies

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1 Overview

This product note describes the characteristics, setup, and operation of an ultra-broadband 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 6.0 GHz of analysis bandwidth depending on the oscilloscope used. See Table 1 for the supported oscilloscope models and the corresponding analysis bandwidths. Appendix A contains suggestions for ultra-wideband 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 to 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 to 390 MHz	1 Gsa/s	32 K
54845A/B	0 to 1.56 GHz	4 Gsa/s	64 K
54846B	0 to 2.225 GHz	8 Gsa/s	64 K
54830B/D	0 to 780 MHz	2 Gsa/s	2 M (4 M or 8 M opt)
54831B/D	0 to 780 MHz	2 Gsa/s	2 M (4 M or 8 M opt)
54832B/D	0 to 1.0 GHz	4 Gsa/s	2 M (4 M or 8 M opt)
54833A/D	0 to 780 MHz	2 Gsa/s	500 K[1] (4 M or 8 M opt)
54853A	0 to 2.5 GHz	10 Gsa/s	250 K (32 M opt)
54854A	0 to 4.0 GHz	20 Gsa/s	250 K (32 M opt)
54855A	0 to 6.0 GHz	20 Gsa/s	250 K (32 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 89601A-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.

1. 54833D main time memory (samples) is 2 M.

1.1 89601A VSA software, continued

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, π/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 4.00 or newer to operate (4.1 for 5485x oscilloscopes). See Section 4.7, "Differences from 89601A VSA operation" for capabilities that are different from, or not available with, the ultra-broadband VSA described in this product note.

1.3 Required Infiniium oscilloscope firmware revision

The following table lists the firmware revision, by model number, for an oscilloscope to work with the 89601A software. GPIB and LAN refer to the choice of connections between the oscilloscope and the PC running the software. Firmware version numbers greater than these will also work.

Table 2. Firmware revision numbers

Model #	GPIB	LAN
54810A [1]	A.03.50	A.04.00
54845A [1]	A.03.50	A.04.00
54845B	A.04.35	A.04.35
54846A [1]	A.03.50	A.04.00
54846B	A.04.35	A.04.35
54830B/D	A.02.20	A.02.20
54831B/D	A.02.20	A.02.20
54832B/D	A.02.20	A.02.20
54833A/D	A.03.10	A.03.10
54853A	A.03.10	A.03.10
54854A	A.03.10	A.03.10
54855A	A.03.10	A.03.10

Infiniium 54800 series oscilloscope upgrade firmware revisions can be ordered, with free shipping, from:
http://software.cos.agilent.com/infiniium.

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1. If the serial number prefix is less than US3844 order hardware/software upgrade E2633-68701. If the serial number prefix begins with US3845, order hardware/software upgrade E2633-68703. Models with serial number prefix lower than US3919 can use GPIB only.

2 Install 89600 VSA Software

Insert the Agilent 89600 Vector Signal Analyzers Installation CD-ROM and follow the instructions in the installation wizard.
1. When the Installation Manager window opens, click **Install Agilent 89600 VSA.**
2. In the Installation Options window, select **Full Installation** (supports hardware and external computer).
3. After the software is installed, exit the Installation Manager window.

3 Hardware Configuration

Connect the oscilloscope 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 oscilloscopes (5483x/5485x).
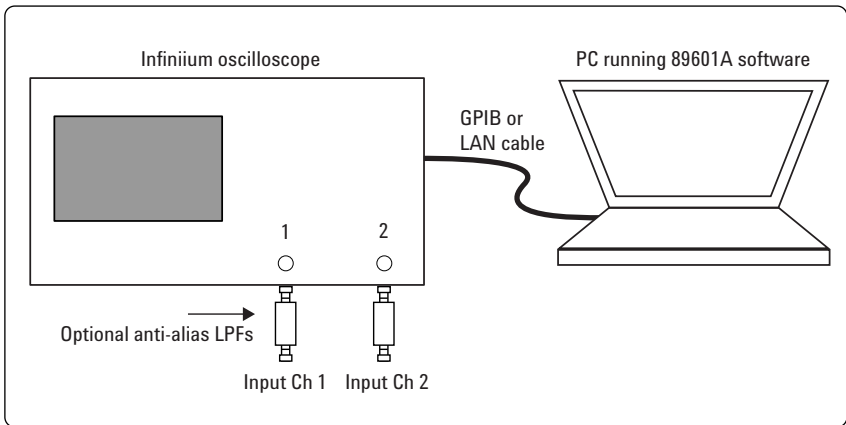
3.1 I/O between computer and oscilloscope

Figure 1a. Equipment connections for 54810A, 54830, and 54833 oscilloscopes
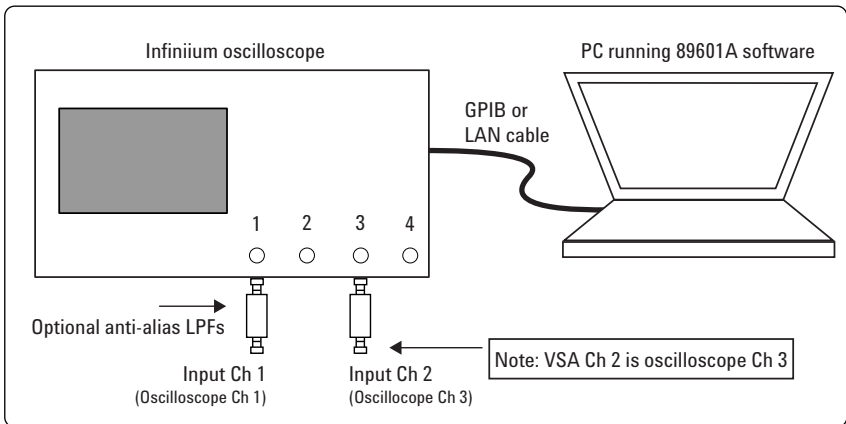

