

University of Washington
Department of Electrical Engineering
EE 351: Energy Systems

Lab 1: Power Electronic Converters

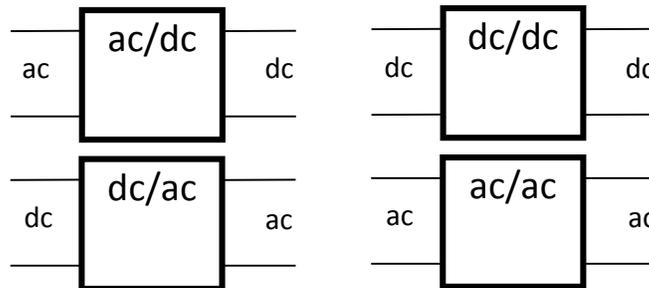
Introduction

With the development of power electronic converters, users can change any waveform from one type to another while achieving some control on variables such as voltages and frequencies. This way, equipment energized through power electronic converters can achieve better performance and higher efficiencies.

The solid-state converters have various configurations as shown in the figure below. There are four types of converters.

1. AC/DC converter that converts an ac waveform into a dc waveform with adjustable voltage.
2. DC/DC converter that converts a dc waveform into adjustable voltage dc waveform.
3. DC/AC converter that converts a dc waveform into ac with adjustable voltage and frequency.
4. AC/AC converter that converts the fixed voltage, fixed frequency ac waveform into ac waveform with adjustable voltage and frequency

In this lab, you will build one converter from each of these four types.

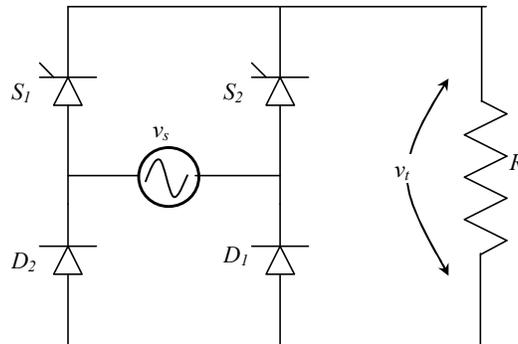


Part 1: AC/DC Converter

Circuit Connection

- With **ALL** switches turned off, setup the full-wave bridge as shown in the figure below
- Connect the SCR triggering circuit
- Connect the low voltage power supplies for the various electronic modules
- Turn on the low voltage power supply to activate the various electronic circuits
- Connect the data acquisition module to display the following:
 1. The triggering signal of one of the SCRs
 2. The currents of the source and the load
 3. The voltage of the load and source
- Start the LabVolt software

- Ask the TA to check your connection
- Set the output voltage of the adjustable ac output to 20V
- Use the PC scope to show the waveforms
- Check the triggering signal with respect to the source voltage. Be sure that you can adjust the triggering angle.
- Increase the output voltage of the adjustable ac source to 120V
- Display the measured variables on the PC scope screen



Experiment

- Start with a very small triggering angle and then increase it slowly. Observe the waveforms of the various voltages and currents. Print two sets of waveforms when the triggering angles are 45° and 135° .
- At a given triggering angle, measure the rms voltage across the load. Use the formula for the rms and compute the load voltage. Compare the measured value to the calculated value.
- Add a small capacitor in parallel with the load and observe the changes in the waveforms. Increase the value of the capacitance and observe the changes. Print two sets of waveforms for two different capacitor values connected in parallel with the load.
- Disable one of the SCRs, or one of the diodes by removing it from the circuit (**DO NOT** short circuit the device). Observe the waveforms. Print the waveforms.

Outcomes of the Experiment

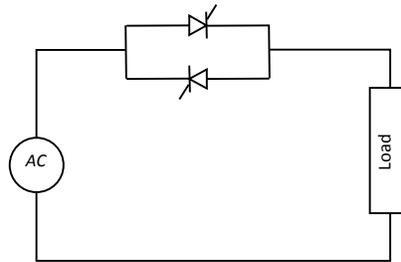
After you finish this part of the experiment, you are required to comment on all of the above steps. Discuss your observations and comment on the various waveforms.

