

Keysight N2867A Infiniium S-Series High-Definition Oscilloscopes

Notices

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Safety Notices

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A **WARNING** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a **WARNING** notice until the indicated conditions are fully understood and met.

Notes

- You can use the Infiniium application software on an oscilloscope or on your laptop. If running the software on an oscilloscope, use the demo in Chapter 1, “Live Signal Demo”. If running the software on a laptop, use the demo in Chapter 2, “Saved Waveforms Demo”.
- Chapter 3, “More Live Demos”, provides a few short demonstrations of the Infiniium oscilloscope’s key features, such as easy ways to determine the power usage of peripherals.
- Chapter 4, “Demo Wizard Demos”, does not require the N2867A demo board. Instead, it uses Infiniium’s built-in Demo Wizard feature to show you just a sampling of some of the many oscilloscope capabilities.
- There are many ways to access controls in the Infiniium user interface, but the methods described in these demos provide an overview of key features and capabilities of this oscilloscope.

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1 Live Signal Demo

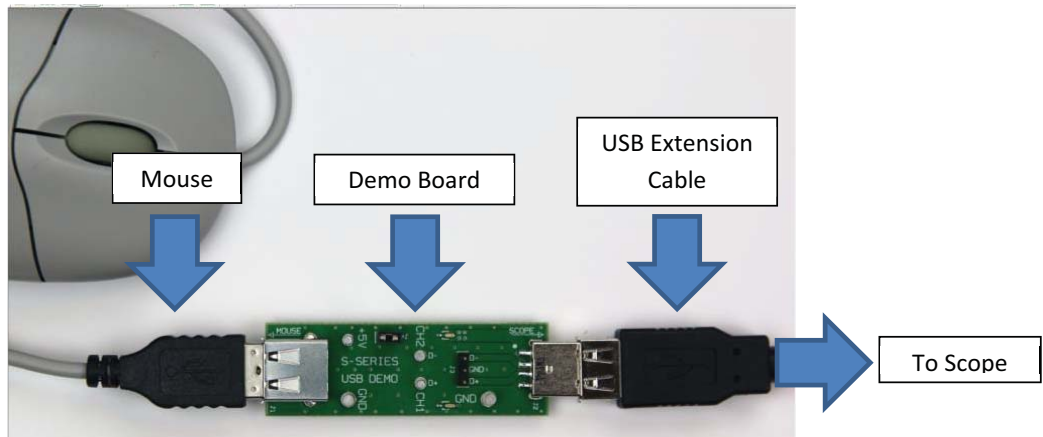
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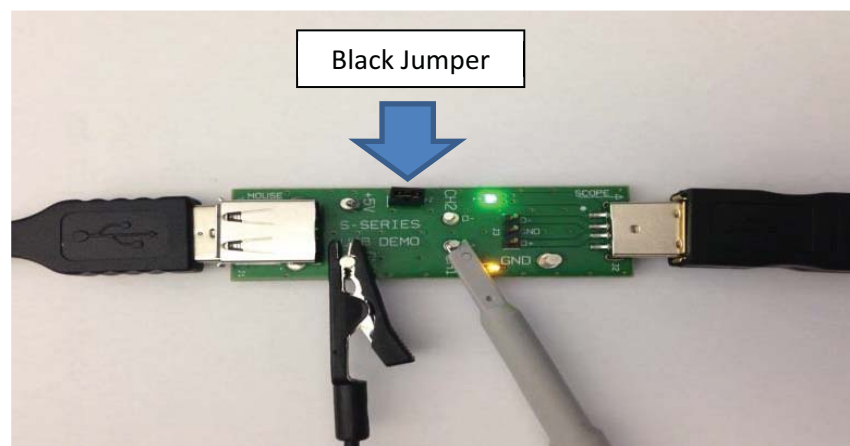
Connecting to the Demo Board

Your Infiniium S-Series oscilloscope demo unit comes with a demo board and a USB extension cable.

- 1 Power the demo board using the USB from the oscilloscope.
 - a Connect the USB extension cable to one of the USB ports on the side of the oscilloscope and then to the demo board.
 - b Connect your mouse to the other side of the demo board.



- 2 Connect scope channel 1 to the D+ Ch 1 turret using the N2873A passive probe, then connect the probe's ground lead. Make sure the black jumper is connected to the demo board.

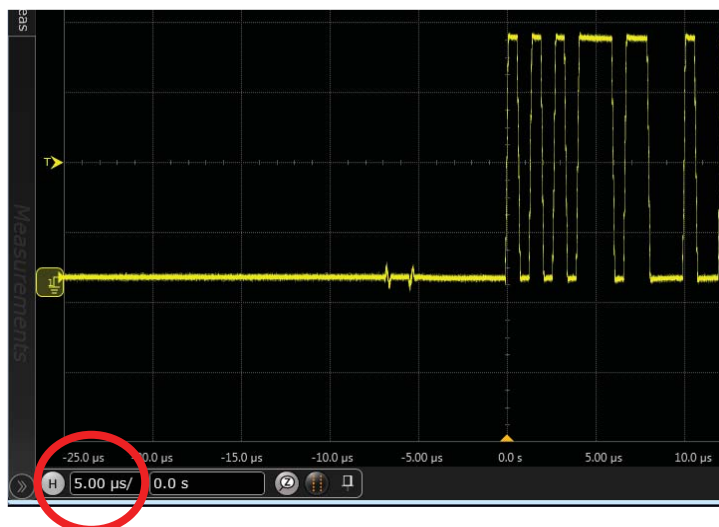


- 3 Press **[Default Setup]** on the front panel of the oscilloscope.

- 4 Press **[Auto Scale]** on the front panel of the oscilloscope. The following screen will appear:



- 5 Change the horizontal scaling to 5 μs/div using one of these methods:
- Turn the front panel knob. Push it to enable fine/coarse scaling.
 - Hover over the horizontal scale control in the lower left corner of the display and use your mouse wheel or the pop-up keypad to adjust the scaling.



You are now ready to begin the basic demo procedure.

Live Signal Demo Procedure

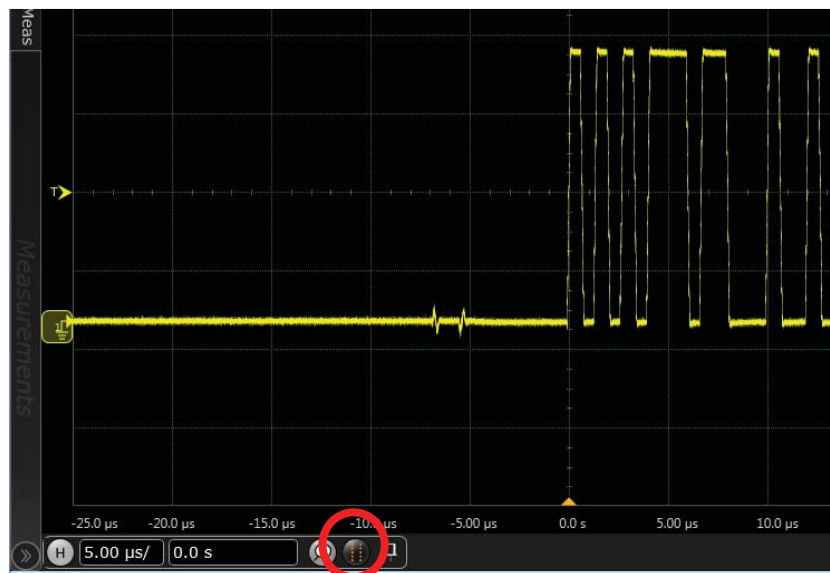
- 1 If you are familiar with Infiniium, you will instantly know how to use the basic functionality of this user interface. Skim through the menus at the top of the display to see that they are very similar to those in the Infiniium Classic interface. Here is an example of the **Display** pull-down menu.



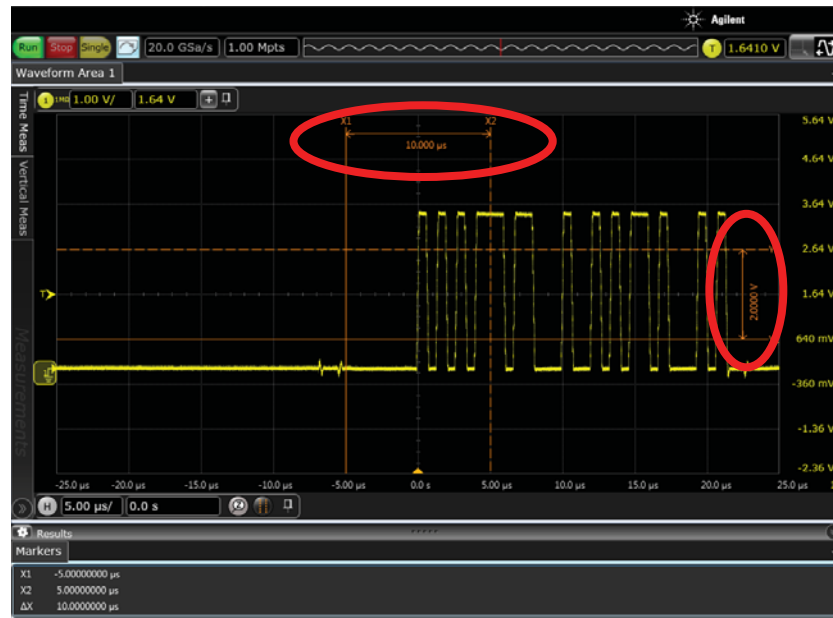
- 2 If you are an existing Infiniium user, you may immediately notice something different about the new user interface: the horizontal and vertical scales are now shown on the display. This differentiating feature helps in documentation when taking screen shots and helps you get an instant idea of time scales and amplitudes.

