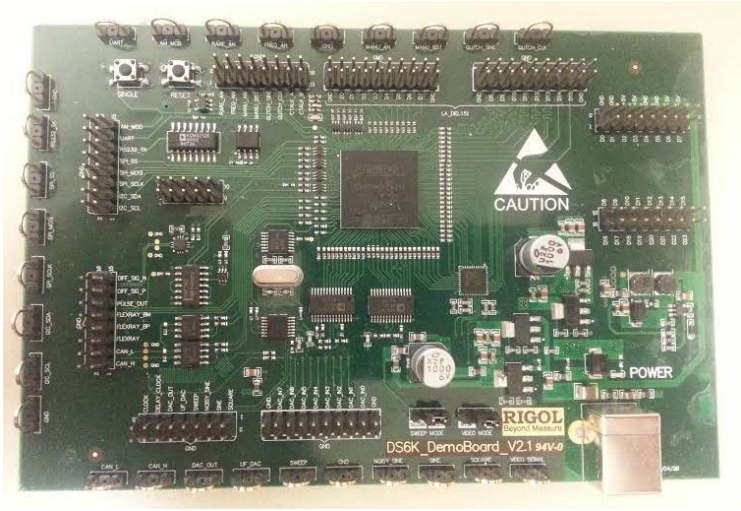
Rigol DS Demo Guide:

Date: 02.06.2014

Basic Demonstration

Items needed:
1 DS1Z, DS2, DS/MSO4, or DS6000 Series Scope
2 Probes
Qty 1 DS6000 Demo Board



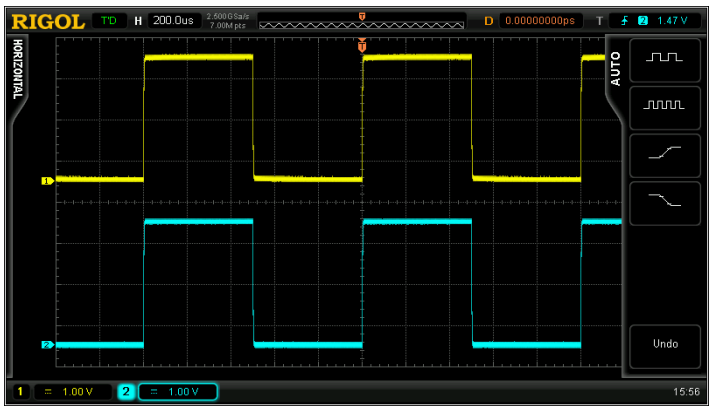
USB memory stick files

Optional items:
DG1000, DG4000 or DG5000 Arb/Function Generator

1. Initial Setup and Demo

Start by connecting the two probes to the 2 channels and connect each to the square wave generator on the front of the scope.

- View the square waves by pushing “AUTO”. After a few seconds you should see this:



Single Wave (F1)
Multiple Wave (F2)
Rising Edge (F3)
Falling Edge (F4)

When the “AUTO” Menu is up just after auto has completed you will see options for looking at multiple waves, single wave, rising edge, or falling edge. That is how the AUTO function works. Whenever you get into trouble or don’t know what you are looking at you can hit AUTO and it will usually find the meaningful signal.

If you still have trouble after that you can go to “SAVE” -> from the “MENU” soft key press it and select FACTORY (F7) . Once FACTORY is pressed this will reload all factory settings and you will recover from whatever settings were altered.

2. Sampling & Memory Depth Demonstration

After AUTO, we can easily demonstrate the Sampling and Memory Depth features.

- Push “CH 2” twice so the light turns off and only channel 1 is shown.

- Turn the Horizontal (time) knob until Time is set to 200 ms / div. This is a slow setting and it looks like hash because the wave is going much faster. Then push the horizontal knob. This enters zoom mode. We can now zoom in on the signal using the Horizontal knob. When you zoom down to a 5 us / div window you should see this:

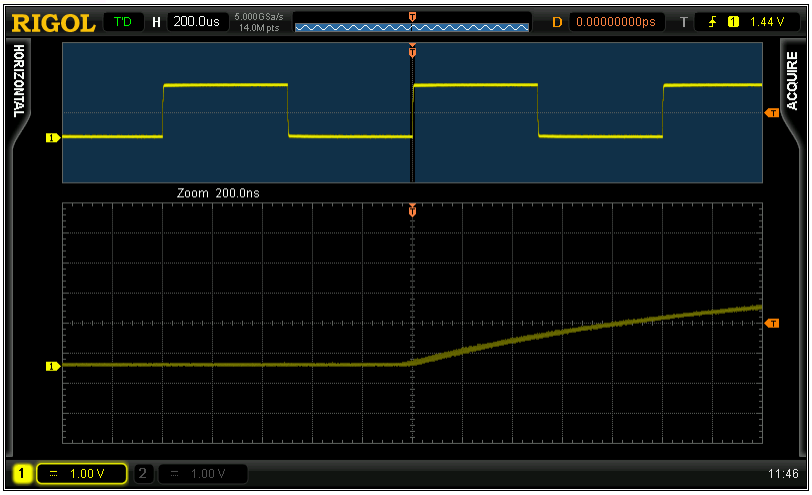
2 things to note in this image:

One: we are looking at just a sliver of our captured wave (the little black slice between the blue bars on top).