Figure 1b. Equipment connections for 54845, 54831, 54832, 54853, 54854, and 54855 oscilloscopes

3.2 Anti-alias filters and alias exposure-free mode

The ultra-broadband VSA can be configured to be essentially alias-free by using the Full Rate sampling mode and installing an external lowpass filter on the oscilloscope input.

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

Table 3. External lowpass filters

Oscilloscope model	Cutoff	Part number
54845A/B, 54832	1.2 GHz	Mini-circuits[1] LP-1200
54830, 54831, 54833	900 MHz	Mini-circuits[1] LP-900
54810A	550 MHz	Mini-circuits[1] LP-550
54846, 54853	2400 MHz	Mini-circuits[1] LP-2400

4 Operation

4.1 Basic operation

Operation of the ultra-broadband 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 oscilloscope's front panel. All oscilloscope operation is controlled by the software. The oscilloscope controls cannot be locked, and adjusting them may cause the software to give errors.

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

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1. Mini-Circuits, Inc., 1-800-854-7949, **www.minicircuits.com**.

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

Full Rate mode

When the Sample Mode is set to Full Rate using the **Utilities/Hardware/ADC1 /Infiniium Series Oscilloscope/Configure/Sample Mode/Edit** menu path, the oscilloscope sample rate is fixed at the maximum for each oscilloscope model according to Table 4.

Table 4. Sample rates of Infiniium oscilloscopes in Full Rate mode

Infiniium model	Full sample rate
54846B	8 Gsa/s
54845A/B, 54832	4 Gsa/s
54810A	1 Gsa/s
54830/31/33	2 Gsa/s
54853A	10 Gsa/s
54854/54855A	20 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 5483x and 5485x oscilloscopes 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 oscilloscope. When it is much less than the full rate, significant increases in Main Time are possible. As with 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 oscilloscope'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 oscilloscope'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 oscilloscope. 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.
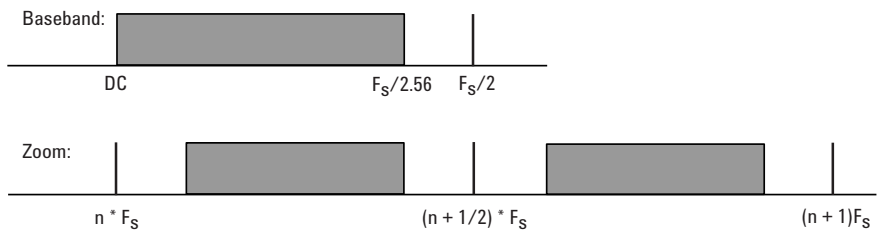
User Rate mode
The User Rate setting allows you to directly control the oscilloscope's sample rate. In this mode you select the oscilloscope sample rate to be used. The actual sample rate selected will be the highest rate that is less than or equal to the "User Sample Rate" setting. By controlling the oscilloscope's sample rate you can directly influence the update rate of the VSA. This is because sample rate directly affects the number of points the oscilloscope must transfer to the PC. Certain measurements can be made significantly faster by limiting the oscilloscope sample rate due to reduced data transfer requirements.

There are two types of signal aliasing to be concerned with when using the 89601 VSA application with the Infiniium oscilloscope. The first is aliasing of unwanted out-of-band signals into the measurement span. This will not be a problem with the majority of clean, single-signal devices. However, devices with multiple or spurious signals could have this type of aliasing. Section 6 describes how to perform a check to determine if there are any unwanted signals present that can alias down into the measurement span. A second type of aliasing happens when the sample rate causes the in-band signal to fold over on itself. This in-band (or self-) aliasing is avoided in Full Rate, Maximize and Minimize mode by automatically selecting a suitable sample rate. However, in User Rate in-band aliasing may be a problem. To avoid in-band aliasing you must select a suitable sample rate based on your measurement center frequency and span.

To avoid in-band aliasing the oscilloscope sample rate (F_S) must be selected so that the analysis span falls within confined regions. Staying within these regions prevents the analysis span from being positioned too close to $F_S/2$. When F_S is selected so that the span is confined to be within a single gray box (see diagrams below), in-band aliasing is avoided. See the following table for the equations that describe these in-band alias-free regions.

Figure 2. Avoiding in-band aliasing by selecting Fs within a confined span

The primary use of User Rate mode is to increase the update rate for measurements that have been carefully engineered to avoid unwanted alias signals.

CAUTION: The VSA does not attempt to avoid alias exposure regions when in User Rate mode.

This table summarizes the difference in approach to alias protection between the various sample modes:

Table 5. Varying approaches for alias protection

Full Rate	Both in-band and out-of-band aliasing are prevented through use of an appropriate low-pass filter.
Maximize and Minimize	In-band aliasing is avoided by VSA software making appropriate sample rate selection based on the center frequency and span settings. Out-of-band aliasing is minimized through use of appropriate low-pass filter. Use of Alias Checker macro (Section 6) is required to detect other unwanted out-of-band signal aliasing. (Note: aliasing of unwanted signals can be eliminated through use of appropriate band-pass filter.)

