APPENDIX D – version 2020

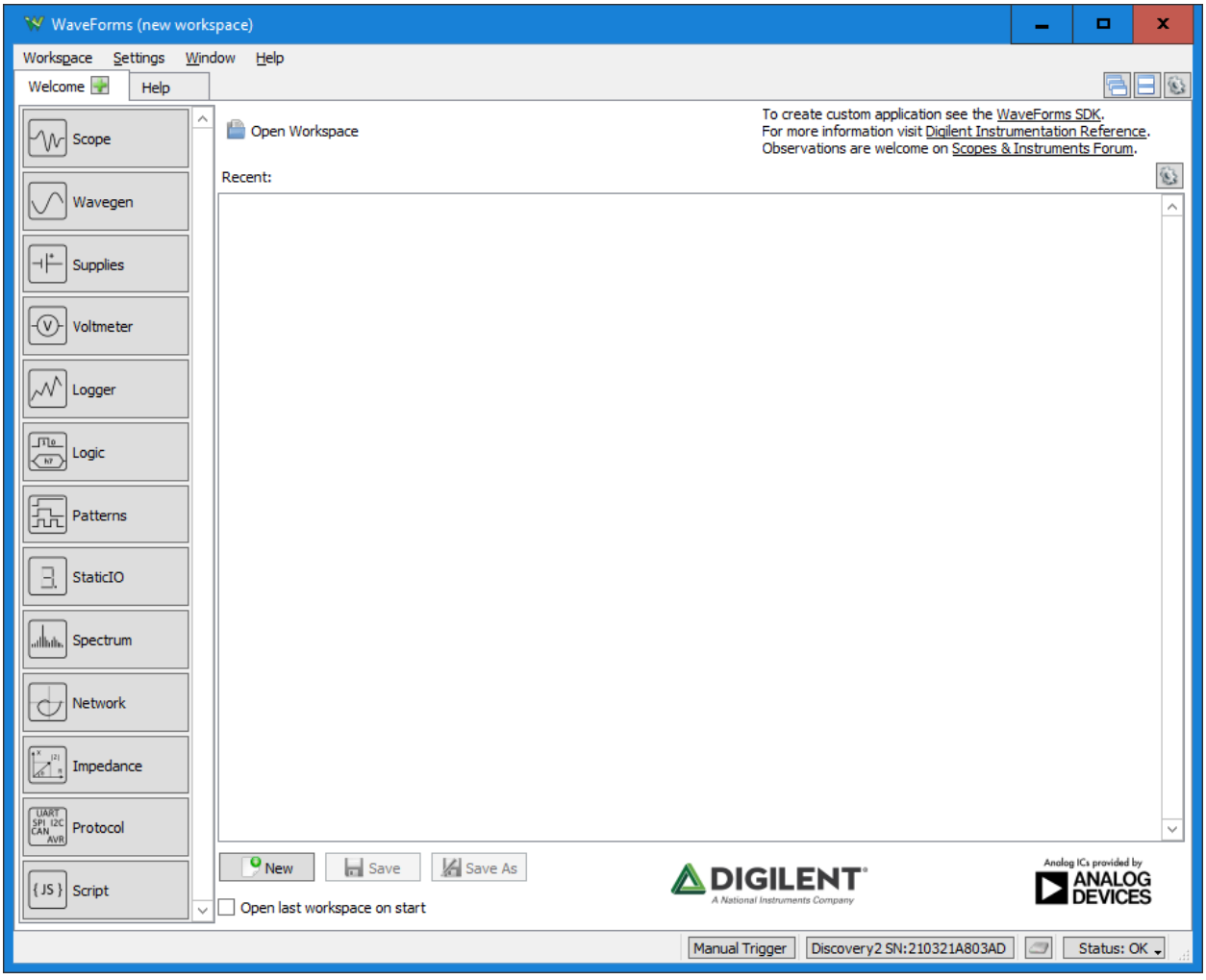
Introduction to the Diligent Analog Discovery 2

Follow the steps below and play with the options to learn more about the AD2.

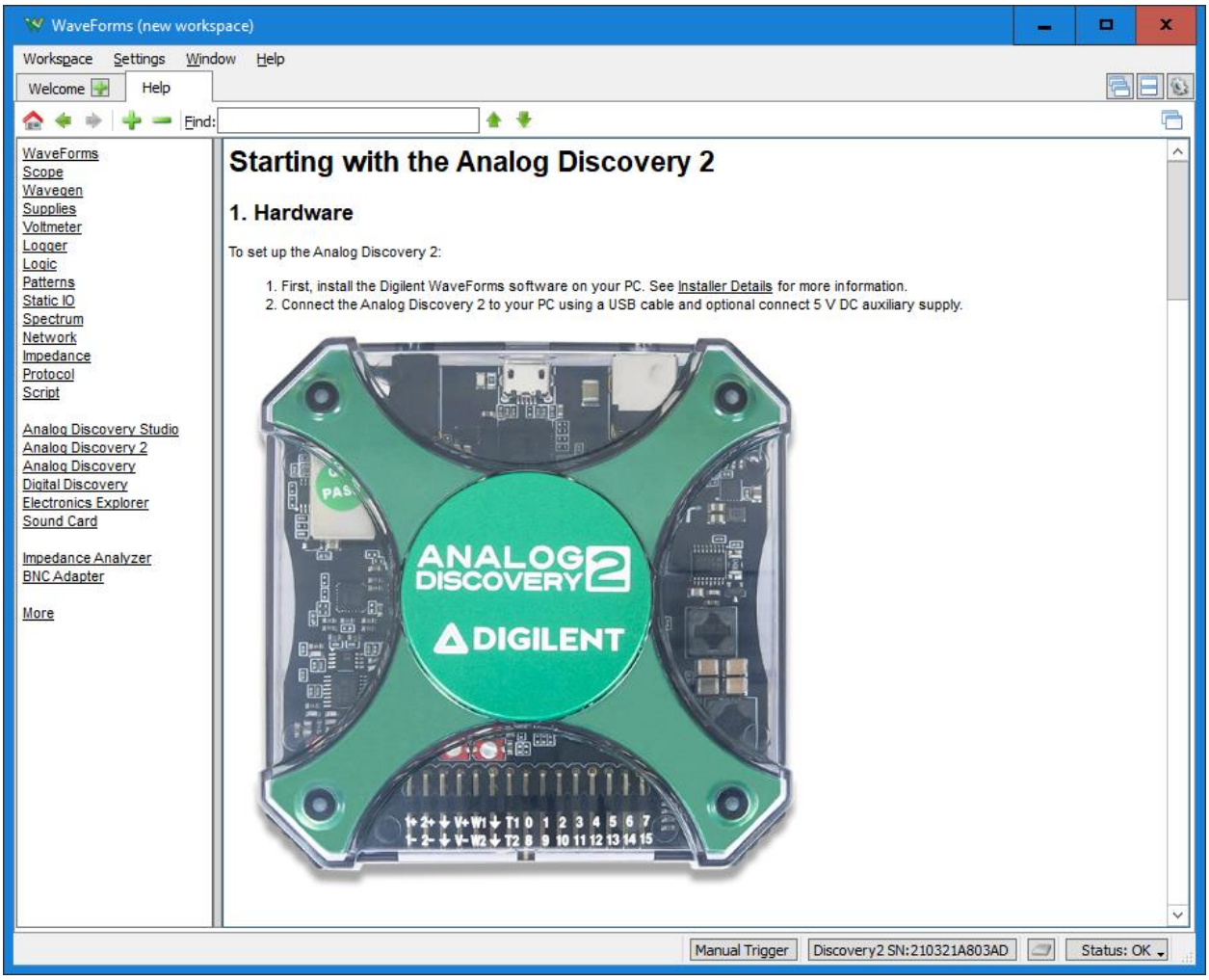
Part I – The Waveform Generator

⇒ **Connect the AD2 – Connect the 5V adapter and the USB cable as described in Lab_00.**

