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Tuesday 3pm-5:40pm

Laboratory Experiment Number 1

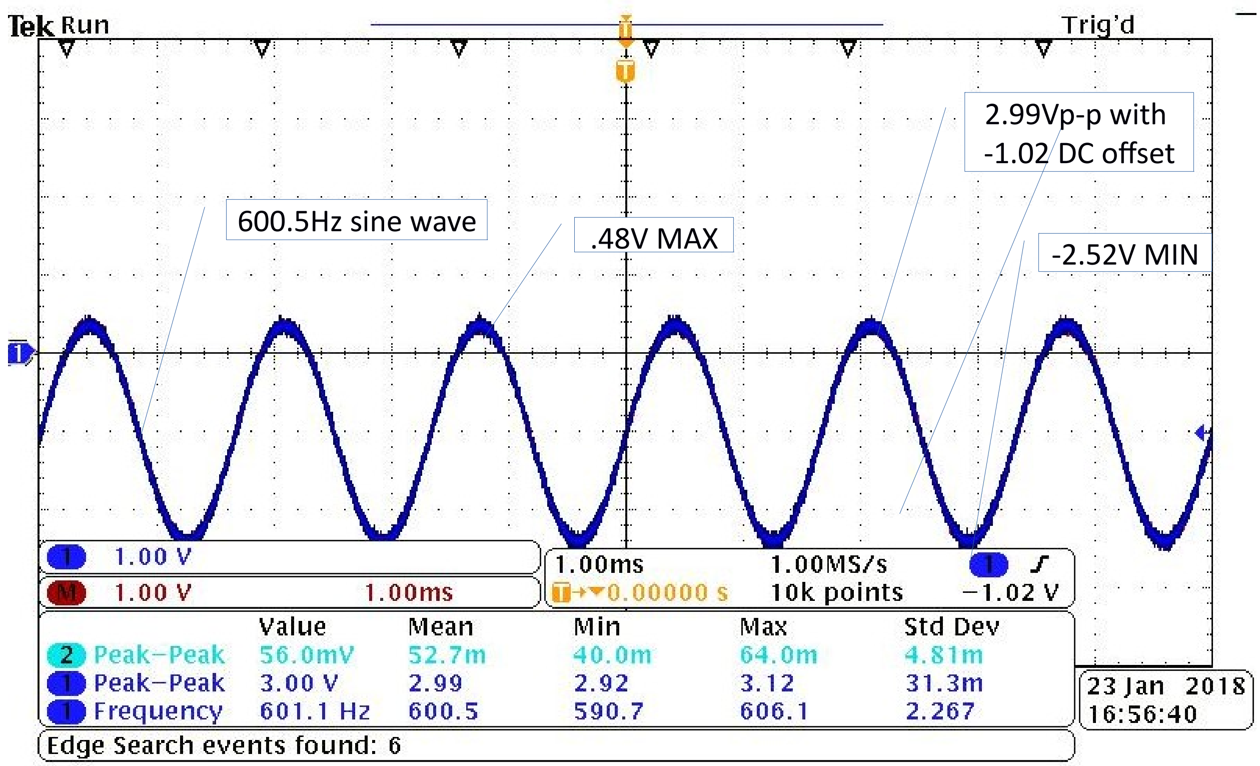
Basic Signals and Measurements

Part I: The Function Generator and Oscilloscope

Step 1. The object of Step 1 is to adjust the function generator until the **oscilloscope** displays a 3 V_{pp}, 600 Hz sine wave signal with a **negative** 0.5-volt DC offset.