User Rate	You are responsible to avoid in-band aliasing through appropriate selection of sample rate based on center frequency and span. To ensure no in-band aliasing is present the oscilloscope sample rate (FS) must be selected to meet this criteria:
	
	Baseband: $F_S/2.56 \leq F_{STOP}$
	
	Zoom: $(n*F_S)/2 \leq F_{CENTER} - (1.28 * F_{SPAN})/2$
	  AND
	  $((n+1)*F_S)/2 \geq F_{CENTER} + (1.28 * F_{SPAN})/2$
	  where n = 1,2,3,4...
	
	Out-of-band aliasing is minimized through use of appropriate low-pass filter. Use of Alias Checker macro (Section 6) is required to detect other unwanted out-of-band signal aliasing. (Note: aliasing of unwanted signals can be eliminated through use of appropriate band-pass filter.)

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 **Utilities/Hardware /ADC1/Infiniium/Configure/Hold-off Type/Edit/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/ADC1/Infiniium/Configure/Hold-off Type/Edit/Low Duty Cycle**. 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 oscilloscope's Help tool for a description of the traditional low duty cycle hold-off.

4.4 Special trigger modes: Custom trigger commands

The Infiniium oscilloscopes have extensive trigger conditioning and pattern capability. To take advantage of any mode not covered in the ultra-broadband VSA personality, a custom trigger mode is available. Click **Utilities/Hardware/ADC1/Infiniium /Configure/Custom Trigger Type/Edit** and click the **check box**. You can then enter the SCPI commands for specific triggering modes using the custom trigger command entry box. Click **Utilities/Hardware/ADC1/Infiniium/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 oscilloscope upon clicking the last **OK** box when closing the Configure windows.

4.5 Changing the preset conditions

The preset conditions can be changed for the oscilloscope by entering SCPI commands in the **Hardware/ADC1/Infiniium/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.

4.6 Differences from 89601A 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

The operating region curves for the ultra-broadband VSAs are different from those of standard VSAs because the Main Time Length may be limited for some sample rate, center frequency, and span combinations. The differences are due to three hardware characteristics of the ultra-wideband ADCs in the Infiniium oscilloscopes:
- 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 Length, Span, and Sample Rate

The record length, or Main Time Length of a measurement is shown in the lower right corner of a spectrum or time display window. This is the length of time the oscilloscope 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 Time tab can then be used to set Main Time Length up to this maximum limit. This setup keeps Main Time Length maximized and within the DSP requirements.

Although Main Time Length 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 online Help tool for a complete discussion.

Note: The maximum Main Time Length can be found as follows:

The relationship between the parameters is shown below:

$$\text{Max Main Time Length} = \frac{\text{Number of frequency points}}{\text{Span}}$$

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

$$\text{Max Main Time Length} = \frac{1.28 \times \text{Number frequency points}}{\text{Sample rate}}$$

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

Maximum Main Time Length may be further limited by oscilloscope memory depth.

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

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 oscilloscopes sample rate (heavy dashed) curves in Figures 3 and 4. For example, for the 54810A, the full rate curve is labeled 1 Gsa/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 oscilloscope 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 angled) line at the top. As the record length changes, the oscilloscope's sample rate also changes as each of the oscilloscope'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 angled) line at the right.

To maintain the record length, as the span changes, the oscilloscope's sample rate also changes as each of the oscilloscope'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 oscilloscope based on its hardware implementation. To increase the Main Time beyond the alias free-zone limit, select **Utilities/ Hardware/ADC1/Infiniium/Configure/Sample Mode/Edit** and either **Maximize, Minimize, or User Rate** from the drop-down menu.

