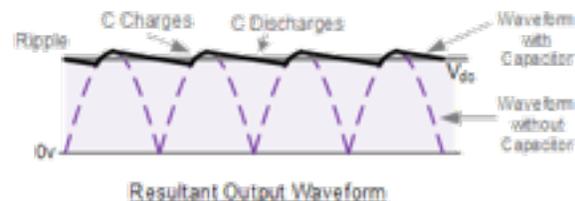
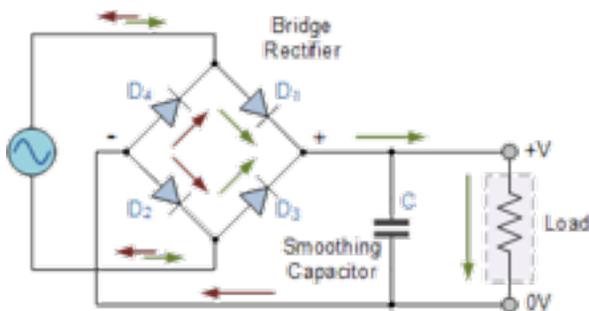
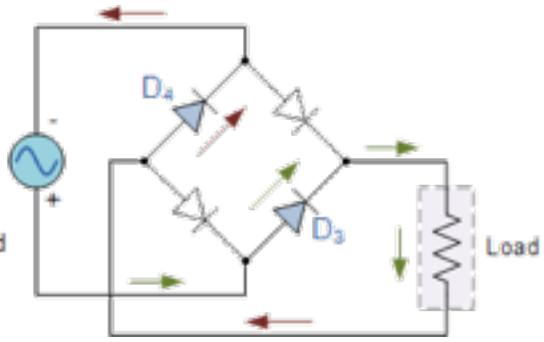
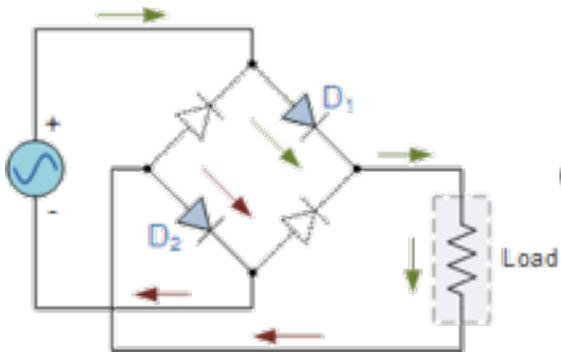


## AC to DC Conversion (Rectifier) (Handout)

You have probably learned that there is something called AC which stands for alternating current and DC which stands for direct current. You have also learned that the power grid transmits AC power because it is easier to transmit long distances without significant power loss than DC power. So all of your standard wall outlets will give you an AC voltage; however, many appliances require a DC voltage for proper operation. A few examples are televisions, gaming consoles, and computers. Therefore, a circuit known as a rectifier is required to convert the AC voltage from the outlet to a DC voltage that can be used to power many household appliances. There are two types of rectifier circuits, half-wave (uses only the positive cycle of the AC signal) and full-wave (uses both cycles of the AC signal), but this experiment will focus on full-wave because it is more widely used in real world applications. Perhaps the simplest full-wave rectifier circuit is the diode bridge rectifier shown below, so that is the circuit you will experiment with in the lab.

The diode bridge rectifier uses four individual diodes connected in a “bridge” configuration to produce the desired output. The four diodes labelled  $D_1$  to  $D_4$  are arranged in “series pairs” with only two diodes conducting current during each half cycle. During the positive half cycle of the supply, diodes  $D_1$  and  $D_2$  conduct in series while diodes  $D_3$  and  $D_4$  are off and the current flows through the load as shown below. During the negative half cycle of the supply, diodes  $D_3$  and  $D_4$  conduct in series, but diodes  $D_1$  and  $D_2$  switch off. The current flowing through the load is the same direction as before. As the current flowing through the load is unidirectional, the voltage developed across the load is also unidirectional. The DC output voltage across the load is approximately  $0.637V_{\text{max}}$ . The final step in the AC to DC conversion is to connect a “smoothing” capacitor to the output which increases the average DC output voltage by eliminating the ripple.





## AC to DC Conversion (Rectifier) (Lab Instructions)

Objective: Build and test a rectifier circuit.