NOTE: There were no 100 Ω resistors available so we used two 50 Ω resistors in series instead. R1 actual:47.5 Ω R2 actual:47.5 Ω

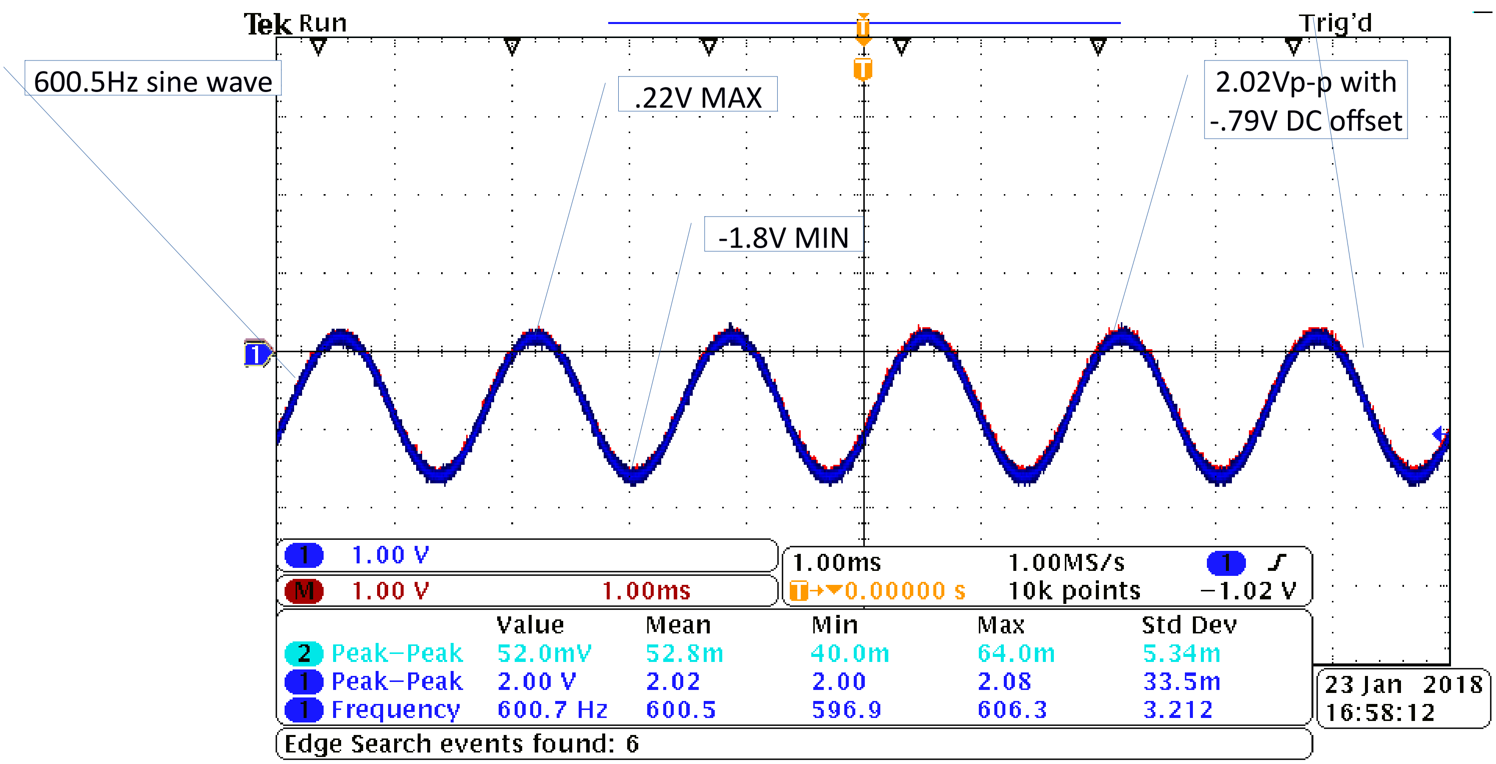
Output from function generator (Column 2) as seen on O-Scope without load (Column 1)



	Column 1	Column 2	Column 3
Parameter	Value Measured with Oscilloscope (no added load)	Setting indicated on function generator	Value Measured with Oscilloscope (with 100Ω Load)
Amplitude, V_{pp}	3	2.76	2.02
Frequency, Hz.	600	600	600
Offset, volts	−0.5	-0.5	-.790

Step 2. Do not change the function generator settings from Step 1! Now, add a 100Ω load at the output of the function generator (in parallel with the function generator output).

