Lab 03 – Bridge Rectifier Filtering

Toronto Metropolitan University

ELE404 – Electronics I

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Introduction:

We examined the properties of diodes in this lab, paying particular attention to their one-way current flow capability. This characteristic is essential for converting AC to DC, which is a process that rectifiers depend on to work. In order to comprehend its importance and use in electronic circuits, we specifically looked at the bridge rectifier, a significant variation within the rectifier family.

Objective:

The purpose of this experiment was to improve our knowledge of the essential electronic circuits of bridge rectifiers that convert alternating current (AC) to direct current (DC). Our goal was to become acquainted with the resistors, capacitors, and diodes that make up a bridge rectifier circuit. Additionally, we learnt how these parts cooperate to generate a DC output. Bridge rectifier circuits were assembled and tested as part of our investigation, and the DC voltage, current, and power outputs were recorded. In order to improve our abilities and learn more about the variables influencing bridge rectifiers' efficiency, we also examined how altering component values affected the circuit's functionality.

Circuit Under Test:

The first circuit we built for our experiment is a simple bridge rectifier, which consists of a load resistor and four diodes placed as figure 5 in the lab handbook illustrates. With this configuration, diodes D1 and D2 become forward-biased and allow current to flow when the supply voltage (Vs) is positive, whereas diodes D3 and D4 assume conduction when Vs becomes negative. In order to simplify our measurements and track the rectification process, we connected the load resistor between the junctions of D1 and D3 and D2 and D4.

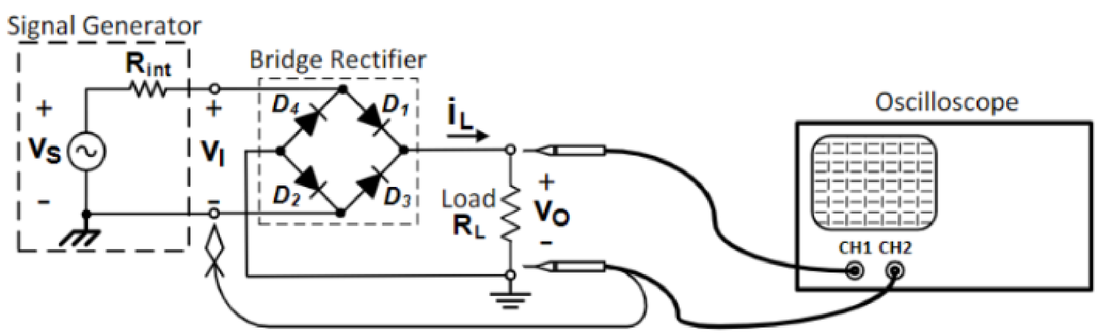


Figure 5. Differential monitoring of the output voltage waveform in the bridge rectifier.

We examined the identical circuit arrangement in the second section of our experiment, but with one more modification: a capacitor connected in parallel to the load resistor. By absorbing variations in the input signal, this capacitor acts as an energy storage device, preserving a constant output voltage. With this configuration, we were able to see how the capacitor reduces ripple voltage and produces a more stable DC output by smoothing out the bridge rectifier's output voltage. This setup is shown in the following diagram (Figure 6).