NOTE: These scales adjust to the units appropriate for whatever is being viewed (such as units of frequency if viewing an FFT plot).

- 3 In the lower portion of the display, click the Markers icon to enable markers and see enhancements made to them.



- 4 Notice that the delta values are shown on the display and that these values dynamically update as you move markers. This feature is very useful for documentation as well as ease-of-use because you no longer have to look up delta values in a table somewhere else on the screen.



- 5 Make sure the touch screen is enabled (the front panel **[Touch]** key will be lit) and then touch the screen anywhere on the graticule. You will see handles appear on the edge of each marker.



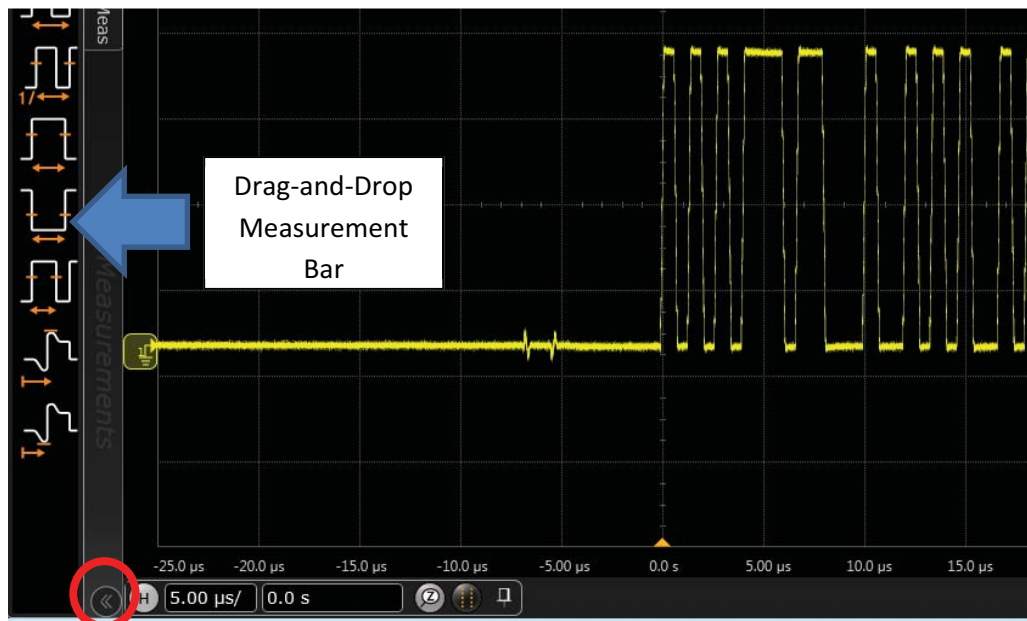
This new Infiniium interface was designed for touch. If you ever tried to move markers with your finger, you know how hard it can be. These handles enable you to easily grab a marker and move it. Experiment now with moving a marker by using a handle.

- 6 Turn the markers off by clicking the Markers button again and then setting the **Mode** to **Off** in the Markers Setup dialog box.



The drag-and-drop measurements are the same as those available in the Infiniium Classic interface, except now you can choose whether to make the measurements visible or not.

- 7 To see the available drag-and-drop measurements, click the chevron at the bottom of the drag-and-drop measurements bar.



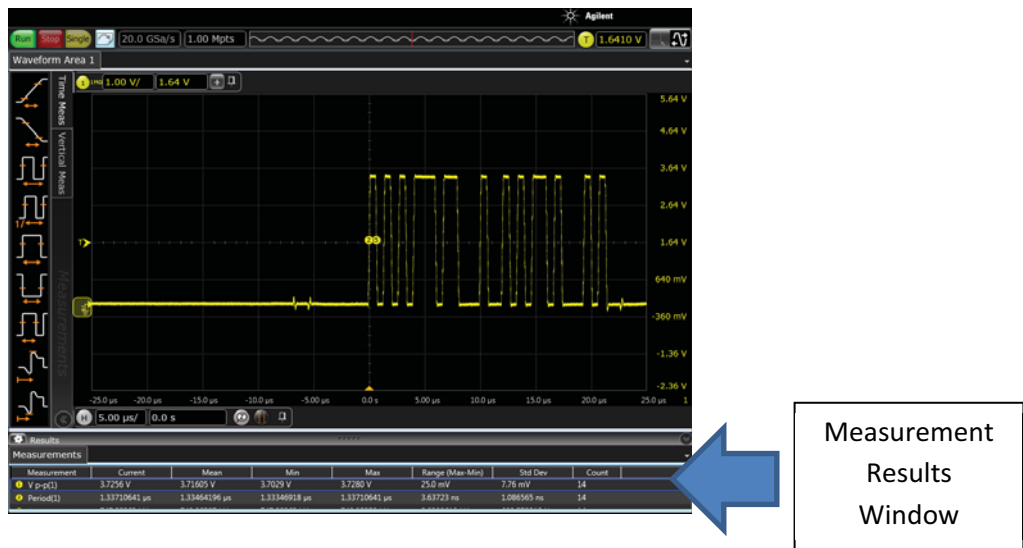
- 8 Drag a rise time measurement onto the waveform. Notice how the color of the icon matches the waveform so you can tell which waveform you are dropping it on when multiple waveforms are displayed.



- 9 To enable measurement callouts, choose **Display > Callouts > Show Measurement Callouts** from the main menu. You will see a measurement callout pinned to the measurement point and can drag the callout to any location on the display. This capability is very useful for documentation because a single screen shot can now show the measurement data right on the screen.



- Turn off measurement callouts by choosing **Display > Callouts > Show Measurement Callouts** again to deselect this choice.
- Next, you will see the improvements in how measurement results are displayed. **Click Measure > QuickMeas** to automatically populate your display with 10 measurements.

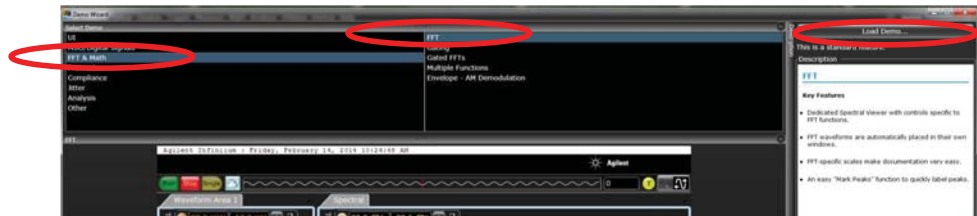


- Notice the slider bar (circled in red below). Drag the slider bar up and see that you can decide how much of the screen is dedicated to measurements results versus the waveform. You can customize your views this way.



- Delete all measurements by right-clicking in the measurement results window and choosing **Delete All Measurements**.

- 14 From the main menu bar, choose **Demos > Show Demo Wizard**. Then select **FFT & Math** from the left menu and **FFT** from the center menu, and then click the **Load Demo** button in the upper right corner. The FFT demo is now loaded so you can see the tabbed custom layout.

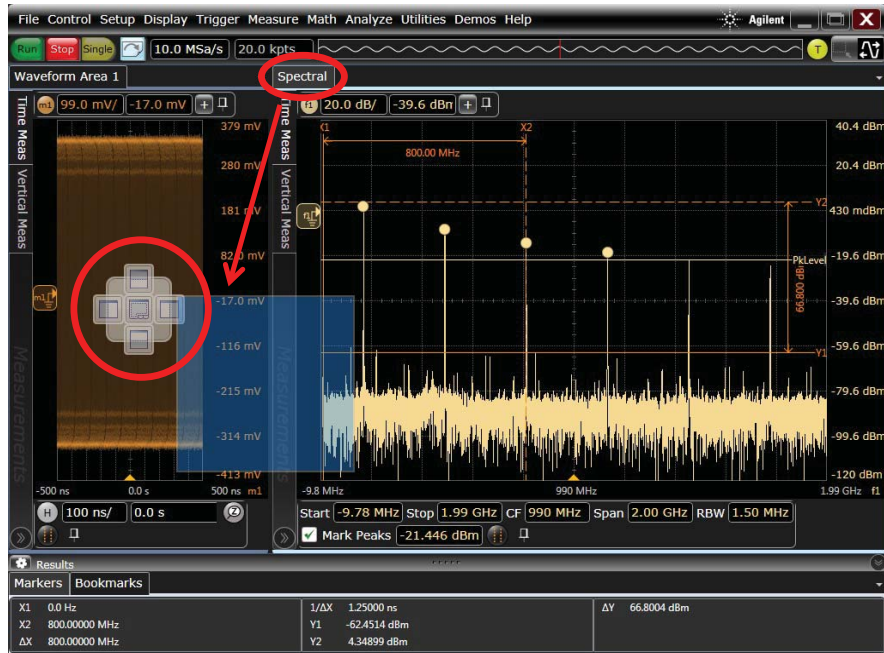


- 15 Minimize the drag-and-drop measurements bar so you have more room on the screen. You will now see a Waveform Area 1 tab, a Spectral tab, a Markers tab, and a Bookmarks tab (similar to those used in most web browsers).