Output from function generator (Column 2) as seen on O-Scope with load (Column 3)



If the function generator has a display, make an observation: when the 100Ω load is added, does the generator's display of the output signal amplitude change?

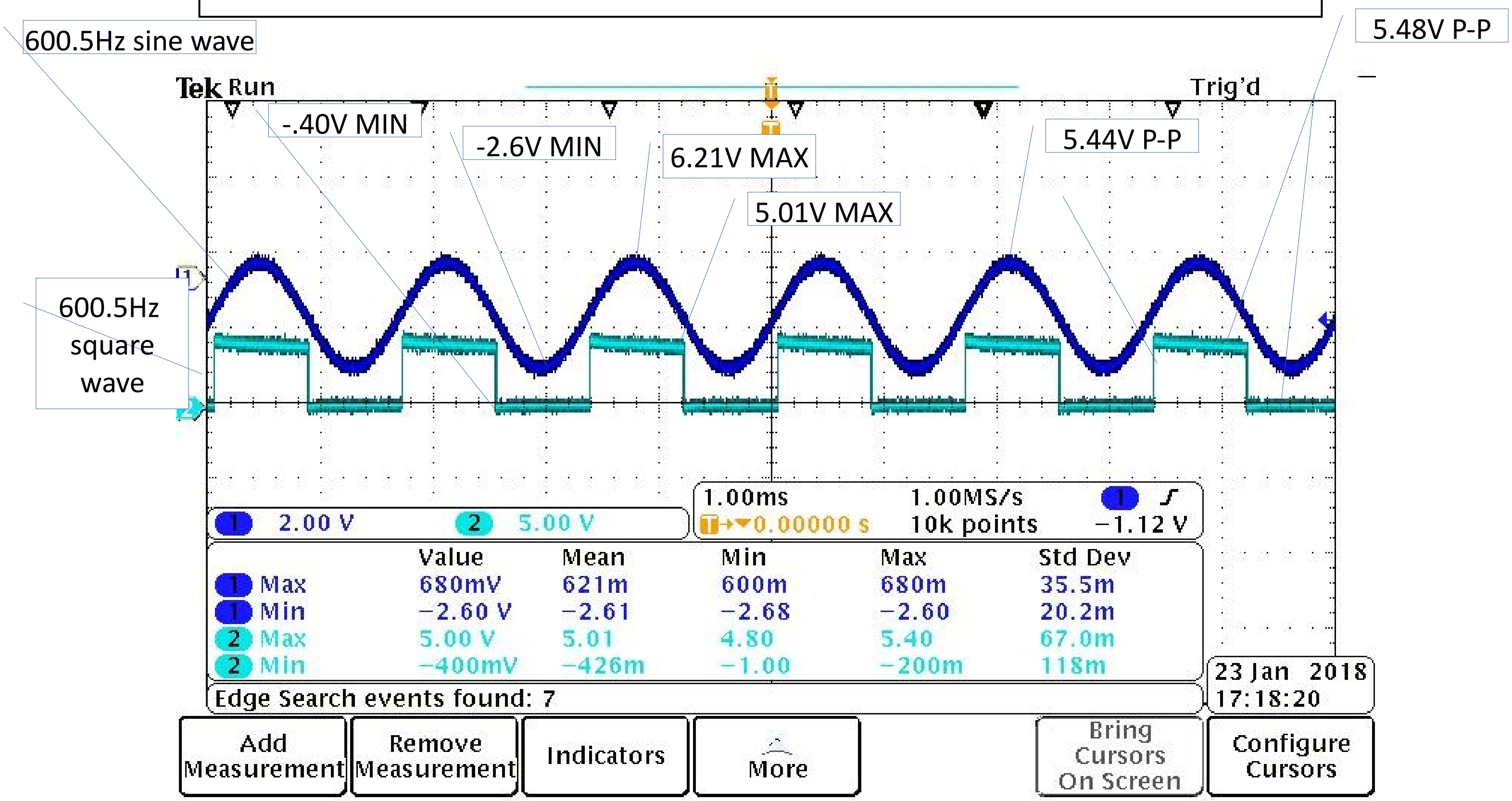
The amplitude does indeed change. My partner and I decided to add a couple measurement tools to make this easy to see through OpenSource. Since the peak to peak values change from 3 volts to 2 volts, the amplitude does too.

