Lab 4: Full Bridge Rectifier

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ABSTRACT

For this lab, a full bridge rectifier was created using red LEDs. First, a range of voltages from -8 through 8 volts was run through the circuit in 1-volt increments. A sine wave with a magnitude of $16V_{p-p}$ with a frequency of 1 kHz was then run through the circuit. The turn-on voltage of the LEDs was determined to be 1.81 volts, and the output wave had a magnitude of $3.5V_{p-p}$ with a frequency of 2 kHz.

Introduction:

In this lab, a full bridge rectifier was created using LEDs. Rectifiers can be used to shift a standard AC wave into the positive domain only. Generally, regular diodes with lower voltage thresholds would be implemented, however, the LEDs provided visual confirmation when activated, which was ideal for a demonstration circuit.

Procedure:

The circuit depicted below in Figure 1 was constructed using LEDs in place of basic diodes. A DC voltage source was then applied to the circuit, starting at -8 volts and progressing up to 8 volts in 1 volt increments. For each voltage level, LED activation was noted, and the voltage drop across each LED, the resistor, and the overall circuit was measured.

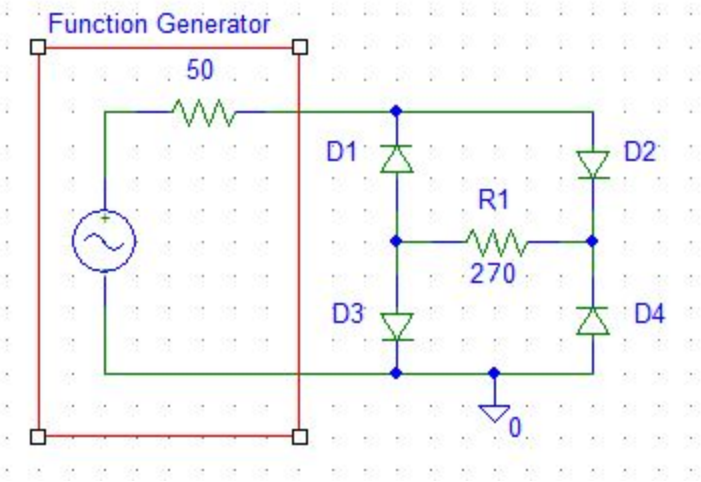

Figure 1: Full bridge rectifier circuit diagram

Next a $16V_{p\text{-}p}$, 1 kHz sine wave was applied to the circuit using a signal generator. The input signal and voltage drop across R1 were measured separately using an oscilloscope.

Results:

Data collected from each component for discreet DC input values can be observed in Table 1. The red LEDs used had a turn on voltage of around 1.81V, only activating once the input voltage reached a magnitude of 4 volts. A graph of LED current vs voltage can be viewed in Figure 2.

For the AC portion of the lab, the output signal had a magnitude of $3.5V_{p\text{-}p}$ with a frequency of 2 kHz vs the input signal with a magnitude of $16V_{p\text{-}p}$ with a frequency of 1 kHz. Representations of the two waveforms are depicted below in Figure 3.

