2Ei5
Project 1

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Lab section: L01
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Submitted by Yichen Lu, luy191, 400247938

Summary:

The purpose of this project is to design a circuit to transfer the alternating current to the direct current. The input source is 120V (rms) at 1000 Hz and the final output should be 10 mA at 3V ± 0.1V.

Design:

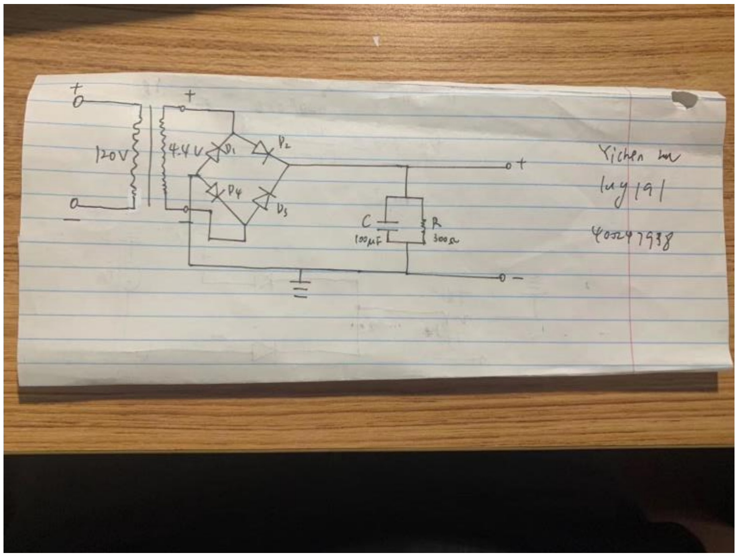
1. Transformer: Used in the design. The purpose of it is to transfer the voltage supply at 120v and 1khz frequency to approximately 4.4v. Therefore, the turns ratio of the transformer in the design should be 0.0259

2. Rectifier: Use four 1N4148 diodes to build the bridge rectifier to control the current direction.

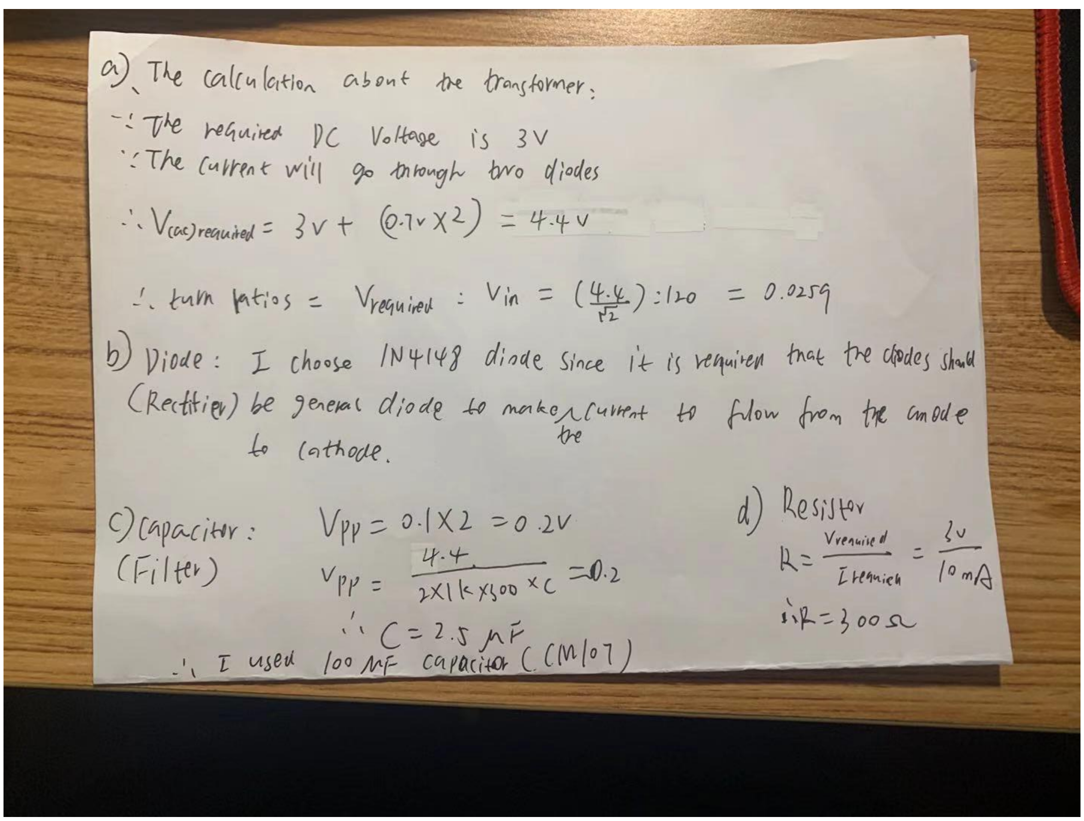
3. Filter: Use the capacitor should be equal or greater than 25 μF which is calculated. I choose 100 μF capacitor