Step 3. Summarize the difference between AC coupling and DC coupling in a few words.

When switching from the DC coupling to the AC coupling, the DC offset that was output from the function generator is removed. The sine wave was shifted up to center on 0 Volts.

Step 4. Return channel 1 to "DC" coupling. In addition to the channel 1 display described above, use channel 2 of the oscilloscope to view the **SYNCH** (or **TRIGGER)** output of the function generator.

Output from function generator as seen on O-Scope without load when monitoring both standard out and SYNCH. Note the frequency for both functions was 600Hz.



Below the graph, write a complete sentence that answers the following question: "What is the instantaneous voltage of the triangle wave when the square wave makes a low-to high transition?"

The instantaneous voltage of the triangle wave when the square wave makes a low to high transition is ideally infinite.

Step 5. Make an observation: Which of the function generator front-panel controls **AMPLITUDE**, **FREQUENCY**, and **OFFSET** have an effect on the output labeled **SYNCH** (or **TRIGGER)**?

Changing the amplitude on the function generator had no effect on the SYNCH wave on the O-Scope.

Changing the frequency on the function generator changed the frequency of both waveforms on the O-Scope. (Increase on FG = Increase O-Scope & Decrease on FG = Decrease on O-Scope)

Changing the offset was interesting, it was almost the same effect in appearance as changing the trigger line when within range. It only changed the intersection point of time 0, trigger, and the wave.

Step 6. On the oscilloscope, identify the **TRIGGER LEVEL** control (sometimes called the
"**TRIGGER THRESHOLD**" control). The objective of this step will be to investigate the effect of this control on the displayed waveform.

Moving the trigger control line moved the waveform side to side, keeping the intersection point of trigger, time t=0, and the waveform true until moved too far out.

