American University of Beirut

Course: EECE 312L

Assignment 2: Rectifier Circuits

Instructor: Dr. Sara Khaddaj

Due Date: Wednesday, November 25th, 1:00 pm

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INDEX:

i. Snapshot of the output (using Scope)
ii. Peak-to-peak output voltage measurement (using Scope)
iii. Measurement of the mean of the output wave (using DMM) and snapshot.

e. Comparison of the outputs of the three circuit diagram in terms of shape and mean.

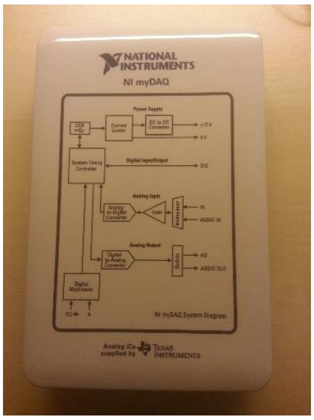
Introduction:

Although diodes have many uses in electrical engineering, their use in the design of rectifier circuits is the most common. Rectifier circuits are considered to be the building blocks of DC power supplies that are required to power our daily electronic devices. What a rectifier circuit does is that it changes an alternating, or bidirectional current or voltage to a unidirectional one. It is important to note that there are many types of rectifier circuits, and they range from the simplest configuration of a rectifier diode and a resistor, to a multiple of diodes connected to a smoothing capacitor and a resistor. In this assignment, we shall investigate 3 configurations of the rectifier circuit: diode-resistor, 4 diodes-resistor, and 4 diodes-resistor-capacitor.

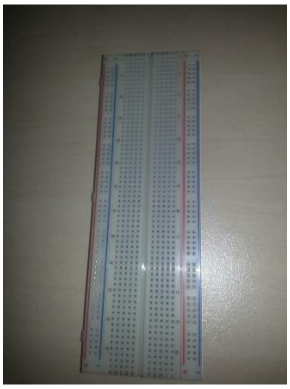
Description of hardware setup:

Components used:

- ❖ LabVIEW Software
- ❖ MyDAQ acquisition system

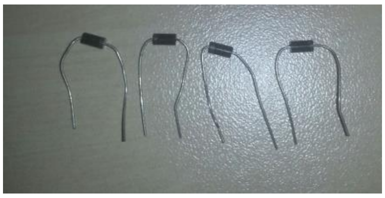


- ❖ PC
- ❖ Breadboard



❖ 5.6 KΩ Resistor

❖ 1N4007 (Rectifier diode) x4

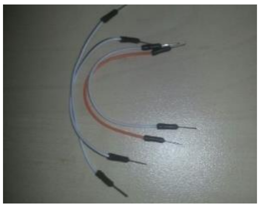


❖ 1 uf Capacitor

❖ Multi-meter wires

❖ USB port wire

❖ Connecting wires



Circuit connections, Connections between myDAQ acquisition board and the circuit, and Input and output lines used:

For this assignment, all we needed was one input and one output from the myDAQ in order to complete all three experiments. The terminal that supplied our input was the AO 0 input on the myDAQ and complementary to it the AGND (ground), on the other hand, the terminal that provided our output was the AI 0 channel $(0^{+}\ and\ 0^{-})$. For all three circuits, we were required to apply a 5V peak-to-peak voltage and a 1 KHz sinusoidal wave as input.

Figure (a): Connections to myDAQ

N.B: The connection above was common between all three circuits

Circuit 1:

- Circuit 1 was the simplest among the 3 configurations since it only contained a diode and resistor connected in series to the source where the output across the resistor was measured.
- Circuit 1 represented a half-wave rectifier.

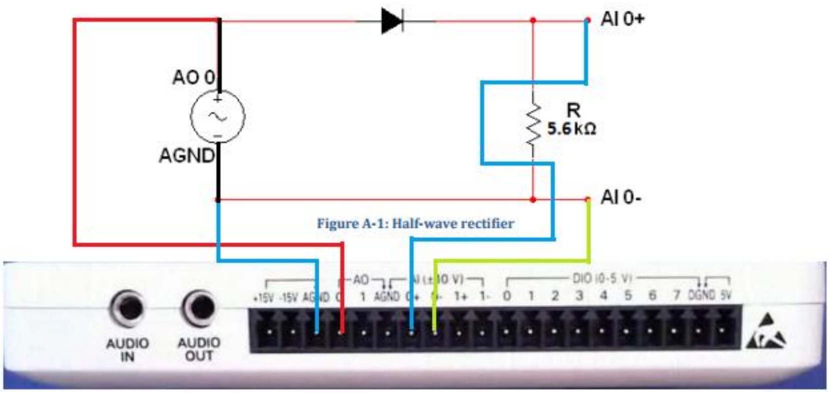


Figure (b): Theoretical connections in Paint

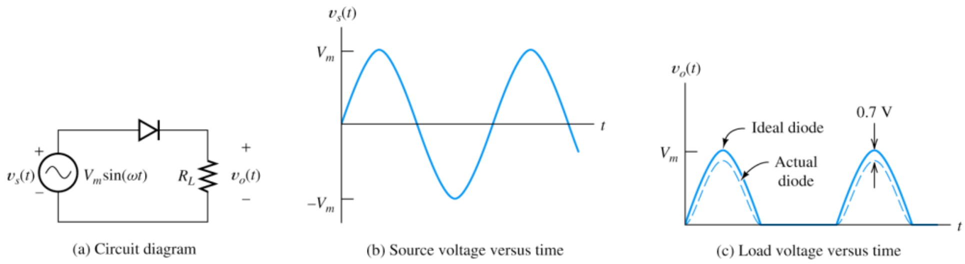


Figure 10.24 Half-wave rectifier with resistive load.