⇒ **Open the Waveforms program. The screen will appear as below:**



If this screen doesn't appear, or there is a warning message, it's possible that the AD2 is not connected properly or that the USB cable is bad. The left side of the GUI shows the capabilities of the AD2. In this class, we will only use the first three functions: Scope, Wavegen, and supplies. Anytime that you need help, there is an online help manual; Click the help tab. Then click on Analog Discovery 2 and you will see the following screen:



⇒ **Scroll through the help file to see what information you can learn.**

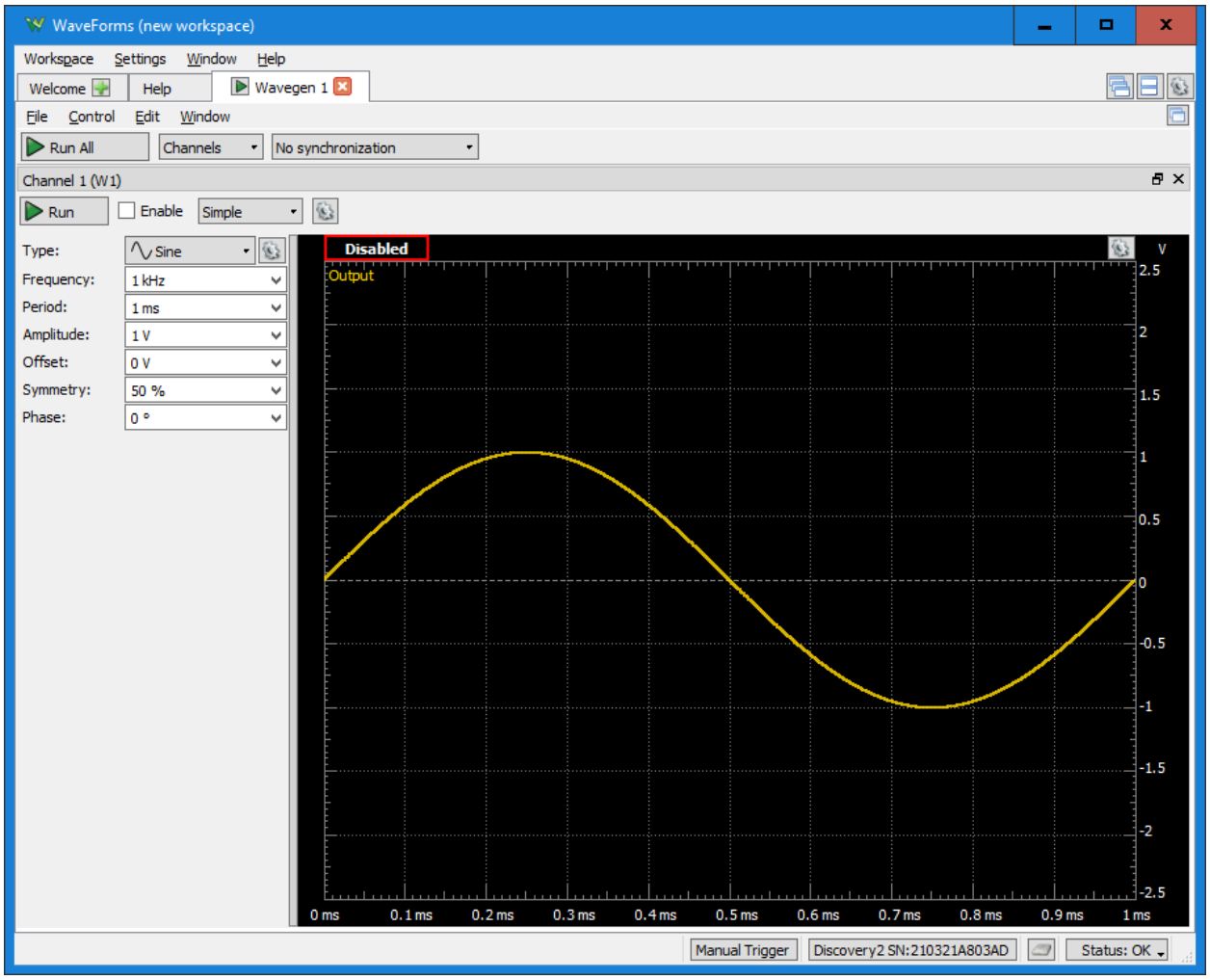
⇒ **Click on the welcome tab when you are done.**

⇒ **Click on the Wavegen button on the left side**

You will see the window shown below. Notice that a new tab appears that's labeled "Wavegen 1." You see that the signal is "disabled", so the signal is not appearing on the wire. You will also see a list of all the default values on the left side, where there are drop-down menus to customize the waveform. Notice also the the axes are labeled so that the period of the signal is 1 ms and the peak-to-peak voltage is 2V.

Adjust the wave form as follows:

⇒ **Set the frequency to 100 kHz.**



⇒ **Set the period to 50 microseconds**

⇒ **Set the amplitude to 2V**

⇒ **Set the offset to 1V**

⇒ **set the symmetry to 75%**

⇒ **Set the phase to 45°**

Your screen should look like Fig. D.1 below.

⇒ **Click on the "file" drop-down menu and then "export"**

⇒ **Click on "Copy to Clipboard".**

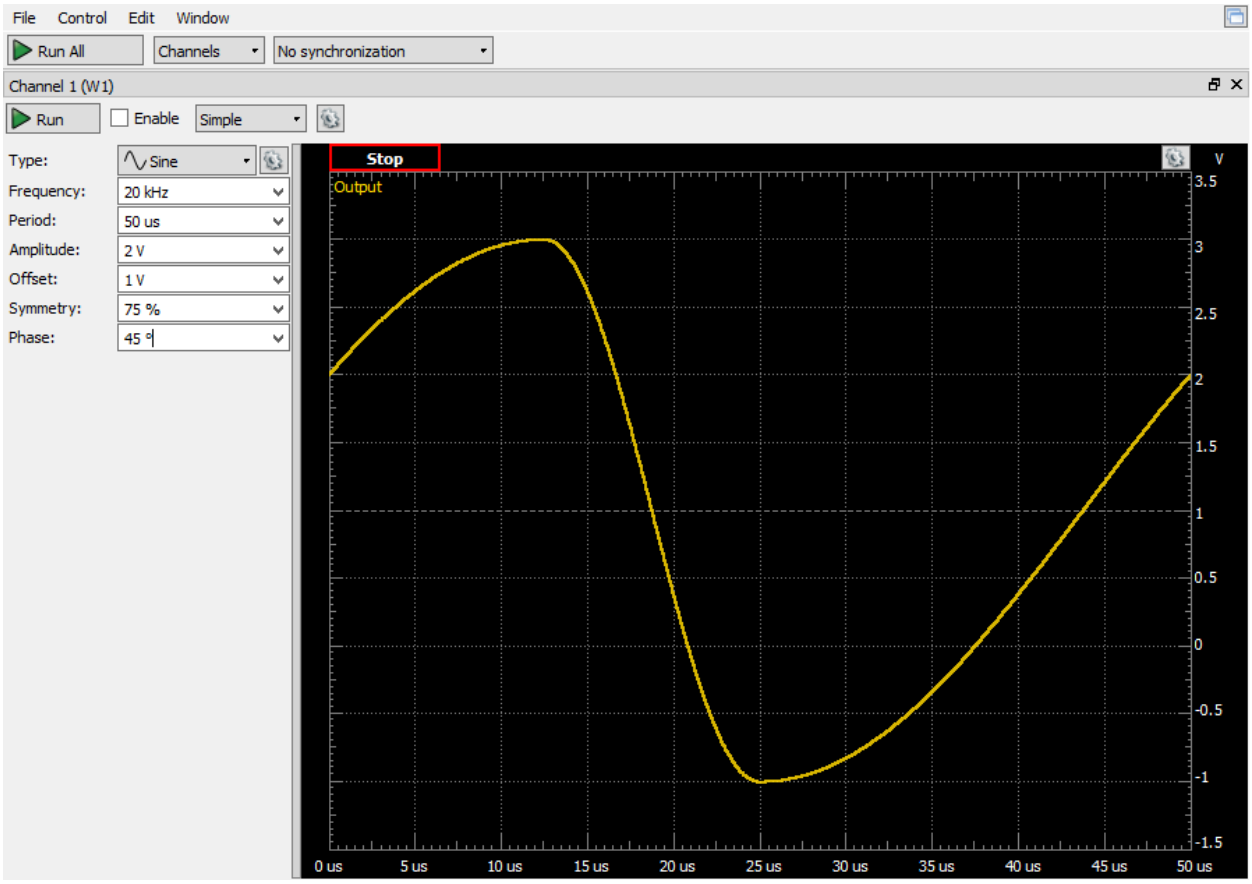


Figure D.1. A sample waveform.