- 16 Notice how the flexibility of the user interface lets you maximize or minimize the different tabs, depending on what is important to you. For example, if the FFT is more important to you, you can drag the boundary between the Waveform Area 1 and Spectral tabs to the left.

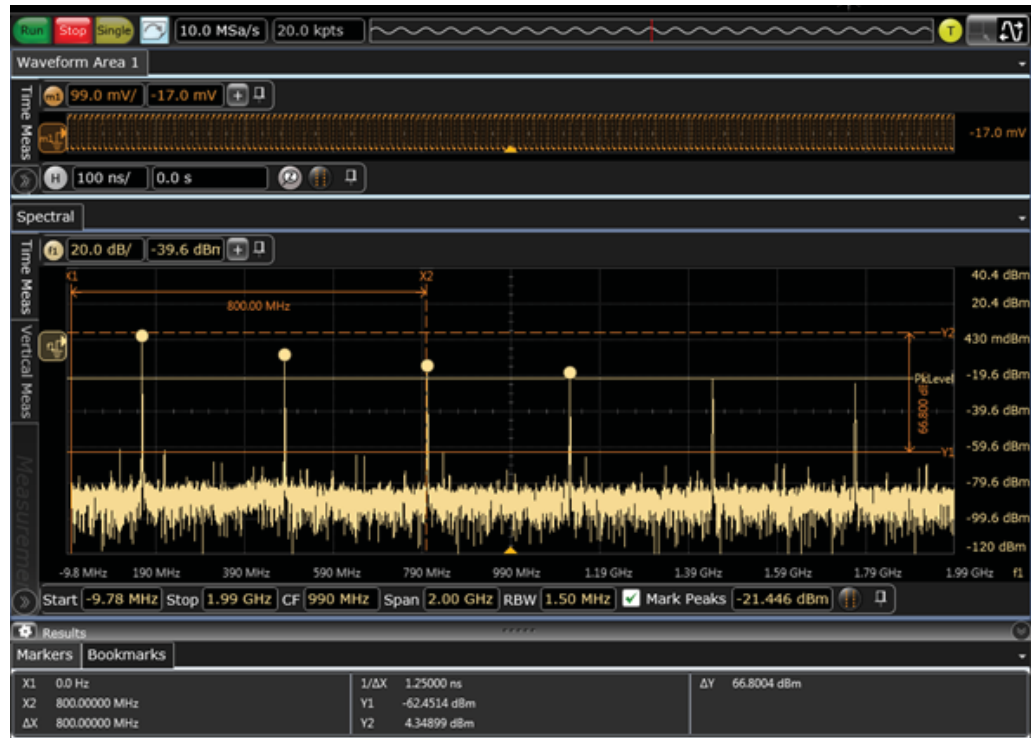
- 17 Grab the Spectral tab and drag it to the middle of the Waveform Area 1 display. You will see the following placement dock cross appear.



The placement deck enables you to choose how the Spectral tab is oriented relative to Waveform Area 1 tab. For example, if you chose to dock it underneath, the display would look like this:

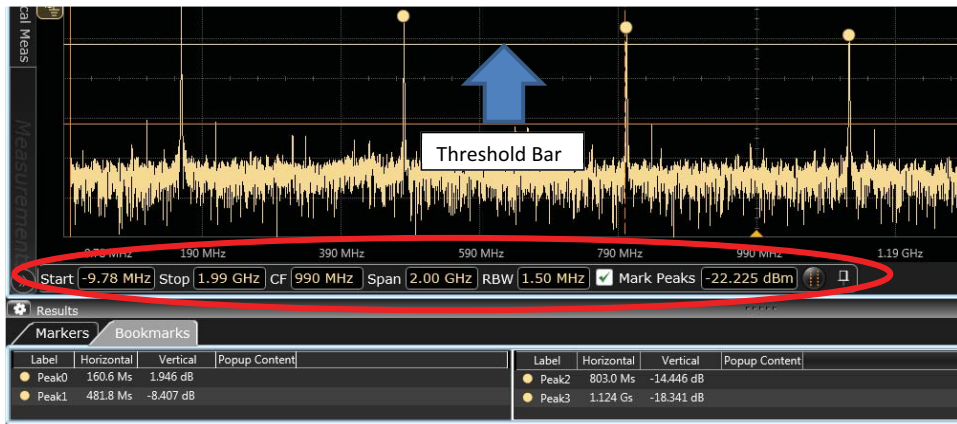


- 18 Grab the bar between the Waveform Area 1 and Spectral tabs and expand the Spectral view as shown. Notice the flexibility of windowing.



- 19 If you are interested in FFT measurements, take a look at some new FFT features:
- You can drag this FFT window off to an external monitor if one is connected. In fact, you can do so with most tabs, such as measurement results, waveform areas, FFTs, jitter plots, and bookmarks.
 - The vertical and horizontal scales are again shown on the display, using the correct units.
 - The markers and delta values are shown on the display, using the correct units.
 - The controls are grouped along the bottom (as circled in the following figure) and are similar to a spectrum analyzer. This feature makes it easy to control FFTs.
 - The threshold bar can be moved up or down to identify peaks that exceed the bar. The table at the bottom of the screen lists the peaks above this threshold. (The default is five peaks, but the value can be adjusted.)
 - You can show the peak values on the actual graticule by enabling FFT peak callouts (**Display > Callouts > Show FFT Peak Callouts**).

1 Live Signal Demo



- 20 The last feature to see in this demo is bookmarks. Press **[Default Setup]** on the front panel and then press **[Auto Scale]**.
- 21 To enable a bookmark, choose **Display > Add Bookmark** from the main menu bar.
- 22 In the Add Bookmark dialog box, the source is already set to channel 1. Type something like *Look at the issue here* in the **Label** field. Click **OK** to place the bookmark on the display.



- 23** Experiment with moving these bookmarks to anywhere on the screen. You can also move the anchor point to different locations on the waveform. This capability is useful for collaboration between multiple people, as you can create bookmarks, save the setup as a composite file (.osc), and send that file to a colleague. When that person opens the file on their oscilloscope or laptop, they will be able to navigate through the waveform and see all of the bookmarks.

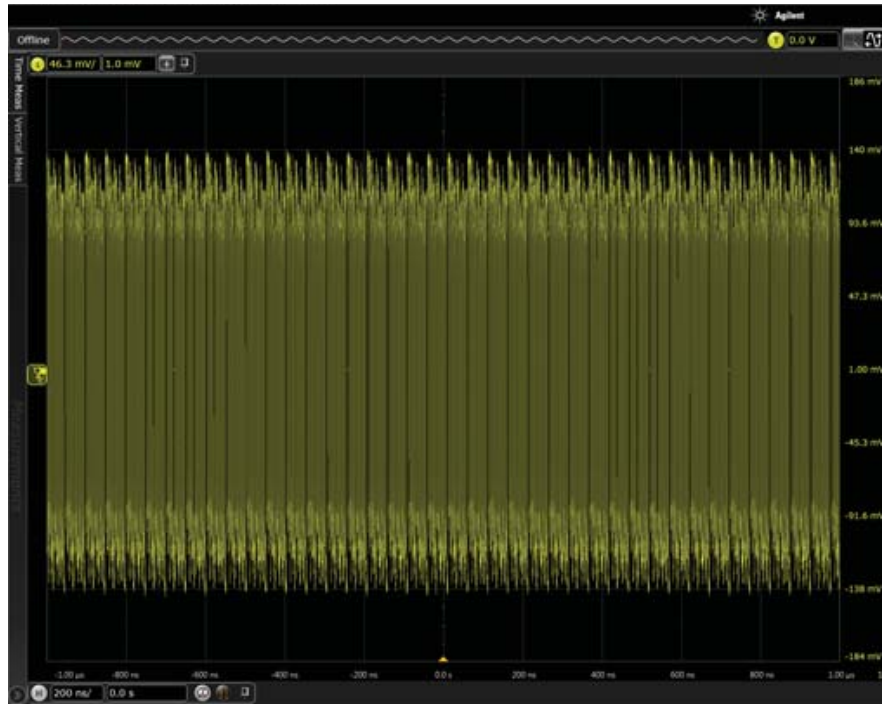
1 Live Signal Demo

2 Saved Waveforms Demo

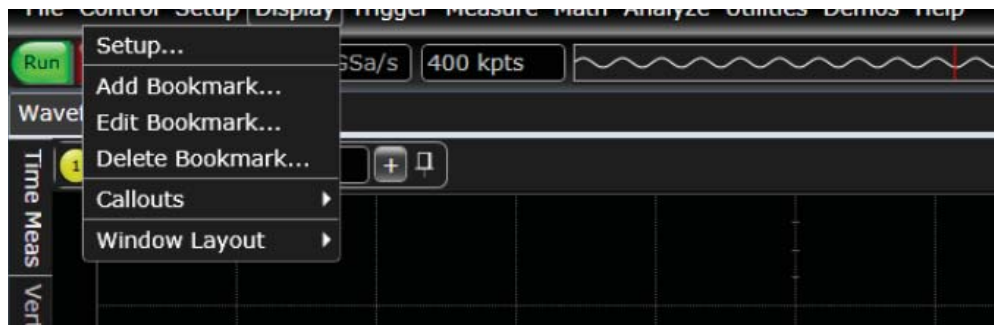
Saved Waveforms Demo Procedure [22](#)

Saved Waveforms Demo Procedure

- 1 From the main menu, choose **Demos > Show Demo Wizard....** In the Demo Wizard dialog box, click **Other** in the left pane and **5 Gbps PRBS 10e-7 pattern** from the options in the middle pane. Click **Load Demo...** in the upper right corner. The following screen will appear:



- 2 If you are familiar with Infiniium, you will instantly know how to use the basic functionality of this user interface. Skim through the menus at the top of the display to see that they are very similar to the Infiniium Classic interface menus. Here is an example of the **Display** pull-down menu.