Figure (b'): Expected theoretical output from circuit 1

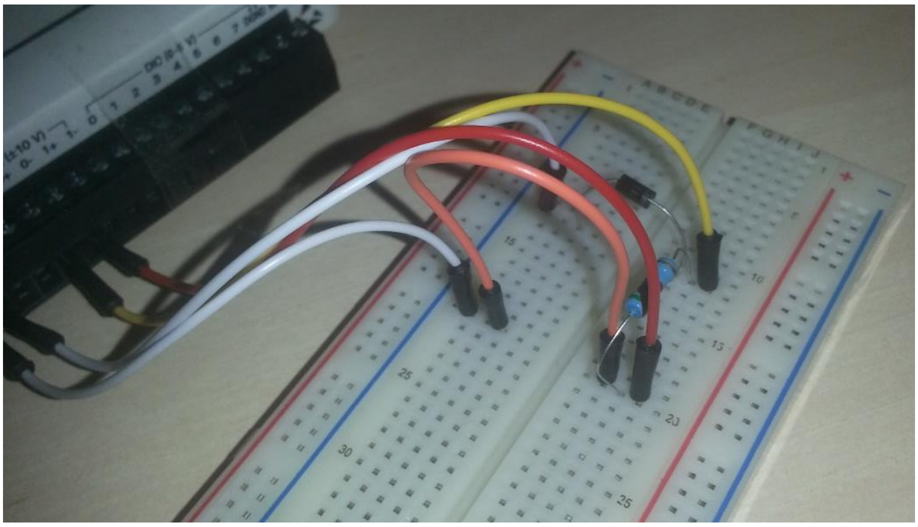


Figure (c): Real circuit on breadboard (circuit 1)

Circuit 2:

- Circuit 2 was slightly more difficult in terms of building and this is due to the fact that now the circuit included 4 diodes connected to resistor (bridge).
- This circuit served as a full-wave rectifier and the connections were as follows.