In the Maximize or Minimize sampling mode, the time limit is increased and alias-free operation is not guaranteed. 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.
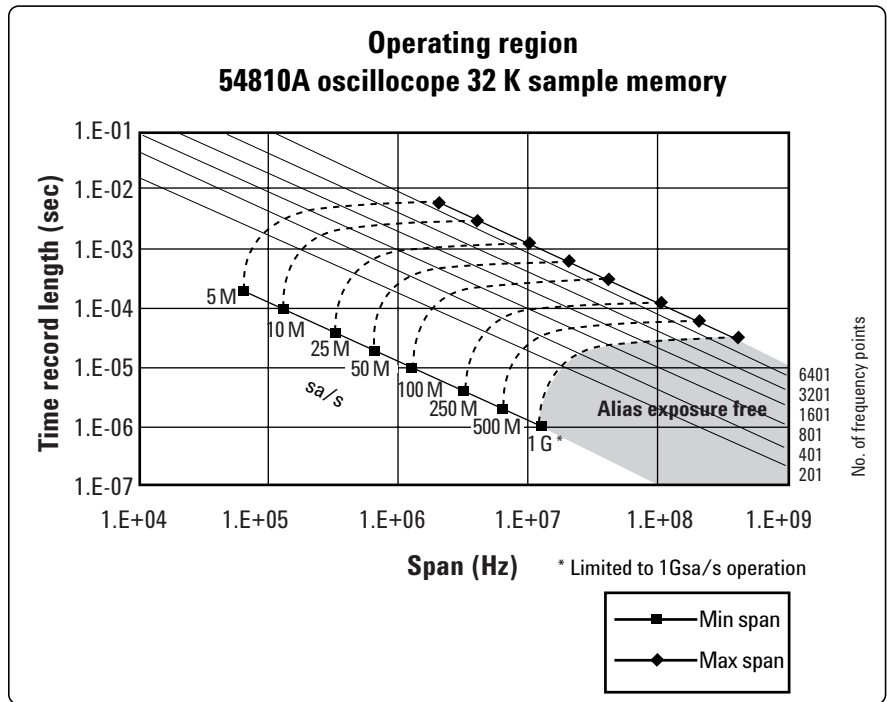
Figure 3. Operating region for 54810A oscilloscope
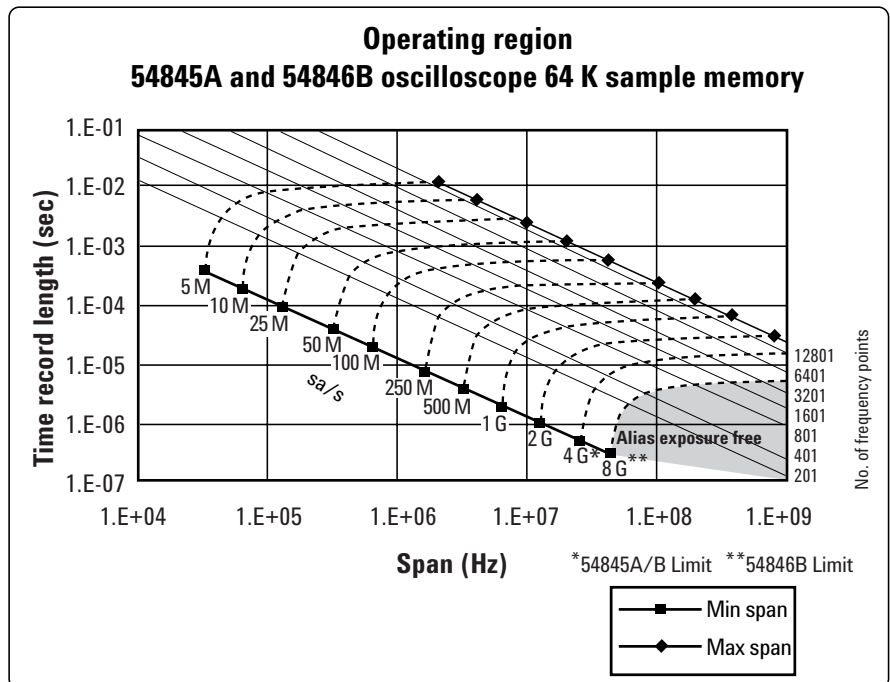

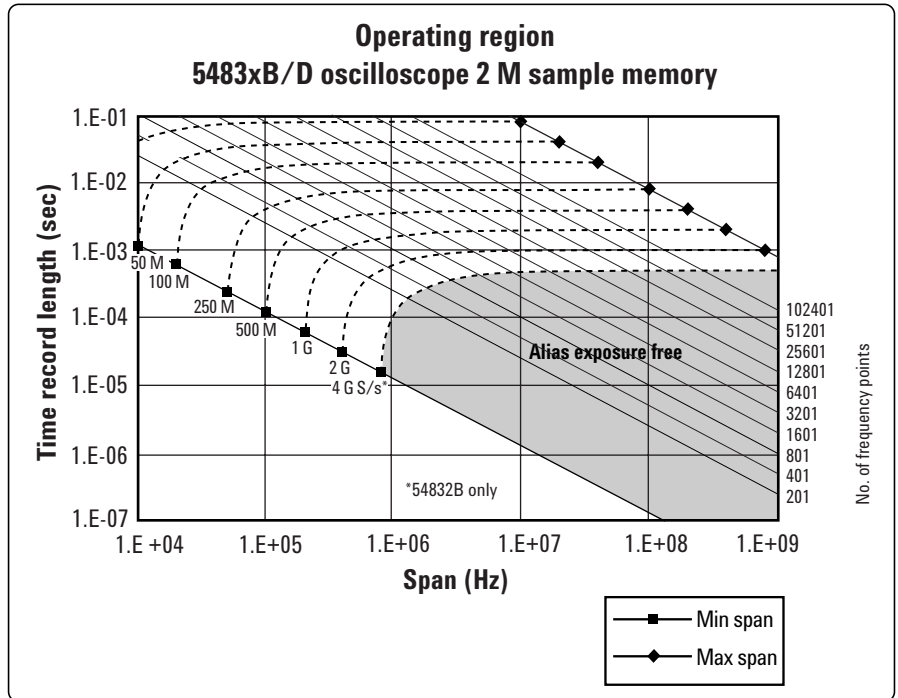**Figure 4. Operating region for 54845A/B oscilloscope**

