Agilent InfiniiVision 7000 Series Oscilloscopes

Evaluation Kit Guide

Agilent Technologies

Notices

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CAUTION

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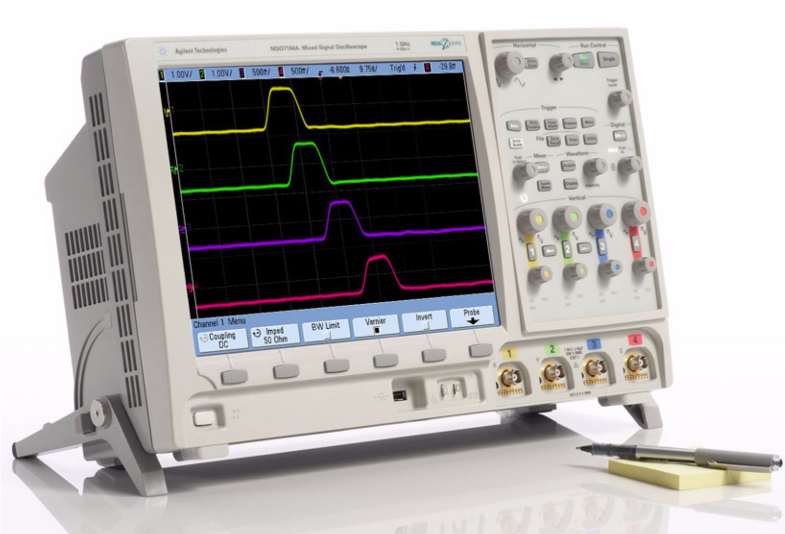
Agilent InfiniiVision 7000 Series Oscilloscope Evaluation Kit Guide

The InfiniiVision 7000 Series oscilloscopes offer bandwidths up to 1 GHz. Each model, equipped with a large 12.1" XGA LCD display, comes in an extremely quiet package that is just 6.5" deep and weighs only 13 pounds. Agilent engineers architected the InfiniiVision 7000 Series oscilloscopes with technology to provide the industry's best signal visibility.



1. Big display. Small footprint.

Bigger displays have become increasingly important as general purpose oscilloscopes need more space to display digital and serial signals in addition to traditional oscilloscope channels. The increased display size helps users who need to display up to 20 channels simultaneously with serial protocol.

2. Fast and responsive.

Have you turned your oscilloscope's deep memory on only to have the controls become sluggish and unresponsive? If so, you've experienced the impact of architecture on performance. While it may be annoying to wait for new settings to take effect on your oscilloscope, this same architecture limitation has a more significant impact. While processing and drawing waveforms the oscilloscope is blind to target signal changes. Infrequent anomalies and critical signal detail are likely to be missed.

Agilent's InfiniiVision 7000 Series is the only oscilloscope in its class engineered to provide maximum signal visibility. The InfiniiVision 7000 Series shows jitter, infrequent events, and subtle signal detail that other oscilloscopes miss. Patented MegaZoom III technology provides up to 100,000 waveforms (acquisitions) per second with responsive deep memory always available. See a display more representative of the actual signals under test than with any other oscilloscope. Turn knobs and the instrument responds instantly and effortlessly. Decoding serial packets? Unlike other oscilloscopes that become less responsive and are blind to target signal changes while employing software-based serial decode, Agilent's hardware-accelerated decode allows the product to stay responsive and does not compromise update rate.

3. Insightful applications.

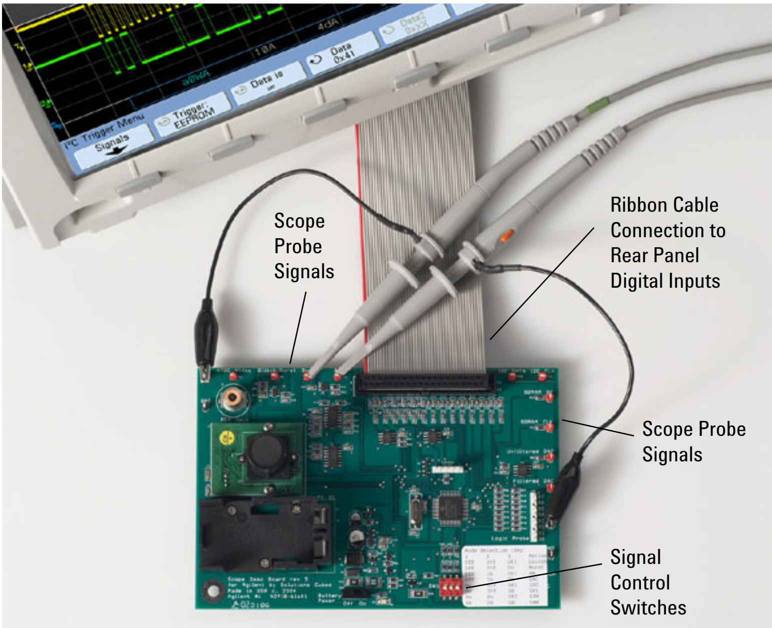
Customize your general purpose oscilloscope. A wide range of application packages provide meaningful insight into application-specific problems. These include:

- Serial with hardware-accelerated decode for: I2C, SPI, CAN, LIN, RS-232/UART, and FlexRay.
- Core-assisted FPGA debug for Altera and Xilinx devices.
- PC-based offline analysis of previously acquired DSO/MSO data.
- Segmented memory.
- Power measurements.

Parts Required for this Demo

- Agilent InfiniiVision 7000 Series Mixed Signal Oscilloscope (MSO).
- Demo kit with demo board and ribbon cable.

Demo board connections:



Power is provided by digital port on back of 7000 Series scopes.

In This Guide

If you are experiencing the InfiniiVision 7000 Series oscilloscope for the first time, begin with Lab 1, the Getting Started Guide. If you have a basic knowledge of the InfiniiVision 7000 Series oscilloscope's front-panel controls, begin with Lab 2.

1
Demo Board Getting Started Guide

If you are not familiar with the Agilent InfiniiVision 7000 Series oscilloscopes, please first look over the main sections of the front panel as illustrated and then follow the exercises in this guide.

Status line shows current settings

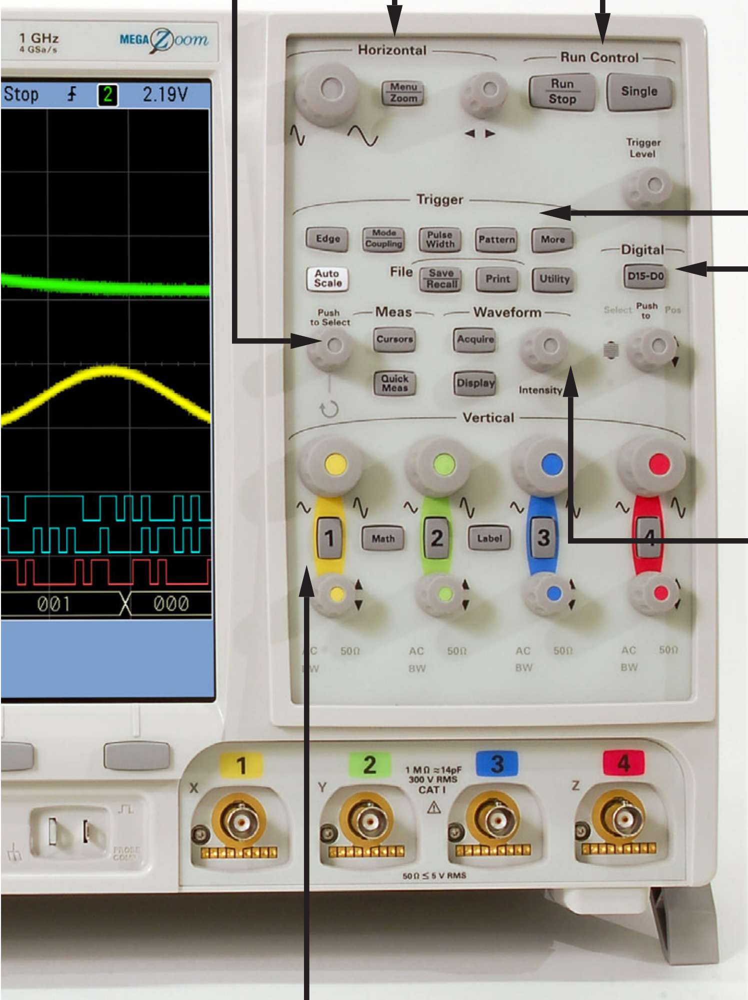
Menu line for 6 softkeys for control of menus selected on the front panel

Instant HELP is available by simply pressing and holding down any key for 2 seconds.

Selection knob, immediate action keys and special menus
Push the knob to make a selection

Time/div and position
horizontal controls

Run Control



Trigger level
knob and
controls

Digital controls
for mixed signal
scope channels
D0 – D15

Push knob to
toggle between
Select and Pos

Waveform
Intensity knob

Vertical color-coded controls
for each scope channel

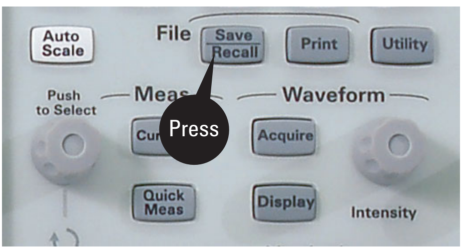
Capturing and Viewing a Simple Signal

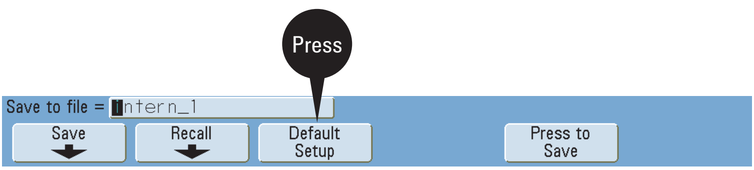
1 Connect the demo kit's 40-pin ribbon cable from the back of the Agilent InfiniiVision 7000 Series oscilloscope to the 40-pin connector on the demo board.

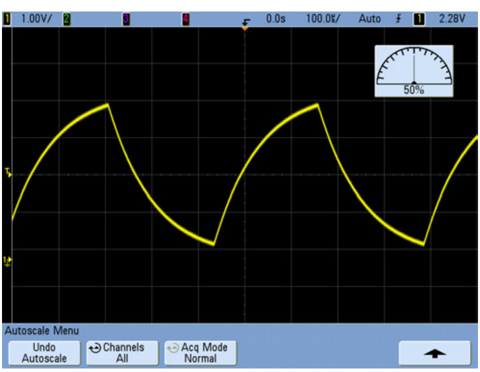
2 Connect the channel 1 probe to the test points labeled SYNC and ground (GND).

3 Set switches on demo board to **off–off–off**.

4 Press the [**Save/Recall**] key on the front panel. Then, press the **Default Setup** softkey under the display.







The oscilloscope is now set in the factory default configuration – just as it left the factory. Since the oscilloscope may have been used in a variety of applications by a variety of people, it is a good measurement procedure to put the oscilloscope in a known starting mode (Default Setup). This will make it easy to duplicate measurements as no special conditions will be set.

5 Press **[AutoScale]**. The oscilloscope will analyze all active channels, turning them on and setting the time base, V/div and trigger conditions for an initial display.

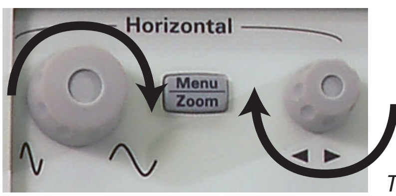
6 Adjust the **Waveform Intensity** knob (in the Waveform section on the front panel) for desired signal brightness. The gauge in the upper right of the display shows the brightness as a percent from 0 to 100% (brightest).