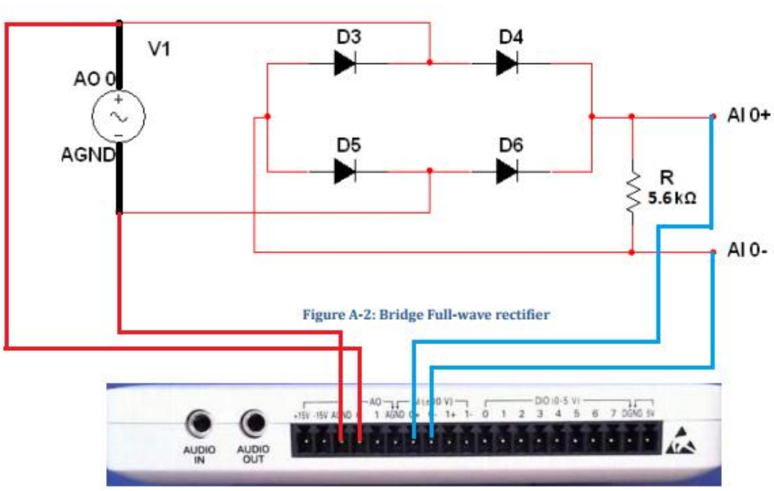


Figure (d): Theoretical connections of Circuit 2

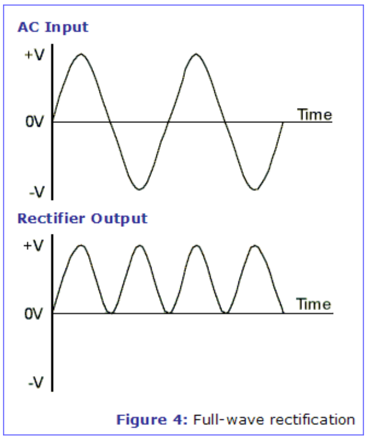


Figure (d'): Expected theoretical output from circuit 2

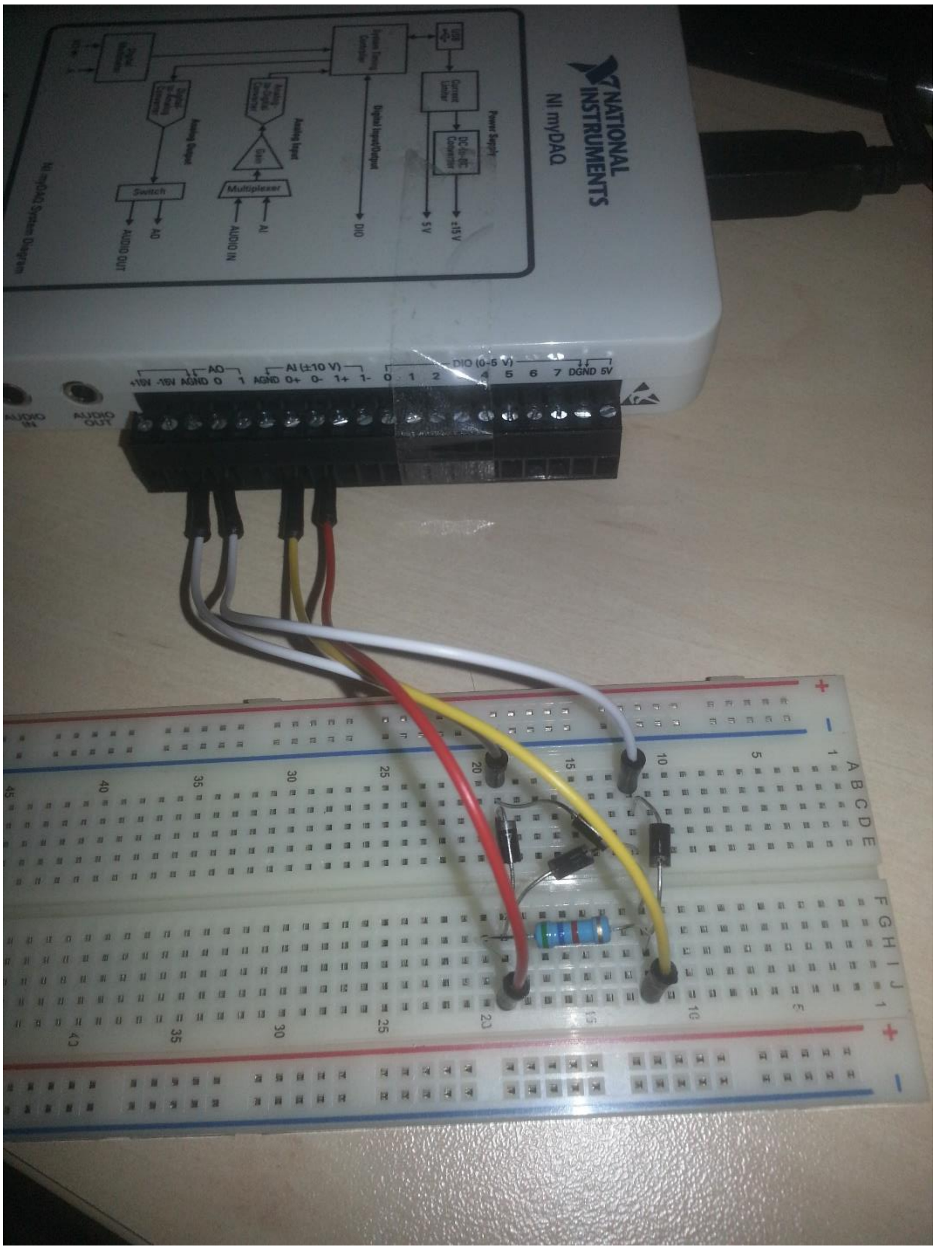


Figure (e): Real circuit on breadboard (circuit 2)

Circuit 3:

- This circuit is the most practical circuit among the three, and this is due to the fact that a capacitor exists in the configuration, which in turn serves as a smoothing mean for the signal.
- The final result of the signal is a fluctuating ripple wave.