Questions:

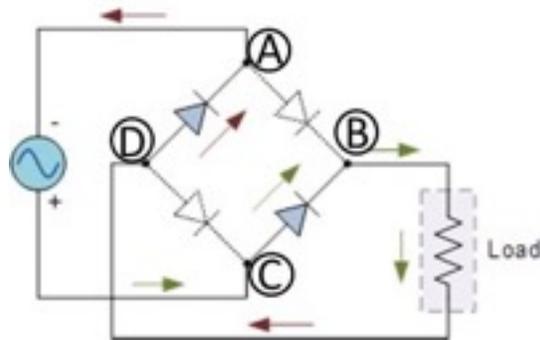
- 1) How does a bridge rectifier convert an AC voltage into a DC voltage?
- 2) What is the relationship between the frequency of the input voltage and the smoothing capacitor at the output?

Safety:

- Do not connect additional wires to the myDAQ
- Pay close attention to how you connect the capacitor

Materials:

- NI myDAQ with wire connected
- Breadboard
- 4 diodes
- capacitor
- resistor
- wire
- NI ELVISmx Instrument Launcher



Instructions:

- 1) Plug in your NI myDAQ to the computer USB port. Make sure the blue LED is on indicating that the device is getting power.
- 2) Open the “NI ELVISmx Instrument Launcher” by going to the Start → All Programs → National Instruments → NI ELVISmx for NI ELVIS & NI myDAQ.
- 3) Click on the Function Generator instrument (FGEN). Make sure the sine wave function is selected (green wave). Change the frequency to 60 Hz, change the amplitude to 5 Vpp, and keep the DC Offset at 0 V. Make sure the Device is myDAQ 1 (NI myDAQ) and the Signal Route is AO 0
- 4) Next, open the Oscilloscope (Scope) from the NI ELVISmx Instrument Launcher. The default settings should be fine, but make sure the Channel 0 source is AI 0 and the Channel 1 source is AI 1.
- 5) Using the 4 diodes and resistor, build the bridge rectifier on the breadboard. The resistor is the load and should be connected to nodes B and D. Note: you can use additional wires to help make the connections.
- 6) Make the following connections:

myDAQ port (wire color)	Rectifier node connection
AO AGND (color)	C
AO 0 (color)	A

AI AGND (color)	C
AI 0+ (color)	A
AI 0- (color)	C
AI 1+ (color)	B
AI 1- (color)	D

- 7) Click the “Run” button (green arrow) on the function generator and oscilloscope. Observe the waveforms on the oscilloscope. Record the peak-to-peak voltages on the lab form.
- 8) Connect the negative terminal of the capacitor(the wire on the side with the minus signs) to node D, and the positive terminal to node B. Observe what happens to the output waveform. (Warning: you could “blow up” the capacitor if you connect it wrong, so make sure the terminals are connected to the right node)

Tips:

- If you aren’t seeing the waveforms, make sure the wires are connected to the correct myDAQ ports or that you corrected the wires correctly on the breadboard.

Task:

- 1) How closely does your circuit behave to the theoretical circuit [ $0.637V_{\max}$ ]?
- 2) What was different about the rectifier with and without the capacitor on the output?
- 3) What happens to the output waveform if you decrease the frequency to 6 Hz?
- 4) What do you think would happen to the peak voltage on the output if the load resistance was increased/decreased?

AC to DC Conversion (Rectifier) (Lab Form)

Peak to peak voltage before capacitor? \_\_\_\_\_

DC voltage after connecting the capacitor on the output? \_\_\_\_\_

## AC to DC Conversion (Rectifier) (Explanation)

The diode bridge rectifier uses four individual diodes connected in a “bridge” configuration to produce the desired output. The four diodes labelled  $D_1$  to  $D_4$  are arranged in “series pairs” with only two diodes conducting current during each half cycle. During the positive half cycle of the supply, diodes  $D_1$  and  $D_2$  conduct in series while diodes  $D_3$  and  $D_4$  are off and the current flows through the load as shown below. During the negative half cycle of the supply, diodes  $D_3$  and  $D_4$  conduct in series, but diodes  $D_1$  and  $D_2$  switch off. The current flowing through the load is the same direction as before. As the current flowing through the load is unidirectional, the voltage developed across the load is also unidirectional. The DC output voltage across the load is approximately  $0.637V_{\max}$ . The final step in the AC to DC conversion is to connect a “smoothing” capacitor to the output which increases the average DC output voltage by eliminating the ripple.