You will want to save the clipboard – part of Lab 01 is to place this figure in your lab report along with eight others that you will generate below.

⇒ **Change the sine wave to a square wave.**

⇒ **Set the offset to zero volts**

⇒ **Set the phase to zero degrees**

⇒ **Set the symmetry to 75%.**

⇒ **Make a copy of this figure (D.2) for your lab report.**

Your figure will look similar, but not identical, to the figure shown below:

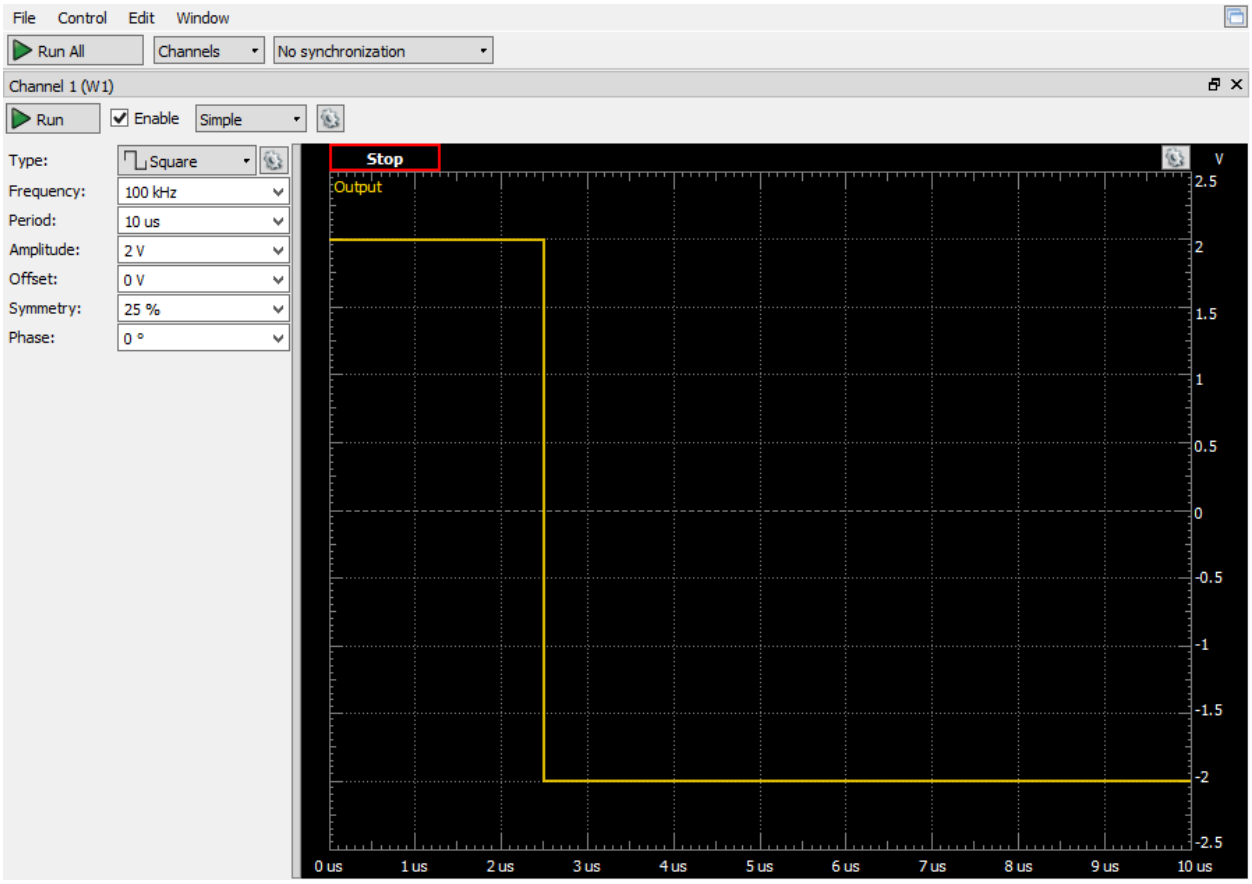


Figure D.2. A square wave with 25% duty factor.

Note that if we were actually going to use this waveform, we would have to click the "enable" checkbox and then push the run button.

There are two waveforms that the AD2 can generate, so let's set up the second one.

⇒ **Depress the "Channels" button and click on "Channel 2".**

⇒ **Adjust the window so that the waveforms have about the same size.**

⇒ **Adjust the second waveform so that it is a 100 kHz triangle wave**

⇒ **Adjust the amplitude to 2V.**

⇒ **Enable both wave forms.**

Your screen should look like Fig. D.3.