Two: you can see the straight line in the zoom because there are no data points between that time.

*Here is the math for those so inclined: DS6000 has 140Mpts per wave in normal mode so in the full window you see 200 ms/div and 14 div = 2.8 sec of data. Divide that by 70 M points and you get a point every 40 nsec or so. Just about what we are seeing above.

- Turn the horizontal scale knob to 200ns/div you should see the signal change to this:



- Push ACQ- > and Mem Depth , then change from Auto to 14kPoint and switch between 140MKPoints and 14kPoint. That curve with 140MPoint is much more appropriate. So if there was an event happening at even µsec timing you can miss it without deep memory. This is especially true when you need to capture or trigger on data over a longer period of time.

NOTE: You can also use the UltraVision Multifunction knob to scroll slowly or more quickly through the waveform. The outer ring will fast-forward and rewind. The inner knob allows you to scroll more slowly.

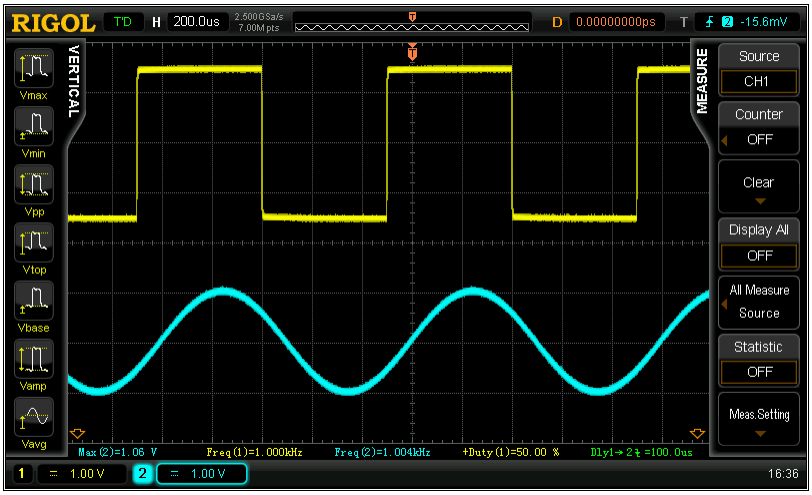
3. Measurement Demo

Start from an AUTO setup on the square wave signal.

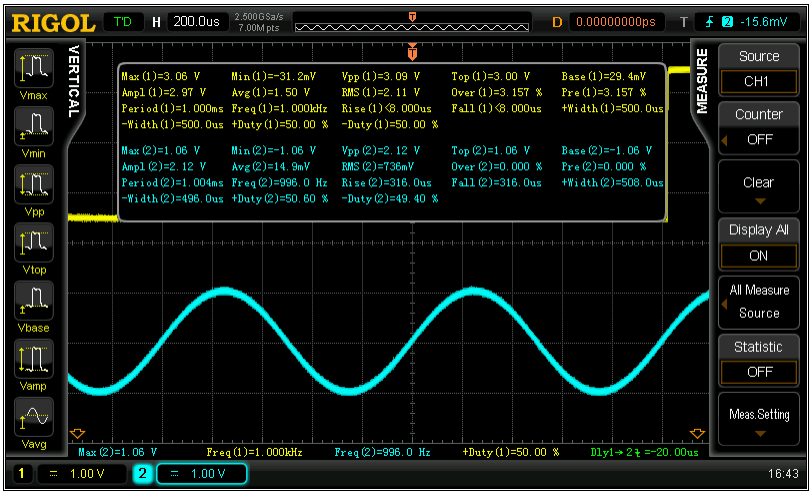
- Push MEAS then press the Menu button on left upper corner. Now the Quick Measurement Menu appears.

- You can change the waveform source by pressing the channel key on the front panel (CH1, CH2, ..) By changing the Source from CH2 to CH1 you will see that the color will change from blue to yellow. On the left side you can now select up to 5 items that will be displayed on the bottom line.

- Switch from frequency to voltage measurement, push the measurement Menu bottom again.



- Push **All Measure Source** and selecting CH1 and CH2 and set **Display All** to ON, you will see this:

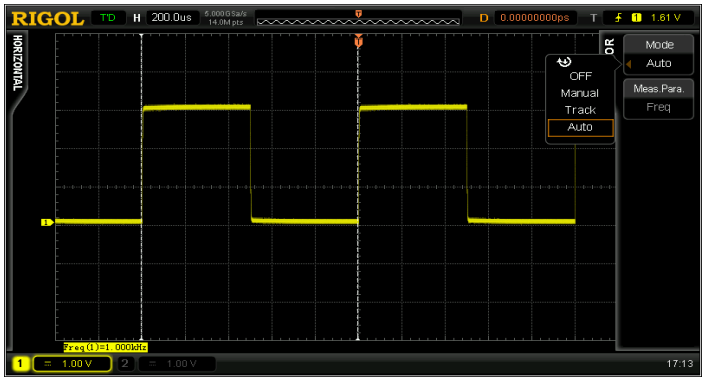


You can also show measurements between cursors… press Measurement > Down Arrow > Meas. Range and select Cursor region. This can be helpful in Zoom mode, as you can measure on the zoomed portion of the waveform of interest and get more detail.