Horizontal Control

1 Turn the **large knob** in the horizontal control section clockwise and counterclockwise to control the time/div setting of the horizontal axis. Observe the changes in the displayed signal. The current time base setting is displayed at top of display in status line.

2 Turn the **small knob** in the horizontal control section to move the waveform horizontally from the trigger point.

Turn to control time/div



Turn to control horizontal position

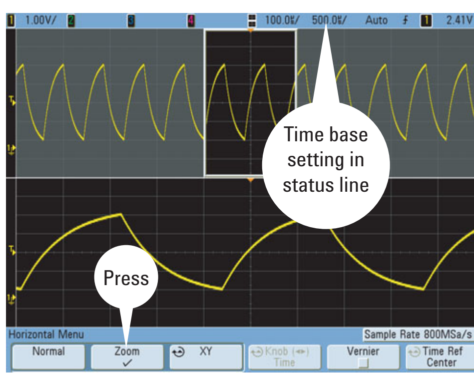
3 Set the time base 500 µs/div.

4 Press the **[Menu/Zoom]** key to display the Horizontal menu. Note the various modes of Normal, Zoom, Roll, XY.

For instant HELP on any topic, press and hold any key or softkey.

5 Press the **Zoom** softkey under the display and observe the split-screen – this mode shows the big picture on top and an expanded view on the bottom.

6 Turn the large time base knob counter clockwise to make the window on top larger.



7 Press the **Normal** softkey to return to the original display.

Note: At any time, to return to the original setup, press [AutoScale].

Run Control

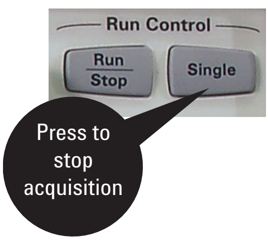
When the oscilloscope is turned on, or if **[AutoScale]** is pressed, the acquisition will be set to **[Run]**. At any time you may **[Stop]** the acquisition process to examine a signal in detail or to save it.

1 Press **[AutoScale]** to return to simple setup.

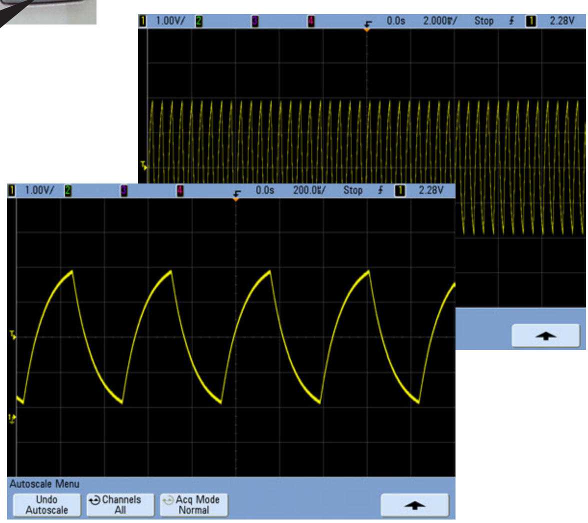
2 Set time base to 2 ms/div.

3 Press the **[Single]** key to make a single acquisition and stop the acquisition process.

4 Use the large Horizontal knob to zoom in on the waveform.



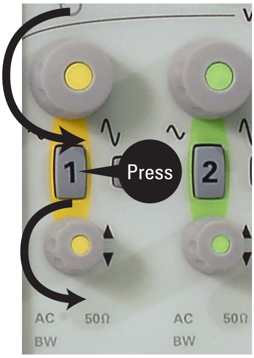
Capture the big picture then zoom in for detailed analysis thanks to MegaZoom III deep memory.



Vertical Controls

1 Press [**AutoScale**] to return to simple setup.

2 Turn the **large yellow knob** in the Vertical section to control the V/div setting. The V/div setting is displayed in the upper left hand corner of the status line at the top of the display. Knobs are color coded to match the waveform color.



3 Press the [**1**] key to display the channel 1 menu. Press again to turn the channel on and off.

4 Turn the **small yellow knob** to control the offset position of the waveform, moving it up or down.

Trigger Controls

1 Press [**AutoScale**] to return to a simple setup.

2 Rotate the **trigger level knob** up and down. The trigger level is displayed when it is being adjusted.

If the trigger level is above or below the signal, the oscilloscope will force a trigger and display a waveform when in Auto mode. Auto is a useful trigger mode to use when unsure of the exact waveform, as activity will be displayed making it easy to better configure the oscilloscope's settings and trigger level.

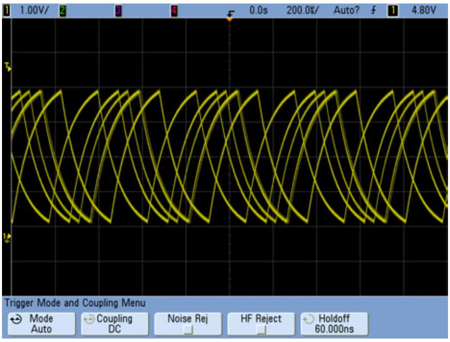
Move trigger level up and down on signal

3 Press the [**Mode/Coupling**] key in the trigger section.

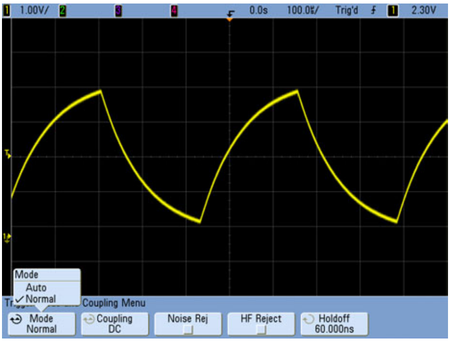
4 **Press and hold the Mode softkey** to read more about the Auto and Normal trigger mode using the built-in **HELP** system.

5 Set the trigger mode to **Normal**. Move the trigger level up and down.

Observe that the oscilloscope only triggers when a valid trigger condition exists – this is the trigger mode to use when you want to set a specific trigger condition and capture waveforms only when those conditions are met.



Auto mode will force a trigger if the trigger conditions are not met and will show untriggered waveform activity.



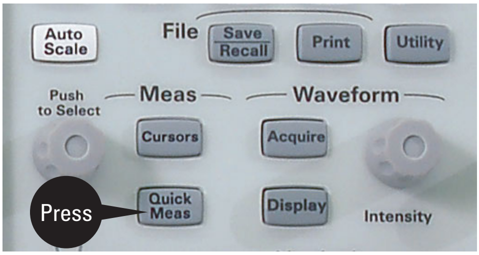
Normal mode waits for a waveform that meets the trigger conditions before displaying any activity.

Making Measurements

1 Press **[AutoScale]** to return to a simple setup.

2 Press **[Quick Meas]** key on front panel.

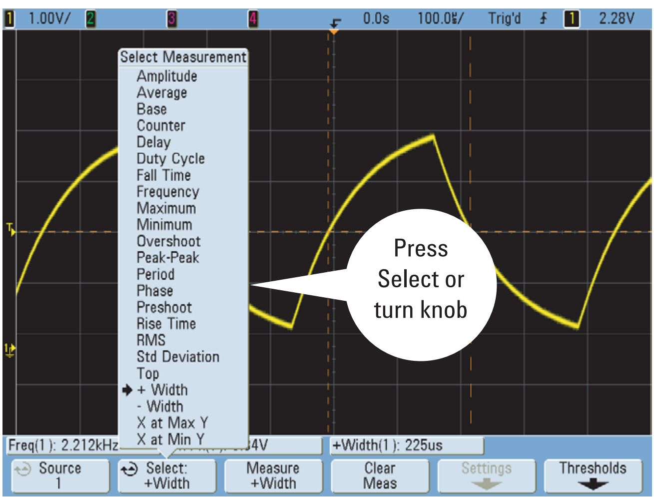
Note the [Quick Meas] key is lit when measurements are active and that two measurements are displayed under the oscilloscope display with the measurement menu. Four measurements may be made at a time. You may clear measurements and select the four you want to make or you may simply add the 4th measurement. Cursors show where the measurement is performed on the last selected measurement.



3 Press the **Select** softkey. Press **Select** repeatedly or turn the selection **knob** to the right of the display to set the measurement to +Width (width of positive pulse).

4 Press **Measure +Width** to start the selected measurement.

5 Press [**Quick Meas**] key on front panel to turn off measurements.

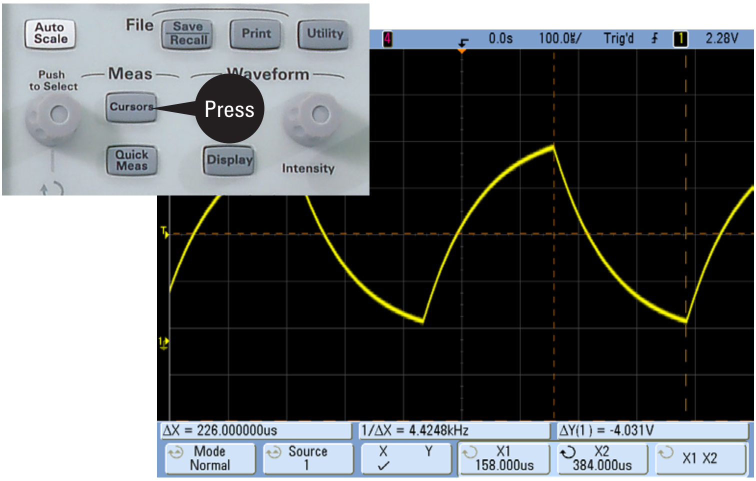


Using Cursors

1 Press the [**Cursors**] key on front panel. Horizontal (X: time) and Vertical (Y: volts) cursors can be positioned on the waveform to measure time or volts of interest.

2 For example, press the **X1** softkey and turn the selection knob to the right of the display to position the X1 cursor on the top peak. Press the **X2**

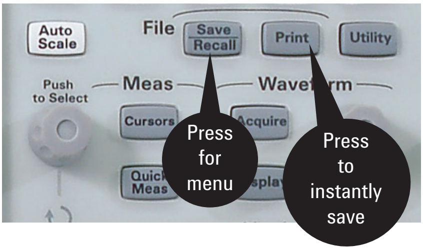
softkey and turn the selection knob to position the X2 on the negative peak. The display shows the value of each cursor and their delta.



Saving Images

USB host ports (the rectangular ports on the front and back panels) make it easy to save and transfer images and data to a USB flash drive.

Images, waveform data, or setups can be easily saved to a variety of media. Choosing the format and type of information to be stored is done by pressing the **[Save/Recall]** key on the front panel and using the Save/Recall Menu.



You can also print to a USB printer connected to one of the host ports. Press the **[Print]** key on the front panel and use the Print Configuration Menu.

For more information, press and hold any key to view the built-in online help.

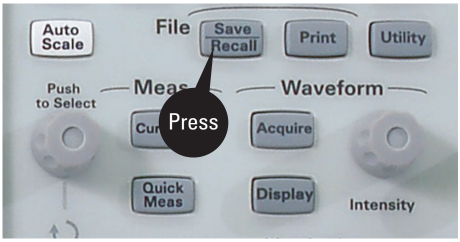
2
Viewing Complex Signals with a High Definition Display

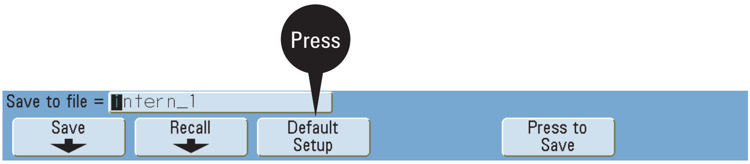
Video signals have been the ultimate display challenge for digitizing oscilloscopes. These complex signals have long been considered the display standard by which the display performance of digitizing oscilloscopes have been compared to analog oscilloscope display technology.