- 3 If you are an existing Infiniium user, you may immediately notice something different about the new user interface: the horizontal and vertical scales are now shown on the display. This differentiating feature helps in documentation when taking screen shots and helps you get an instant idea of time scales and amplitudes.

NOTE: These scales adjust to the units appropriate for whatever is being viewed (such as units of frequency if viewing an FFT plot).

- 4 Adjust the horizontal scale to 2.00 ns/div by hovering over the horizontal controls in the lower left corner of the display and then using your mouse wheel or the pop-up keypad to adjust the scaling.



- 5 In the lower portion of the display, click the Markers icon to enable markers and see enhancements made to them.



- 6 Notice that the delta values are shown on the display and that these values dynamically update as you move markers. This feature is very useful for documentation as well as ease-of-use because you no longer have to look up delta values in a table somewhere else on the screen.



- 7 Left-click anywhere on the graticule and you will see handles appear on the edge of each marker.

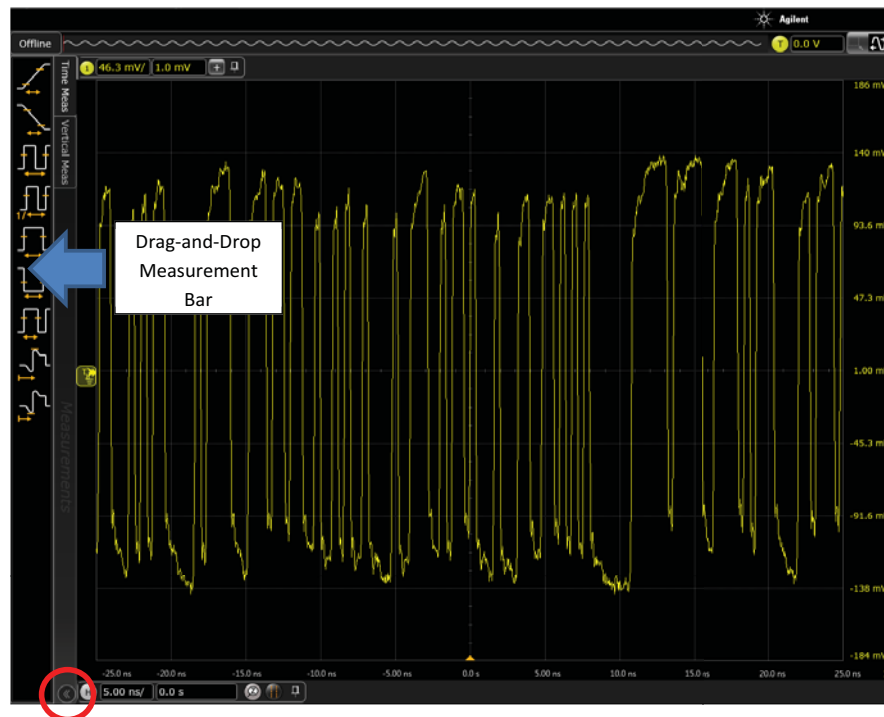


- Turn the markers off by clicking the Markers button again and then setting the **Mode** to **Off** in the Markers Setup dialog box.

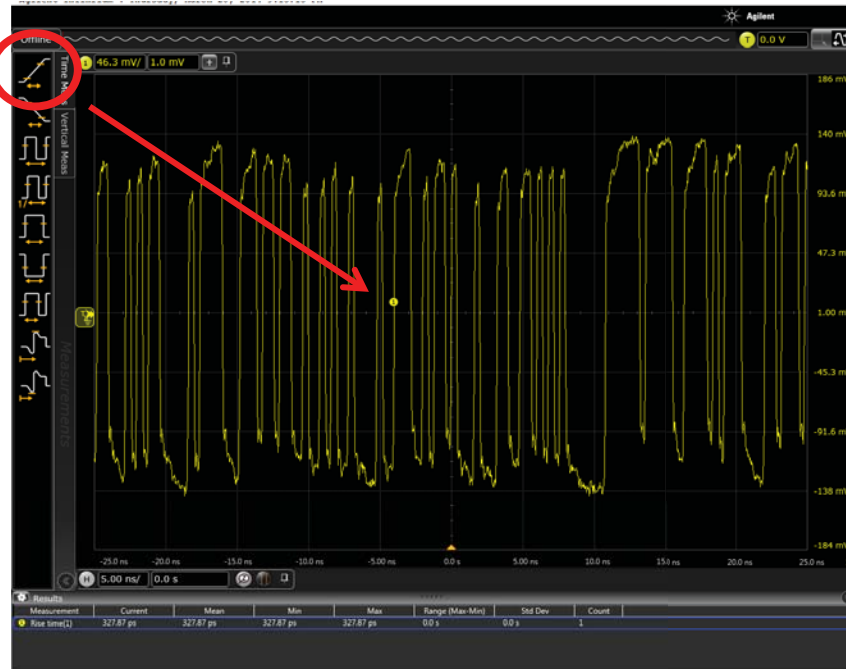


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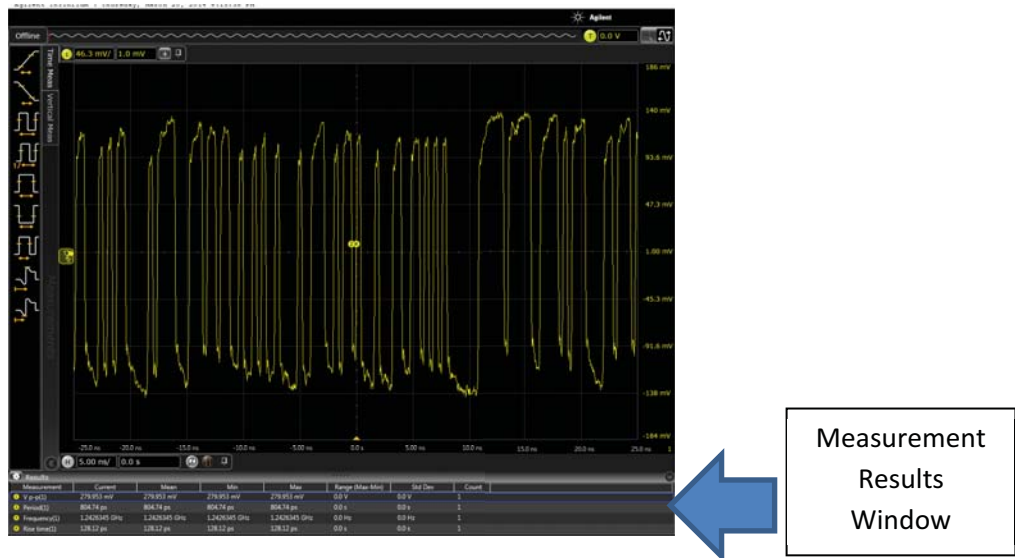
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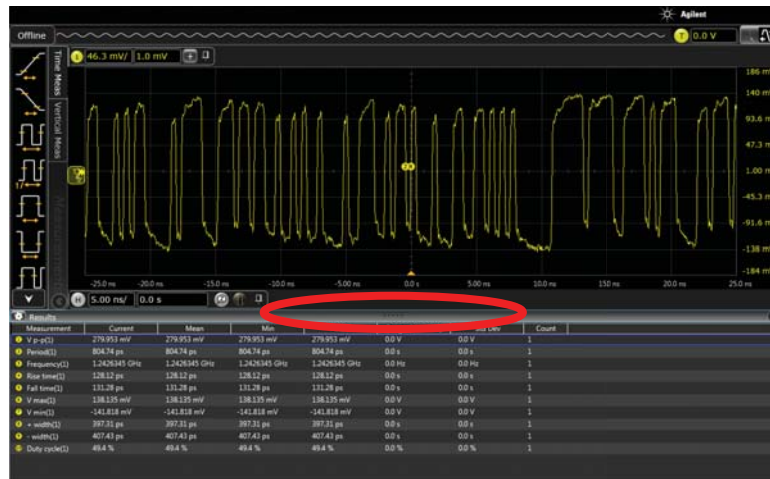
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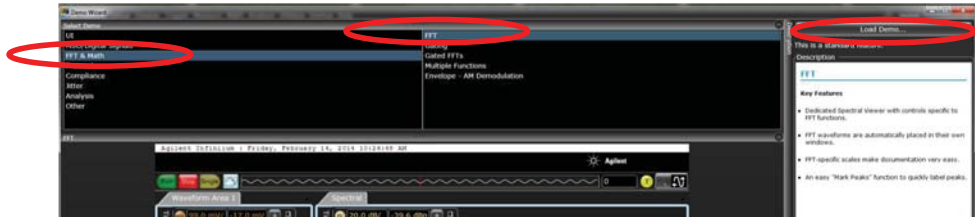