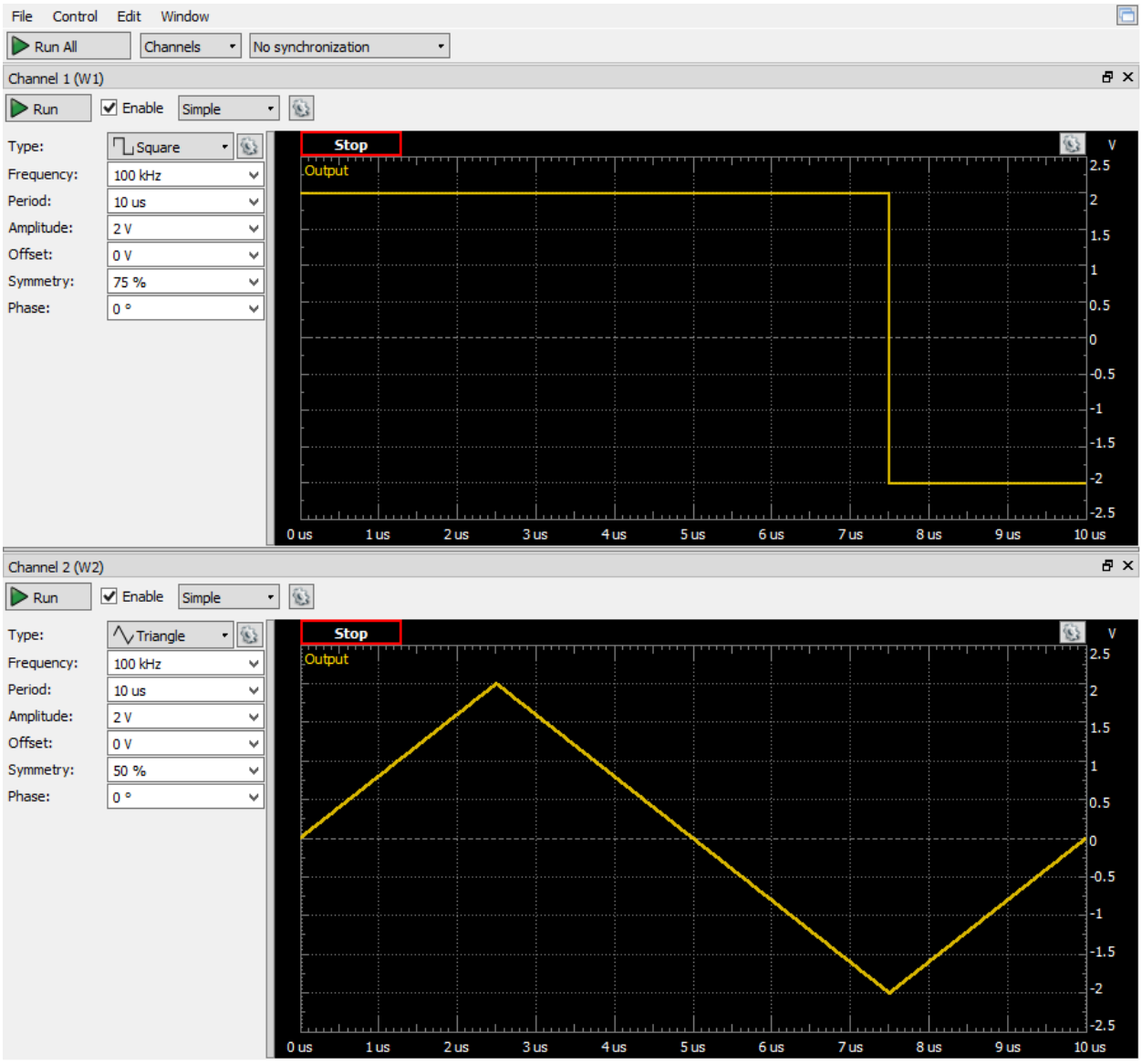


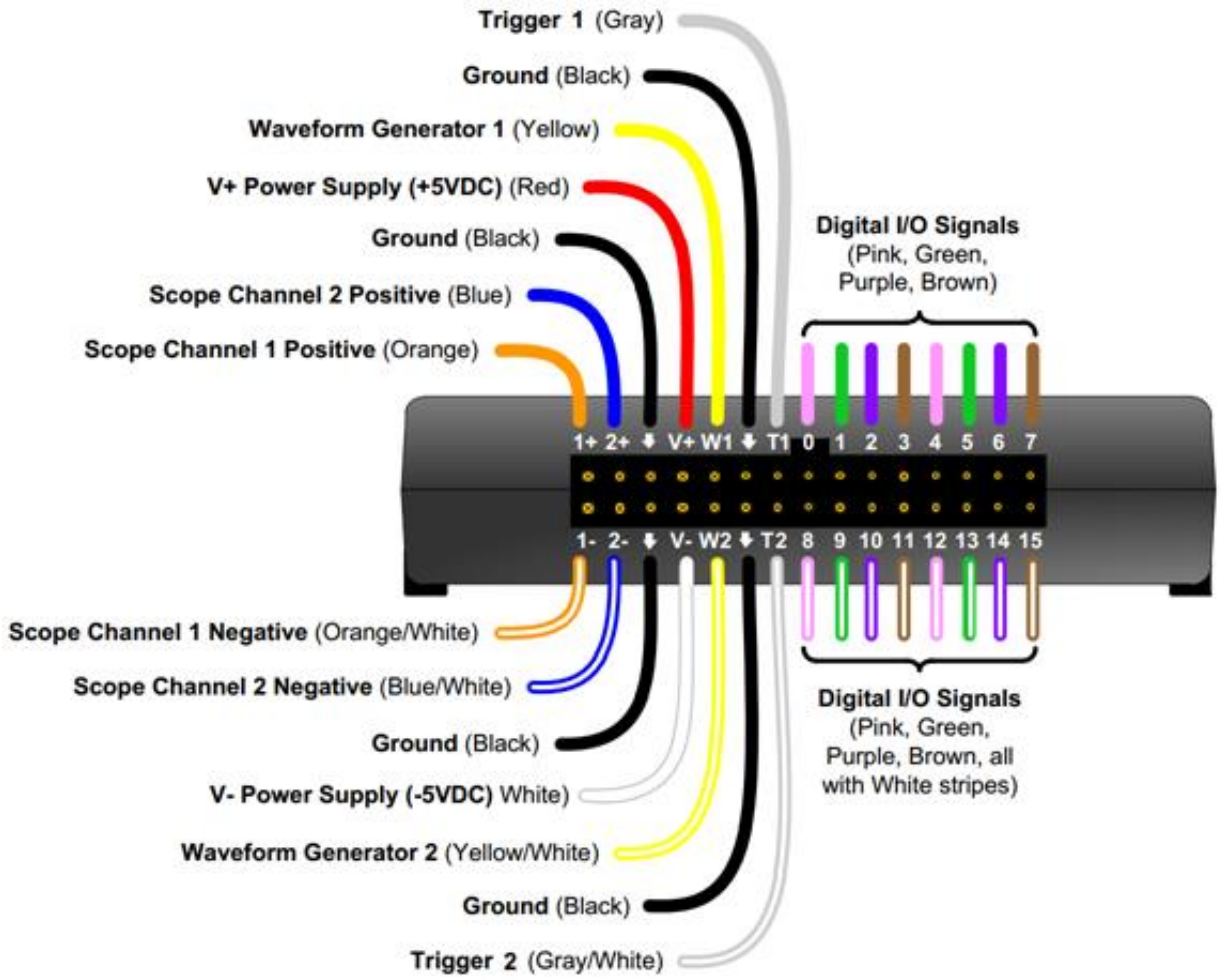
Figure D.3. Two different 100 kHz waveforms.

Part II – The Oscilloscope

We are now going to connect those two waveform outputs to the two input channels of the oscilloscope and we will look at and manipulate those signals in real time.

Remember the wiring diagram for the AD2 (repeated below). To connect waveform 1 to channel 1 of the oscilloscope:

⇒ **Connect the solid orange wire to the solid yellow wire with a jumper**



⇒ **Connect the orange/white wire to one of the black ground wires with a jumper.**

⇒ **Click on the welcome tab and then click on scope.**

⇒ **Press the "Run" button**

⇒ **Click the checkmark on channel 2 to remove it from the screen.**

Your screen should look like the screen in Fig. D4 below; (file→export works here too. But be careful! Exporting the image also stops the oscilloscope – you'll need to push the run button again to see a new trace). If your trace doesn't look like Fig. D.4, then:

⇒ **Change the time base to 2 microseconds/division**

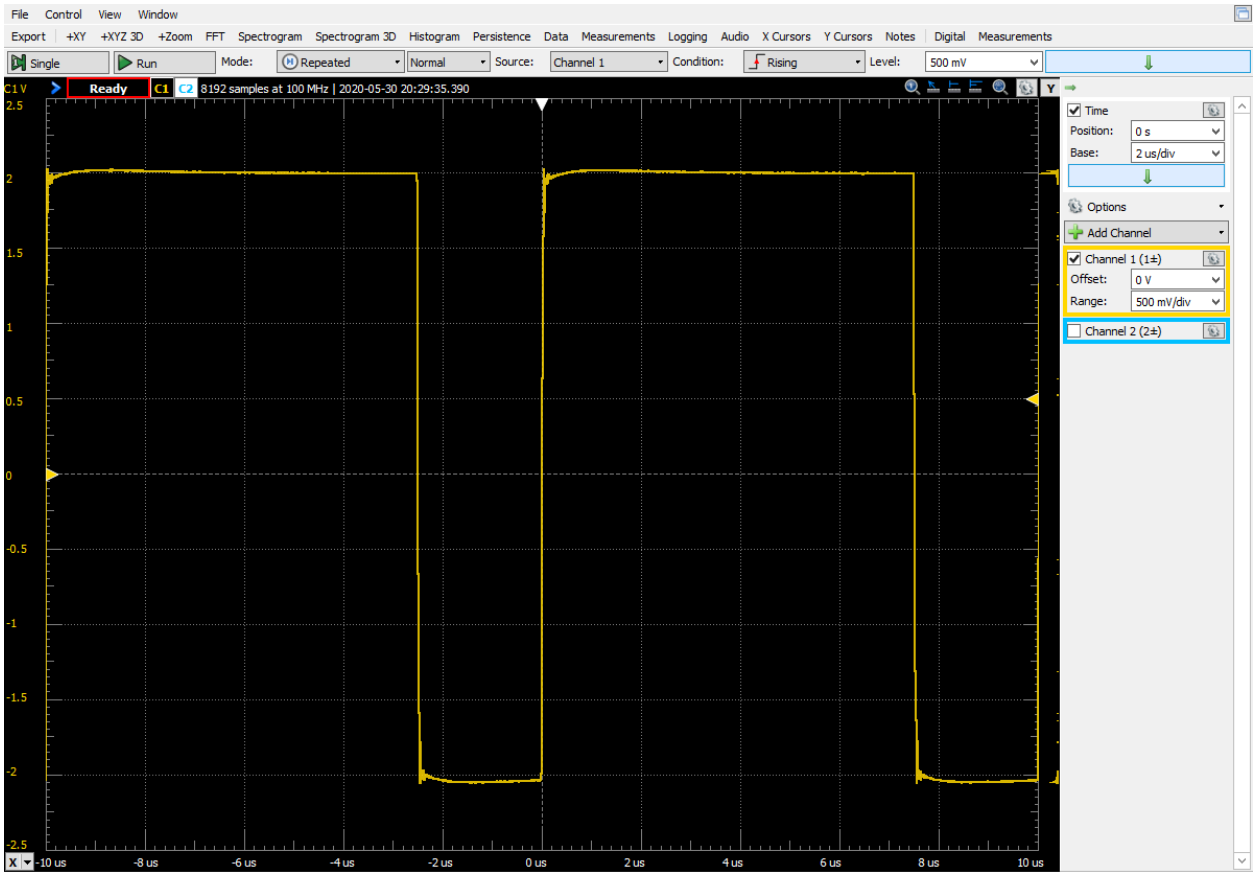


Figure D.4. The oscilloscope trace of the square wave.

⇒ **Connect the solid blue wire to the solid yellow/white wire with a jumper**

⇒ **Connect the blue/white wire to one of the black ground wires with a jumper.**

Now Waveform 2 is connected to oscilloscope channel 2.

⇒ **Turn back on channel 2 by clicking the box on the scope tab.**

⇒ **Go to the wavegen tab and either press "Run all" button on the left above channel 1 or just press the "run" button for channel 2.**

⇒ **Go back to the scope tab. Press "run" if necessary.**

Your oscilloscope should look similar to Fig. D.5 below. However, it shouldn't look exactly the same.

⇒ **Go back to the wavegen tab and stop and start the waveforms.**

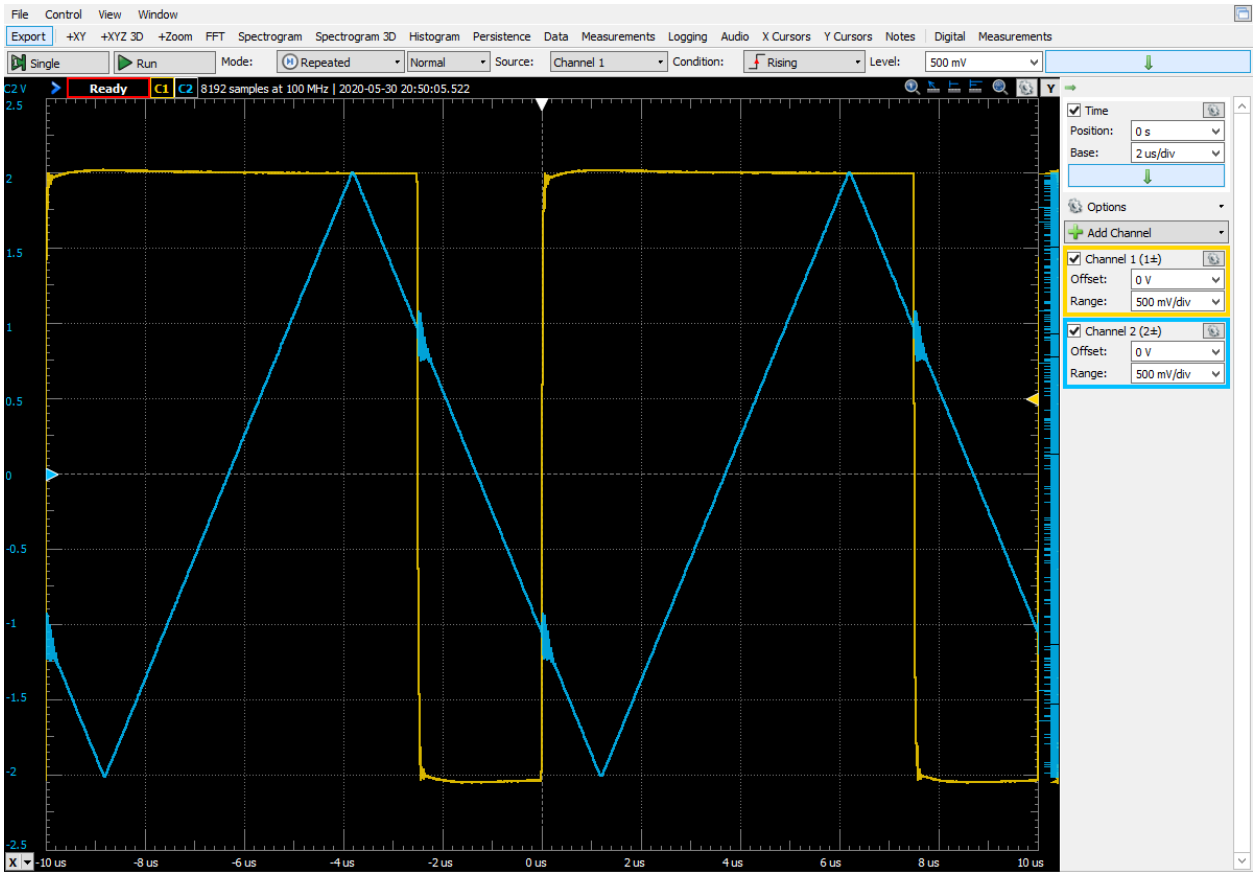


Figure D.5. Two different 100 kHz waveforms.

⇒ **go to the scope tab and observe the difference.**

⇒ **Repeat the past two steps a few times and note what happens.**

⇒ **Now look on the wavegen tab near the top where it says "No synchronization".**

⇒ **On that drop down menu choose "Synchronized".**

⇒ **Now repeat the previous experiment a few times and note what happens.**

⇒ **Go back to the wavegen tab and change the frequency of the triangle wave to 200 kHz**

⇒ **Now go to the oscilloscope and run it.**

Your trace should look similar to Fig. D.6 below:

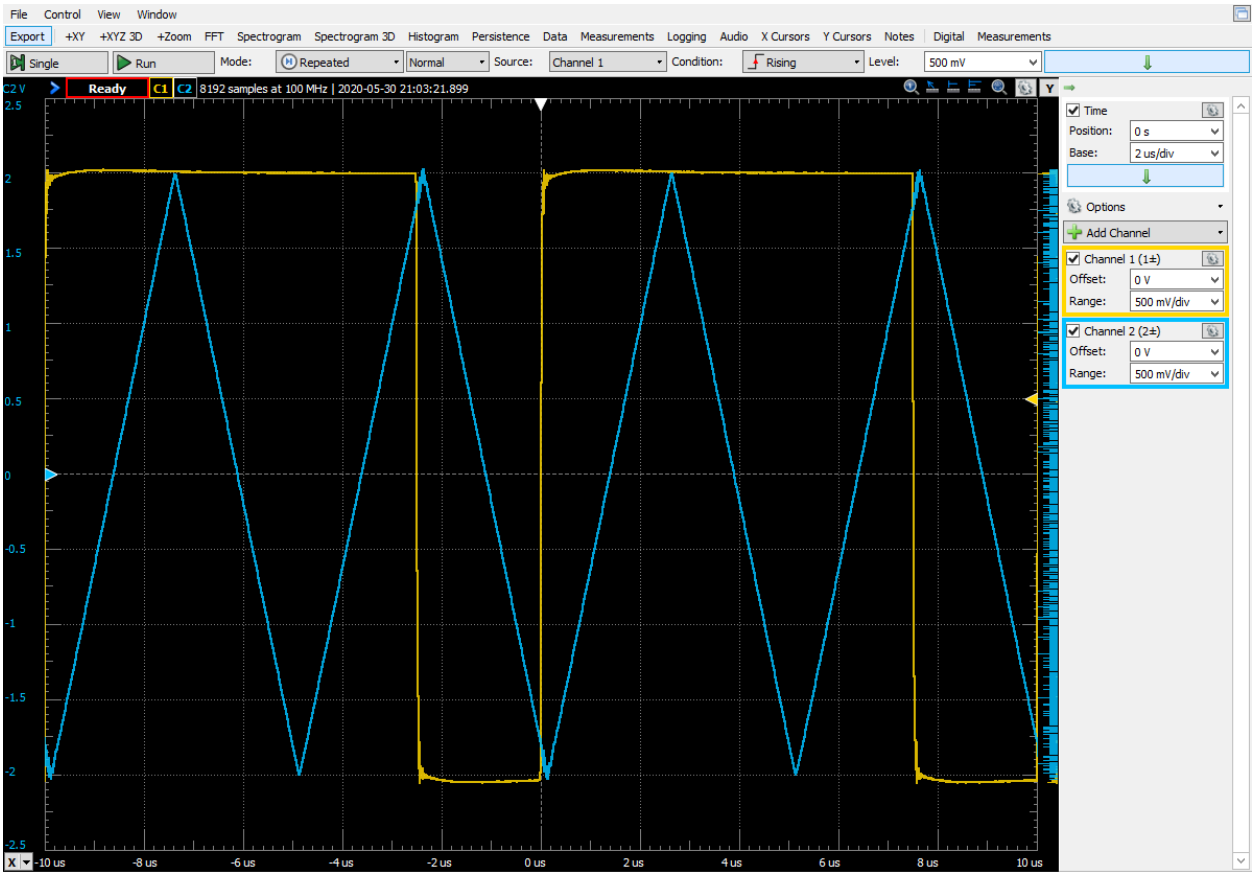


Figure D.6. Two different waveforms at different frequencies.

The trigger is the method that the oscilloscope uses to synchronize the traces on the channels with the display on your screen. The trigger will look at a certain signal, look for a certain voltage on that signal, and look for the voltage to be rising or falling. The time when those conditions are met, the scope calls “zero”, and it places that time at the middle of the screen and shows you times before and after that trigger time. The default trigger is set to Channel one.

⇒ **Click the source button at the top of the scope tab and change the source to channel 2.**

Note what happens to the traces.

⇒ **Now change the source to “Exsternal 1”.**

⇒ **To the left of source it either says “normal” or “auto”. If it says “normal”, change it to “auto”.**

A “normal” trigger means that traces will be plotted only if a trigger is found. If it is found, the upper left corner of the trace will say “Trig’d”. Otherwise, it will say “Armed”. The trace you see when it says “Armed” is an old trace, not the current one. “Auto” means that it will display traces even if no trigger is found. Usually that means that trace will move across the screen in a random way.

Part III – Measurements

⇒ **Turn off Channel 2 on the scope tab**

⇒ **Disable Wavefoem 2 on the Wavegen tab**

⇒ **Unclick channel 2 on the Wavegen tab**

⇒ **Change the channel 1 waveform to a 10 kHz sine wave.**

⇒ **Change back to “No synchronization”**

⇒ **Go back to the scope tab and adjust the time step to see two periods on the screen**

⇒ **There are two “Measurements” tabs on the top of the scope trace. Click on the “measurements tab that is to the right of “Data”**

⇒ **Click on “Add”**

⇒ **Click on “Defined Measurement”**

⇒ **Make sure Channel 1 is highlighted and click on the > sign to the left of vertical**

⇒ **Click on “Frequency”**

⇒ **Click on “Add”**

⇒ **click on “Close”**

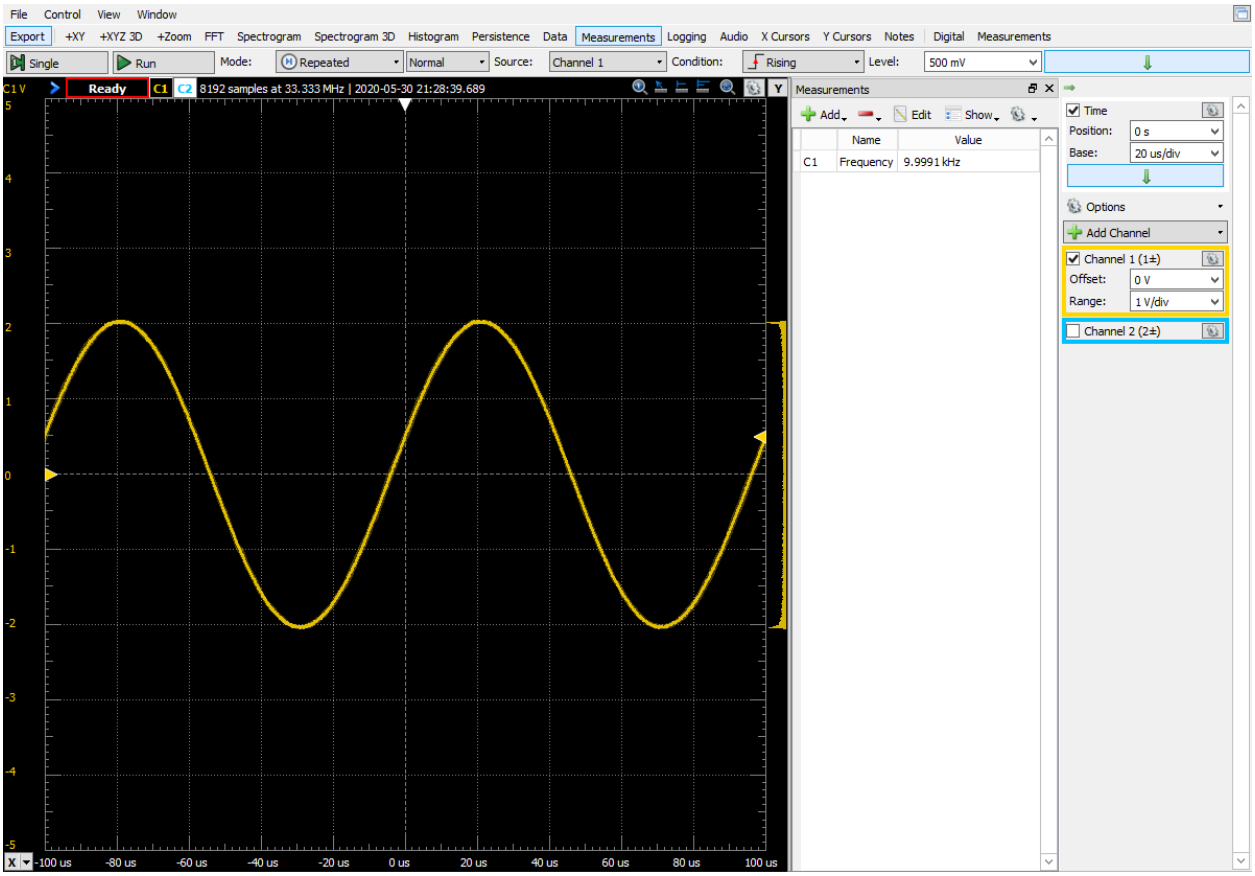


Figure D.7. Measuring the frequency.