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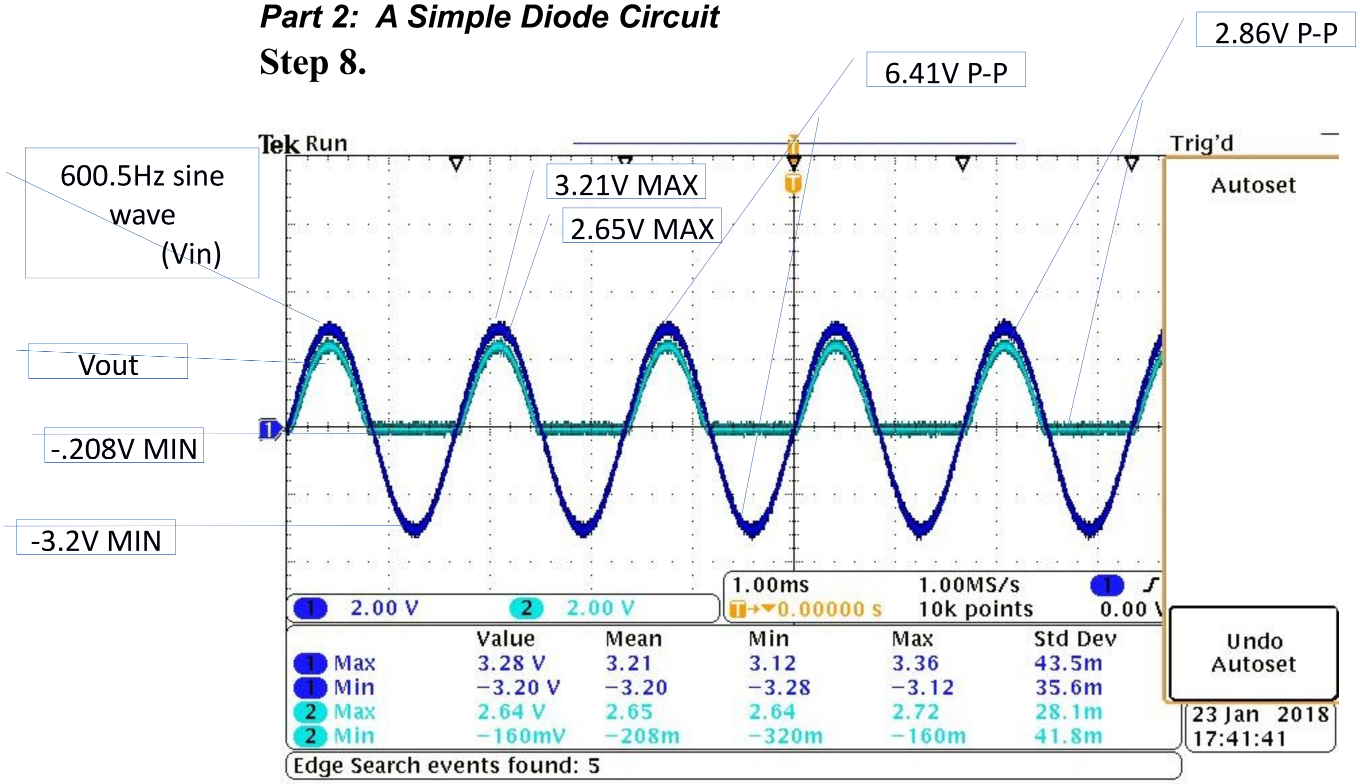
Step 7. Now select the trigger source to be channel 2 (channel 2 is still connected to the **SYNCH** output). Again, move the trigger level control and be sure that you can tell when the oscilloscope is triggering and when it is not. In this case, in the range where the oscilloscope is triggering, the display does not shift left and right as the trigger level is moved. Why is this so?

This is because the point of triggering or range of intersection is a vertical line so as the trigger level is moved up and down the wave does not need to be moved to still intersect.

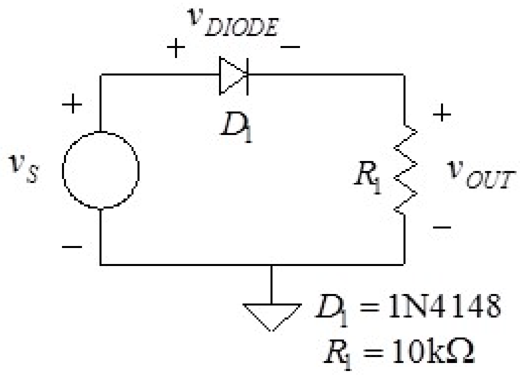
Part 2: A Simple Diode Circuit

Step 8.