Video signals, due to their complexity, demand an oscilloscope with high resolution, a fast display update rate, and a high sample rate to avoid aliasing.

Setup

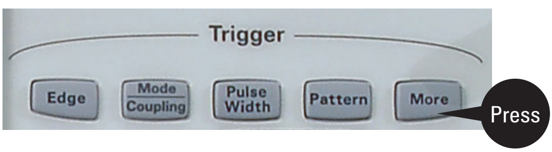
1. Connect the demo board's 40-pin ribbon cable from the back of the InfiniiVision 7000 Series oscilloscope to the 40-pin connector on the demo board.
2. Connect the channel 1 probe to the test points labeled NTSC Video and ground (GND). Disconnect all other probes.
3. Remove the cap from the video camera lens.
4. Set switches on the demo board to **off–off–off**.
5. Press the **[Save/Recall]** key and the **Default Setup** softkey to ensure the oscilloscope is in an initial known state.





6 Press **[AutoScale]** (next to **[Save/Recall]** on front panel).

7 In the Trigger section of the front panel, press the **[More]** key.



8 Toggle the **Trigger** softkey until "TV" mode is selected.

9 Press the **Settings** softkey and ensure the following trigger conditions are set:

   a Source = 1

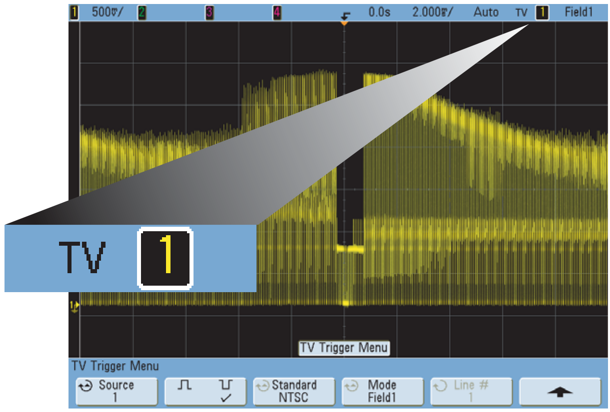
   b Trigger on negative-going pulse

   c Standard = NTSC

   d Mode = Field 1

10 Using the large Horizontal knob, adjust the time base to 2 ms/div.

11 Adjust the volts/div setting to 500 mV/div.



The trigger conditions are at the upper right hand corner of the display.

The Mega*Zoom* III Advantage

Some oscilloscopes today have simulated phosphor display modes, with just a handful of intensity levels, intended to reproduce the display fidelity of analog oscilloscopes. With the Mega*Zoom* III display system, a live, interactive, color display, capable of mapping up to 8 Mpts of deep memory to 256 intensity levels, far exceeds the display capability of any other oscilloscopes on the market today. With an update rate of up to 100,000 waveforms/second, users can be confident they won't be missing out on infrequent events or glitches.

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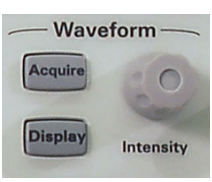
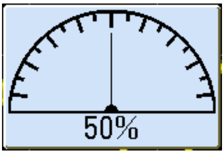
12 Wave your hand over the video camera lens on the demo board to observe the fast (up to 100,000 wfms/sec) display update rate of the oscilloscope.

13 Use the waveform intensity knob (in the Waveform section on the front panel) to adjust the intensity. The Agilent InfiniiVision 7000 Series oscilloscope has 256 levels of intensity grade to highlight subtle details of your signals.

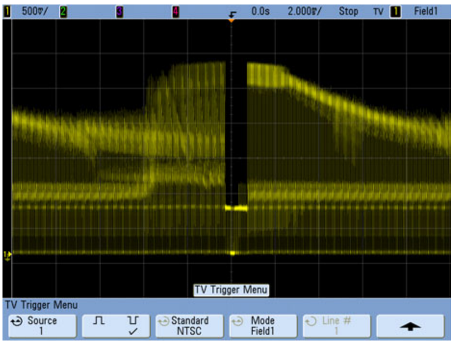


14 Set the intensity level to approximately 50%.

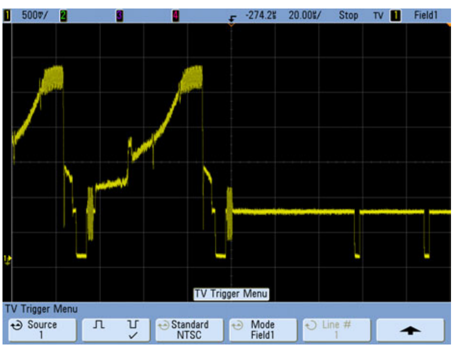


15 To obtain a more in-depth view of this signal, press **[Single]** to obtain one acquisition using the maximum memory depth of the oscilloscope.

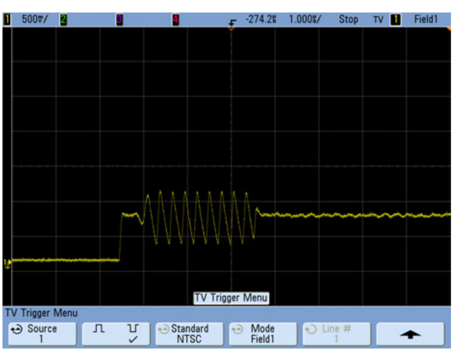
16 Using the large Horizontal knob, adjust the time base setting to 1 μs/div to zoom in on the color burst. If available, compare this to the performance of a shallow-memory oscilloscope. With Mega*Zoom* III, the deep memory helps sustain a high sample rate, enabling you to zoom in and easily see all the details.



With deep memory, we are able to zoom in by a **factor of 2,000** from the original waveform to analyze details of the color burst of this video signal.



Use the Horizontal position knob to move a color burst to center screen.



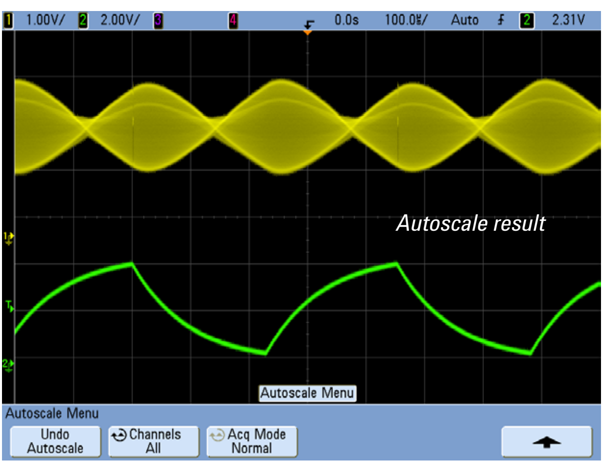
Then zoom in on a color burst.

3
Uncovering Signal Anomalies with Responsive Deep Memory

An amplitude modulated (AM) signal is a very complex modulated waveform where a high-definition display and deep memory are needed for successful capture, viewing and analysis. In this lab we will capture an AM signal that includes an embedded anomaly (a glitch). With the InfiniiVision 7000 Series **Mega*Zoom* III** technology, the display system will clearly show this glitch while the deep memory will allow us to zoom in for detailed analysis of the glitch after capture.

Setup

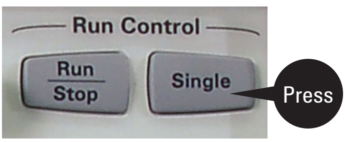
1. Connect channel 1 probe to test points labeled AM and ground (GND).
2. Connect channel 2 probe to test points labeled Sync and GND.
3. Set switches on the demo board for the AM signal (**off–on–off**).
4. Press [**AutoScale**].



In this lab, a stable trigger is accomplished by triggering on the synchronization signal on channel 2. Turn **off** channel 2 (still the trigger source) by pressing the [**2**] key twice. Re-adjust channel 1's vertical scale to 500 mV/div and its vertical position to 2.3 V offset in order to optimize viewing the complex channel 1 signal. In the absence of a synchronization signal, trigger holdoff can be used to achieve a stable trigger (see Appendix A).

5 Use the Waveform Intensity knob (in the Waveform section on the front panel) to adjust the waveform brightness to approximately 40% so that the subtle details in this complex waveform can be seen. Note the glitch is present in every other envelope.

6 Press **[Single]** to capture a single shot acquisition of this complex waveform.

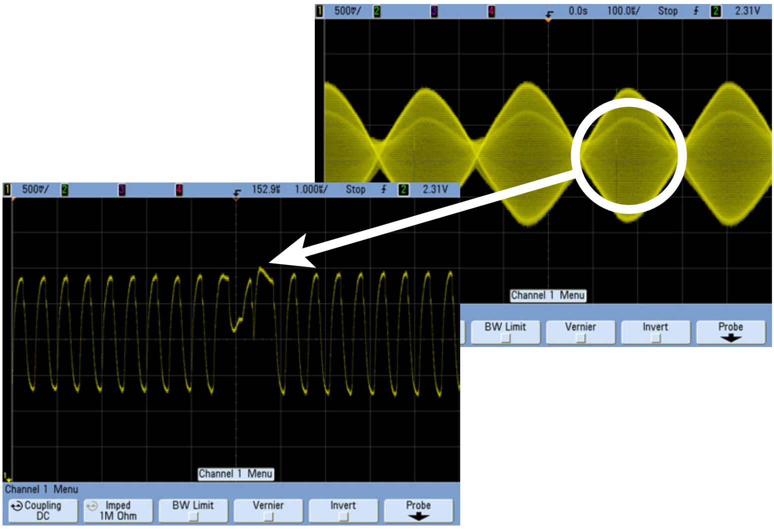


Take advantage of deep memory: zoom in on one of the glitches to see the details:

Step 1: Using the small Horizontal position knob, move one of the glitches to the center of the display.

Step 2: Using the large Horizontal time/div knob, set the time base to 500 ns/div (turn clockwise) to see characteristics of the glitch in detail.

With up to 8 Mpts of deep memory you are able to see the big picture (envelope of the entire AM signal) as well as zoom in on the details of this anomaly while maintaining a high sample rate.



4
Discovering an Infrequent Glitch with Fast Waveform Update Rates

Capturing infrequent anomalies such as random glitches requires oscilloscopes with extremely fast update rates. Faster update rates will improve the probability of capturing random glitches. This lab demonstrates capturing a glitch that occurs approximately one time every 40,000 cycles of a digital data stream. With up to 100,000 waveforms/sec update rate, we will be able to view this glitch multiple times a second. Scopes with long dead times will have difficulty capturing and displaying this glitch.

Setup

1 Connect channel 1 probe to test points labeled Glitch/Burst and ground (GND).

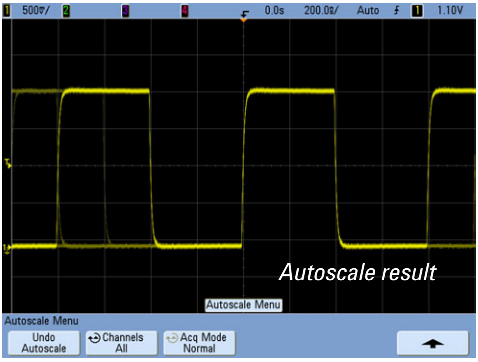
2 **Make sure all other probes are disconnected from the oscilloscope**.