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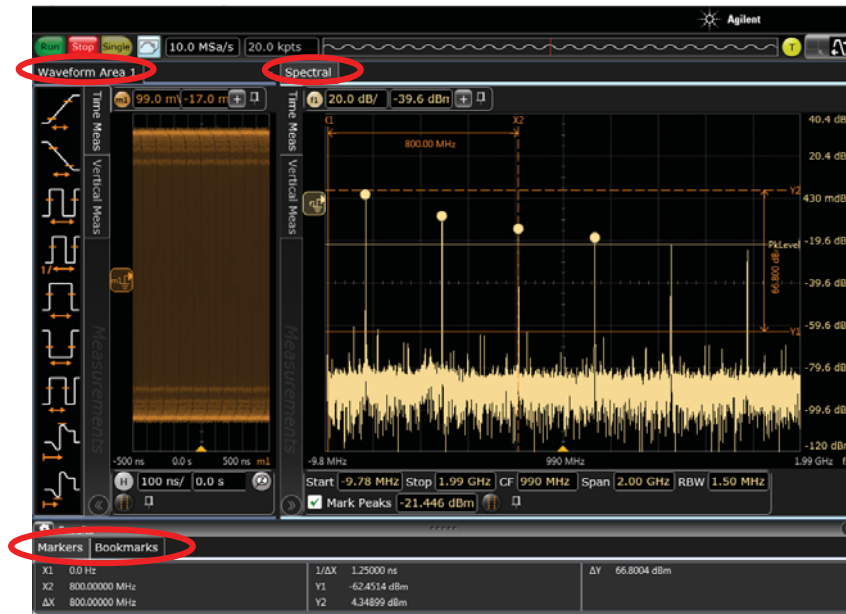


- 15 Delete all measurements by right-clicking in the measurement results window and choosing **Delete All Measurements**.

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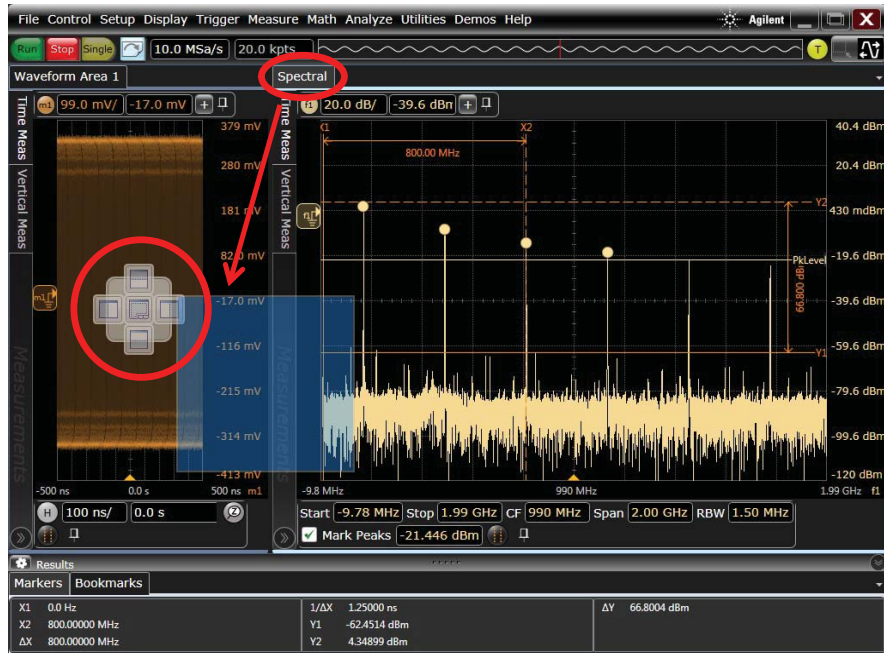


- Minimize the drag-and-drop measurements bar so you have more room on the screen. You will now see a Waveform Area 1 tab, a Spectral tab, a Markers tab, and a Bookmarks tab (similar to those used in most web browsers).



- Notice how the flexibility of the user interface lets you maximize or minimize the different tabs, depending on what is important to you. For example, if the FFT is more important to you, you can drag the boundary between the Waveform Area 1 and Spectral tabs to the left.

- Grab the Spectral tab and drag it to the middle of the Waveform Area 1 display. You will see the following placement dock cross appear.



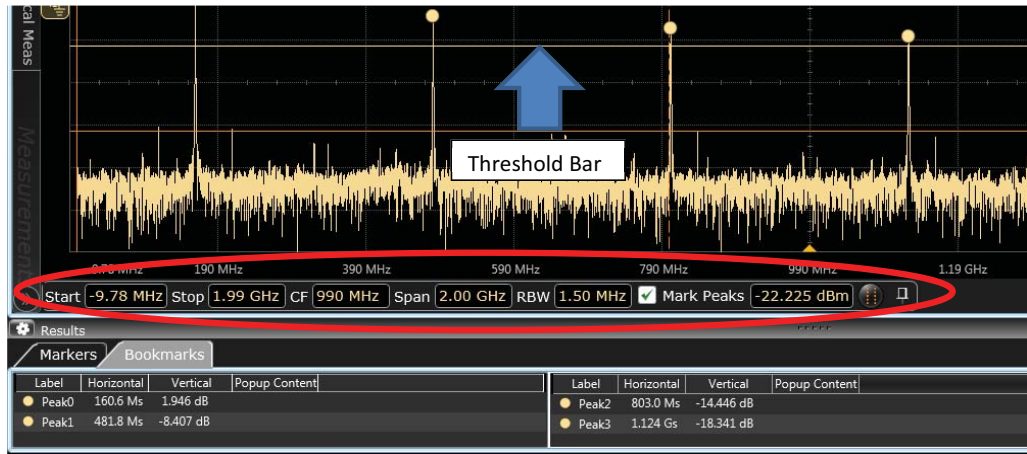
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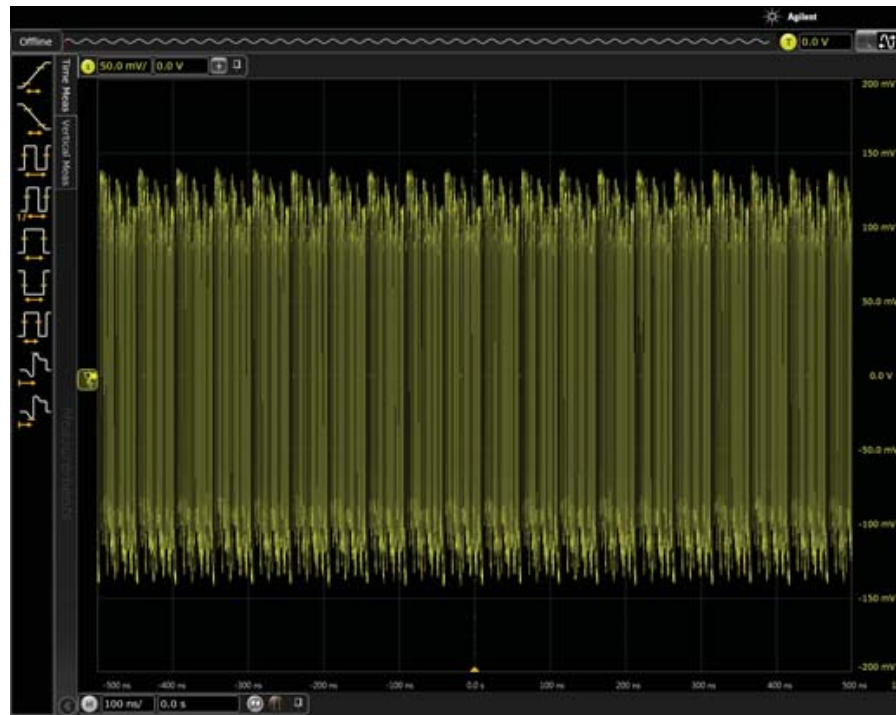
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 - The threshold bar can be moved up or down to identify peaks that exceed the bar. The table at the bottom of the screen lists the peaks above this threshold. (The default is five peaks, but the value can be adjusted.)
 - You can show the peak values on the actual graticule by enabling FFT peak callouts (**Display > Callouts > Show FFT Peak Callouts**).



- 22 The last feature to see in this demo is bookmarks. Choose **Control > Default Setup**.
- 23 Change the vertical scale to 50 mV/div by hovering over the control in the upper left corner and using your mouse wheel to scroll to this scaling.



- 24 To enable a bookmark, choose **Display > Add Bookmark...**

- 25 In the Add Bookmark dialog box, the source is already set to channel 1. Type something like *Look at the issue here* in the **Label** field. Click **OK** to place the bookmark on the display.