Part 2: AC/AC Converter

Circuit Connection

- With **ALL** switches turned off, setup the ac/ac converter as shown in the figure below
- Connect the SCR triggering circuit
- Connect the low voltage power supplies for the various electronic modules
- Turn on the low voltage power supply to activate the various electronic circuits
- Connect the data acquisition module to display the following:
 1. The triggering signal of one of the SCRs

2. The currents of the source and the load
 3. The voltage of the load and source
- Ask the TA to check your connection
 - Set the output voltage of the adjustable ac source to 20V
 - Use the PC scope to show the waveforms
 - Check the triggering signal with respect to the source voltage. Be sure that you can adjust the triggering angle.
 - Increase the output voltage of the adjustable ac source to 120V
 - Display measured variables on the PC scope screen



Experiment

- Start with very small triggering angle and then increase it slowly. Observe the waveforms of the load and source. Print two sets of waveforms when the triggering angles are 20° and 170° .
- At a given triggering angle, measure the rms voltage across the load. Use the formula for the rms and compute the load voltage. Compare the measured value to the calculated value.

Outcomes of the Experiment

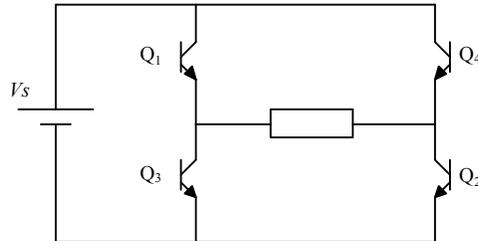
After you finish this part of the experiment, you are required to comment on all of the above steps. Discuss your observations and comment on the various waveforms.

Part 3: DC/AC Converter

Circuit Connection

- With **ALL** switches turned off, setup the dc/ac converter as shown in the figure below
- Connect the triggering circuit of the transistor
- Connect the low voltage power supplies for the various electronic modules
- Turn on the low voltage power supply to activate the various electronic circuits
- Connect the data acquisition module to display the following:
 1. The triggering signal of one of the transistors
 2. The currents of the source and the load
 3. The voltage of the load and source
- Ask the TA to check your connection

- Set the output voltage of the adjustable dc source to 20V
- Use the PC scope to show the waveforms
- Check the triggering signal with respect to the source voltage. Be sure that you can adjust the triggering angle.
- Increase the output voltage of the adjustable dc source to 100V
- Display the measured variables on the PC scope screen



Experiment

- Fix the triggering frequency to any value between 50-120Hz
- Start with small duty ratio and then increase it slowly. Observe the waveforms of the load and source. Print two sets of waveforms when the duty ratios are 20% and 50%.
- At a given duty ratio, measure the rms voltage across the load. Use the formula for the rms and compute the load voltage. Compare the measured value to the calculated value.

Outcomes of the Experiment

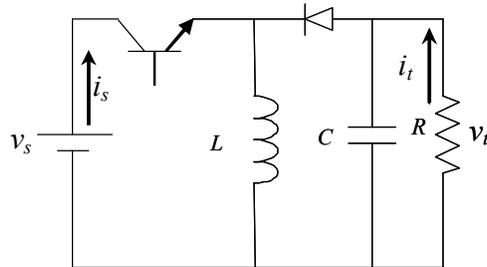
After you finish this part of the experiment, you are required to comment on all of the above steps. Discuss your observations and comment on the various waveforms.

Part 4: DC/DC Converter

Circuit Connection

- With **ALL** switches turned off, setup the dc/dc converter as shown in the figure below
 - Use the following settings for R, L, and C: 3600 ohms of resistance, 1 full bank of capacitors, 2 full banks of inductors (in parallel).
- Connect the triggering circuit of the transistor
- Connect the low voltage power supplies for the various electronic modules
- Turn on the low voltage power supply to activate the various electronic circuits
- Connect the data acquisition module to display the following:
 1. The triggering signal of the transistor
 2. The currents of the source and the load
 3. The voltage of the load and source
- Ask the TA to check your connection

- Set the output voltage of the adjustable dc source to 20V
- Use the scope to show the waveforms
- Check the triggering signal with respect to the source voltage. Be sure that you can adjust the triggering angle.
- Increase the output voltage of the adjustable dc source to 50V
- Display the measured variables on the PC scope screen



Experiment

- Fix the frequency to any value between 500-1500Hz
- Start with very small t_{on}/t_{off} ratio and then increase it slowly. Observe the waveforms of the load and source. Print three sets of waveforms when the ratio is 50%, 100%, and 140%.
- At a given t_{on}/t_{off} ratio, measure the average voltage across the load. Use the formula for the average and compute the load voltage. Compare the measured value to the calculated value.
- Decrease the value of the capacitance and observe the changes in the waveforms. Print the new waveforms.

Outcomes of the Experiment

After you finish this part of the experiment, you are required to comment on all of the above steps. Discuss your observations and comment on the various waveforms. Discuss the effects of the capacitor and inductor.