⇒ **Click on "Show"**

⇒ **Click on "Average" then click on show (or somewhere else)**

You can see that it is measuring the frequency and there is a lot of jitter, but the average changes much less frequently and so it is easier to read.

⇒ **Add a few more measurements. On horizontal, add "Period"**

⇒ **On vertical, add Peak2Peak and AC RMS.**

Your plot should look like Fig. D.8 below

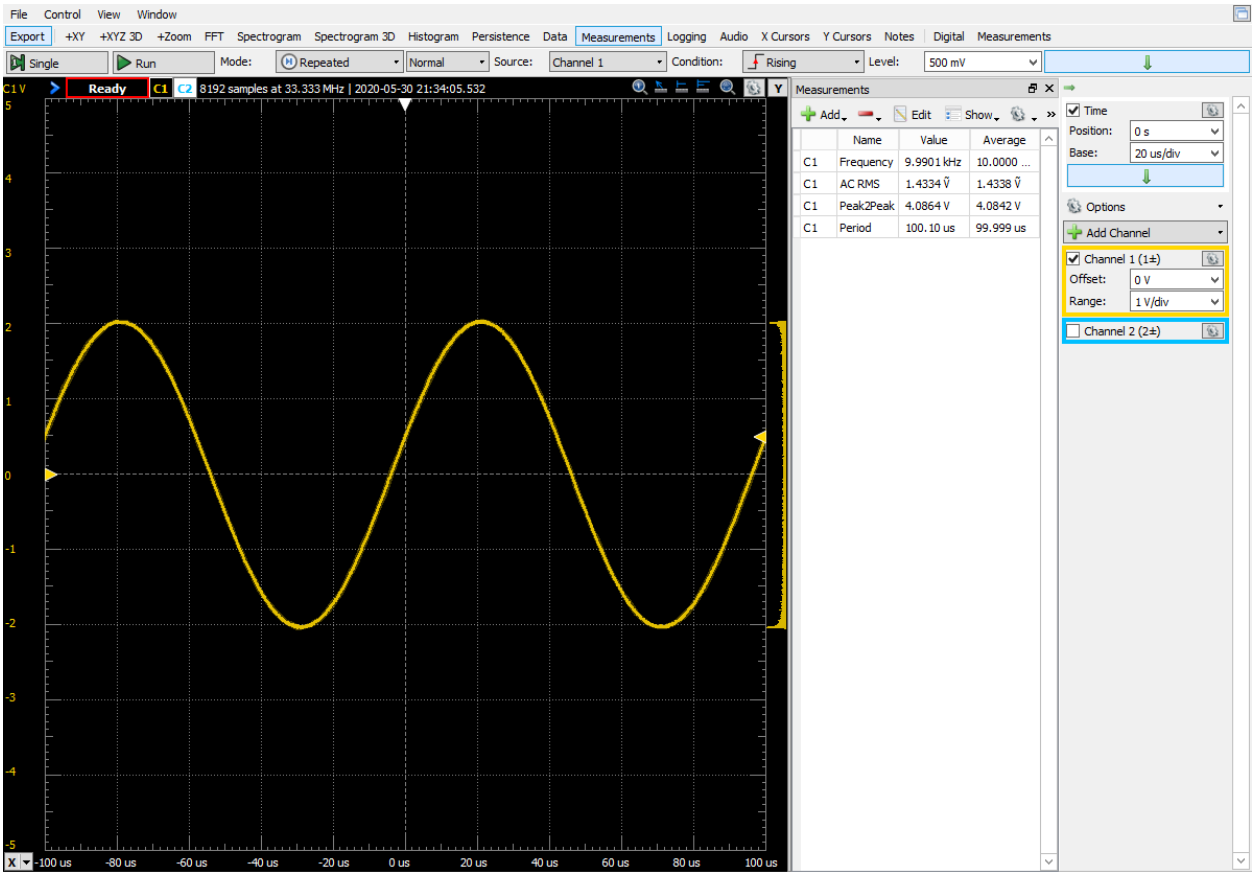


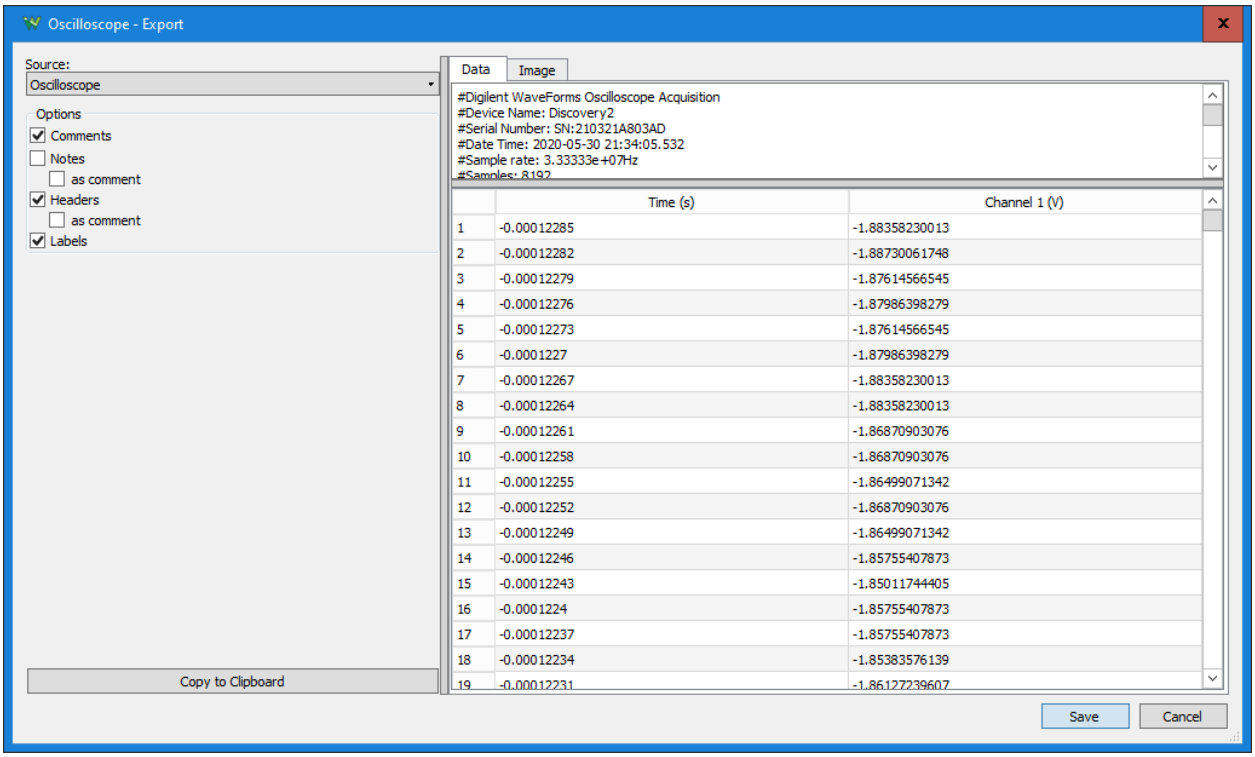
Figure D.8. Multiple measurements.

You can actually export the data and not just the figures.

⇒ **Click on “export”**

⇒ **Click on the “Data” tab**

you should see the following screen. If you copy it to the clipboard, and then paste it into a spread sheet, you can analyze and manipulate the raw data yourself.



Our final step will be to look at the cursers.

⇒ **Click on the x on measurements to get the measurements to disappear**

⇒ **Click on channel 2 so that it reappears**

⇒ **Click on the "X curser" button**

⇒ **Click on the green "+" beside "Normal"**

Your screen should look like Fig. D.9. below

⇒ **Drag the cursor around with your mouse to move it (hold the left mouse button down).**

Notice that you can read the time and the voltages on Channels 1 and 2.