- 26 Experiment with moving these bookmarks to anywhere on the screen. You can also move the anchor point to different locations on the waveform. This capability is useful for collaboration between multiple people, as you can create bookmarks, save the setup as a composite file (.osc), and send that file to a colleague. When that person opens the file on their oscilloscope or laptop, they will be able to navigate through the waveform and see all of the bookmarks.

3 More Live Demos

Math/Power Demo **34**

USB Mouse Protocol Demo **42**

Touch Screen Controls Demo **48**

Math/Power Demo

This demo shows how to determine the amount of power a USB mouse consumes.

- 1 Connect Ch1 on the N2873A to USB +5V voltage rail.
- 2 Connect oscilloscope Channel 2 to USB current rail using the N2820A current probe. (The red probe wire is closest to the green LED.)

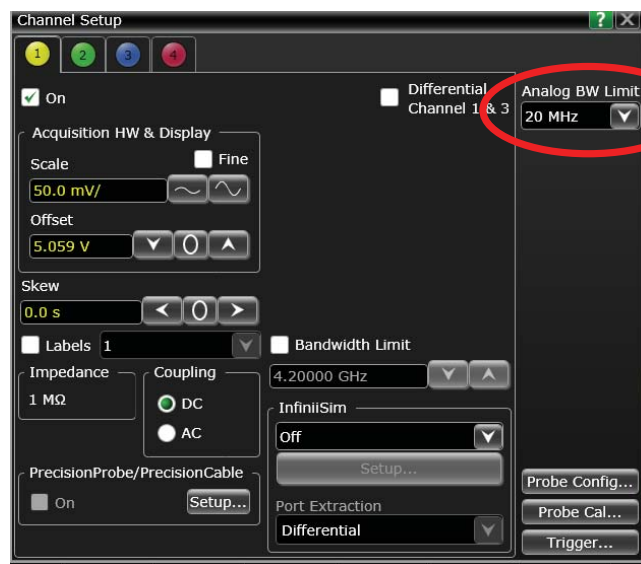


- 3 Press **[Default Setup]** and then press **[Auto Scale]** on the front panel of the oscilloscope. You can manually scale the signals, as they are very small.

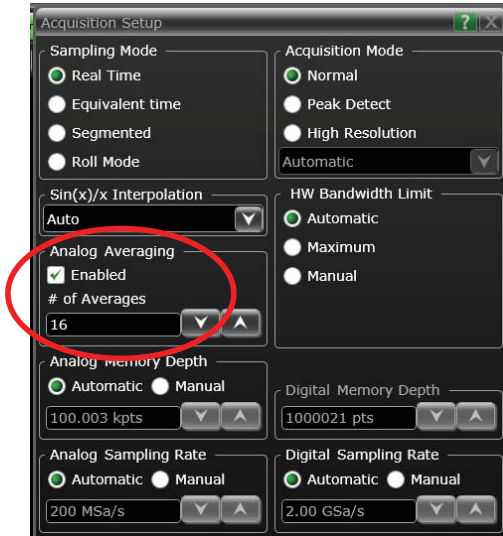
NOTE: Different mouse designs will have different waveform characteristics.



- 4 Use the Channel Setup dialog box (**Setup > Channel 1...**) to turn on the 20 MHz **Analog BW Limit** to reduce noise.



- 5 Turn on **Analog Averaging** (Setup > Acquisition...) and notice how averaging reduces noise for repetitive signals.



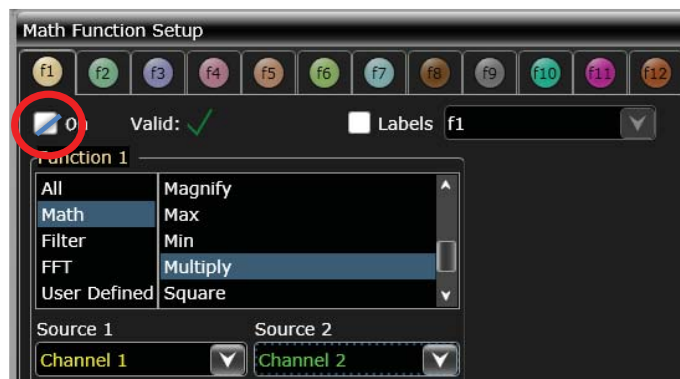
- 6 Expand both waveforms and center them to fill the full screen by setting Channel 1 = 10 mV/div and Channel 2 = 10 mA/div.
- 7 Press **[Stop]** on the front panel. Notice that the current is pulsed rather than static, because the LED on the mouse consumes the most power.
- 8 Set markers manually to span 1 cycle, at about every 200 μ s or at a 5 kHz rate.
- 9 Use the drag-and-drop measurements to place **Vmax** onto both channels so you can see the maximum vertical values.

Notice the rough ratio of power consumption when the LED is on, compared to off. Using current as an approximation of power, you have determined that 90% of the power consumption is associated with LED pulses.

- To perform a simple power measurement, start by right-clicking on the graticule and setting **Number of Grids > 4**.



- Turn on Function 1 (**Math > Functions...**) and make it equal to channel 1 * channel 2 (V*) as shown below.



- Close the Math Function Setup dialog box.

13 Drag the **f1** waveform to the second grid.



14 Click the **Vertical Meas** tab on the left side of the display, then drag-and-drop the **Vmax** and **Vmin** measurements onto **f1** so you can see maximum and minimum power values.



15 Notice how much power the mouse is consuming. Vmax and Vmin measurement values show about 475 mW max and 266 mW min, depending on the mouse design. The LED pulse contributes to a delta value of 237 mV, or about 80% of the power consumed by the mouse.

The next steps demonstrate how functions can be made as gates. Math or measurements can then be made on the gated region exclusively.

16 Turn on function 2 (**Math > Functions... > f2** tab) and make f2 equal Gating(f1).



17 Close the Math Function Setup dialog box.

18 Use the mouse to make the gate window equal to one period of f1 as shown below.

19 Pull the f2 waveform to the third grid.



Now that function 2 has been set up to create a gate for a single cycle, you can use this gate to determine power consumption over one cycle.

- 20 Turn on function 3 (**Math > Functions... f3** tab) and make f3 equal Integrate(f2).
- 21 Pull the f3 waveform to the fourth grid.
- 22 Increase f3 scaling to 10 $\mu\text{J}/\text{div}$. F3 shows total power consumption over 1 cycle.



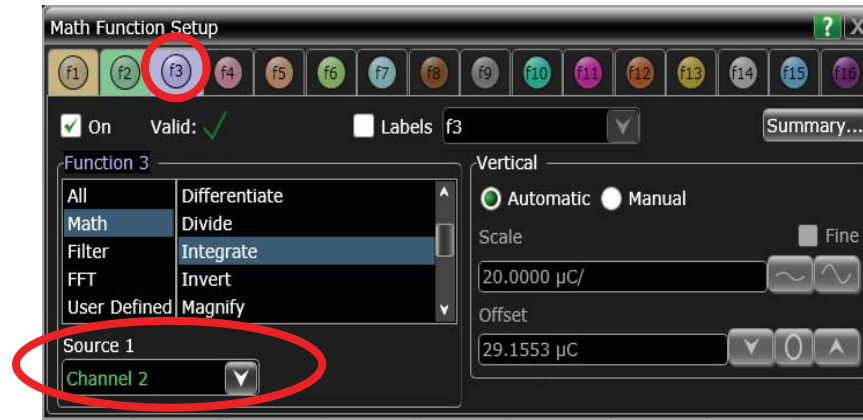
- 23 To determine how much energy is consumed over 1 cycle, drag and drop the Vmax measurement onto f3 to show how many joules are consumed in a single pulse.



If you were designing a mobile device, this capability would show you what happens if you pulse slower or have a less bright LED, for example.

If you were a battery manufacturer and wanted to know how much charge (Coulombs) were consumed, follow the next step to find out.

- 24 Go to the f3 tab in the Math Function Setup dialog box and change the f3 function to source = channel 2 (current).



The integration function now shows results in Coulombs. The charge consumed per LED pulse of the mouse is approximately 56 μC .

USB Mouse Protocol Demo

This demo uses your mouse to show USB protocol decoding on the oscilloscope.

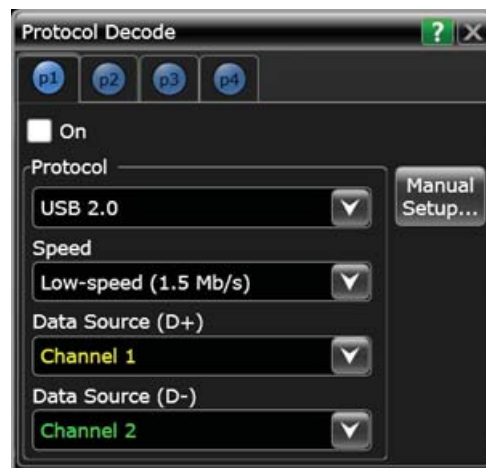
- 1 Power the demo board using the USB from the oscilloscope.
- 2 Connect scope channel 1 to D+ and channel 2 to D-.

NOTE: Be careful not to ground D+ or D-. If you ground one or both, just unplug the mouse and plug it back in.