Voltage Values In Volts (V) millivolt (m)= 10^{-3} V							Lighting of diode			
Input		Across Diodes				Resistor	On or Off			
Fun_Gen	Mes	D1	D2	D3	D4	R=270 Ω	D1	D2	D3	D4
-8	-7.57	2.004	-5.37	-5.57	2.20	3.35	on	off	off	on
-7	-6.52	1.976	-4.54	-4.55	1.985	2.56	on	off	off	on
-6	-5.67	1.94	-3.72	-3.73	1.94	1.78	on	off	off	on
-5	-4.81	1.894	-2.91	-2.92	1.89	1.02	on	off	off	on
-4	-3.94	1.81	-2.13	-2.13	1.81	.312	on	off	off	on
-3	-3	1.5	-1.5	-1.49	1.49	.280	off	off	off	off
-2	-2	.73	-.64	-.64	.730	.010	off	off	off	off
-1	-1	.13	-.13	-.025	.140	.005	off	off	off	off
0	0	0	0	0	0.00	0.00	off	off	off	off
1	1	-.03	.14	.03	-.130	.005	off	off	off	off
2	2.01	-.64	.73	.64	-.730	.009	off	off	off	off
3	3.01	-1.5	1.5	1.48	-1.49	.292	off	off	off	off
4	3.95	-2.13	1.81	1.81	-2.13	.312	off	on	on	off
5	4.8	-2.92	1.89	1.89	-2.13	1.02	off	on	on	off
6	5.67	-3.72	1.95	1.94	-3.72	1.78	off	on	on	off
7	6.52	-4.54	1.98	1.94	-3.72	2.56	off	on	on	off
8	7.37	-5.37	2.10	2.00	-5.36	3.35	off	on	on	off

Table 1: Measured voltages for each component

Discussion:

Due to the use of LEDs instead of basic diodes in the circuit, the rectifier was inefficient, as depicted in Figure 3. The activation point was much higher, and there was greater power loss across the LEDs due to light production. While current flow increased dramatically after reaching the activation threshold, as seen in Figure 2, the ideal current flow would have been zero below the threshold. In all other regards, the circuit operated as expected.