5.3   Operating region curve for the Infiniium 5483X oscilloscopes

The Infiniium 54830/31/32 oscilloscopes have deep memory, which allows greater movement on the operating region curve for the Full Rate/User Rate sampling modes. Table 6 shows the limits on Main Time for various memory options.
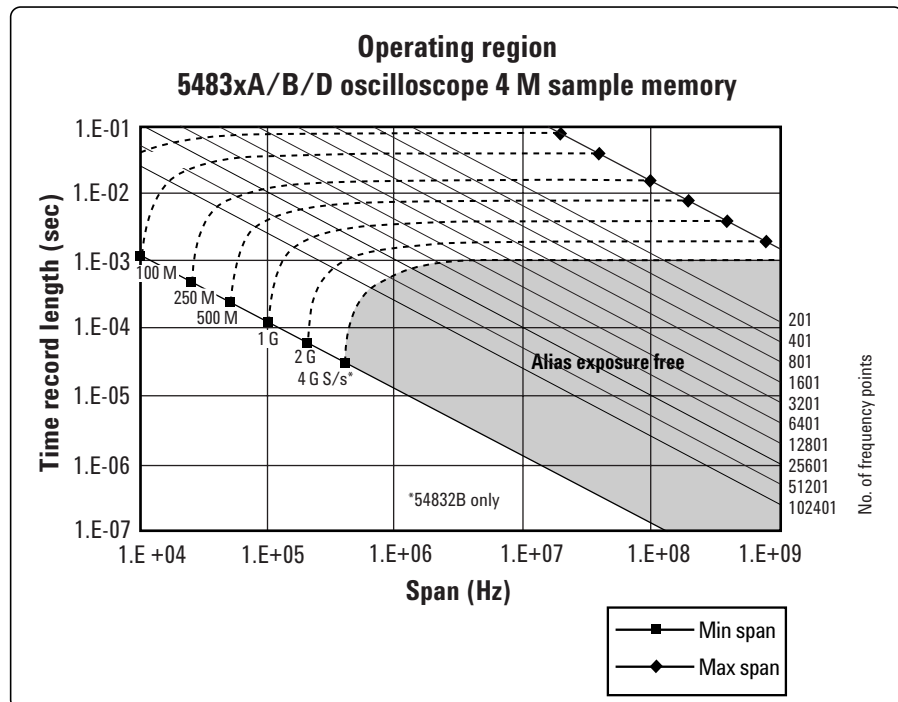
The operating region curve for the 548330/31/32/33 oscilloscopes are shown in Figures 5, 6, and 7.

Table 6. Time limits versus oscilloscope memory (Full Rate Mode)

Main time limits (µs)

Memory sample points	2 M (std)	4 M (opt)	8 M (opt)	VSA bandwidth (MHz)
Oscilloscope				
54830	1,000	2,000	4,000	0 to 780
54831	1,000	2,000	4,000	0 to 780
54832	500	1,000	2,000	0 to 1,000
54833	1,000[1]	2,000	4,000	0 to 780

Figure 5. Operating region for 2 M point memory for 5483X oscilloscopes

1. 54833D only.

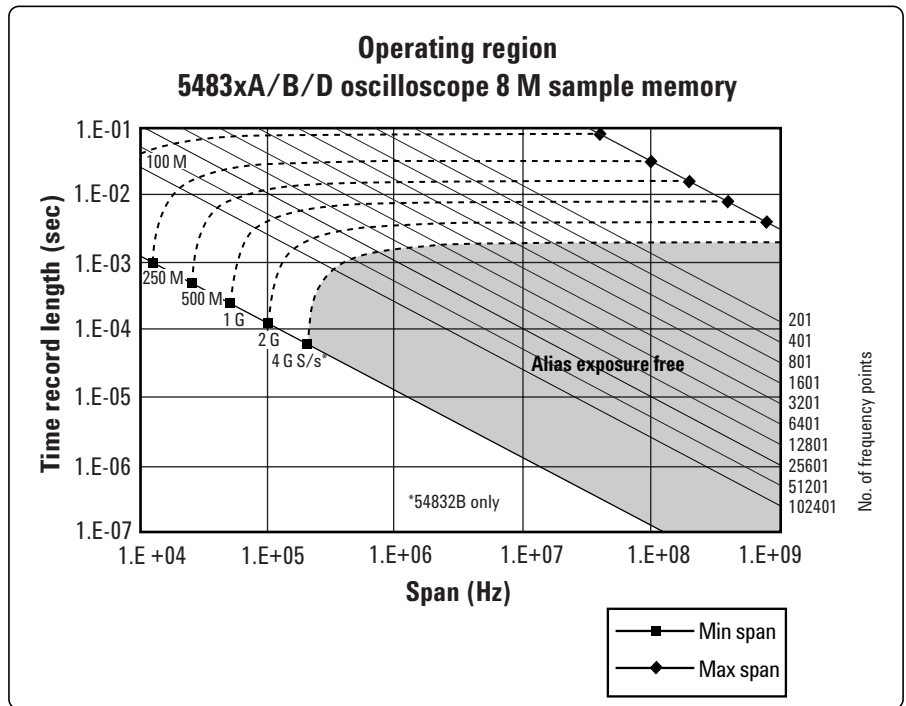Figure 6. Operating region for 4 M point memory for 5483X oscilloscopes

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Figure 7. Operating region for 8 M point memory for 5483X oscilloscopes

5.4 Operating region curve for the Infiniium 5485x oscilloscopes

The Infiniium 54853/54/55 oscilloscopes have deep memory, which allows greater movement on the operating region curves for the Full and User Rate sampling modes. In addition, the amount of memory available can be dependent on the sample rate. Table 7 shows the limits on Main Time for the various memory options.