4. Cursors

You can also set up a single measurement like FREQUENCY and then set the cursor to AUTO. The AUTO cursor takes the last measurement and places the cursor on the screen to show how it is making that measurement. This is an easy and great way to align cursors and highlight characteristics of a signal for review or reporting.

- Press MEAS, press **Clear** and select **All Item** to Delete, then add FREQUENCY as the only measurement. That should display on the screen. Then push CURS and set mode to AUTO. It should now look like this:



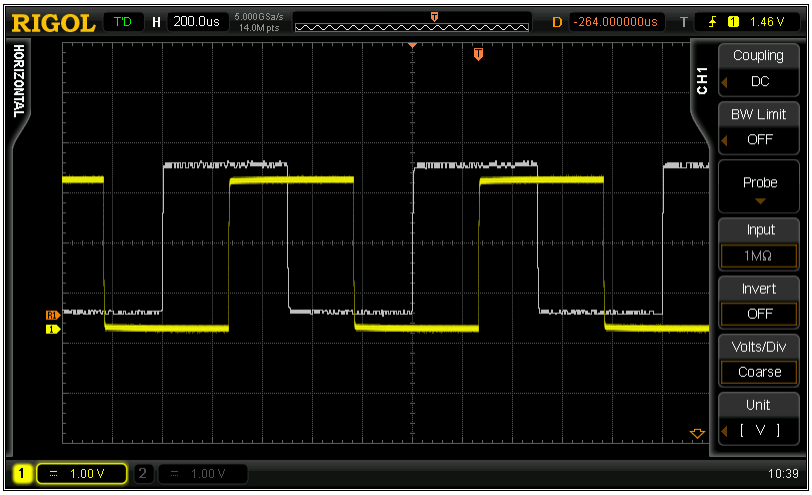
The cursor is locked to the zero crossing showing the time between consecutive waves.

- You can also show the TRACK and MANUAL modes of the CURSOR.
- Use the menu KNOB to move the cursor position.
- In MANUAL mode note that you can use the soft keys to highlight Cursor A,Cursor B, or Coursor AB. This determines which cursors will move with the knob. If you haven't shown the RECORDING & PLAYBACK yet, this is a great time to show the SINC or SINE wave signals and you can use the cursors on the recorded data. That is a great way to do post- analysis of signals.

5. Reference Waveform

Sometimes, it is useful to have reference signals available on the screen. This can help designers see how changes they make can effect the output of a circuit or design. It can also be helpful for EMC and Compliance Engineers to capture different characteristics before and after changes have taken place. The Reference Waveform function can help by capturing a trace and displaying it along with newly captured data.

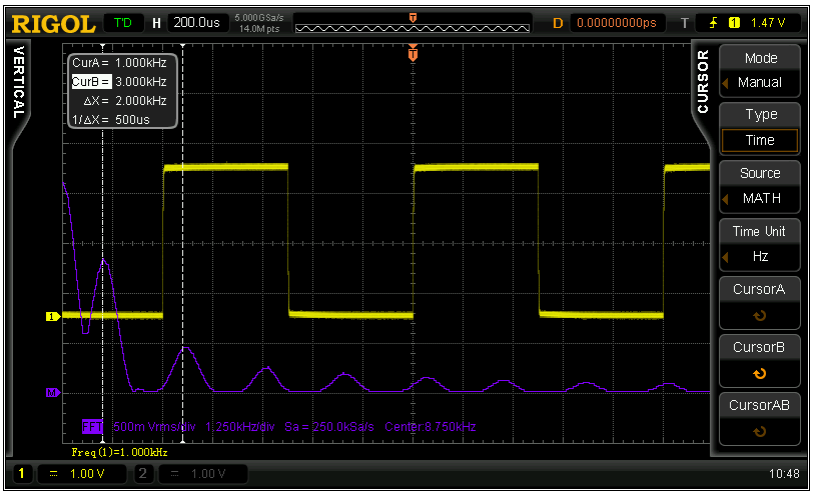
- Press AUTO and select single
- Push REF (below or next to the CH buttons on most scopes). Select SAVE. Note that you can save and reload References from internal or external memory. This is a great way to compare traces between scopes or to use as a guide for verification testing. Once saved, the reference will appear as a white trace that you can then visually compare to live signals on any channel. It looks like this:



6. FFT

One great feature available on all the scopes is FFT (Fast Fourier Transform). This provides a basic Frequency domain measurement of a signal.

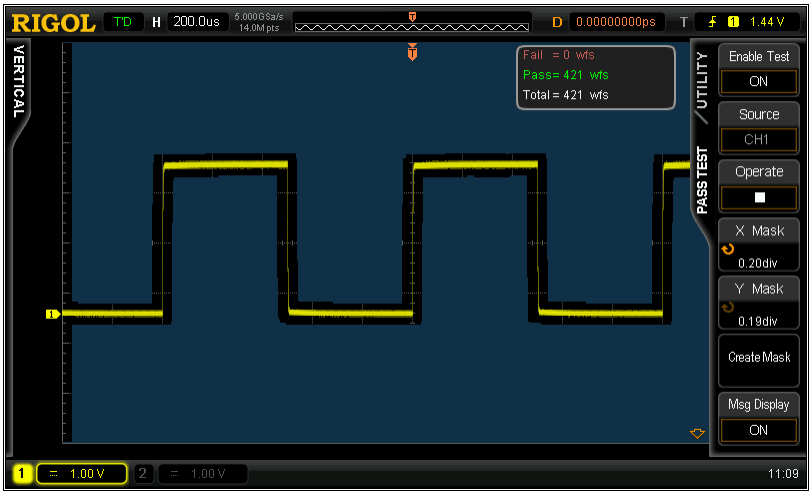
- Push MATH and select FFT as the function
- Select CH 1 as the source
- Use the VERT and HORIZ knobs to set the scaling appropriately. If you do an FFT on the square wave you should see a primary frequency at 1 KHz and harmonics at 3,5,7,… KHz respectively like this:



7. PASS/FAIL Measurements

You can use Pass/Fail measurements for a number of applications. With Rigol scopes you can set it up to stop or continue when there is a failure or a pass, you can set the output to be the speaker or
through the optically isolated output on the rear of several models or both, you can create masks with varying error budgets around a target signal, and you can even use the record mode to record all the failures as frames. In this way, you could set up a test over night, let it run, and come back and have all the failure states recorded for you.

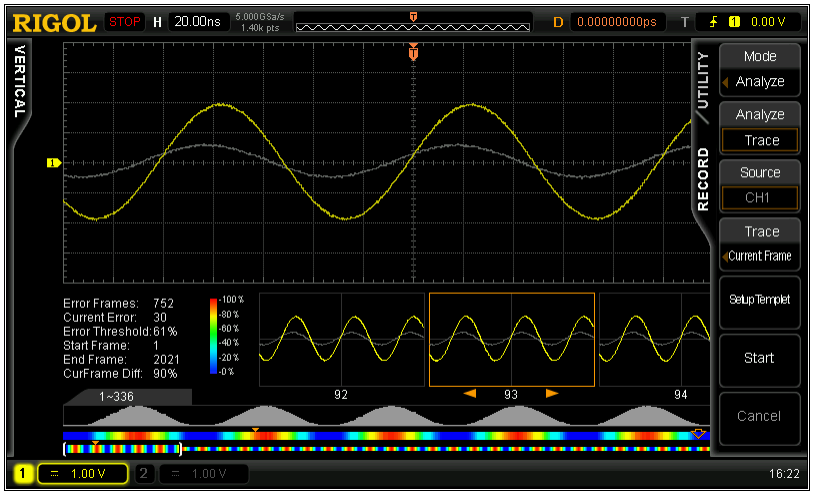
- PASS/FAIL push UTIL and push PASS/FAIL.
- Set Enable to ON, automatically a mask will be created.
- To change the mask parameter use X mask and Y mask and then press CREATE MASK.
- You can turn on the Msg Display and then press OPERATE.
- You will now see the Total Wfs counter counting up. If you remove the signal or adjust the probe attenuation switch you can cause failures. If you set it to stop on the failure you will see something like this:



8. Record Mode

This mode can be used to capture a large number of single waveforms and allows you to play back and/or analyze them. It is basically stacking bitmap images of each triggered event in memory. They can then be reviewed frame-by-frame or contiuously, like a movie.

- To activate this mode press UTIL and Record, then set the Mode to Record
- Press the Operate soft key the recording will start
- By selecting the play back mode you can run captured signal again
- You can play the record from and selected Start Frame to an End frame with a tunable interval or scroll per Knob over the selected frames
- Another feature is the Analyze function, available by choosing Mode Analyze. By pushing Setup Template and pressing Start you recorded waveform will be analyzed
- You can also use Previous and Next buttons to select only the “failed” frames within the recording
- In addition, you can use the UltraVision Multifunction knob to scroll slowly or more quickly through the waveform. The “Stop”, “Play/Pause”, and “Record” keys located below the UltraVision Multifunction Knob are also active in these modes. They can be used to quickly capture and view new frames.
- In Playback mode, you can set the speed of playback between frames quickly using the UltraVision Knob. The outer ring makes the interval increase quickly. 500ms/frame is a good start.
- You can enable timestamps in Playback mode as well. The “TimerTag” needs to be enabled on page 2/2 of the Record menu.



9. Roll Mode for slower moving signals
You need a scope and a generator. Select an Arb function like Cardiac and set the signal to 5Vpp and 1 Hz and make sure the output is ON.

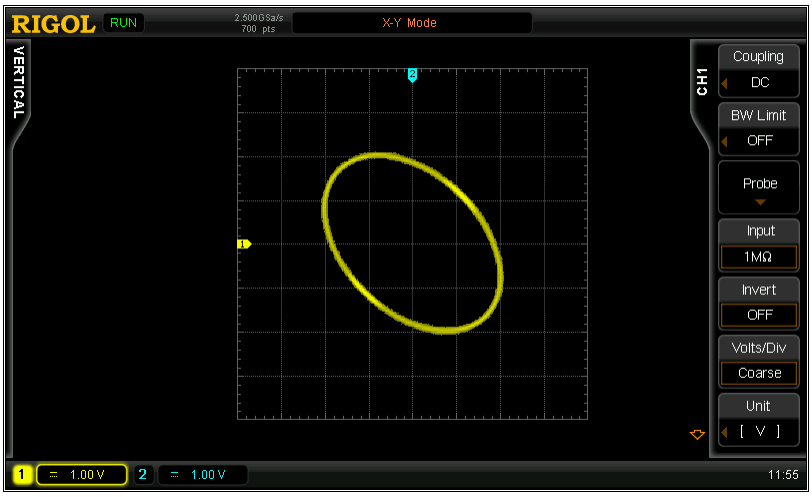
Roll mode is a nice option for slower moving signals that helps you follow it visually.
To select ROLL MODE, push MENU next to the horizontal knob and change time base to ROLL. Once your timing is set you should see something like this.