3 Set switches on the demo board for Glitch (burst) mode signal (**off–off–off**).

4 Press [**AutoScale**].

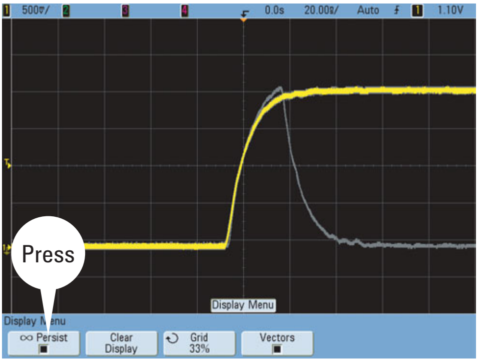
5 Change the time base setting to **20 ns/div** to view one rising edge in detail.

6 Adjust the waveform intensity knob to 100% to more clearly see the infrequent glitch.



Note that the glitch is captured multiple times a second thanks to Mega*Zoom* III's fast update rate which minimizes dead time between acquisitions.

7 Press the [**Display**] key on the front panel and turn on **Infinite Persistence**.

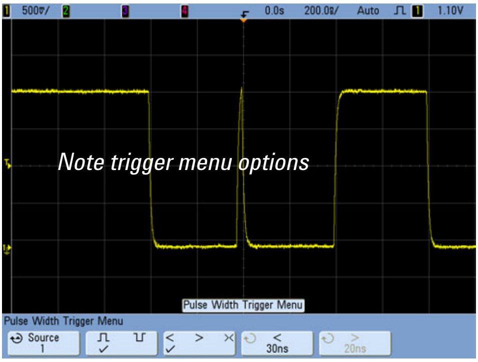


With the infinite persistence mode, all acquisitions are accumulated and displayed on screen. This is very useful when setting up an overnight measurement to capture an elusive glitch or trigger event.

Note: With AutoScale, the oscilloscope triggers on a random rising edge of the input signal. Let's now set up a glitch trigger condition that will trigger exclusively on the anomaly.

8 Press [**AutoScale**].

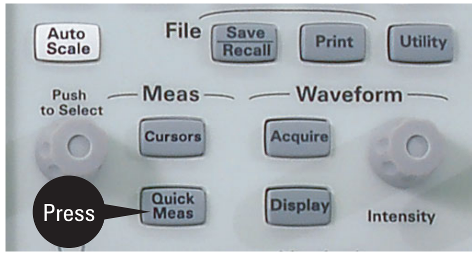
9 Press **Pulse Width** in trigger section on the front panel – the default setting of pulse width selection is set to trigger on positive pulses less than 30 ns wide. This setting easily captures our glitch that is occurring only once every 40,000 cycles in this data stream.



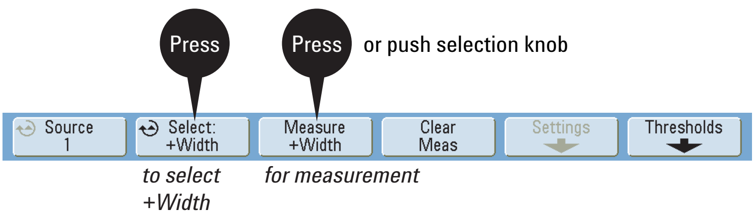
Note the other options for uniquely qualifying trigger conditions in this menu (positive or negative-going pulses, greater than, less than, range, etc). In fact, the pulse width setting can be qualified as low as 2 ns.

10 To better view the glitch, set the time/div setting to **10 or 20 ns/div**.

11 To measure the width of this glitch embedded in the data stream, press [**Quick Meas**]. Next, press the **Select** softkey and turn the selection knob to change from Freq to +Width (positive pulse width) measurement.



12 Push the selection knob or press the **Measure +Width** softkey to start the measurement.

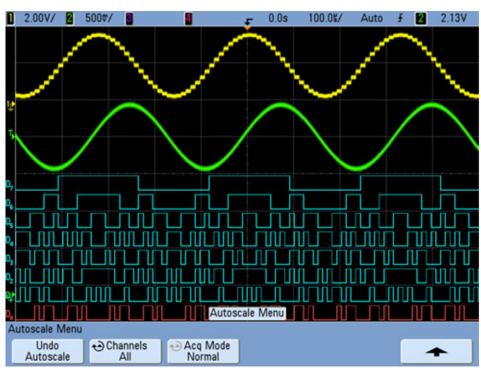


5
Viewing Multiple Signals in an MCU-based Design with an MSO

In mixed analog and digital designs, it is often important to view multiple analog and digital channels, which is significantly beyond the capability of a 2- or 4-channel oscilloscope. With 2 or 4 oscilloscope channels plus 16 logic timing channels, the unique 2+16 or 4+16 channel Mixed Signal Oscilloscope (MSO) affords the opportunity to view more signals and to make time-correlated measurements across all channels.

Setup

1. Connect channel 1 probe to test points labeled Unfiltered DAC and ground (GND).
2. Connect channel 2 probe to test points labeled Filtered DAC and GND.
3. Set switches on the demo board for the DAC signal (**off–on–on**).
4. Press [**AutoScale**]. Adjust the waveform intensity to approximately 50%.



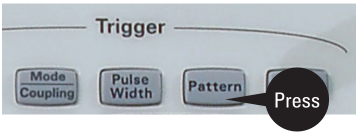
The channel 1 signal (yellow) shows the stair-step output of a microcontroller-based Digital-to-Analog Converter (DAC). The channel 2 signal (green) is the filtered version of the output. Channels D0 – D7 (blue) are the input control lines to the DAC. We were able to easily trigger on channel 2. However, what if we wanted to trigger on a specific voltage instruction based on the input to the DAC using pattern trigger?

5 Press the **[D15-D0]** key on the right hand side of the instrument to go to the digital channel controls.

6 Press the **Bus** softkey.

7 In the Digital Bus Menu, press **Bus1** twice to enable the Bus 1 display (whose default setup contains digital channels 0 through 7).

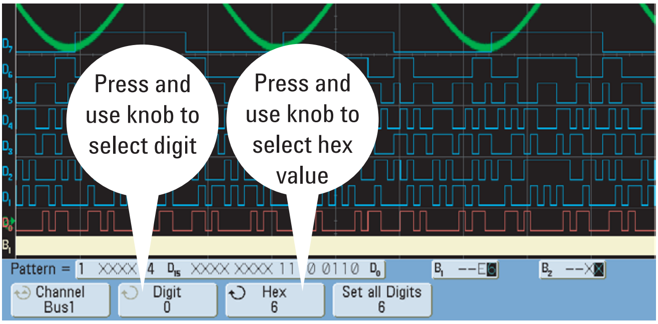
8 To trigger at the highest voltage level output of the DAC, press the **[Pattern]** key on the front panel of the scope.



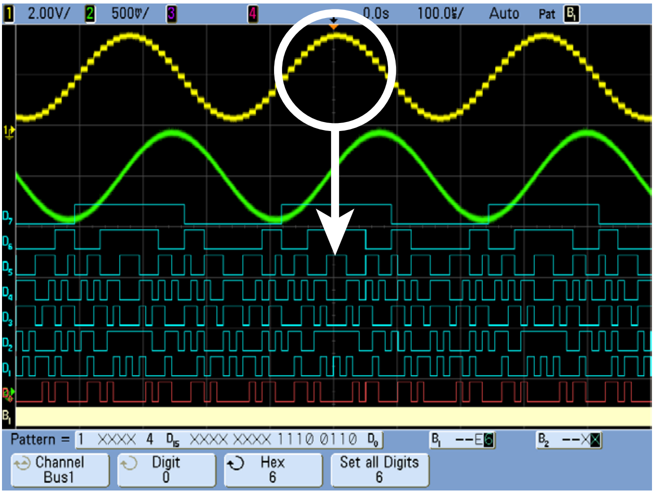
9 In the pattern menu, press **Channel** and use the selection knob to select "Bus1".

10 Now, set the pattern trigger condition to E6 hex:

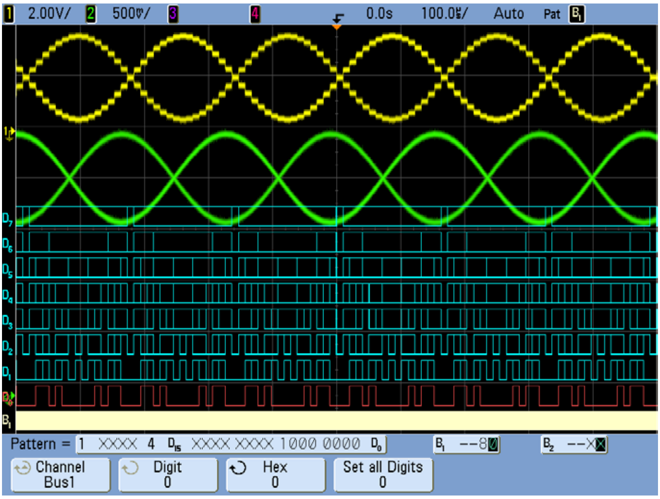
- Press **Digit** and turn the selection knob to select "1"; then, press **Hex** and turn the selection knob to select "E".
- Press **Digit** and turn the selection knob to select "0"; then, press **Hex** and turn the selection knob to select "6".



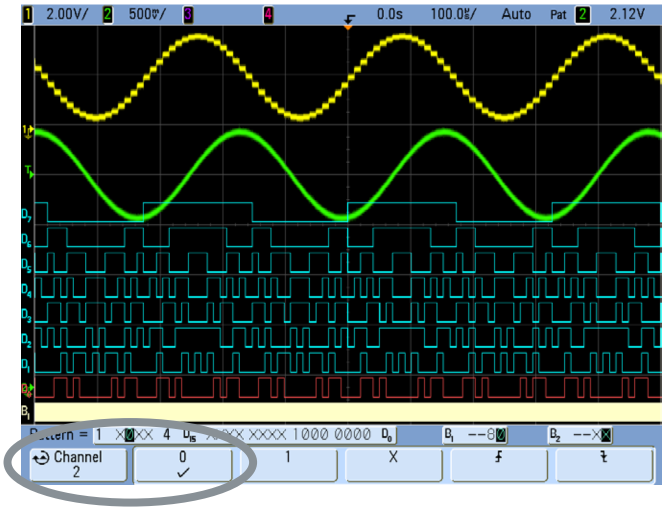
At center screen, notice the pattern of channels D0 – D7, which is synchronous with the highest voltage level of the analog DAC output on channel 1. Triggering at this high point using an edge trigger would be difficult, if not impossible.



11 Let's now trigger synchronous with the 50% level based on the DAC inputs. Change the pattern to 80h (1000 0000b). Notice that the signal appears not to be triggered. This is because there are two unique points of this signal that correspond to the 50% level of the DAC input.



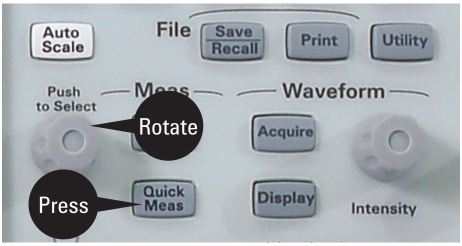
12 To qualify on the rising or falling 50% level, use channel 2. Select **Channel 2** in the pattern menu press the **0** softkey to force the trigger to be synchronous with just the rising edge of the output of the DAC.