The operating region curves for the 54853/54/55 oscilloscopes are shown in Figures 8 and 9. Figure 8 gives the operating region when only the standard memory is present (256k). Figure 9 gives the operating region when extended memory (32M) is present. Note there is a breakpoint at the 2 G sample-per-second rate. For this rate and below the entire extended memory is available to increase the time length of the acquired record. However, for sample rates greater than 2 Gsa/s only a portion of the extended memory is used.

Table 7: Time limits versus oscilloscope memory (Full Rate mode)

Main time limits (µs)

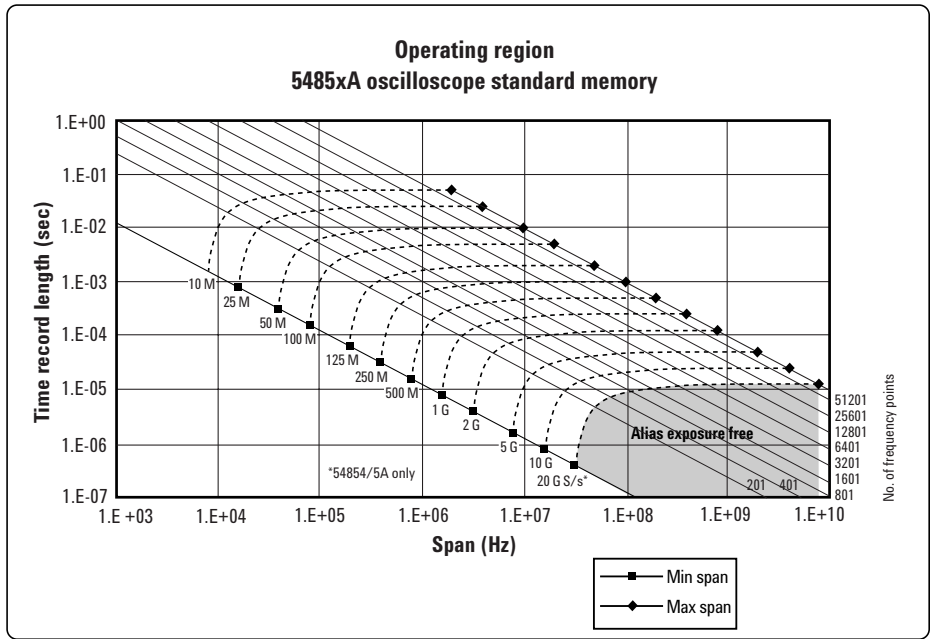| Memory sample points	256 k (std)	32 M (Option 001)	VSA Bandwidth (MHz)
Oscilloscope			
54853	25 µs	198 µs	0 to 2.6 GHz
54854	12.7 µs	98 µs	0 to 4.0 GHz
54855	12.7 µs	98 µs	0 to 6.0 GHz

Figure 8: Operating region for 54953/54/55 with standard memory
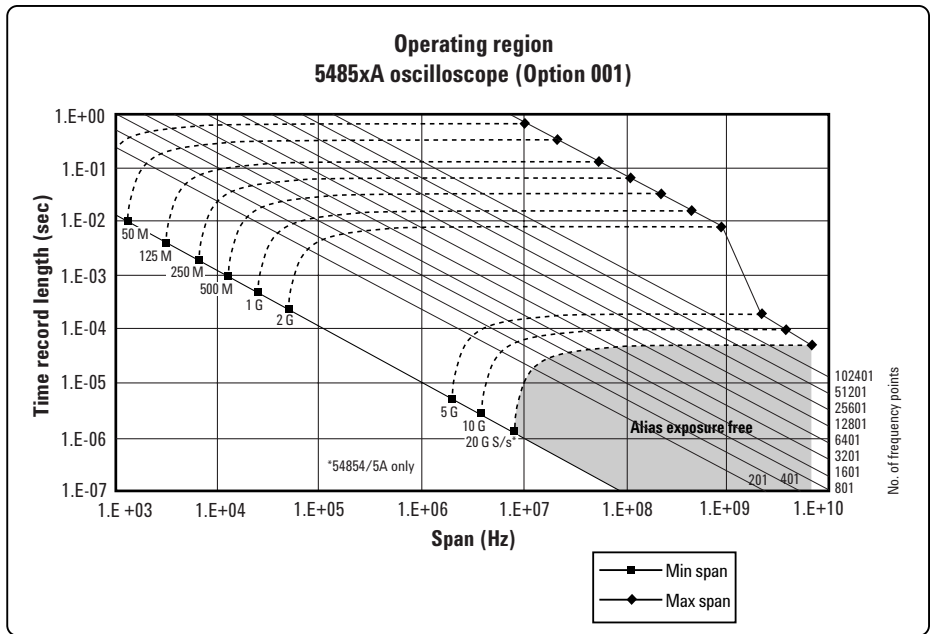

Figure 9: Operating region for 54953/54/55 with extended memory (Option 001)

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 **AliasChecker** 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.