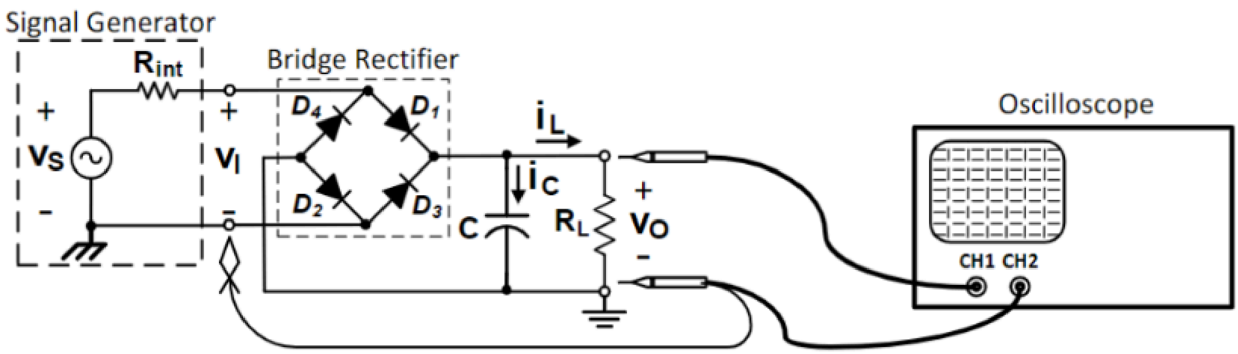
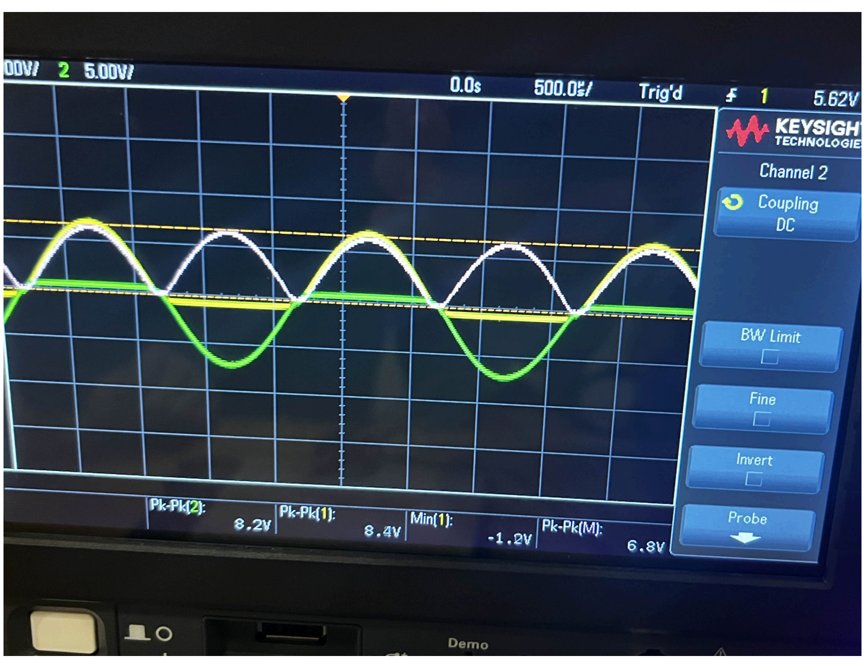


Figure 6. Bridge rectifier with smoothing capacitor.

Experimental Results:

In this lab, we were required to construct a bridge rectifier on our breadboard and visualize the input and output voltage using an oscilloscope. Two distinct bridge rectifiers were used for this; one had a resistor load of 5.6 kΩ connected in parallel to a polyester capacitor, which would significantly alter the output voltage, and the other had just a resistor load. We computed the output voltage and voltage ripple for various bridge rectifiers, particularly for the bridge rectifier with the resistor and capacitor connected in parallel. The picture from the lab is below.



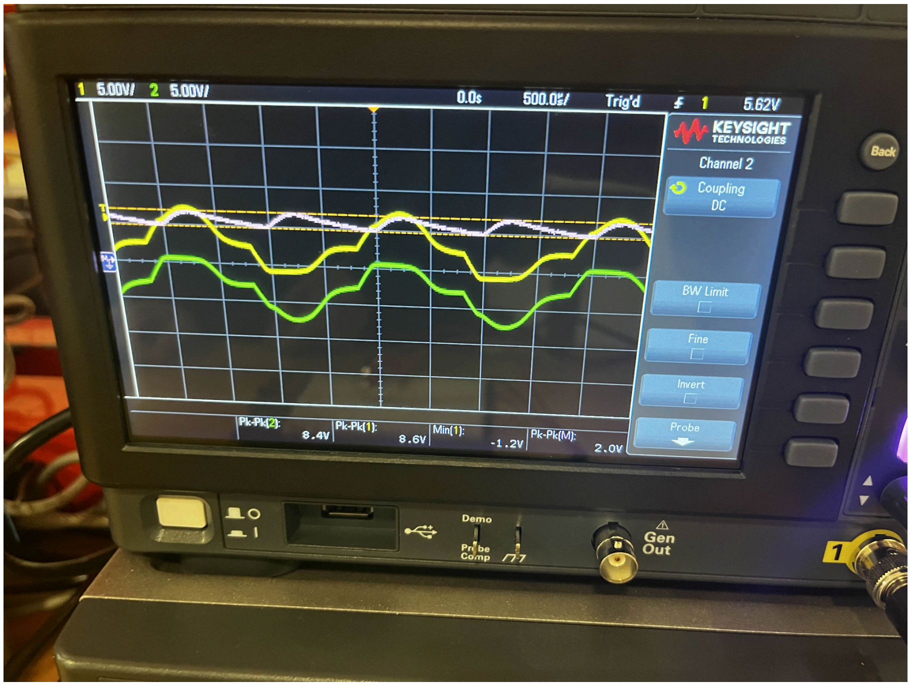


Table E3. DC output voltage and peak-to-peak ripple

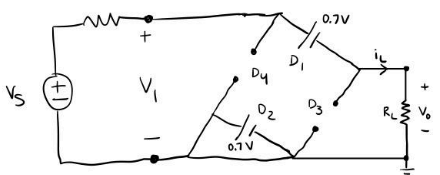
$\vec{v}_o]V]$	$V_r]V]$
5.7757	2.2

Conclusion & Remark:

C1

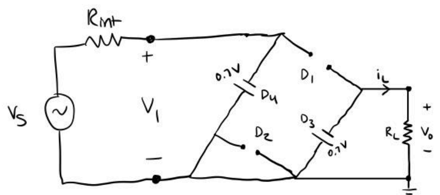
It is evident by comparing Graph P1 with Graphs P2A and P2B that Graph P2A more closely matches the transfer characteristics shown in Graph P1. The voltage against time (V vs. t) profile in P2A, where peak voltages hardly surpass 6V, is largely responsible for this alignment, in contrast to Graph P2B, where peak voltages barely reach 6V. The load resistor's resistance value, which is a key factor in determining the circuit's transfer characteristics, can be linked to the difference in peak voltage values between the two graphs.

C2



When $V_S > 0.7$
D_1, D_2 ON → replaced with 0.7 V batteries
D_3, D_4 OFF → open circuit

$i_4 = 0A$



When $V_S < -0.7$
D_3, D_4 ON → replaced with 0.7 V batteries
D_1, D_2 OFF → open circuit

KVL:

$$0.7 + R_{int}(i_4) - V_S = 0$$

$$i_4 = \frac{|V_S| - 0.7}{R_{int}}$$

$$= \frac{8 - 0.7}{50} = 0.146A < 0.15A$$

Satisfies graph P3, so our calculations are correct

Negative input voltages are eliminated by grounding the voltage source's negative terminal. In other words, grounding keeps the input voltage (Vi) close to zero volts when the source voltage (Vs) drops. Because none of the diodes are on, the output voltage drops to zero when the Vs is negative. The diodes in conduction may overheat if the source can deliver a significant current, which could cause damage or circuit failure.

C3

Somewhere in the circuit, the LED flashing pattern would probably be a timing sequence or signal indicator. Red LEDs flash in a pattern that can be synced or proportionate to the green LED, which could be a reference or clock signal. To show various system states or phases, the red LEDs may flash at a multiple or a fraction of the green LED's constant rate of blinking (for example, 30 Hz). In order for the circuit to function normally, this connection is usually designed to provide information, such as timing intervals, error signals, or synchronization signals.

C4

Graph P2(a) and Graph E2 show that they follow the same trend and have almost the same peak-to-peak voltage(approximately both have a peak voltage of 8.4V).

C5

Although Graphs P4(a) and E3 have different forms and don't follow the same trend, the ripple voltage was comparable. These differences might result from a mistake made during creating the circuit, particularly with regard to the capacitor employed, which would explain the strange appearance of the graph.

Error percentage:

	V_o / DC Output Voltage [V]	V_r / Voltage Ripple [V]
Measured	5.7757	2.2
Theoretical	6.6	2.86
Percentage	14.27%	23.08%

The percentage error for the DC output voltage is under 20%, which is acceptable. However, the percentage error for the voltage ripple is above 20%, which is high. This could be due to errors when constructing the circuit.

C6

P4's results show that there is a pattern in the voltage output and voltage ripple whenever the resistor load rises and falls. The voltage output would peak at 6 volts when the resistor load was 560 ohms, and there would be a large amount of ripple in the voltage. The voltage output would peak at 6.4 volts when the resistor load was 5600 ohms. The voltage ripple would also reduce, resulting in fewer ripple gaps. The voltage output would peak at 6.5V when the resistor load was 56000 ohms, and the ripple voltage would be very low, giving the appearance of continuous voltage. Thus, the output voltage rises and the voltage ripple falls as the resistor load grows.

Remark

Ultimately, we discovered a great deal about the vital members of the family that comprise Bridge Rectifiers as a whole. It demonstrated more applications for diodes and supported their use in circuits. The ability of bridge rectifiers to convert AC current to DC current was also aided by this. All things considered, bridge rectifiers are useful instruments for the modern world and have a wide range of applications.