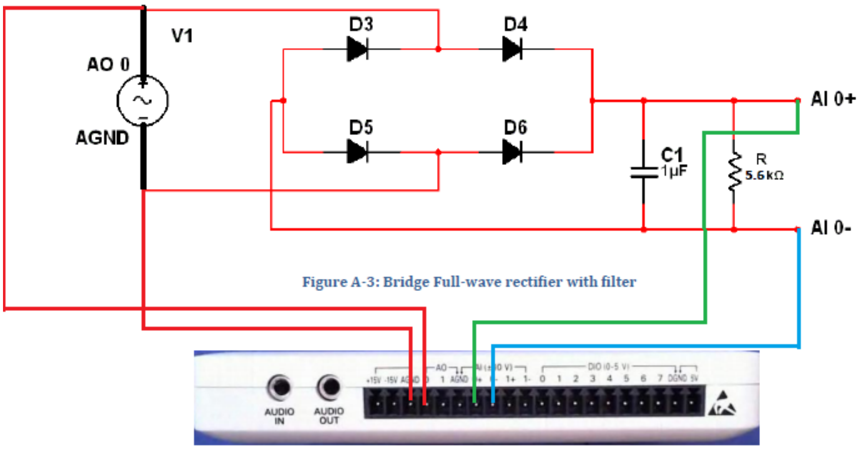


Figure (f): Theoretical connections of circuit 3

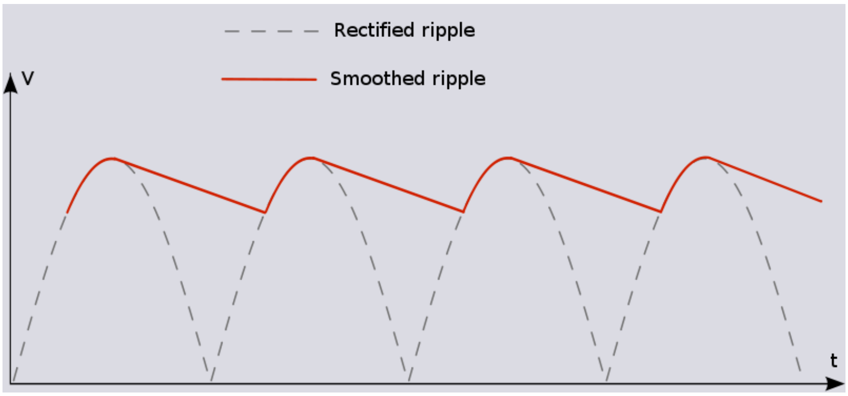


Figure (f'): Expected theoretical output from circuit 3

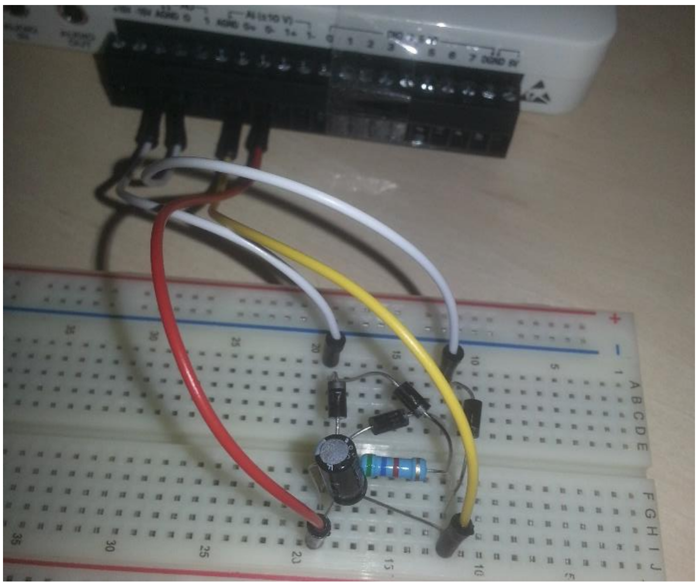


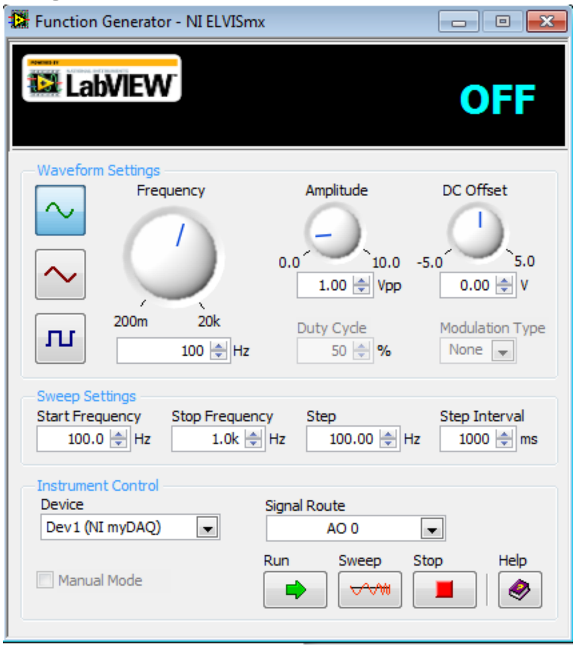
Figure (h): Real connections on breadboard for circuit 3

Description of the software setup:

b. Modules used and Configurations

FUNCTION GENERATOR (FGEN)

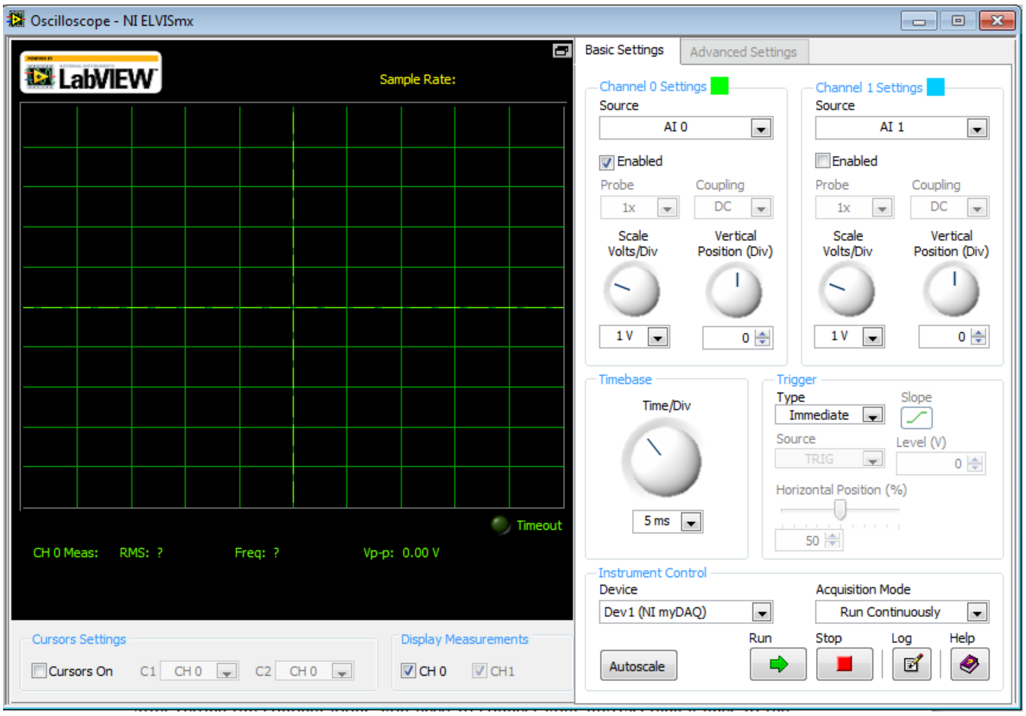
The NI ELVISmx Function Generator (FGEN) generates standard waveforms with options for the type of output waveform (sine, square, or triangle), amplitude selection, and frequency settings.



OSCILLOSCOPE (SCOPE)

The NI ELVISmx Oscilloscope (Scope) displays voltage data for analysis. This instrument provides the functionality of the standard desktop oscilloscope found in typical undergraduate laboratories. The NI ELVISmx Oscilloscope SFP has two channels and provides scaling and position adjustment knobs along with a modifiable time-base. The auto-scale feature allows you to adjust the voltage display scale based on the peak-to-peak voltage of the AC signal for the best display of the signal. The computer-based scope display has the ability to use cursors for accurate screen measurements.

Channel Source: Channels AI 0 and AI 1. Hence, analogue input lines (AI 0 or AI1) of myDAQ will be used to display the output signal from the circuit design built on the breadboard (AI 0 in my case).



DIGITAL MULTIMETER (DMM)

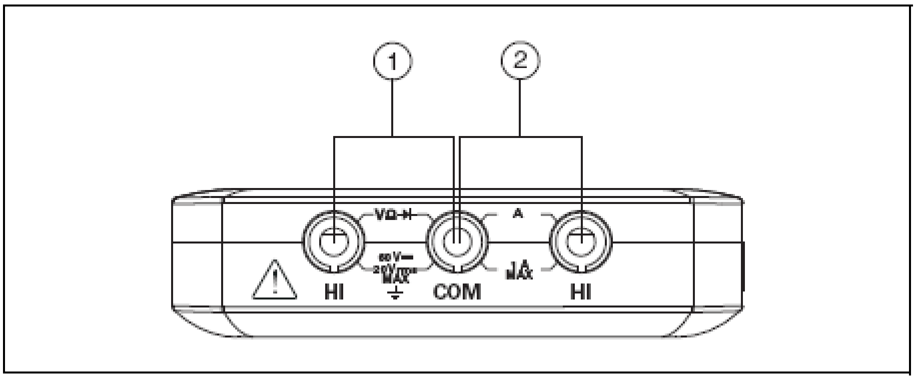
NI ELVISmx Digital Multi-meter (DMM) is a stand-alone instrument2 that controls the basic DMM capabilities of NI myDAQ. This commonly used instrument can perform the following types of measurements:

- Voltage (DC and AC)
- Current (DC and AC)
- Resistance
- Diode test
- Audible continuity