Making Measurements:

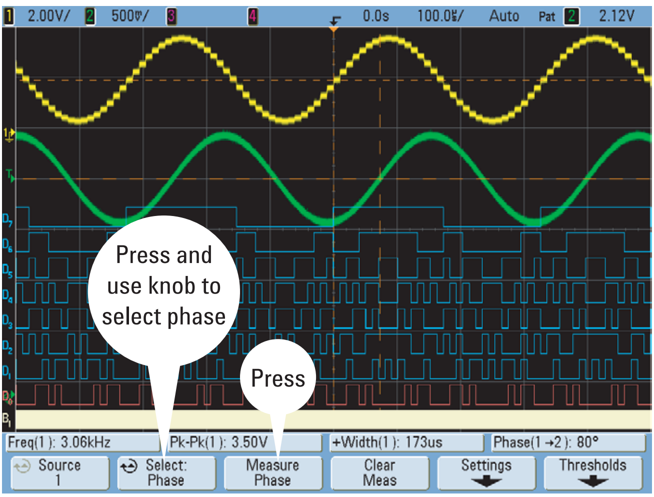
13 Let's now measure the phase difference between the filtered and unfiltered signals.

14 Press [**Quick Meas**] on the front panel.



15 Press the **Select** softkey and rotate the selection knob (located near the Meas keys) to select **Phase**. Or you may also press the **Select** softkey repeatedly until **Phase** is selected.

16 Push the selection knob or press the **Measure Phase** softkey—note that the cursors show where the measurement was made from the rising edge of channel 1 at the center of screen to the rising edge of the channel 2 and measures approximately 80 degrees.



6
Synchronizing on and Verifying I^2C Serial Bus Communication

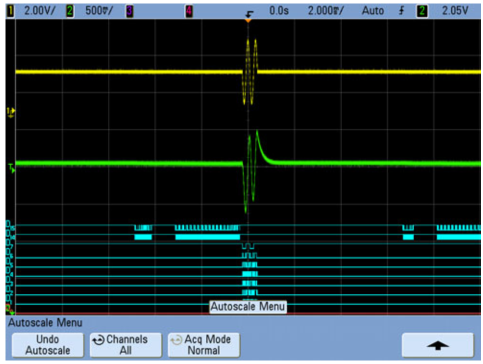
Many of today's embedded designs include serial bus communications using protocols such as I^2C (Inter-Integrated Circuit). The I^2C bus is primarily used for chip-to-chip communications. In this lab you will see that the I^2C bus generates a series of commands to instruct the microcontroller to generate three specific sine wave chirps (or bursts) with varying numbers of pulses. Our goal is to synchronize the oscilloscope's display on specific chirps using this oscilloscope's I^2C trigger capabilities and verify the serial data transmissions by using the optional I^2C/SPI decode function (option LSS or N5423A).

Setup

To enable I^2C serial decode, your oscilloscope has to have the low speed serial bus decode option LSS installed. (You can check the installed options on your oscilloscope at **Utility > Service > About Oscilloscope**.)

1. Connect channel 1 probe to test points labeled Unfiltered DAC and ground (GND).
2. Connect channel 2 probe to test points labeled Filtered DAC and GND.
3. Set DIP switches on the demo board for the I^2C with DAC signal (**on–off–off**).
4. Press [**Save/Recall**] and then press **Default Setup**.

5 Press **[AutoScale]** to see signals.

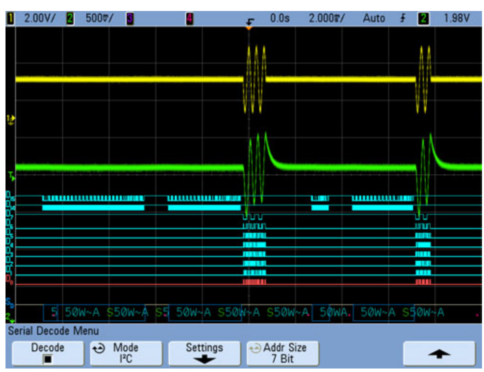


6 Set the logic threshold level to CMOS by pressing the **[D15-D0]** key on the right-hand side of the front panel; then, press **Thresholds** and set both logic pods to **CMOS (2.5V)** level.

Notice that the oscilloscope may trigger on multiple chirps of different lengths (1, 2, or 3 cycles) using standard edge triggering. To trigger on the first chirp that consists of three sine wave cycles, we can set up the I^{2}C triggering of the oscilloscope to trigger on an EEPROM read cycle based on specific serial data content. Digital signals D7 – D0 are the digital inputs to the DAC generated by the MCU. D14 is the I^{2}C clock signal (SCL) and D15 is the I^{2}C data signal (SDA). Before we set the trigger, we will turn on the I^{2}C serial decode on the oscilloscope that displays I^{2}C serial data decode on-screen in hexadecimal values.

Note that analog channels can also be used as serial decode sources.

7 Press **[Acquire]**. Press the **Serial Decode** softkey and then turn on **Decode** to enable I^{2}C serial decode function.



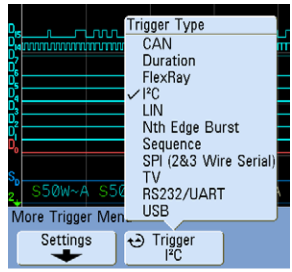
8 Press **Settings**. Then press **SCL** (serial clock) and using the selection knob select “D14”.

9 Press **SDA** (serial data) softkey and using the selection knob select “D15”.

10 After defining the clock (SCL) and data (SDA) signals for serial decoding, set up the oscilloscope to trigger on an EEPROM read cycle with a serial data content of 0x41Hex, which is the binary ASCII code for “A”.

11 To trigger on the ASCII "A" character, first press the **[More]** key in trigger section on the front panel to access the advanced triggering functions of the InfiniiVision 7000 Series oscilloscope.

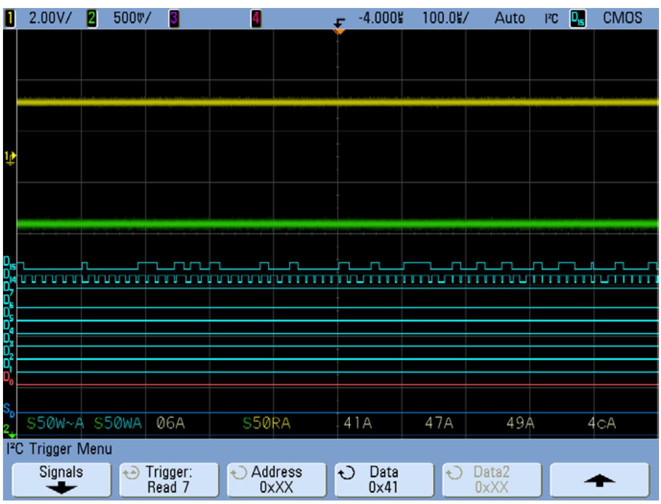
12 Press the second softkey (**Trigger**) and use the selection knob to change from "TV" to "I^2C" triggering.



13 Press **Settings**. Now press the **Trigger** softkey and use the selection knob to select "EEPROM Data Read".

14 Press the **Data** softkey and use the selection knob to enter hex code 0x41 (for ASCII character "A").

15 Switch the time base to 100 µsec/div to zoom in on the hex decoded I^2C data string (41A 47A 49A 4cA 45A 4eA 54~A).



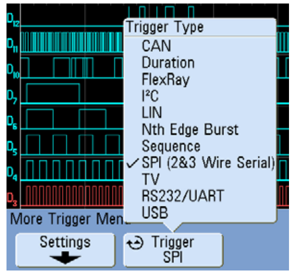
7
Synchronizing Acquisitions Based on SPI Serial Bus Triggering (SPI Signal)

Another common serial bus protocol used in many embedded designs is the Serial Peripheral Interface (SPI). Although this bus requires more signals than the I^2C bus, it is a very flexible bus that the designer can define such as number of bits in each serial transmission. While I^2C is primarily used for chip-to-chip communication, the SPI bus can be used for chip-to-chip communication or for serial communications to nearby peripherals.

Setup

To enable SPI serial decode, your oscilloscope has to have the low speed serial bus decode option LSS installed. (You can check the installed options on your oscilloscope at **Utility** > **Service** > **About Oscilloscope**.)

1. **Disconnect all oscilloscope probes** from the demo board. *This is a digital signal only demo*.
2. Set switches on the demo board for the SPI signal (**on–off–on**).
3. Press [**Save/Recall**] and then press **Default Setup**.
4. Press [**AutoScale**].
5. Press [**Acquire**].
6. In the Acquire Menu, press the **Serial Decode** softkey.
7. In the Serial Decode Menu, press the **Decode** softkey to enable serial decode.
8. Press the **Mode** softkey and turn the selection knob to select “SPI”.
9. Press the [**More**] key in trigger section of front panel to set up the SPI trigger.



10 In the More Trigger Menu, press the **Trigger** softkey and use the selection knob to change from "TV" to "SPI" triggering.

11 Press **Settings** to define the inputs.

12 In the SPI Trigger Menu, press **Signals**.

13 In the SPI Signals Menu, press the **Clock** softkey and use the selection knob to select "D11".

14 Press the **Data** softkey and use the selection knob to select "D10".

Note that there are actually two data lines, one used for send strings (D10 on rising edge of clock) and another data line used for receive strings (D12 on falling edge of clock).

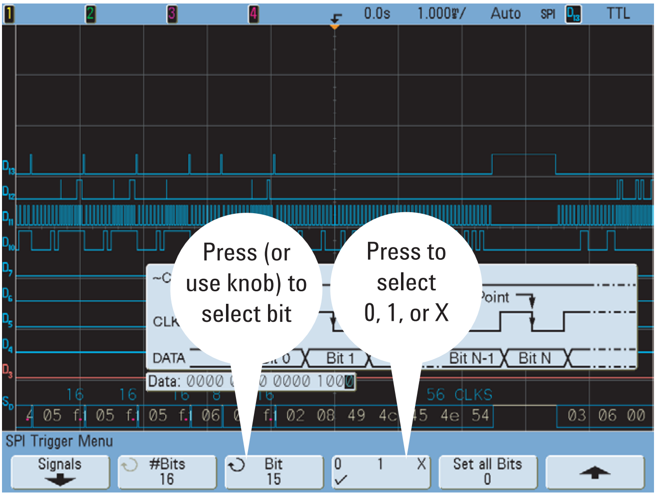
15 Press the **~CS** softkey and use the selection knob to select "D13".

16 To define the trigger condition, press the "up" arrow softkey ▲ on the far right to return to the SPI Trigger Menu.

17 Press the **#Bits** softkey and turn the selection knob to select "16".

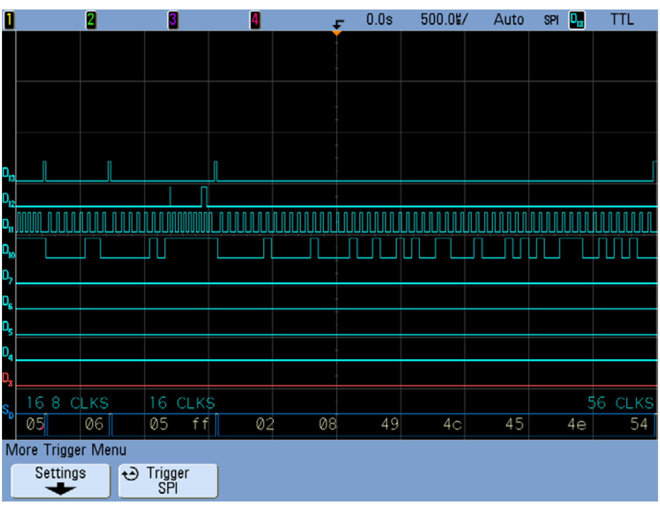
18 Define the serial pattern as 0000 0010 0000 1000 for Bits 0 to 15:

- Press the **Bit** softkey to advance the bit position (or turn the selection knob to select the bit position).
- Press the **0 1 X** softkey to toggle between the settings for each bit.