10. XY mode
XY mode is another way to look at 2 signals and how they interact.

- To activate, push MENU next to the Horizontal knob and change time base to X- Y.
- Select CH1 and push the vertical position knob to center the signal, then adjust the scale using the larger vertical scale knob until it fills one dimension of the screen without clipping.
- Then, select CH2 and repeat.
- If you have a Dual Channel Arb Generator, like the DG1022, you can enable both outputs and connect them to both scope channels. Set both outputs to SINE waves at the same frequency and amplitude. Align the Phase of both channels and next change start phase of the CH2 from the generator.

The ellipse below is generated in XY mode where both signals are sine waves and channel 1 is on the Y axis and channel 2 is on the X- Axis. This is one way to measure the phase between 2

sine waves. To complete the calculation follow the instructions from the manual shown below. There are a number of uses for XY mode. This is just one example.



Consequently, if you change the PHASE DEVIATION between the two Generator Outputs on the DG1022 you can alter the orientation of the ellipse. If you hook it up to 2 different generator outputs that are on different units and not synced the ellipse will change shape over time.

NOTE: In X-Y mode, the data points are displayed as dots. There is no interpolation between them. If the waveform is not as crisp, increase the number of samples by lowering the horizontal scale. This will slow the waveform update rate.

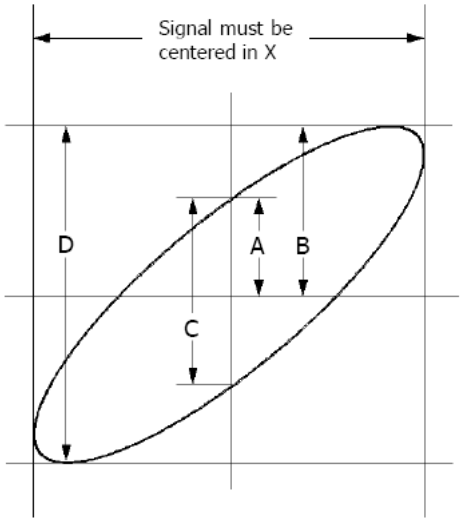


Figure 3-6
Ellipse method to observe the phase difference

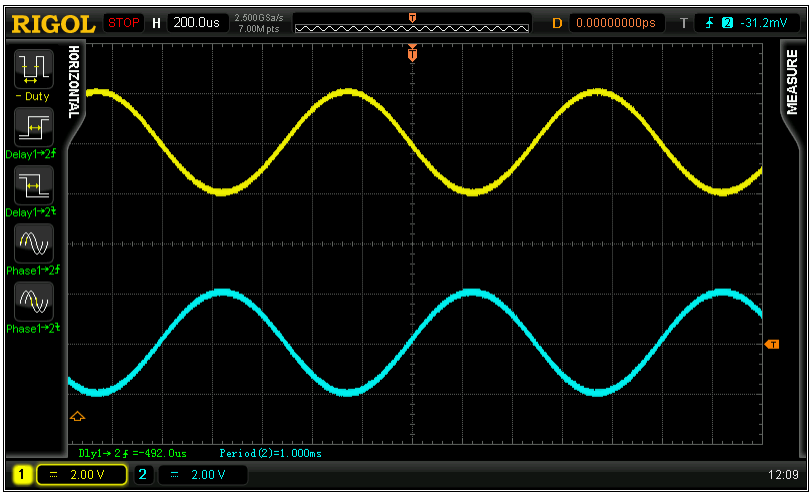
Sinθ = A/B or C/D, where θ = phase shift (in degrees) between the two signals. From the formula above, you could get:

$$\theta = \pm\textbf{arcsine (A/B) or } \pm\textbf{arcsine (C/D)}$$

If the main axis of the ellipse is at I and III quadrant, θ must be in the range of (0~π/2) or (3π/2~2π). If the main axis is at II and IV quadrant, θ must be in the range of (π/2~π) or (π~3π/2).

11. Measurements Between Channels

Perhaps an easier way to measure the phase difference of the two signals is to use the Delay 1->2f MEASUREMENT function and PERIOD measurements. See the 2 sine waves in normal view below. The phase difference is the (Delay 1->2f/ Periode)*360 in degrees. You can select those items from the MEASURE menu as we did earlier. The Delay 1->2f MEASURE options measure the time between zero crossings for channel 1 and channel 2. When they are the same frequency we can use this to understand the phase difference. It should look like this:



The 2 Sine waves are 180 degrees out of phase.

You can calculate this as:

(Delay 1->2f/ Periode)*360 -> (500e-6/1e-3)*360 = 180

12. Persistance

Persistence allows you to view how the signal changes over time on a scope. This is most useful when viewing signals that are dynamic such as a modulated waveform. To turn on Persistance, push DISP and turn PERSIST Time to Infinite. Use a Arb Generator and leave it in SINE wave mode as above, then PUSH the MOD button. Select the TYPE to AM or FM accordingly.