4. Regulator: No regulator used in this design.

5. The complete circuit schematic:



6. The calculation of data calculated in my design:



a) The calculation about the transformer:

∵ The required DC Voltage is 3V

∵ The current will go through two diodes

∴ $V_{(ac)required} = 3V + (0.7V \times 2) = 4.4V$

∴ turn ratios = $V_{required} : V_{in} = (\frac{4.4}{\sqrt{2}}) : 120 = 0.0259$

b) Diode (Rectifier): I choose 1N4148 diode since it is required that the diodes should be general diode to make the current to flow from the anode to cathode.

c) capacitor (Filter): $V_{pp} = 0.1 \times 2 = 0.2V$

$V_{pp} = \frac{4.4}{2 \times 1k \times 300 \times C} = 0.2$

∴ $C = 2.5\ \mu F$

∴ I used 100 μF capacitor (CM107)

d) Resistor

$R = \frac{V_{required}}{I_{required}} = \frac{3v}{10mA}$

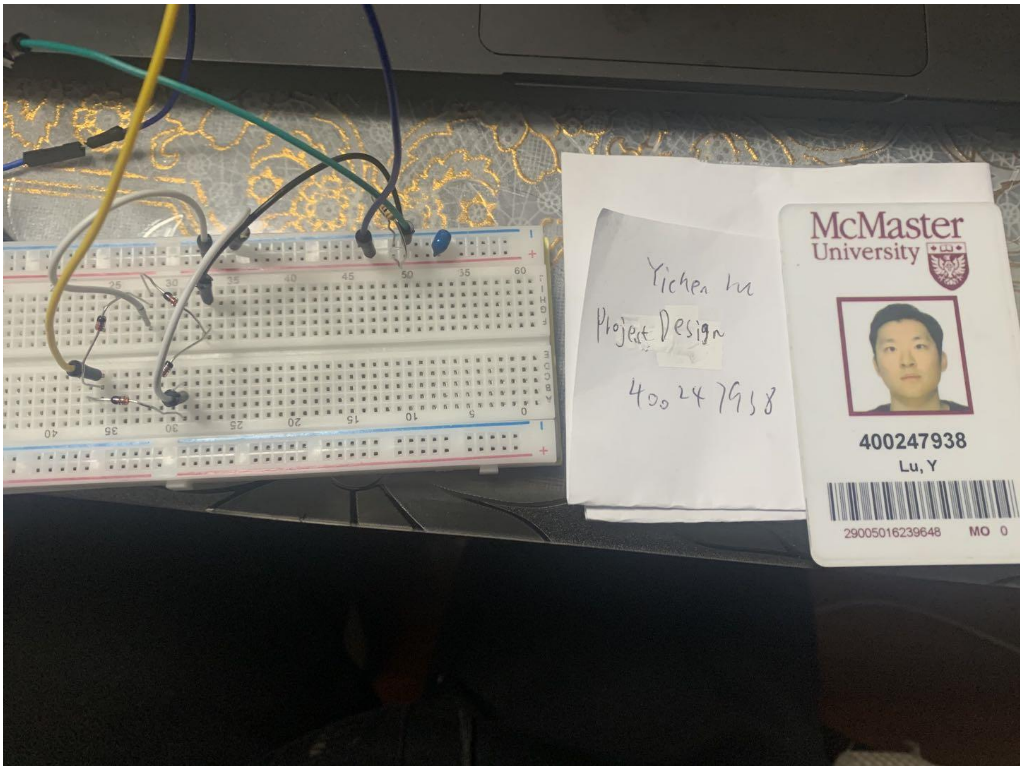
∴ $R = 300\Omega$

7. Expected result in my design:
    a. The required voltage of the transformer which is generated by AD2 should be 4.4V.
    b. The output DC voltage should be a steady 3V.
    c. The results should be in the range between 3.1V and 2.9V.