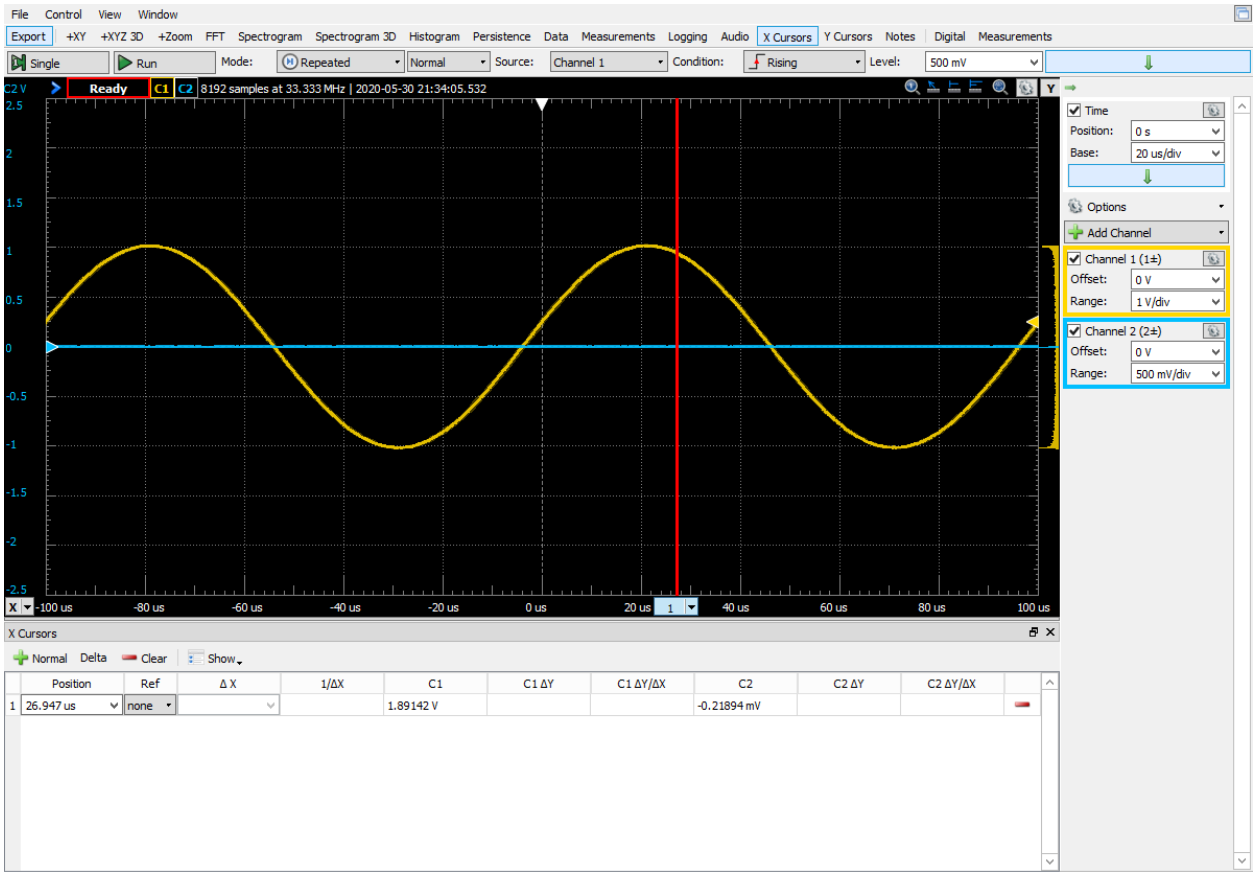


Figure D.9. The X cursors.

⇒ **Now add a "Delta cursor"**

Notice that you can see the differences between the times and the voltages on the two channels.

⇒ **Click on the "Y curser" button**

⇒ **Add a "Normal" cursor**

⇒ **Add a "Delta" cursor**

⇒ **Play with the cursors by moving them around to see how they behave. You may need to make the trace area smaller to read the voltage values on the Y cursors.**

⇒ **Try to make your scope look like Fig. D.10.**

Notice that the X cursors give both time and voltage, but the Y cursors only give voltage.

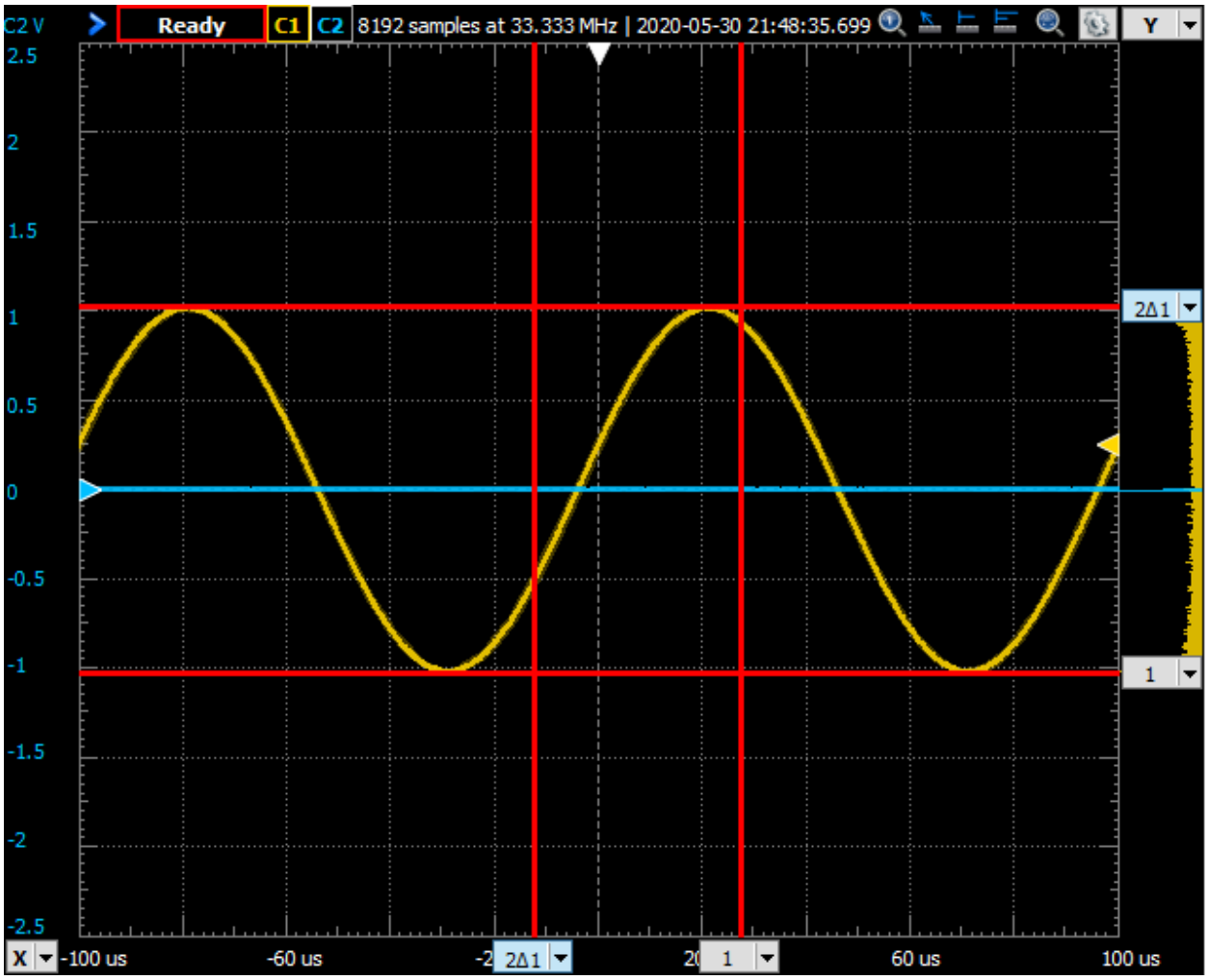


Figure D.10. The X and Y cursors.

The End!