These images below show AM waveform modulations from a Generator while using PERSISTANCE on the scope. PERSISTANCE allows you to see how signals are changing over time more clearly. On the image you can see shows the depth of the AM modulation quite clearly which can't be seen from the single live waveform, how much the frequency is really changing.

13. Trigger and Decode the CAN bus signal (Optional)

NOTE: This requires that the scope has the CAN Serial Decoding option activated. You can check the active decoding buses by pressing the DECODE1 or DECODE2 buttons located on the front panel near the CH2 vertical position knob on the DS1Z, DS2, and DS/MSO4 or the MATH > BUS1 or BUS2 on the DS6.

- Starting from Factory Defaults (Button labeled "default" located in the upper-right-hand side of the front panel for the DS1Z, DS2/A, and DS/MSO4. DS6 defaults are under Storage > Factory), set the timbase to 5us

- Connect the DS6000 Demo board USB connector to the USB connector on the scope (DS/MSO4s and DS6s have a additional USB port on the rear panel. DS1Z and DS2000/A have only a front USB port for powering the board)

- Connect the signal output pin CAN_H and GND to CH1 of the oscilloscope properly using the probe clip

- Set the vertical scale of CH1 to 1V/div

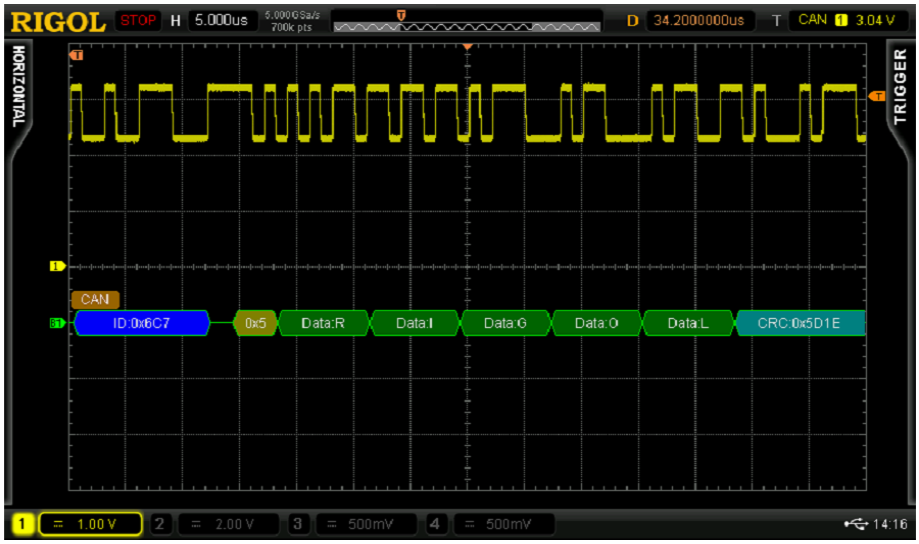
- In the trigger menu (press Menu in the Trigger area on the front panel) and set the trigger type to “CAN” , the signal source to “CH1” , the signal type to “CAN_H” , the trigger condition to “SOF”, the baud rate to “1Mb/s” and the trigger mode to “Auto”, and set the trigger level to ~ 300mV

- When the oscilloscope is in T’D state, press the DECODE1 button to open the decode menu

- Set the decoding type to “CAN”, Source CH1, Signal type CAN_H, Baud Rate 1Mb/s, and the format to ASCII

- On page 2/2 of the decode menu (accessed by pressing the light blue down arrow on the lower right-hand side of the display), select threshold. Use the intensity/multifunction knob to move the decode threshold to 2.7V

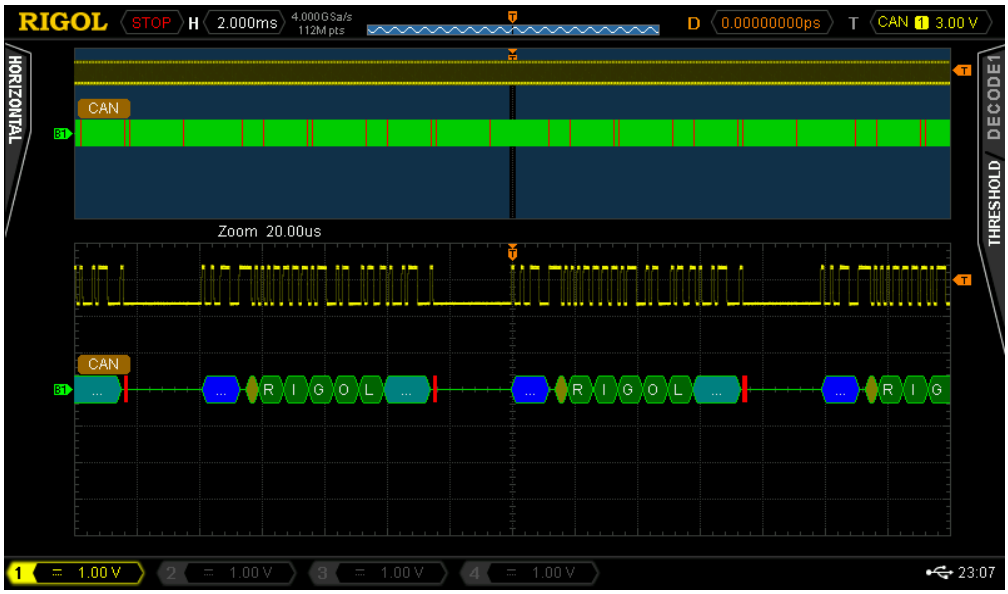
- Set the BUS status to “ON” and the demonstration result is as shown in the figure below