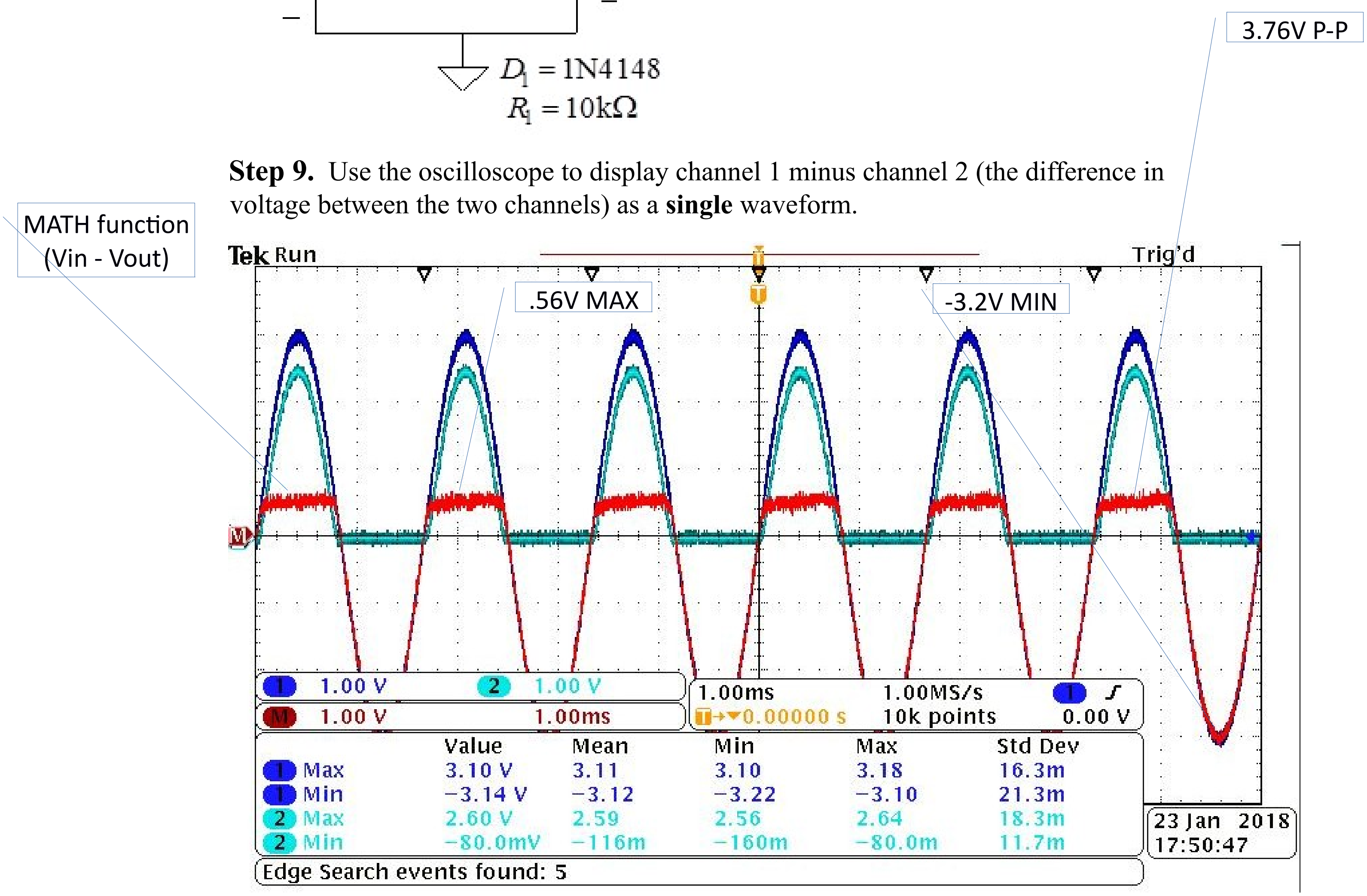


Below the sketch, write a complete sentence stating the voltage across the diode when it has the maximum forward bias. Is this value reasonable (make a comment)? If it does not seem reasonable, figure out why or ask for help.

Maximum forward bias will occur at the location where the peak voltages occur for both waves. According to the diagram, the drop across the diode will be Vs – Vout. Here, that is 3.21V – 2.65V = .56V. Although getting near, this is still within the breakdown point so it seems reasonable.