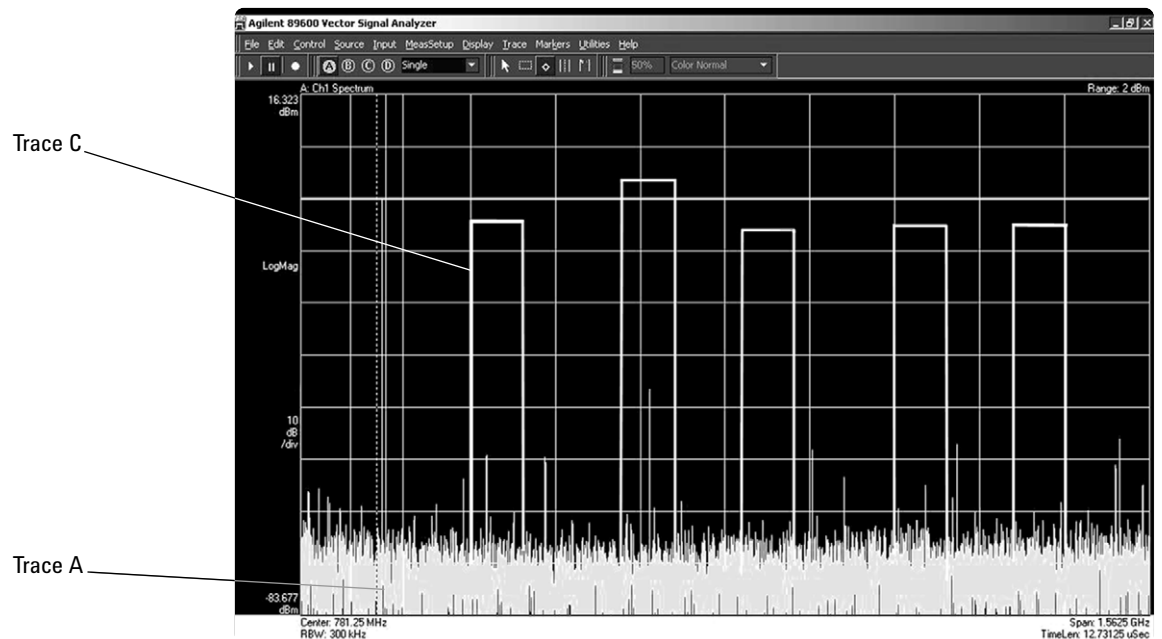## 6.2 Using the Alias Exposure Zone Checker

The Alias Exposure Zone Checker calculates the frequencies of the alias exposure zones for any combination of center frequency, span, and oscilloscope 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 oscilloscope's 8-bit digitizer, and represents the limit of the oscilloscope's dynamic range. The –40 dBc level is sufficient for 1 to 2 percent 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 10) 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 10. 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 second 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 11).
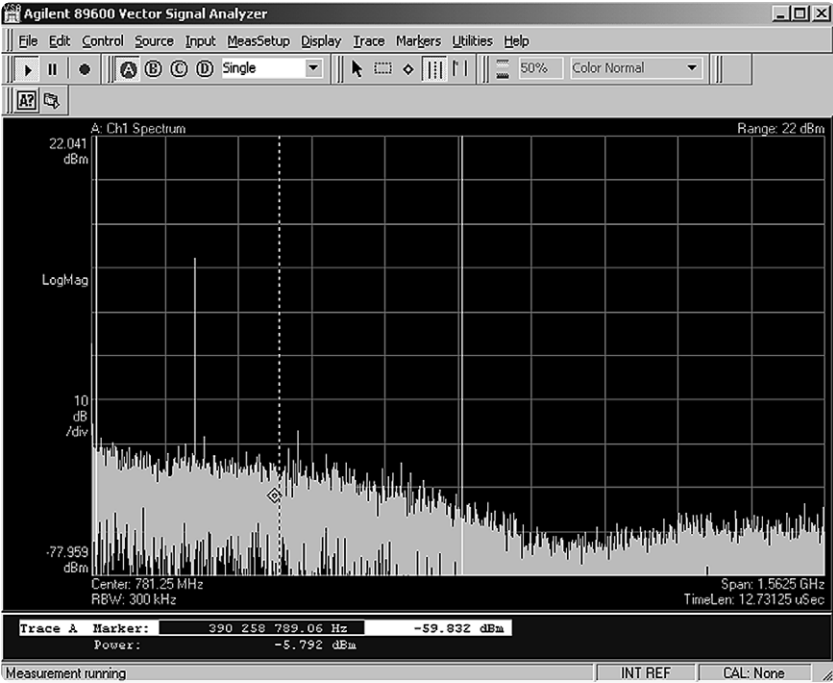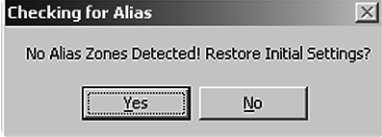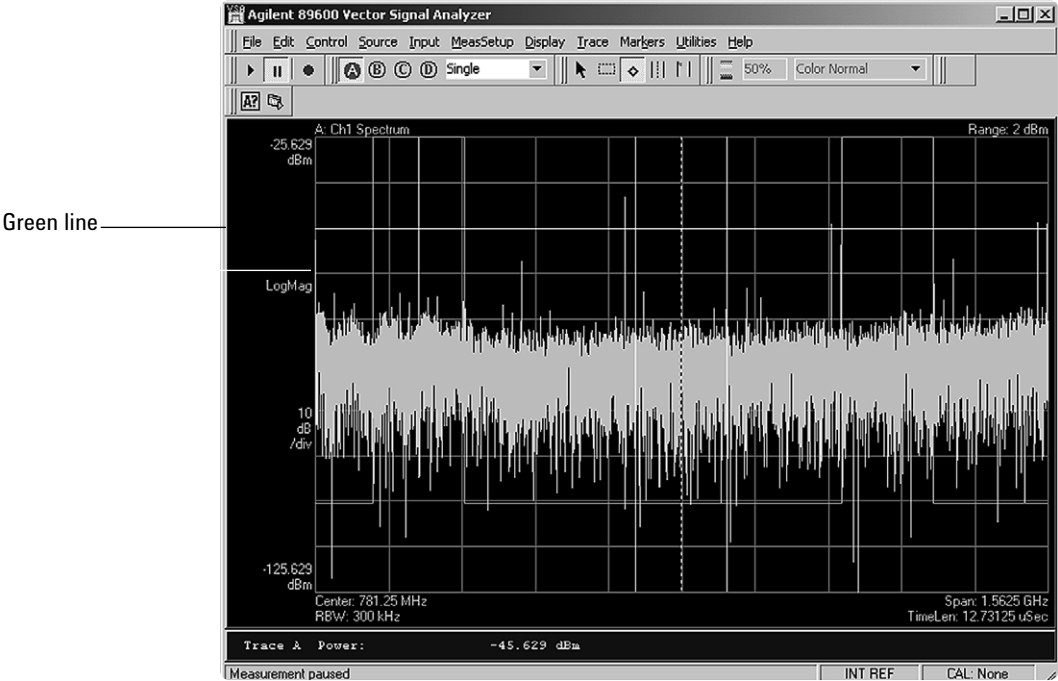