- You can see that the ASCII data reads “RIGOL”

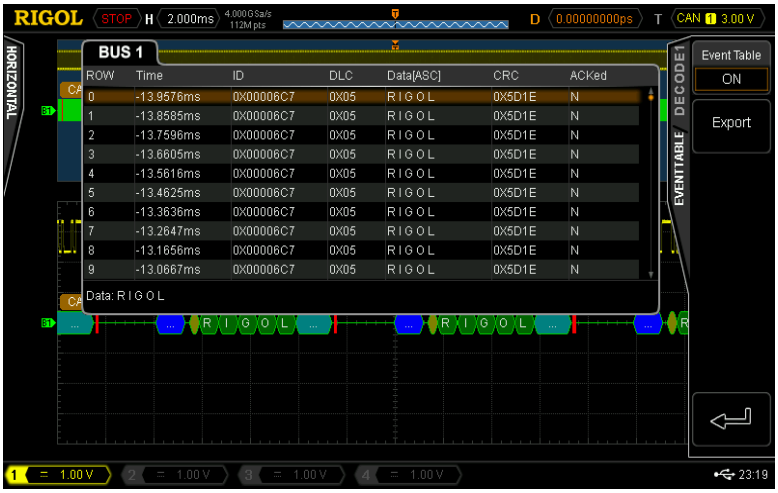
Deep Memory with Decode:
You can also use the deep memory of the scope during the decode. This enables you to capture a long string of communications with the ability to analyze and decode sections of the string.

- Same configuration as above, then set the timebase to 2ms. Now, you can see that you have collected quite a few packets of communication
- Press Run/Stop and then press the Horizontal Scale knob in to enable Zoom
- Rotate the Horizontal Scale Knob to set the Zoom scale to 20us/div
- Note that the packet is decoded



- You can use the Inner Navigation Knob to step through the data, or you can use the outer knob to fastforward and rewind through the zoomed data.

- You also enable the event table to view and export a table of the decoded data. You can access the event table in the Decode menu



14. Trigger and Decode the SPI bus signal (Optional)

NOTE: SPI is not available on 2 channel DS4 scopes.

- Starting from Factory Defaults (Button labeled “default” located in the upper-right-hand side of the front panel for the DS1Z, DS2/A, and DS/MSO4. DS6 defaults are under Storage > Factory), set the timbase to 5us

- Connect the DS6000 Demo board USB connector to the USB connector on the scope. The DS/MSO4s and DS6s have a additional USB port on the rear panel. The DS1Z and DS2000/A have only a front USB port for powering the board

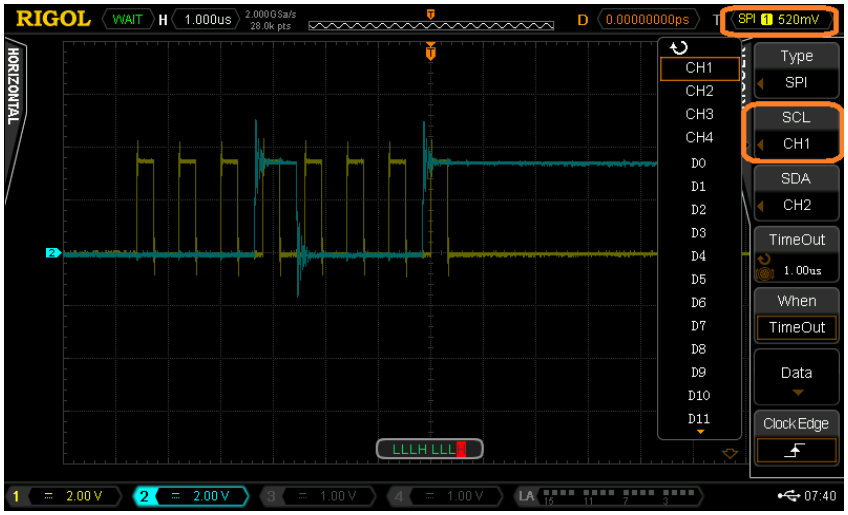
- Connect CH1 probe to the SPI_SCLK loop on the Demo Board. Connect the probe ground lead to the GND loop on the Demo Board. Set the CH1 vertical scale to 2V

- Connect CH2 probe to the SPI_MOSI loop on the Demo Board. Connect the probe ground lead to the GND loop on the Demo Board. Press CH2 to activate the channel and set the vertical scale to 2V