Note that we now have a stable trigger condition on this SPI serial data transmission.

19 Press the "up" arrow softkey ▲ and change the time base setting to 500 μs/div to easily see the serial decode.



8
CAN/LIN Demo Instructions

CAN Demo Instructions

To enable CAN serial decode, your oscilloscope has to have the automotive serial bus decode option AMS installed. (You can check the installed options on your oscilloscope at **Utility > Service > About Oscilloscope**.)

1 Connect logic demo cable to the demo board and to the MSO connector on the back of the InfiniiVision 7000 Series oscilloscope.

2 Set the demo board switch (SW1) to the “CAN” mode (**on–on–on**).

3 Connect channel 1 probe to the “Glitch/Burst” test point (single-ended CAN_L signal).

4 Connect channel 4 probe the “Unfiltered DAC” test point.

5 Press [**Save/Recall**] and then press **Default Setup**.

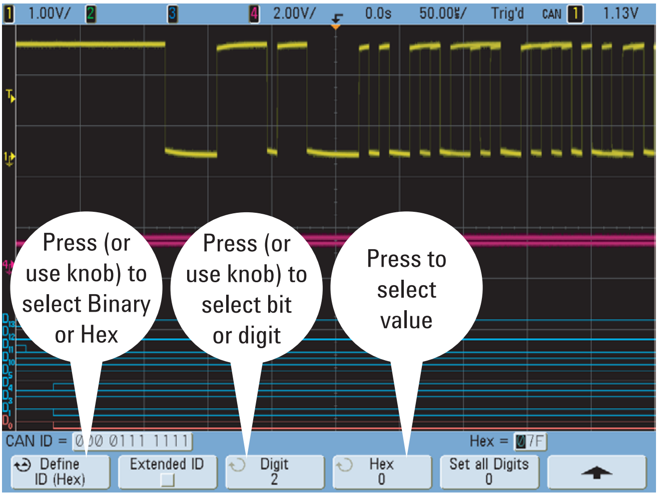
6 Press [**AutoScale**].

7 In the Trigger area on the front panel, press [**Mode/Coupling**]; then press **Mode** twice to select “Normal”.

8 Press the [**More**] triggering menu on the oscilloscope’s front panel and then change triggering from the default “TV” trigger to “CAN” triggering.

9 To configure CAN triggering, first press **Settings**, then **Signals** and then set **Source** to channel 1 and **Baud** rate to 125 kb/s.

10 Change to trigger specifically on data frame ID 07F hex by first moving up one menu level (press the "up" arrow softkey ▲), and then change the triggering condition to "Data Frame ID (~RTR)". Press **Bits** and use the softkeys and selection knob to enter the CAN ID = 000 0111 1111. The oscilloscope triggering should now be stable on data frame ID: 07F hex.



11 To turn on CAN protocol decoding. First, press the [**Acquire**] key on the oscilloscope's front panel, press the **Serial Decode** softkey, change **Mode** from "I^2C" to "CAN", and then press the **Decode** softkey.

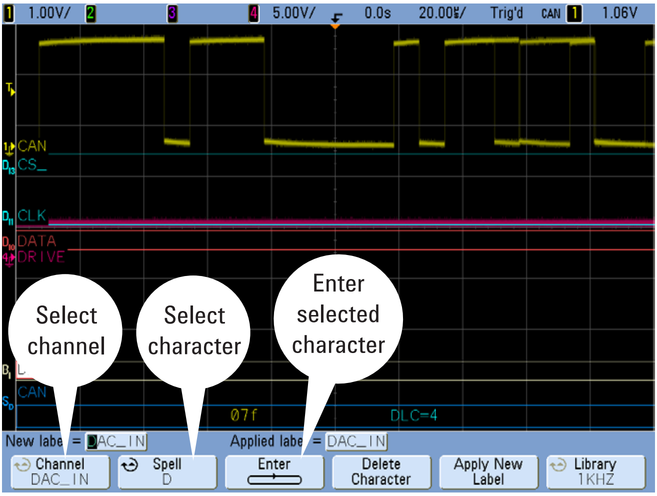
12 Press the [**D15-D0**] key on the front panel. Press the first softkey to select medium-sized waveforms. Then, turn channels on or off so that only D10, D11, and D13 are on.

13 Press the **Bus** softkey then **Bus1** twice to display D7 - D0 as a bus.

When Bus1 is enabled, the softkey to the right shows which channels are assigned to Bus1.

14 Press the **[Label]** key and give these labels to the channels and buses:

- Channel 4: DRIVE
- D10: DATA
- D11: CLK
- D13: CS_
- Bus1: DAC_IN



15 Re-arrange the waveforms, change the vertical scaling of channel 4, and change the horizontal scale to 100 μs/div so that your oscilloscope's display is similar to Figure 1.

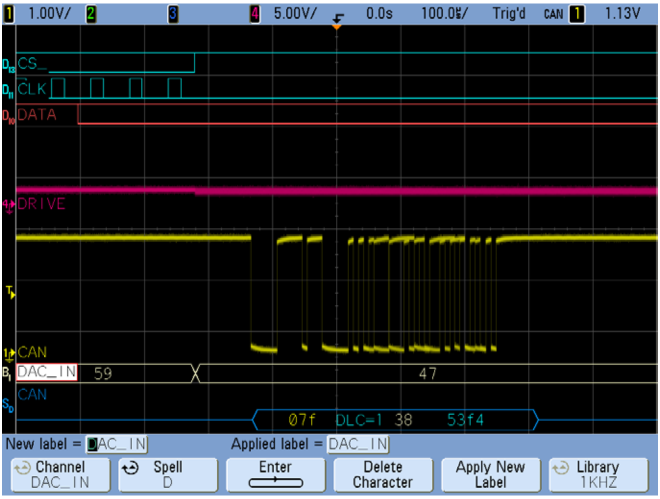


Figure 1 Triggering on data frame 07Fh

There is an occasional glitch during data frame ID: 07F hex, so if you look at the decode string closely, you will see red "flashing" occurring near the end of the frame. This indicates form error conditions and error frames.

The low-frequency sine wave signal on channel 4 simulates an analog output drive signal. The SPI signals (D10, D11, and D13) serially command specific output values of this analog signal. The SPI serial string is converted to a parallel digital output (D0 – D7), and then converted to the analog value (Ch4) using a DAC. The CAN processor reads the analog value and transmits the data value during frame 07F.

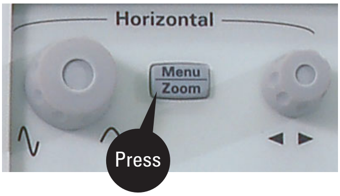
16 With the oscilloscope running, change to trigger on "error frames" and rotate the horizontal position/delay know to delay = -300 µs. You should observe that there are errors occurring in three different frames. During 07F, there is a glitch and a stuff bit (low) error. During frame 0BD there is a stuff bit (high) error. And during frame 000 there is a missing acknowledge error. Remote and data frame 0296A95D have no error conditions and show extended addressing (29-bits). All other remote and data frames utilize standard addressing (11-bits).

17 To see the individual "error frames", either press **[Stop]** or **[Single]** until you catch the particular error frame you are interested in. If you want to observe the glitch, you need to repeat until frame 07F appears.

18 After capturing frame 07F with the glitch:

a Turn the horizontal position knob to center the glitch on the display.

b Press [**Menu/Zoom**] key. In the Horizontal Menu, press the **Zoom** softkey.



c Adjust the horizontal scale and position knobs to display the glitch.

Figure 2 shows the zoomed glitch at a 50 ns/div horizontal scale.

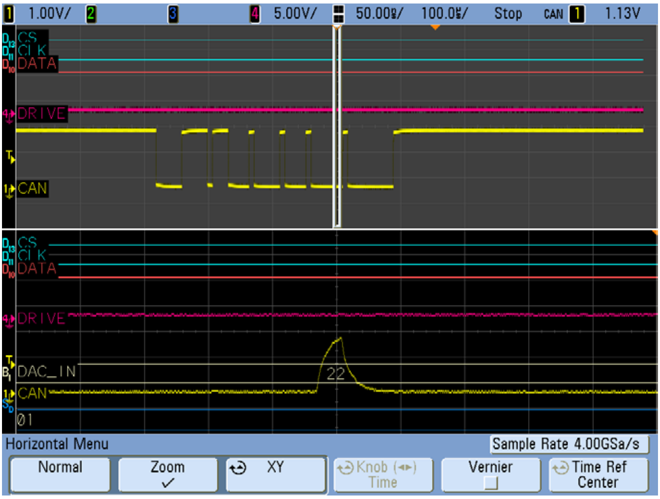


Figure 2 Zooming in on the infrequent glitch that occurs during CAN data frame 07Fh

19 Press [**Run**], turn off the Zoom time base mode (press "Normal" in the "Horizontal" menu), and set the main time base back to 100 µs/div. To synchronize on the "missing acknowledge" error frame, you can select to trigger specifically on "Acknowledge Error" to capture this particular frame (000 hex) as shown in Figure 3.

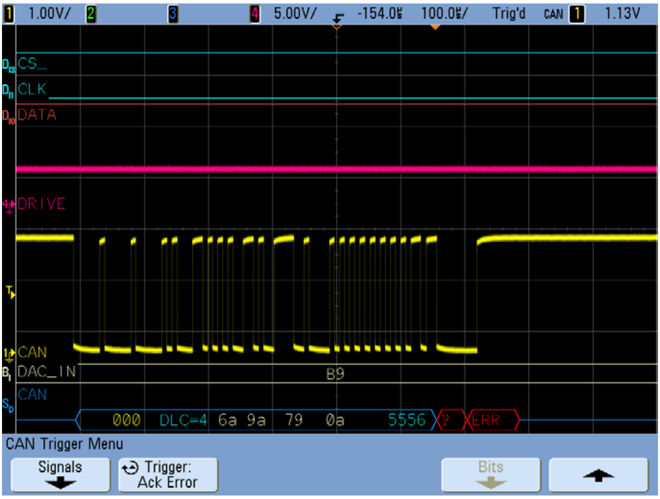


Figure 3 Triggering on Acknowledge Error

20 To see the error rate and bus utilization (totalize function), you need to go the serial decode menu (press the **[Acquire]** key, then the **Serial Decode** softkey).

This demo board generates errors at an approximate 2% rate and bus utilization (frame time/(frame time + idle time)) of approximately 24% as shown in Figure 4.

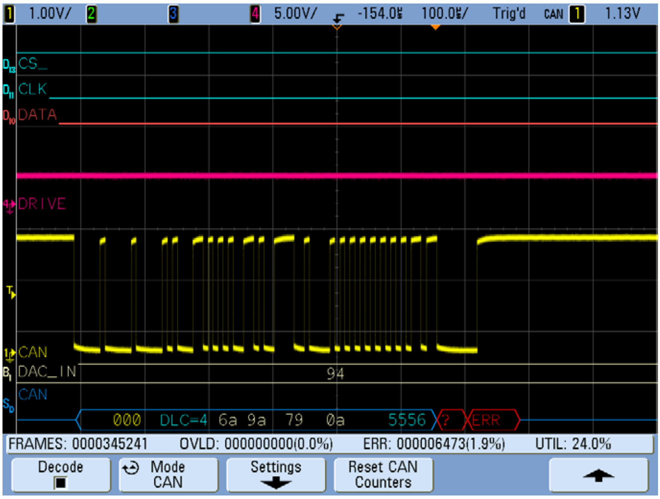


Figure 4 Totalize functions provide bus efficiency and error statistics

LIN Demo Instructions using Modified Demo Board

To enable LIN serial decode, your oscilloscope has to have the automotive serial bus decode option AMS installed. (You can check the installed options on your oscilloscope at **Utility > Service > About Oscilloscope**.)