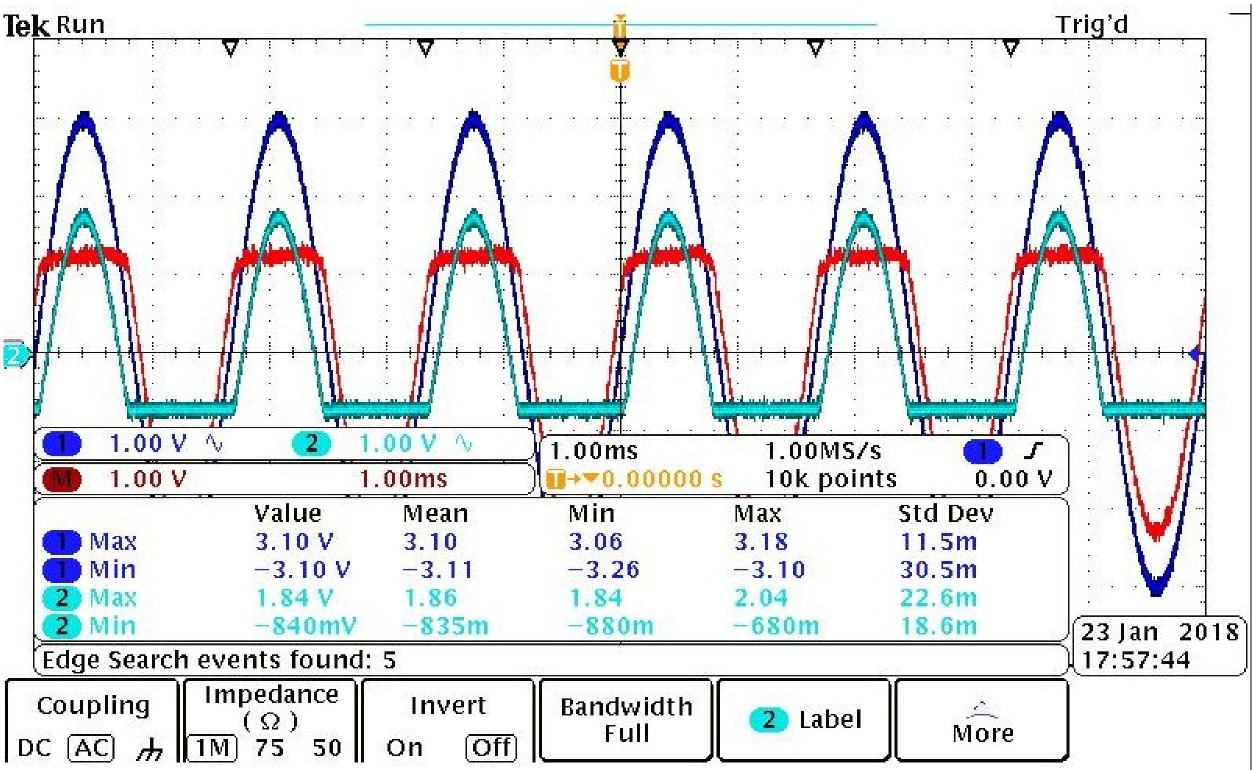
Step 9. Use the oscilloscope to display channel 1 minus channel 2 (the difference in voltage between the two channels) as a **single** waveform.



Write a sentence below the graph stating whether this sketch agrees with the peak voltage across the diode as found in Step 8 above.

The flat peaks here do agree with the voltage I found above.

Step 10. Observe ,, on channel 1 of the oscilloscope while changing to "AC" coupling and back to "DC". Does the display shift up or down? How can you tell? Now observe v_{OUT} on channel 2 while changing to "AC" coupling and back to "DC".



Does ,, have a DC component? No

Does v_{OUT} have a DC component? Yes

How can you tell?

When changing the coupling type for channel 1 (Vin) the wave did not move so there was no correction for the DC offset occurring. When changing the coupling type for Channel 2 (Vout) the wave was shifted down meaning there was a positive DC offset present.

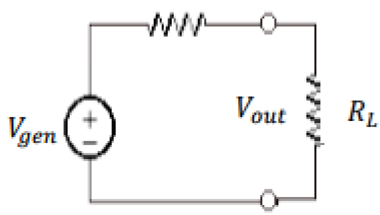
Conclusions

<u>Reminder</u>: respond to each numbered item with a paragraph or paragraphs that make sense when read by itself. Assume that the reader of your conclusions <u>has not seen this handout</u>.