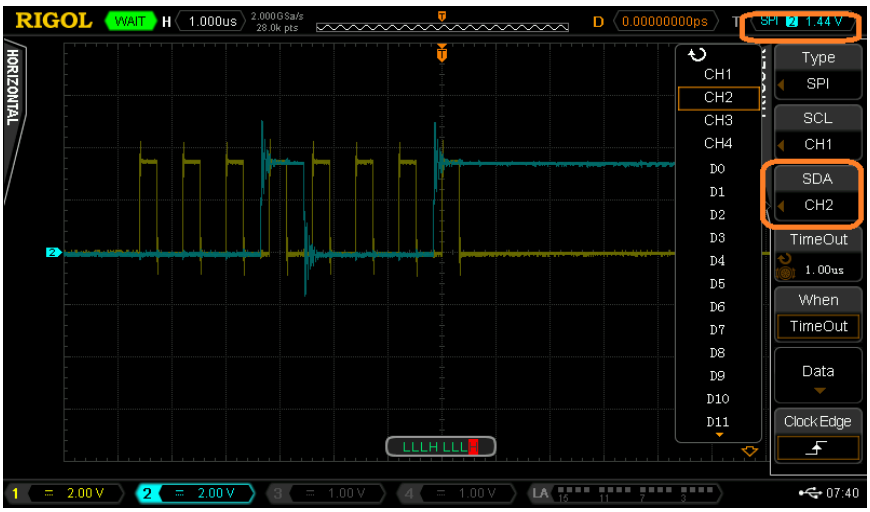
- Open the Trigger Menu by pressing the MENU button in the trigger area and set the trigger type to “SPI”

- Set the SCL to “CH1”

    - Set the SCL trigger level to 1.5V by pressing SCL and adjusting the trigger level using the trigger level knob located in the trigger section on the front panel



- Set the SDA to “CH2”
    - Set the SDA trigger level to 1.5V by selecting SDA and adjusting the trigger level using the trigger level knob

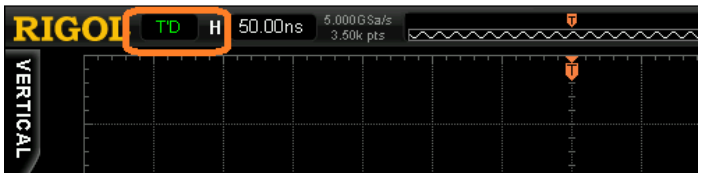


- Set the trigger condition to “Timeout”

- Select Data and open the Trigger Data menu. Set the bits to 8, the data to “LLLH LLLH” and the clock edge to “Leading”. The oscilloscope should be triggering stably

  TIP: You can use the intensity/multifunction knob to adjust the CurrentBit selection by rotating it. You can change the data (H, L, X) by pressing the knob.

- Set the trigger mode to Normal by pressing the Mode button in the trigger menu area on the front panel. The scope should trigger stably. This is shown as a green “T'D” indication in the upper-right-hand portion of the display.



- When the oscilloscope is in T'D mode, set the decoding type to "SPI" by pressing the DECODE1 button near the CH2 vertical position knob and selecting SPI as the Decode bus type

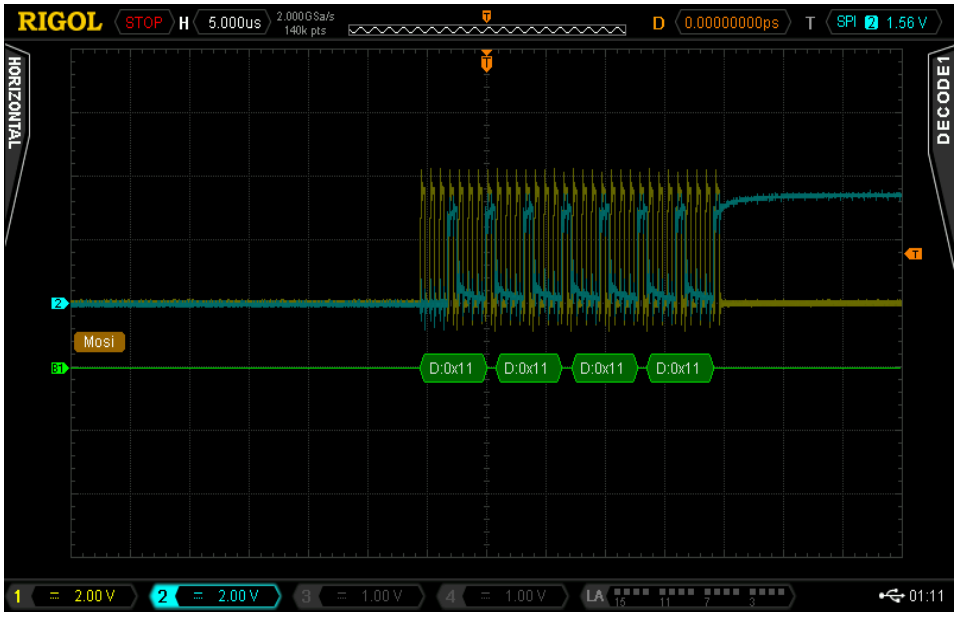
- Set SCLK to "CH1"and set the threshold to 1.5V using the intensity/multifunction knob near the upper-right-hand corner of the display

- Set MISO to "NONE"

- Set MOSI to "CH2" and set the threshold to 1.5V using the intensity/multifunction knob near the upper-right-hand corner of the display

- Press the down arrow near the lower-left-hand-side of the display to access page 2/2 of the decode menu. Set the data bits to 8, the endian to MSB and the format to hex

- Set the BUS status to "ON" and the demonstration result is as shown in the figure below



- You can use the Offset setting located on the Decode menu page 2/2 to move the decode line on the display

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