1 Connect logic demo cable to the demo board and to the MSO connector on the back of the InfiniiVision 7000 Series oscilloscope.

2 Set the demo board switch (SW1) to the “LIN” mode (**on–on–off**).

3 Connect channel 1 probe to the “Glitch/Burst” test point. Disconnect all other probes from the oscilloscope’s inputs.

4 Press [**Save/Recall**] and then press **Default Setup**.

5 Press [**AutoScale**].

6 Change the time base to 500 µs/div.

7 In the Trigger area on the front panel, press [**Mode/Coupling**]; then press **Mode** twice to select “Normal”.

8 Press the [**More**] triggering menu on the oscilloscope’s front panel and then change triggering from the default “TV” trigger to “LIN” triggering.

9 To configure LIN triggering, first press **Settings**, then **Signals** and then set **Source** to channel 1, **Baud** rate to 19.2kb/s, and **Standard** to LIN 1.3.

You should now see that the oscilloscope is triggering stable on sync breaks of random frames.

10 Change to trigger specifically on frame ID 12 hex by first moving up one menu level (press the "up" arrow softkey ▲), and then change the triggering condition to "ID – Frame ID". Now enter "0x12" using the front panel's selection knob. The oscilloscope should now be triggering stable on frame ID: 12 hex.

11 To turn on LIN protocol decoding, first press the **[Acquire]** key on the oscilloscope's front panel, press the **Serial Decode** softkey, change **Mode** from CAN to LIN, and then press the **Decode** softkey. Your oscilloscope's display should now look similar to Figure 5.

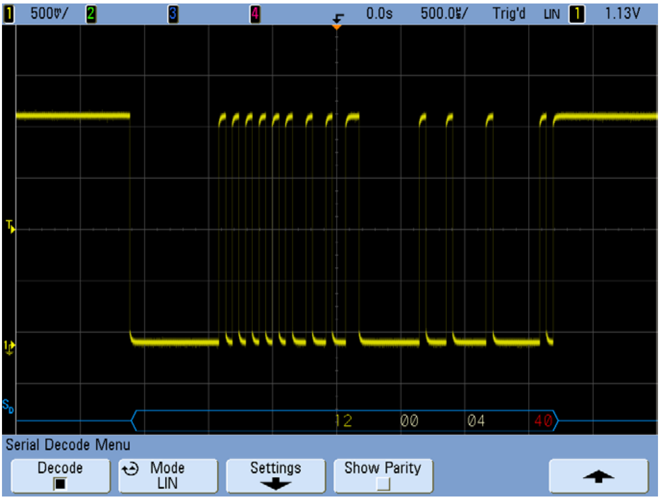


Figure 5 While triggering on LIN frame ID:12h, hardware -accelerated decoding shows infrequent checksum error

Note that in this frame we see that the hardware-accelerated decode identifies this frame as 12 hex with the first hex byte color-coded in yellow. The next two bytes show the data payload color-coded in white. And the last byte in the decoded string is the checksum for this frame. A valid checksum is always color-coded in blue. But if you look closely while the oscilloscope is acquiring data repetitively, you will see that the checksum value occasionally flashes a "red" value. This is an indication that calculated and transmitted checksum don't always agree. Hardware-accelerated decode enhances the oscilloscope's ability to capture random and infrequent errors such as this.

12 To see just a “bad” frame, continually press **[Single]** until you capture a checksum color-coded in red.

13 Press **[Run]** again to acquire repetitive LIN frames and then change the main time base to 10 ms/div to capture multiple LIN frames (5) on the oscilloscope’s display.

14 To simultaneously view multiple frames while also viewing a single frame with higher visual resolution, press the **[Menu/Zoom]** key and turn on the **Zoom** mode.

15 Now change the zoomed time base to 1 ms/div and then rotate the horizontal position/delay knob to display the first frame after the triggering/center frame (delay = approximately 19.0 ms). Your oscilloscope’s display should now look similar to Figure 6.

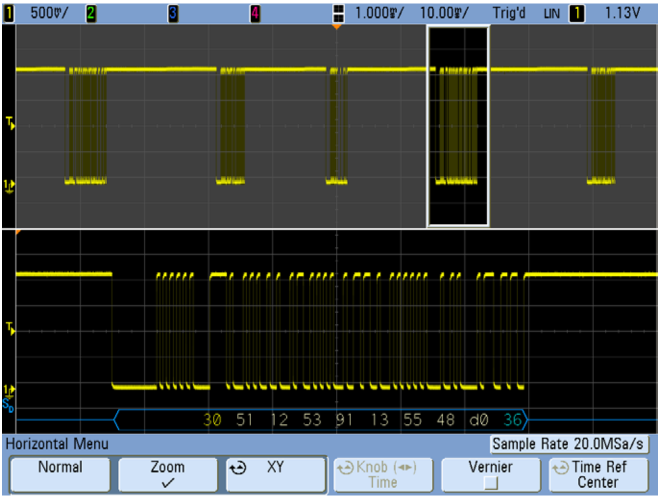


Figure 6 LIN frame ID:30h contains no errors

Note that this frame is decoded as frame ID: 30 hex and contains many more data bytes. You should see that checksum of this frame is always valid (no errors) since it is always color-coded in blue.

9
Triggering and Decoding RS-232 Serial Buses

The RS-232/UART serial triggering and decode option (Option 232 or N5454A) displays responsive, time-aligned, on-screen decode of RS-232 and other UART serial buses. It provides triggering capabilities on specified transmit or receive values, as well as on parity errors.

Note

Evaluation boards that have firmware to support RS-232 are needed for this section. The evaluation board will have a sticker on the front showing the RS-232 switch setting.

Setup

To enable RS-232/UART serial decode, your oscilloscope must have the decode option, 232, installed. (You can check the installed options on your oscilloscope at **Utility > Service > About Oscilloscope**.)

1 Connect channel 1 probe to the Rx test points labeled SDRAM CLK and ground (GND).
2 Connect channel 2 probe to the Tx test points labeled SDRAM D0 and GND.
3 Set DIP switches on the demo board for the RS-232 signal (**on–on–off**).
4 Press [**Save/Recall**] and then press **Default Setup**.
5 Press [**AutoScale**] to see the signals.
6 Adjust the timebase to 1 ms/div.

7 Press [**Acquire**] in the Waveform section of the front panel.

8 Press **Serial Decode**.

9 Press **Decode**.

10 Press **Mode** and use the selection knob to choose “UART/RS232”.

11 Press **Settings > Bus Config > Parity**, and use the selection knob to select “Odd”.

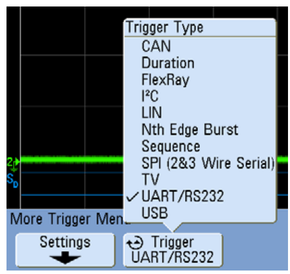
12 Press the “up” arrow softkey ▲ to move up a level to the UART/RS232 Settings Menu; then, press **Base** and select “ASCII”.

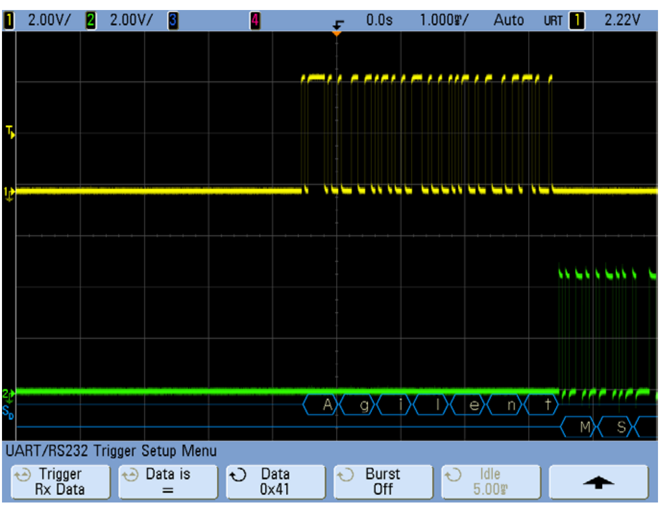
13 To set up an RS-232 trigger, press [**More**] in the Trigger section of the front panel.

14 Press the second softkey (**Trigger**) and use the selection knob to change from “TV” to “UART/RS232” triggering.

15 To trigger on an ASCII “A” character on the Rx line, press **Settings > Trigger Setup > Trigger**, and use the selection knob to select “Rx Data”.

16 Press **Data** and use the selection knob to enter “0x41”.





10
Using Segmented Memory

Agilent's segmented memory option (Option SGM or N5454A) can optimize your oscilloscope's acquisition memory, allowing you to capture more selective signal details with less memory and then easily view all captured waveforms and scroll through each individual waveform segment.

Setup

To enable segmented memory, your oscilloscope must have option SGM installed. (You can check the installed options on your oscilloscope by pressing **Utility > Service > About Oscilloscope**.)

1 Connect channel 1 probe to test points labeled Glitch/Burst and ground (GND).

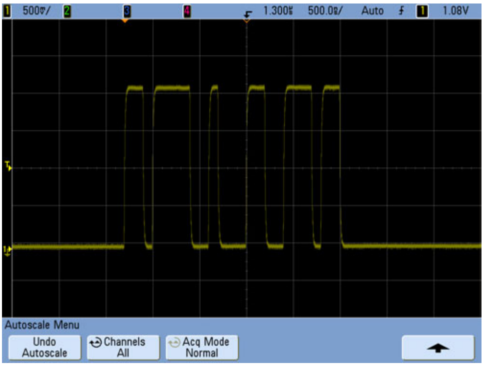
2 Set DIP switches on the demo board for the I^2C with DAC signal (**off–off–on**).

3 Press [**Save/Recall**] and then press **Default Setup**.

4 Press [**AutoScale**] to see signals.

5 Adjust the horizontal scale to 500 ns/div.

6 Adjust the horizontal position to 1.3 µs.

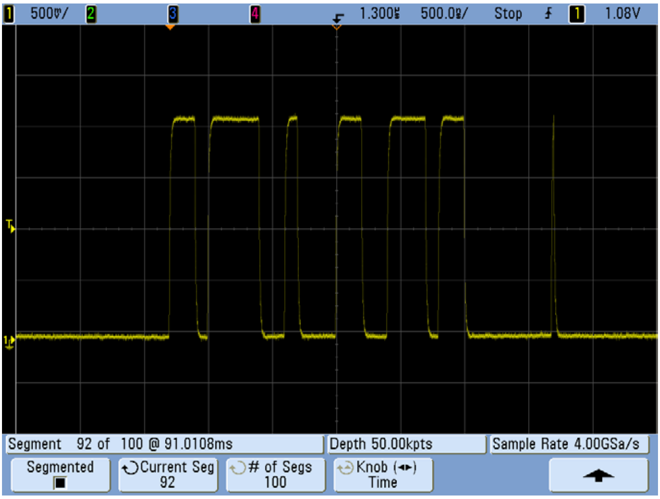


7 Press [**Acquire**] > **Segmented** > **Segmented**.

8 Press **# of Segs** and use the selection knob to enter “100”.

9 Press [**Run/Stop**].

10 Press **Current Seg** and turn the selection knob to view the acquired waveforms.



Note:

- The time between segments.
- The occurrence of an occasional glitch.
- The time of the last segment.

11 In the Trigger section of the front panel, press [**Pulse Width**].

12 In the Pulse Width Trigger menu, set up to trigger on pulses < 30 ns.

13 Press the [**Display**] key, then press ∞ **Persist** to turn on infinite persistence. This will overlay all segments simultaneously on the display.