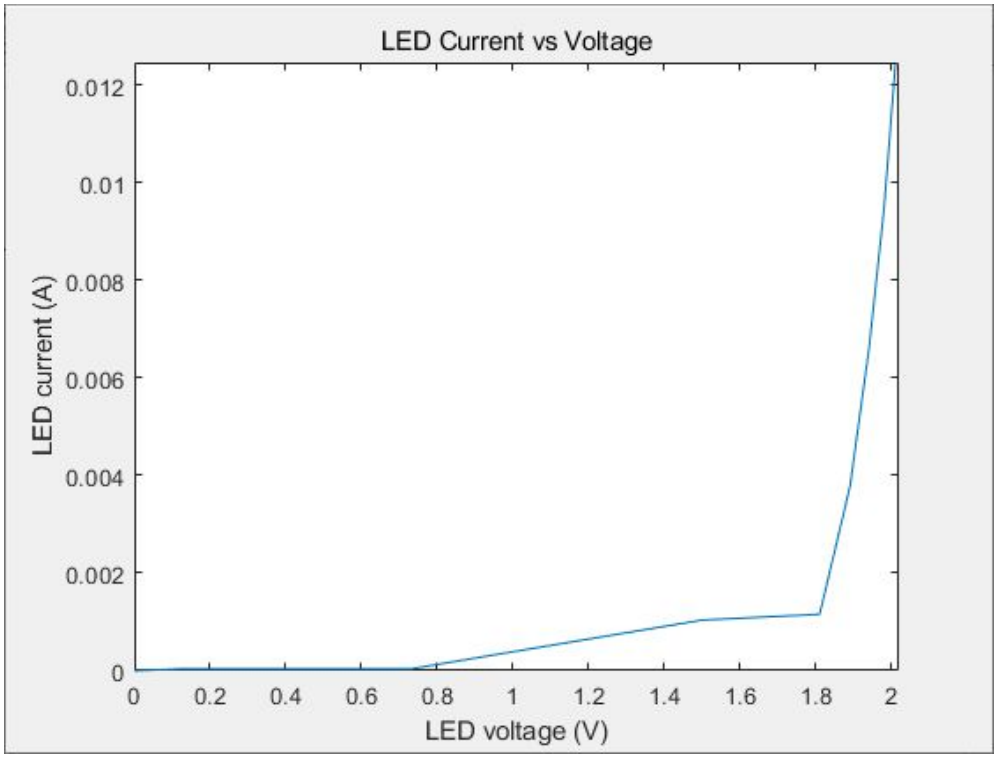

Figure 2: LED current vs voltage plot, for MATLAB code, please see Appendix A

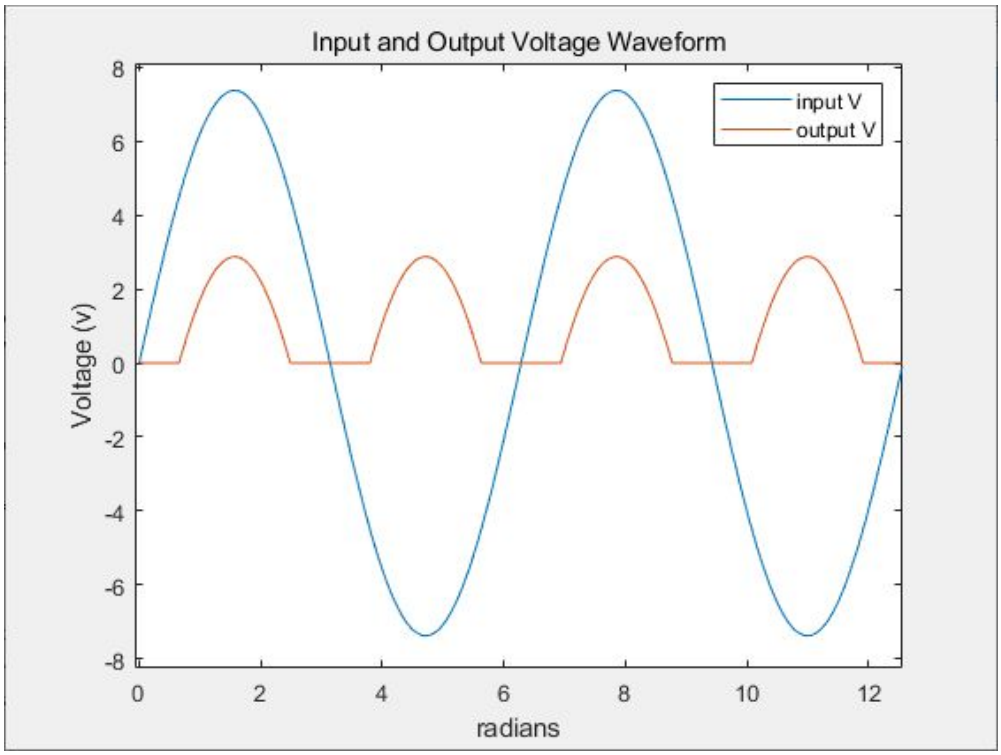

Figure 3: Input and output voltage general waveform. For MATLAB code, please see Appendix A

Conclusion:

The purpose of this lab was to build a full bridge rectifier with LEDs, determine its general properties with DC current sources, and then demonstrate its transformative nature with AC voltage sources. The activation threshold of the LEDs was 1.81 volts. When a $16V_{p-p}$ sine wave with a frequency of 1 kHz was applied to the circuit, an output signal of $3.5V_{p-p}$ with a frequency of 2 kHz was measured. The only discrepancy between expected and actual results was a slight current flow through the LEDs prior to activation.

References:

Peterson, Todd. EE 333 Lab#4 Rectifier Circuits lab sheet

Appendix A

Matlab code used to plot figures 2 & 3

```
v=[3.36,2.56,1.78,1.02,0.312,0.28,0.01,0.01,0.00];
r=270;
i=v/r;
Vd=[2.01,1.98,1.94,1.89,1.81,1.50,0.73,0.13,0.0];

figure (1)
plot(Vd,i);

i=1;
x=zeros(1,1000);
while x(1000)==0
   i=i+1;
   x(i)=x(i-1)+pi/250;
end

V1=7.38*sin(x);
sub1=4.5*ones(1,1000);
V2=abs(V1)-sub1;

i=1;
while V2(1000)<0
   if V2(i)<0
      V2(i)=0;
   end
   i=i+1;
end

figure (2)
plot(x,V1);
hold on
plot(x,V2);
```