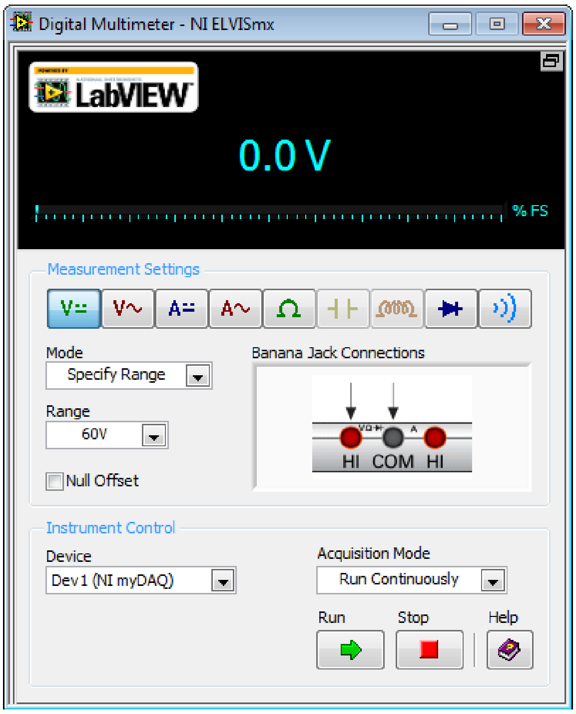
This instrument has the following measurement parameters:

- DC voltage: 60 V, 20 V, 2 V, and 200 mV ranges
- AC voltage: 20 V, 2 V, and 200 mV ranges
- DC current: 1 A, 200 mA, and 20 mA ranges
- AC current: 1 A, 200 mA, and 20 mA ranges
- Resistance: 20 MΩ, 2 MΩ, 200 KΩ, 20 KΩ, 2 KΩ, and 200 Ω ranges
- Diode: 2 V range

We shall use the DMM interface to make voltage and resistance measurements.

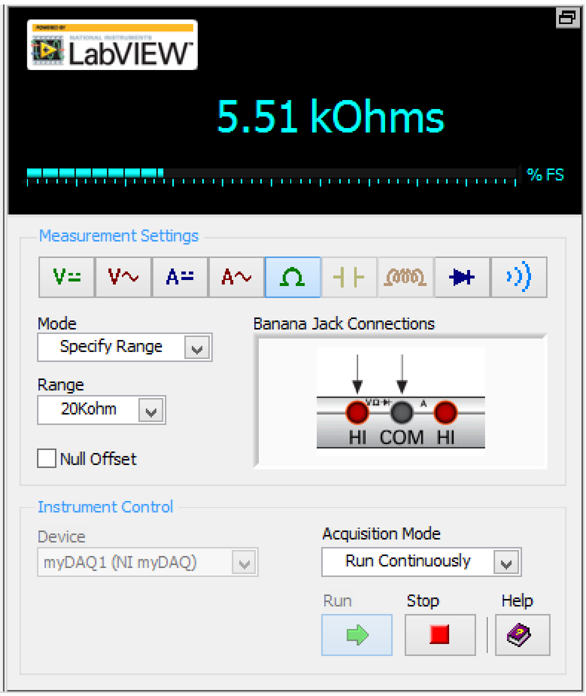


1	Connectors for Voltage/Resistance/Diode/Continuity
2	Connectors for Current



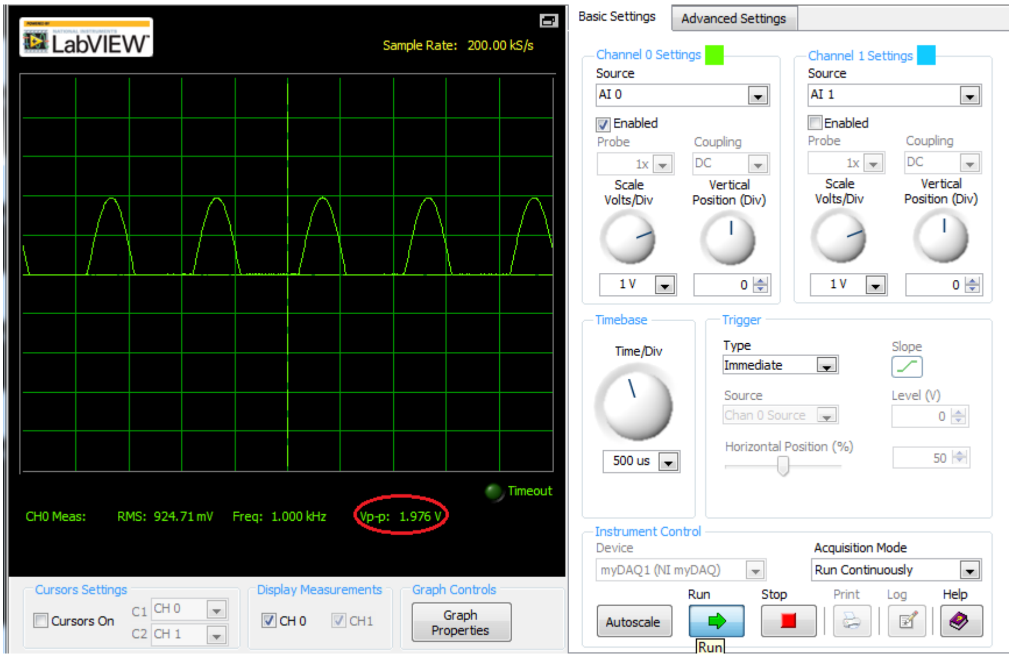
Testing:

a. Measurement of the value of resistance.