14 Adjust the horizontal scale to 10 ns/div.

15 Adjust the horizontal position to 0 s.

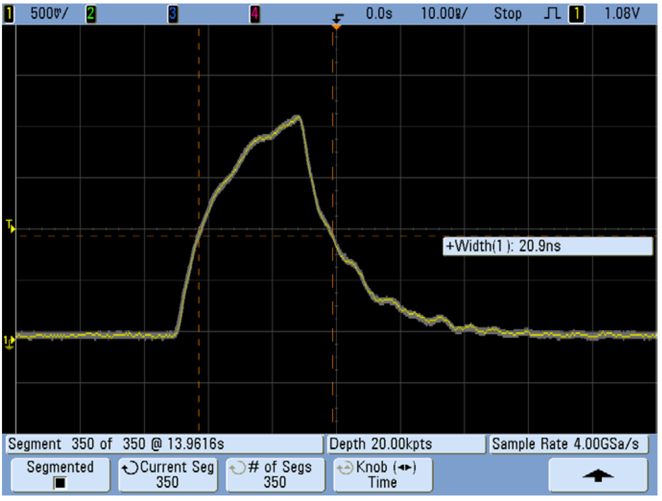
16 Press [**Quick Meas**] and press **Clear Meas**. Press **Select**, use the knob to select and **+ Width**, and then press **Measure + Width**.

17 Press [**Acquire**] > **Segmented**.

18 Press **# of Segs** and use the selection knob to enter "350".

19 Press [**Run/Stop**] and wait for all 350 acquisitions to be acquired.

20 Then, press **Current Seg** and turn the selection knob to view the acquired waveforms.



Note that:

- You can measure the pulse width of all 350 segments.
- You can see the overall time it takes for 350 glitches to occur.

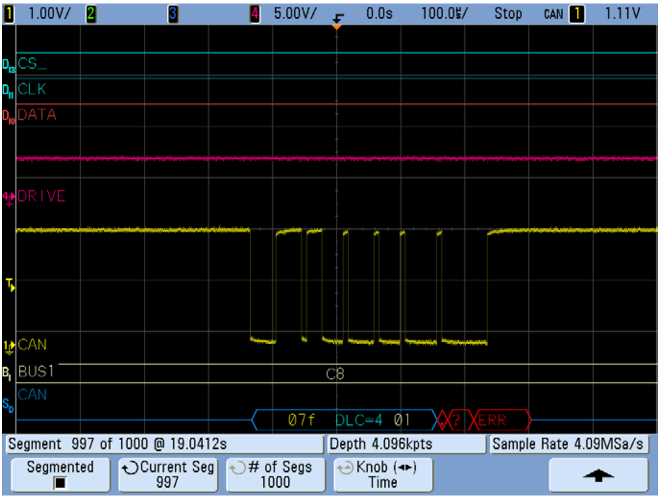
21 Set up CAN bus triggering and decode as described in steps 2 through 15 in "CAN Demo Instructions" on page 39.

22 Press [**Acquire**] > **Segmented** > **Segmented**.

23 Press **# of Segs** and use the selection knob to enter "1000".

24 Press [**Run/Stop**] and wait for all 1000 acquisitions to be acquired.

25 Then, press **Current Seg** and turn the selection knob to view the acquired waveforms.



Note:

- The time tag of the last captured CAN error frame.

26 Press [**More**] > **Settings** > **Trigger** and use the selection knob to select "Error Frame".

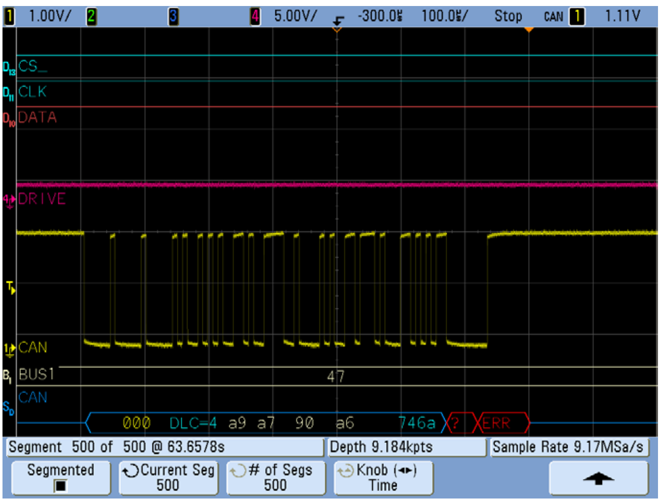
27 Adjust the horizontal position to -300 µs.

28 Press [**Acquire**] > **Segmented**.

29 Press **# of Segs** and use the selection knob to enter "500".

30 Press [**Run/Stop**] and wait for all 500 acquisitions to be acquired.

31 Then, press **Current Seg** and turn the selection knob to view the acquired waveforms.



Note:

- The time tag of the last captured CAN error frame — 63 seconds of data have been captured.

A
Using Trigger Holdoff to Synchronize Acquisition/Display on Complex Signals

Triggering on simple repetitive signals is very easy using standard edge triggering. But if you need to synchronize your oscilloscope's acquisitions/display on more complex signals, such as an amplitude-modulated signal, you will need to use your oscilloscope's trigger hold-off capability unless you have an external synchronization signal available. This lab will show you how to use trigger holdoff to achieve a stable trigger in the absence of a synchronization signal.

Setup

1 Connect the 40-pin ribbon cable from the back of the InfiniiVision 7000 Series oscilloscope to the 40-pin connector on the demo board
2 Connect channel 1 probe to test point labeled AM and ground (GND).
3 Disconnect all other probes from the oscilloscope.

4 Set switches on the demo board for the AM signal (**off–on–off**).

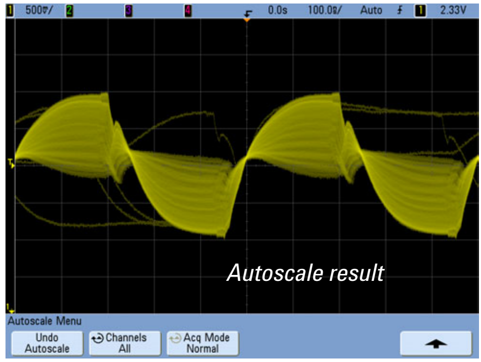
5 Press [**Save/Recall**] and then press **Default Setup**.

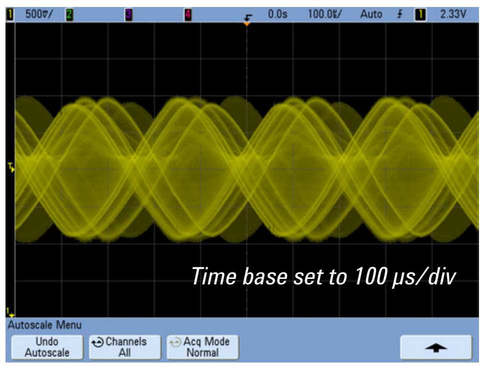
6 Press [**AutoScale**].

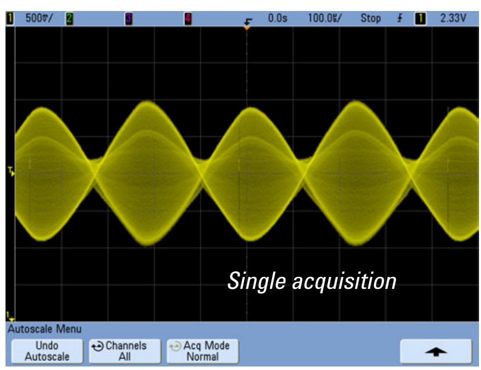
Note that AutoScale sets up the triggering and horizontal display based on the carrier signal. However, our desire is to set up the oscilloscope's triggering based on the envelope of this complex AM signal.

7 Change **time base setting** to 100 µs/div. Note that the oscilloscope will appear to be untriggered.

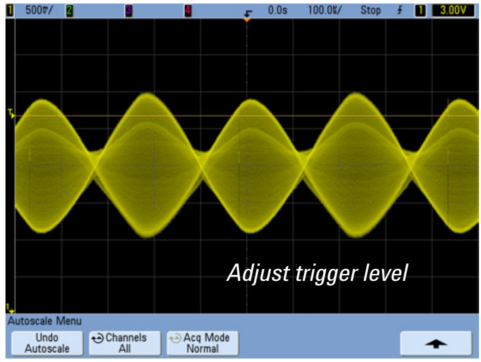
8 Press the [**Run/Stop**] key. This will stop acquisitions and display the last acquisition on screen—the expected AM signal is now displayed on a single acquisition when stopped. Now let's setup the holdoff trigger value to achieve a stable trigger.





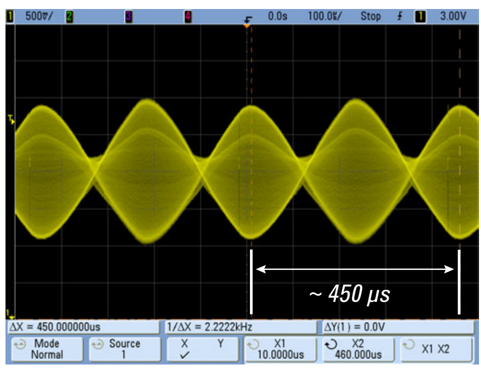


9 Adjust trigger level to approximately 3 volts, which is down approximately 1/3 below the highest peak. Using this level will provide potential re-arm times during the valleys of the envelope.



10 Estimate the cycle time of this complex signal – note that there are two unique envelopes per cycle time (use cursors if you wish). Note that the cycle time is approximately 400 µs. On the front panel, press [Cursors] and set X1 to top of peak of small envelope and X2 to top of the peak of the next small envelope. The delta is approximately 450 µs.

The correct holdoff time to achieve stable trigger on this signal is a value slightly less than this cycle time. Note that 400 µs should work.



11 Press [**Run/Stop**] key to start unstable acquisitions again.

12 Press the [**Mode/Coupling**] key on front panel in Trigger section.

13 Press the **Holdoff** softkey.

14 Turn select knob to right of display to set holdoff to approximately 400 µs – observe a very stable display in the absence of a synchronization signal.

Holdoff is an under-utilized tool that can achieve stable trigger conditions on complex signals. The idea is that the trigger will arm on the first edge of the small envelope and will then holdoff 350 µs – this causes the oscilloscope to ignore the rising edges of the large envelope as it will not rearm until 350 µs later and then trigger on the second small envelope.

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Agilent InfiniiVision 7000 Series Oscilloscopes

Model	Bandwidth	Max. sample rate	Memory	Channels	Other standard features
DSO7032A	350 MHz	2 GSa/s	Mega*Zoom* III memory 8 Mpts standard	2	• Dedicated controls for each channel • AutoScale • Automatic and cursor measurements • Front panel USB port • Built-in help • Infiniium AutoProbe interface
MSO7032A	350 MHz	2 GSa/s		2 + 16	
DSO7034A	350 MHz	2 GSa/s		4	
MSO7034A	350 MHz	2 GSa/s		4 + 16	
DSO7052A*	500 MHz	4 GSa/s		2	
MSO7052A*	500 MHz	4 GSa/s		2 + 16	
DSO7054A*	500 MHz	4 GSa/s		4	
MSO7054A*	500 MHz	4 GSa/s		4 + 16	
DSO7104A*	1 GHz	4 GSa/s		4	
MSO7104A*	1 GHz	4 GSa/s		4 + 16	

* Maximum sample rate and memory are interleaved

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