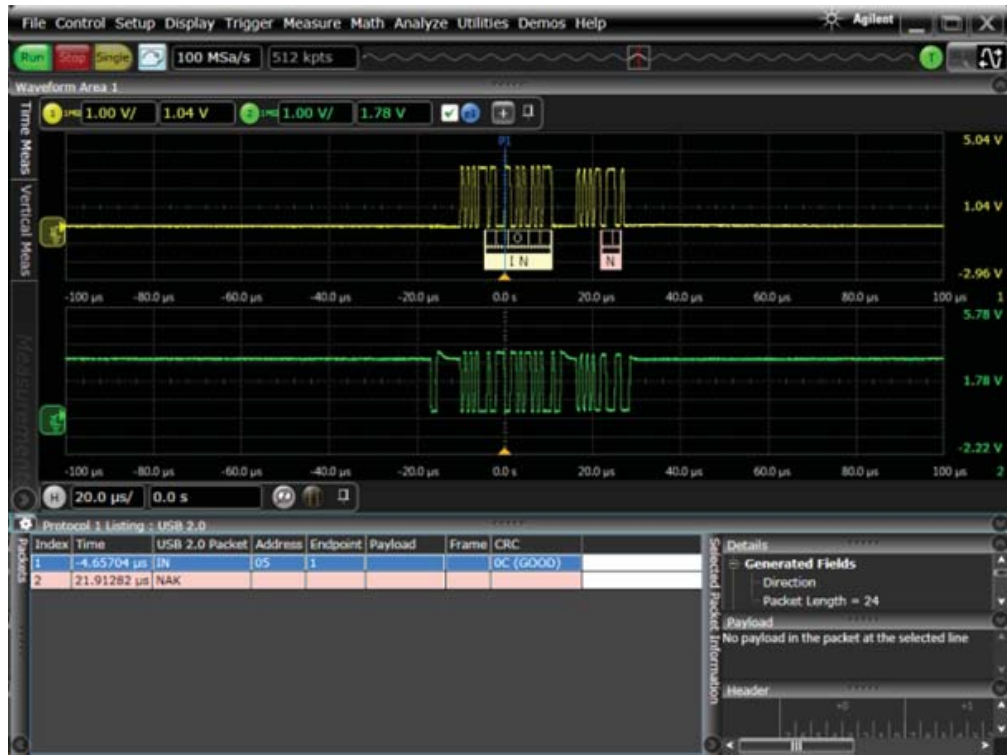
- 3 Connect a USB mouse to the demo board.



- 4 Press **[Default Setup]** on the front panel to restore system default settings.
- 5 Press **[Auto Scale]** on the front panel to automatically scale voltage and time.
- 6 Press **[Serial Decode]** on the front panel and click **Yes**. You could also choose **Setup > Protocol Decode...** to access the Decode Setup dialog box.
- 7 Select **USB 2.0** and **Low-speed(1.5 Mb/s)**, and assign **Channel 1** to D+ and **Channel 2** to D-.



- 8 Click **Auto Setup** in this dialog box. Auto Setup is an exclusive feature that is protocol smart. Auto Setup automatically sets measurement thresholds and sample rate, and adjusts the timebase for specified protocol, which eliminates time required for manual setup.
- 9 Close the Protocol Decode dialog box and press the **[Run]** key on the front panel. Notice the USB traffic generated by the USB mouse communicating with the PC host.



Infiniium displays serial packet decode below the signal waveforms and also in a protocol viewer. The line shaded in blue in the protocol viewer is time correlated with the blue bar in the waveform area. If you double-click a new packet in the protocol viewer, the blue marker in the waveform area tracks automatically.

The next steps show how to determine how long it takes for the mouse to enumerate when it is plugged in.

- 10 In the Trigger dialog box (**Setup > Trigger...**), set the oscilloscope to trigger on USB data packets.



- 11 Move the mouse to generate USB data packets that contain XY coordinates. The scope now triggers only when data packets are transmitted.



When USB devices are plugged in, they get a Setup packet from the host. This is the only time this packet occurs. Multiple Setup packets are sent, with other packets between them. When measuring from the first Setup packet to the last one when the USB mouse is plugged in, each setup is separated by several ms.

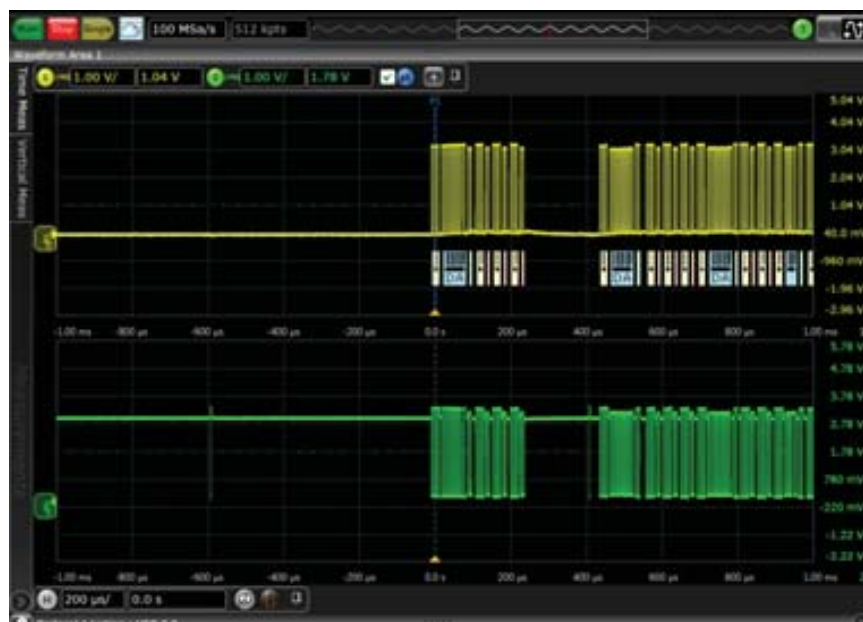
In the next steps, you will set up the oscilloscope to capture a Setup packet.

- 12 In the Trigger dialog box (**Setup > Trigger...**), select **Token** as the Type, then **SETUP**.



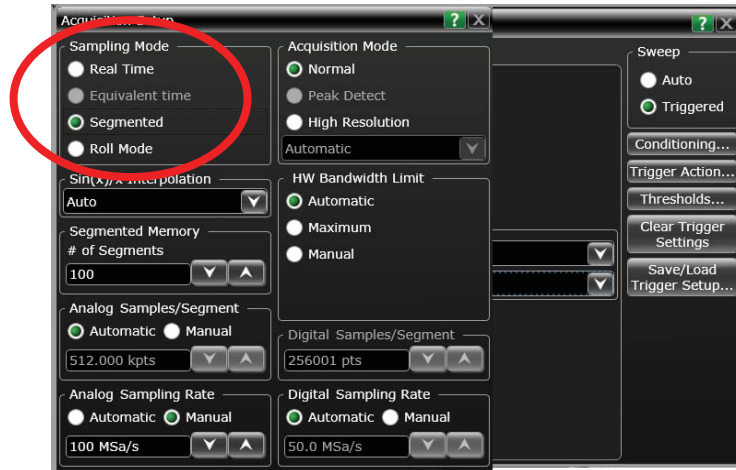
- 13 Unplug the mouse, press **[Single]** on the oscilloscope, and plug the mouse into the USB port.

You have triggered on one Setup packet, but there may be more. It is unknown how many Setup packets occurred. Different USB devices require varying numbers of Setup packets. For example, a USB keyboard or higher-speed USB device will have a different number of Setup packets before enumeration is complete. One option would be to increase memory depth to capture more Setup packets, but there may not be enough memory to capture them all.



A better way is to use segmented memory to capture all Setup packets.

- 14 Using the Acquisition Setup dialog box (**Setup > Acquisition...**), change the acquisition type to **Segmented** and set **# of Segments** to 100, a number that is well above the number of Setup packets needed for enumeration.



- 15 Disconnect the mouse and press the **[Single]** key on the front panel of the oscilloscope to begin looking for the Setup packet.
- 16 Plug the mouse into the target. The acquired segment count is located in the upper right area of the display.



You have set the oscilloscope to acquire up to 100 segments, but enumeration was complete before 100 segments were acquired. The oscilloscope is still looking for more Setup packets.

Each segment includes a Setup packet (trigger condition), and the amount of time between segments is shown at the bottom of the display.

- Press the **[Stop]** key on the front panel. Scroll through the segments, noting the total distance from the first segment trigger on the Setup packet until the last segment Setup packet. This approach gives you an idea of total enumeration time.