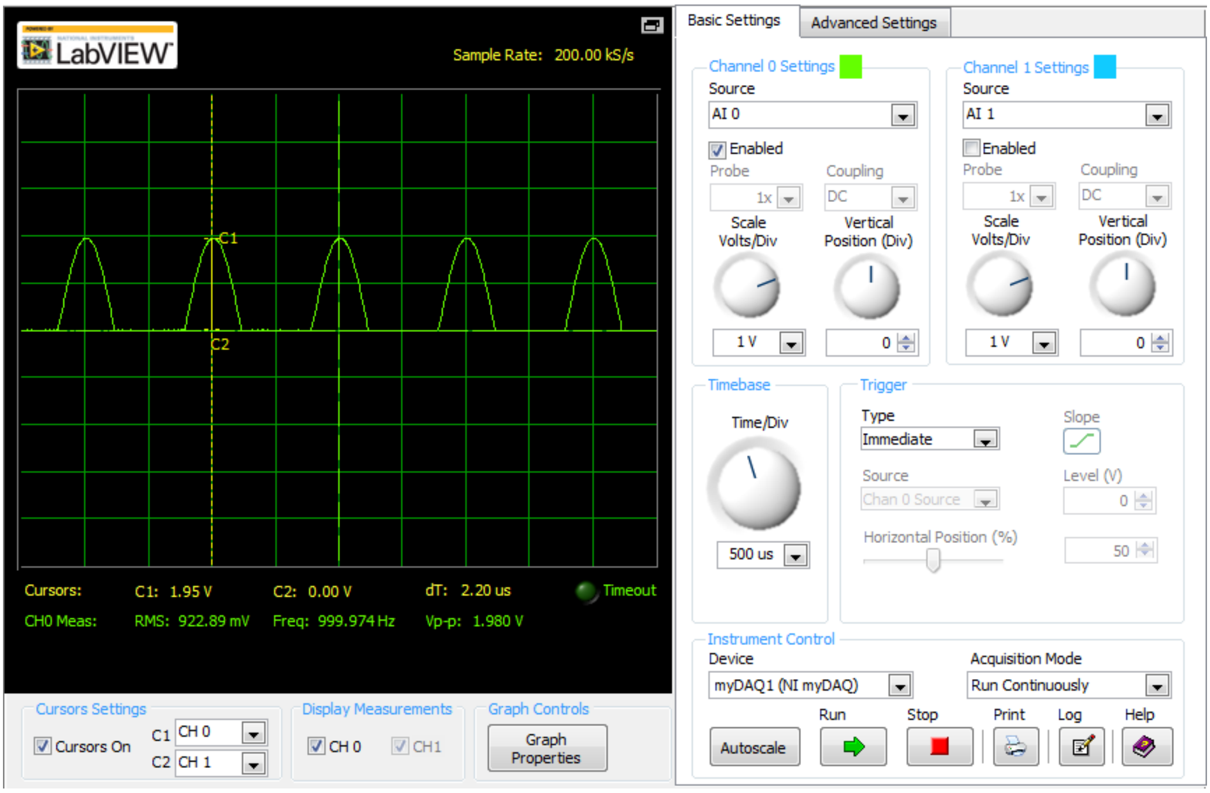


b. Half wave rectifier

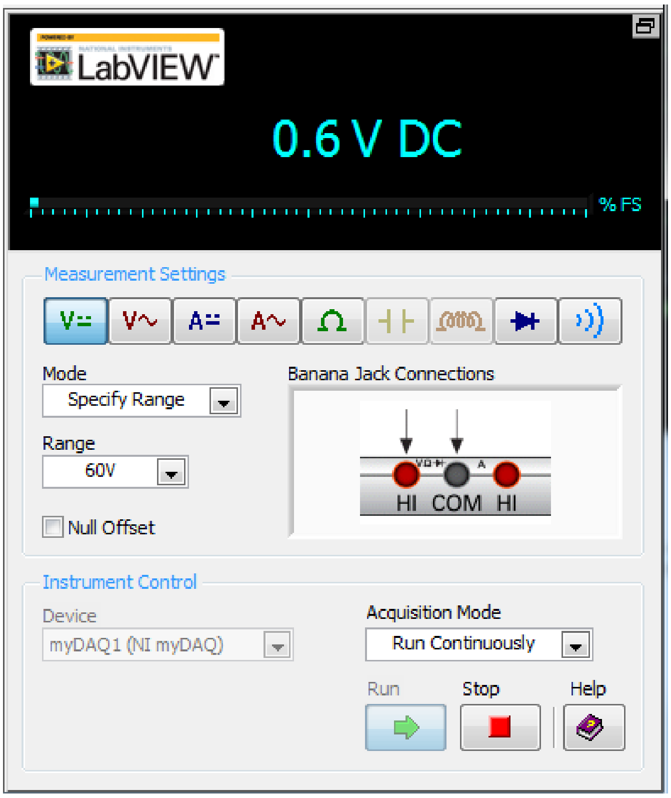
i. Output signal using scope:



ii. Peak-to-peak voltage using cursors:

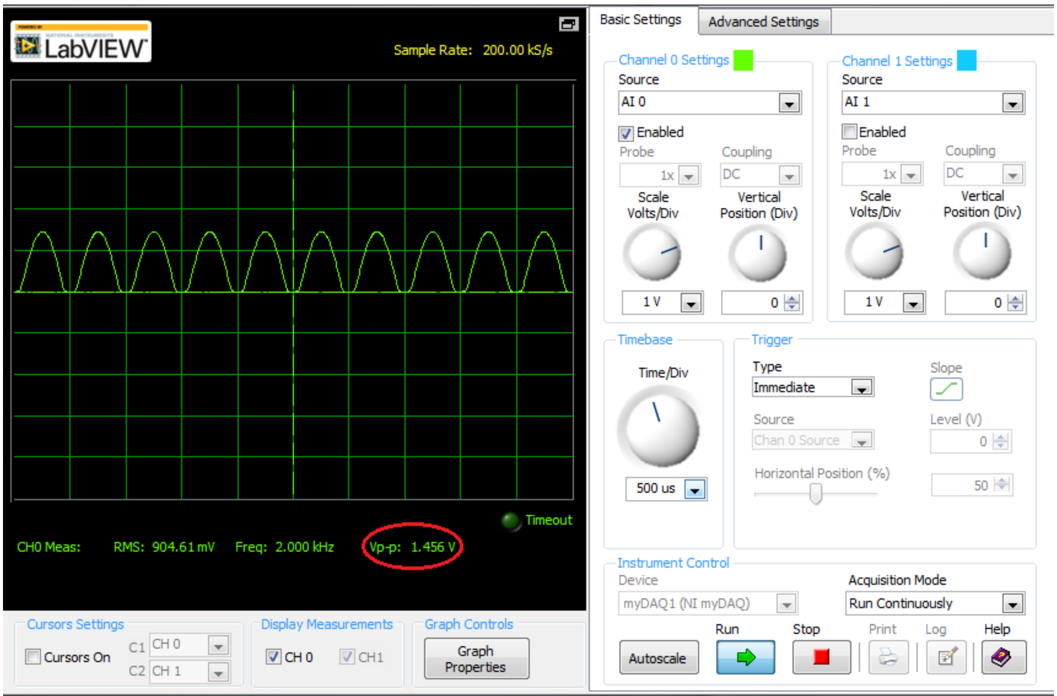


iii. The mean output voltage (DC) using DMM:

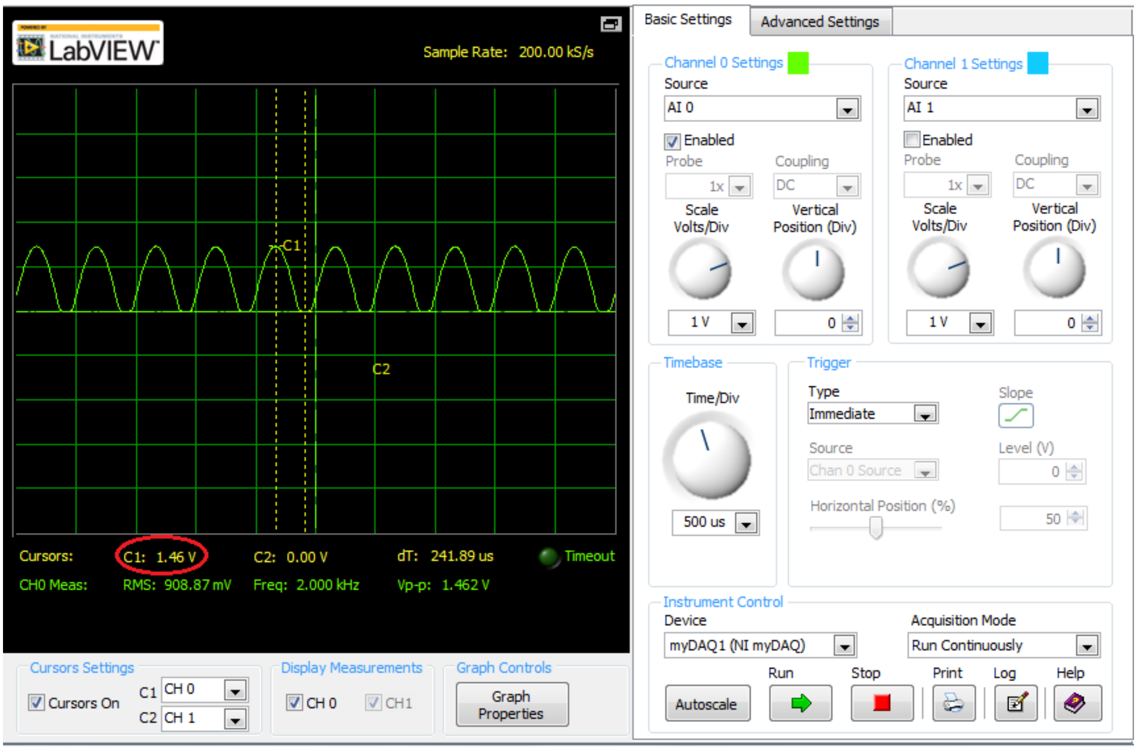


c. Full-wave rectifier (without capacitor)

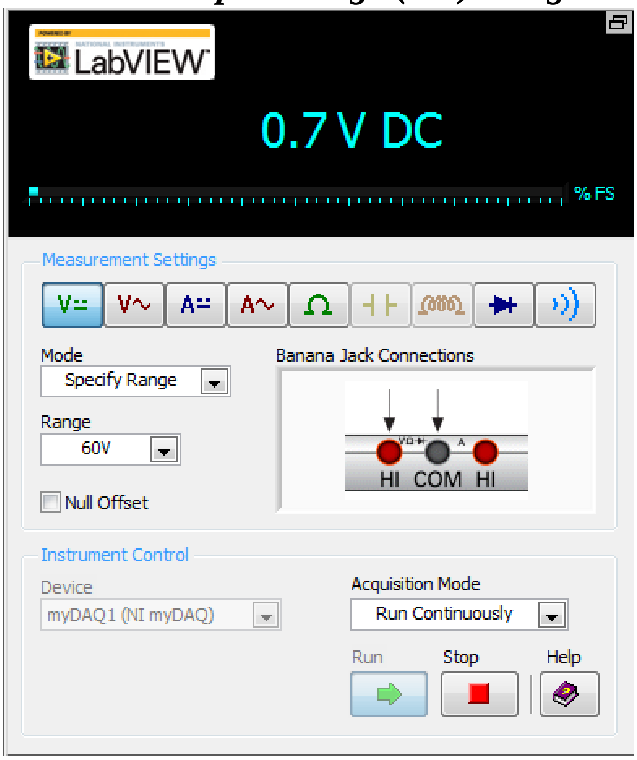
i. Output signal using scope:



ii. Peak-to-peak voltage using cursors:

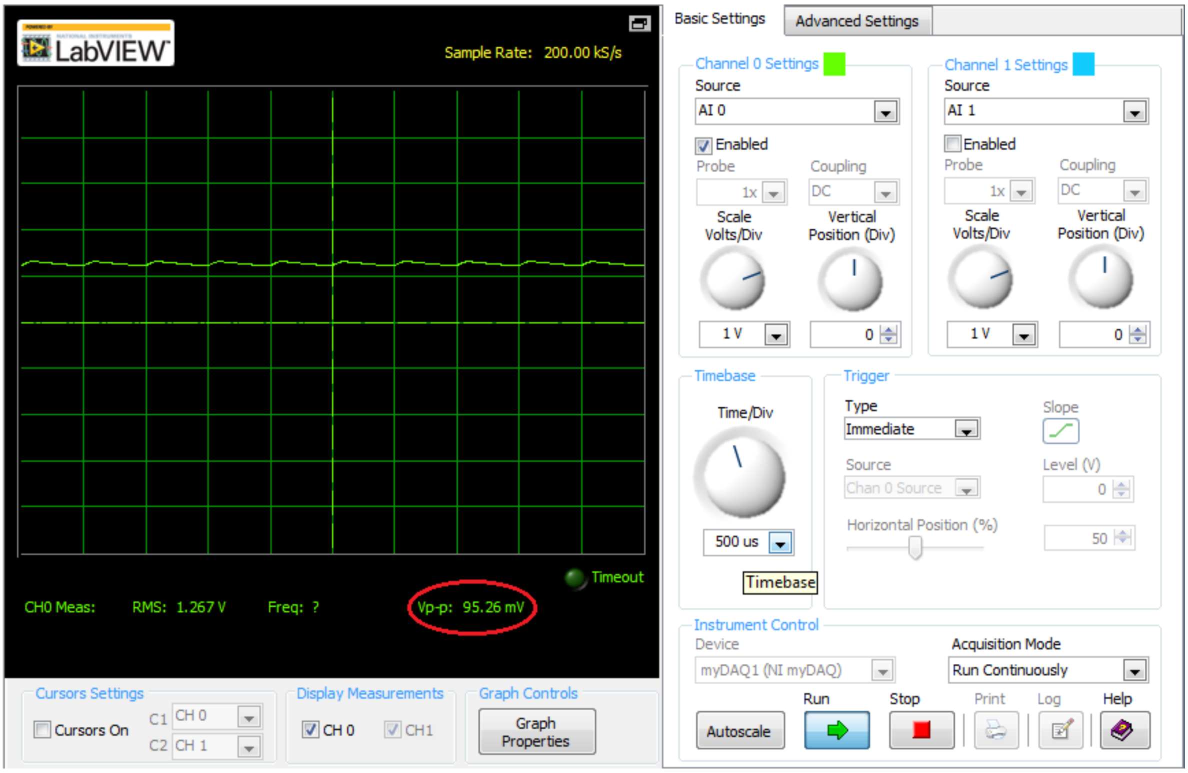


iii. *The mean output voltage (DC) using DMM:*

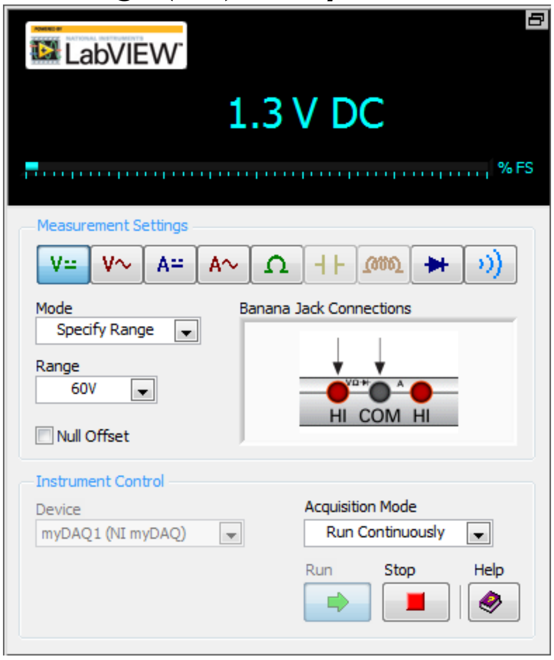


d. Full-wave rectifier with smoothing capacitor

i. Output voltage measurement using Scope:



ii. The mean output voltage (DC) read from DMM:



e. *COMPARISON BETWEEN OUTCOMES OF THE TESTED CIRCUITS:*

After performing the above experiments, it is rather noticeable to us the fact that the increasing complexity of the circuits speaks for itself when it comes to the comparison of the results.

For the half wave rectifier, we notice that the output showed a half-sine wave, in which all the negative part of the signal disappeared making the signal look unidirectional.

As for the full wave rectifier (without smoothing capacitor), we notice that all of the output signal is now positive such that the negative part and positive part of the signal are adjacent to one another.

Considering the full wave rectifier with the smoothing capacitor, we notice that the signal is a kind of shy horizontal line having small fluctuations tending to the shape of a DC signal.

The numerical comparison is what we can call the "Meat and Potato" of the whole purpose of the experiment. Starting from experiment one the peak-to-peak voltage was 1.976 V (from scope) and as we moved to experiment two the peak-to-peak voltage went down to 1.456 V, and as we moved further to experiment three the peak-to-peak voltage went down dramatically to 95.26 mV. As we can see the peak-to-peak voltage is decreasing as we move from one experiment to the other.

On the other hand, if we consider the mean voltage measurements that we've done using the DMM, we notice that for experiment one $V_{DC} = 0.6\ V$, then it becomes $V_{DC} = 0.7\ V$ for experiment two, after which it becomes $V_{DC} = 1.3\ V$ for experiment three, which is a relatively high value compared to the peak-to-peak voltage.

Henceforth, as we further proceed in rectifying the signal, it starts losing its AC properties, and starts exhibiting DC properties.

References:

- Documents posted on Moodle
- EECE 312 Lecture notes: *Dr. Lama Hamandi*
- **http://www.paleoelectronics.com/2011/03/sidebar-rectification-and-filtering/**
- **http://electronics.stackexchange.com/questions/68526/what-can-the-source-of-100hz-noise-be**