Figure 11. Alias checker results when no zones are detected. No orange alias zone boxes appear.

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 12. Further, all zone boxes will be well above the green threshold line.

Figure 12. 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 ultra-broadband 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 /Frequency** menu picks. See the Help text for further details on using the external frequency tool.
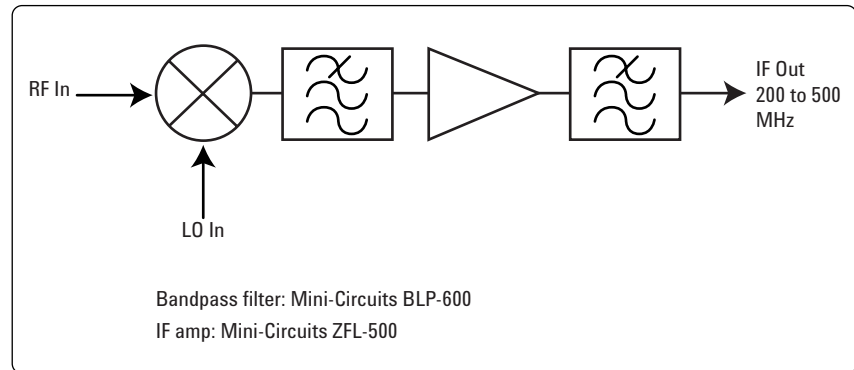

Figure 13. Block diagram of suggested downconverter. See Table 4 for further details.

Table 8. External wideband downconverter details

RF range	Mixer	LO	IF amp	Remarks
0 to 6 GHz (see Table 1)		None	None	Use oscilloscope Ch 1 or Ch 3 (VSA Ch 2)
0.2 to 6 GHz	Marki[1] M2-0006MA	16 to 19 dBm $F_{LO} = F_{RF} - F_{IF}$	Mini-Circuits[2] 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 to 40 GHz	Marki[1] M9-0540IN	3 to 17 dBm $F_{LO} = F_{RF} - F_{IF}$	As above	Mxr: CL = 8 dB, TOI = 16 dBm
26.5 to 40 GHz	Agilent 11970A	15 dBm $F_{LO} = (F_{RF} - F_{IF})/8$ $F=0\text{-}1$ GH$_3$	As above	8th harmonic waveguide mixer. Mxr: CL = 22 dB, TOI = 15 dBm
33 to 50 GHz	Agilent 11970Q	15 dBm $F_{LO} = (F_{RF} - F_{IF})/10$ $F_{IF}=0\text{-}1$ GH$_3$	As above	10th harmonic waveguide mixer. Mxr: CL = 24 dB, TOI = 15 dBm

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

Appendix B

Cables and I/O cards for connecting a PC to an Infiniium oscilloscope

Table 9. PC interfaces and connection cables

Description	Part number	Notes
PCMCIA GPIB card cable.	778034-02	For laptop PCs. Comes with two-meter GPIB Available from National Instruments.
PCI GPIB interface card	82350	For desktop PCs. Requires GPIB cable (10833A). Available from Agilent.
USB/GPIB interface	82357A	Requires USB port and Windows 2000® or XP Professional®.
One-meter GPIB cable	10833A	Available from Agilent.
LAN cross-over cable	8121-0545	Available from Agilent.

Appendix C

PC requirements to run 89601A software

The 89601A requires a PC connected via GPIB or LAN I/O to the Infiniium oscilloscope. Either a laptop or desktop PC may be used as long as it meets or exceeds the following minimum requirements: [1]

* \> 300 MHz Pentium® or AMD-K6 256 MB RAM (512 MB recommended for use with 1 MB memory 5483x and 5485x oscilloscopes)
* 4 MB video RAM (8 MB recommended) hard disk with 100 MB of available space
* Microsoft Windows 2000, or XP Professional
* CD ROM drive (can be provided via network access), 3.5 inch floppy disk drive (can be provided via network access)
* GPIB or LAN interface

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1. 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

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ww.agilent.com/find/assist

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