- If you had a device that did not enumerate, you could look through the protocol and at the waveform to see what caused the issue:



Touch Screen Controls Demo

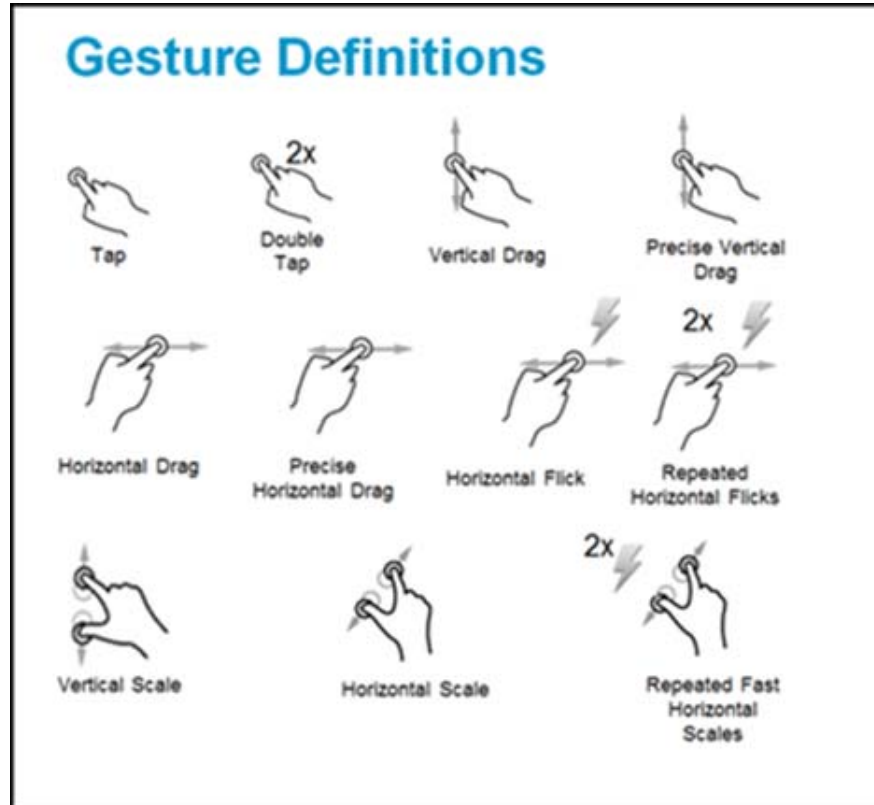
- 1 Get a signal on the screen the same way you did at the beginning of Chapter 1, “Live Signal Demo”. It should look similar to this:



- 2 Make sure the touch screen is enabled. (The front panel **[Touch]** key will be lit.)
- 3 Enable gesture control by selecting the Drag Waveform Mode icon from the upper right corner of the display.

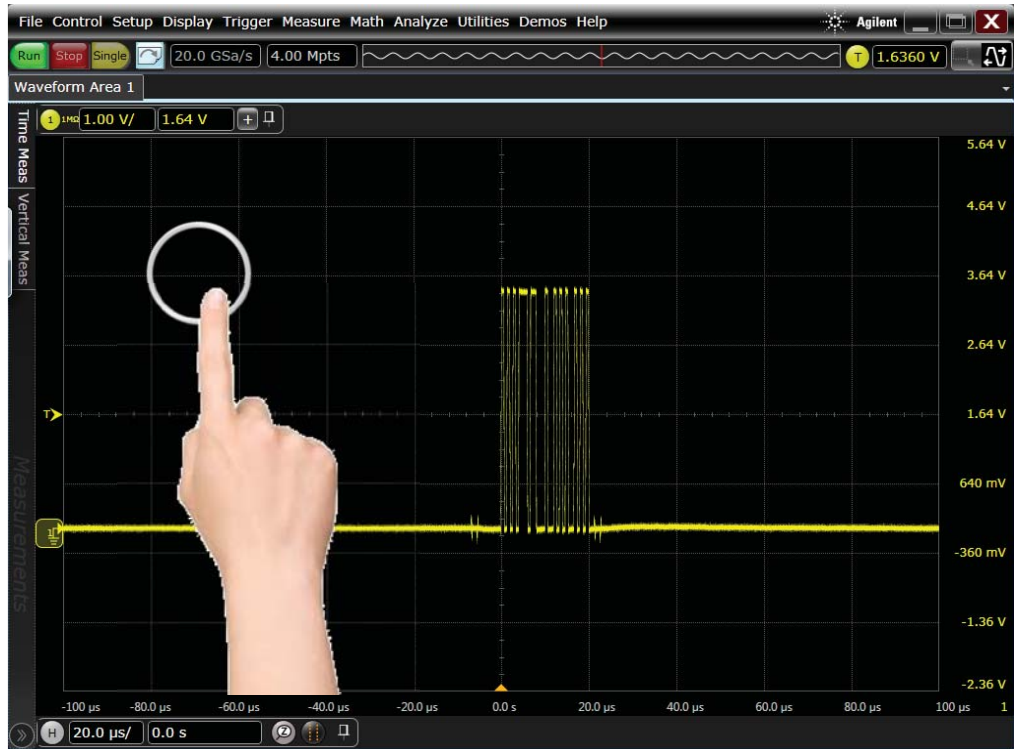


You can use all of the following gestures on the display. They are similar to those used on a smart phone or tablet.



- 4 You can set up your oscilloscope so that when you press the **[Touch]** key on the front panel, dialog boxes become larger and therefore easier to use. To do so, go to the **Appearance** tab of the Display Setup menu (**Display > Setup...**) and set the **Dialog Size** to **Track Touch**.
- 5 To experiment with this feature, open the Channel Setup dialog box (**Setup > Channel 1...**) and press the **[Touch]** key to alternate between the touch screen being enabled and disabled.

- 6 To right-click in the graticule using your finger, press and hold your finger to the display until a circle appears and whirls around. When it completes a rotation, remove your finger from the screen and the right-click menu appears.



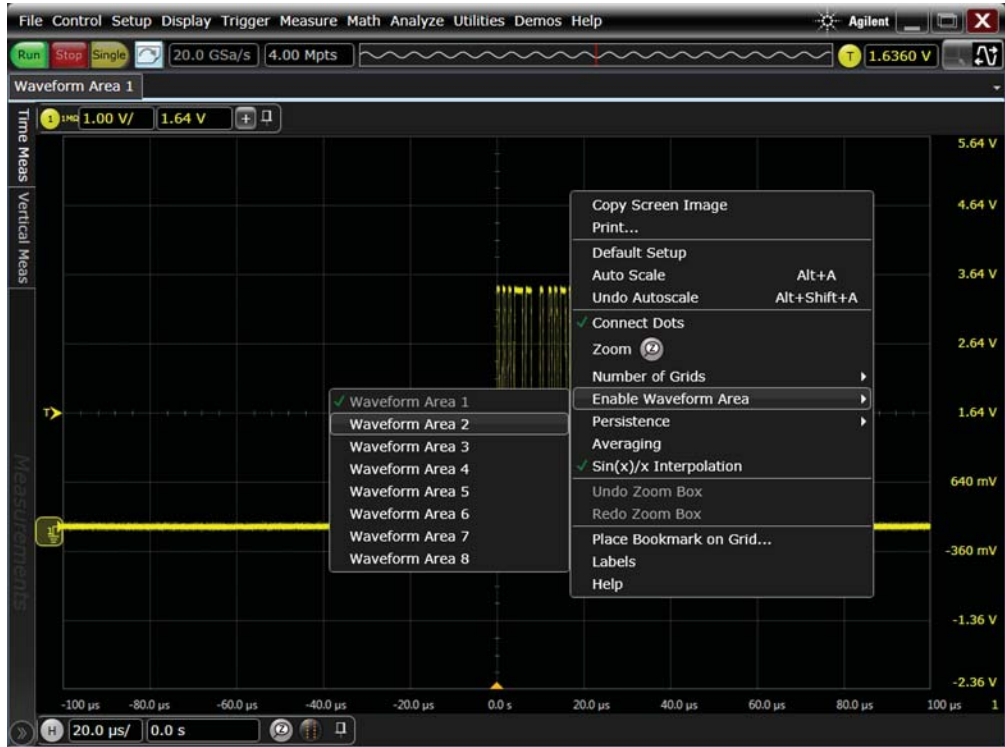
- 7 Turn on markers (using the icon at the bottom of the display) and then click somewhere on the display with your finger. Notice the handles appear for each marker, making them easy to grab and move.

4 Demo Wizard Demos

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Waveform Areas Demo

- 1 Choose **Demos > Show Demo Wizard...** and select **UI** and **Waveforms**.
- 2 Click **Load Demo...**
- 3 To add a waveform area, right-click on the graticule and select a new waveform area, such as **Waveform Area 2**.



- 4 Experiment with the new waveform area, such as by moving a waveform from one area to another. Using the custom tabbed view, you can even drag waveform areas to another monitor.

Protocol Demo

- 1 Choose **Demos > Show Demo Wizard...** and select **Protocol** and **USB 2.0 High Speed**.



- 2 Click **Load Demo...**
- 3 Experiment with this and other protocol decode demos in the demo center, such as by moving the blue time-correlation marker across packets in the waveform area. Click a row in the listing to move to a specific packet.

Gated FFTs Demo

This demo shows how you can look across both the frequency and time domain.

- 1 Choose **Demos > Show Demo Wizard...** and select **FFT & Math** and **Gated FFTs**.



- 2 Click **Load Demo...**
- 3 Experiment with the Gated FFT features. Notice that gating can be applied to live waveforms, memories, or functions.

Serial Data Analysis Demo

This demo highlights features related to clock recovery and eye measurements.

- 1 Choose **Demos > Show Demo Wizard...** and select **Analysis** and **Real-Time Eye**.



- 2 Click **Load Demo...**
- 3 Experiment with the real-time eye measurements.

Jitter Demo

- 1 Choose **Demos > Show Demo Wizard...** and select **Jitter** and **EZJIT+ Jitter Analysis**.



- 2 Click **Load Demo...**
- 3 Experiment with Infiniium's many jitter capabilities.