Part I:

Item 1. Does the output voltage of the function generator actually change when the function generator is loaded by a 100Ω resistor? Why is this so? Cite the measurements you made (the conditions and voltages) and show calculations that support your answer. For full credit, calculate the function generator's output resistance.

When a function generator is loaded with a 100 Ohm resistor, the output voltage does actually change. This is because of the voltage divider circuit created by the load. Since the load provided in this instance is relatively small, the output voltage does change. Given this circuit:



We have Vout = Vgen((RL) / (RL+Rgen))

As RL approaches infinity (open circuit), Vout approaches Vgen. But if RL is relatively small then Vout drops in value.

Using the measurements I made, RL = 95 Ohms, Vgen = 2.76Vp-p, and Vout = 2.0Vp-p. Plugging this into the above function, we then get Rgen is roughly 36.1 Ohms.

Item 2. (Skip this item if your function generator does not have a numerical display on the front panel) Does the amplitude displayed on the front panel of the function generator change when the function generator is loaded by a 100Ω resistor? Why or why not? Is the amplitude value displayed on the function generator a *measurement* of the voltage present at its output terminals? How would you interpret the meaning of the amplitude parameter as displayed on the function generator? (Is the displayed amplitude intended to be peak, peak-to-peak, or RMS?)

I believe the front panel of a function generator displays it's internal voltage with respect to ground and not necessarily whats at the output terminals. We can use an oscilloscope to measure voltage at the output terminals and across a load. I believe this is the case because when adding a small load, the function generator does not change its displayed values even though the output voltage is drastically changed.

I would interpret the amplitude as displayed on the function generator as the peak or the amplitude as understood when referring to the amplitude of a wave in mathematics.

Item 3. What are the possible advantages of using the function generator output labeled **SYNCH** or **TRIGGER** as the trigger source for an oscilloscope? Hint: What if the circuit being tested adds noise to the signal or reduces its AC component?

Possible advantages of using the function generators SYNC output as a triggering source include but are not limited to:

- A triggering source immune to circuit noise. SYNC is a source disconnected from but timed the same as a circuit on its output.

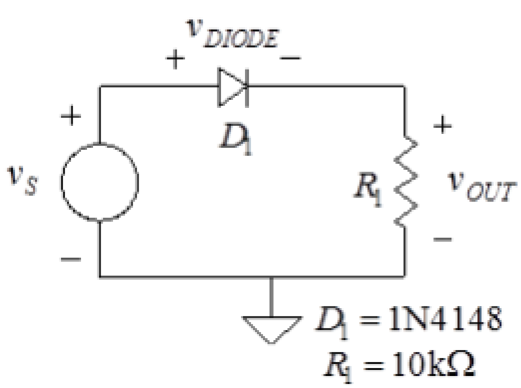
-A triggering source that will always provide a square wave from roughly 0 to 5V. This means that if a circuit is described by a wave that is extremely small in magnitude, a stable trigger can be used.

Part II:

Item 4. In Step 8, what was the peak current through the diode during forward bias? Cite data you measured and show your calculations.

Peak current through a diode in forward bias would occur when there is the greatest potential difference across it. Using the diagram below, we can see that the diode we would like to measure peak current for is in series with a resistor. Using my measurement for Vout and the resistance value I used we can calculate the current through the resistor and thus the whole system. Given Vout = 2.65V at its peak and R1 = 10978 we now have 2.65V / 10978 Ohms is roughly .241mA

Item 5. The circuit of Figure 1 models the function generator as having an output resistance of zero ohms, when in reality the function generator has some nonzero output resistance. Why is it not important to include the function generator's output resistance in the analysis of this particular circuit?



In a circuit such as this it is not important to include the internal resistance of the function generator simply due to the magnitude of the load being measured as Vout. In a voltage divider the 10000 Ohm resistor will be responsible for nearly 100% of the voltage drop so ignoring the function generators sub 100 ohm resistance is acceptable.