8. All issues that I consider in my circuit (Safety questions):
    a. It is important to calculate the safe range for the voltage across the whole circuit.
    b. I used 100 μF instead of 25 μF. However, it also works well even to be a better filter.

Measurement and analysis:

1. The photograph of my actual circuit:



2. The measurement Procedure:

   I used the channel 1 to measure the voltage of the resistor which is the output voltage. Afterwards, checking the wave of the capacitor and the wave should be close to 3 V. At last, I used Ohm's Law to calculate the current across the resistor by using the voltage which should be 3V and the value of the resistor 300 ohms.

3. The table with the key measurement results:

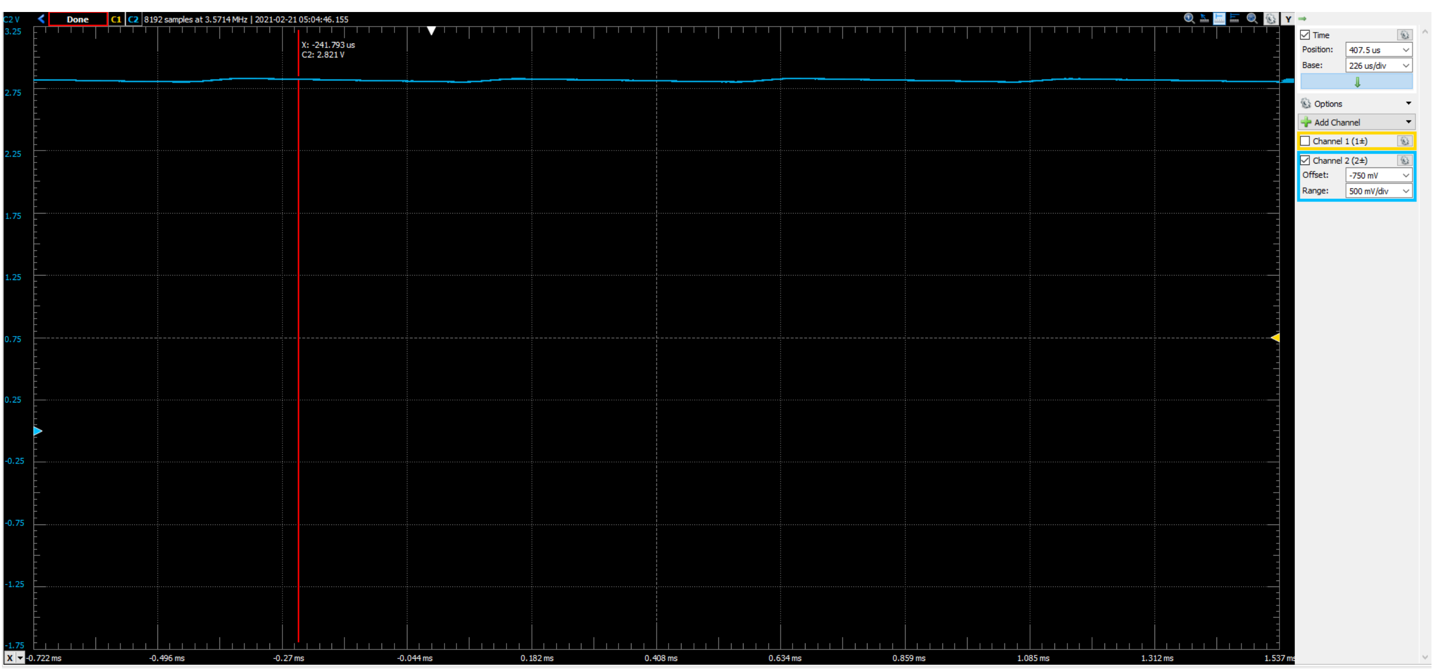
   (Key measurement)

Input voltage	Output voltage	current
4.4V	3V	0.01A

(From the oscilloscope)

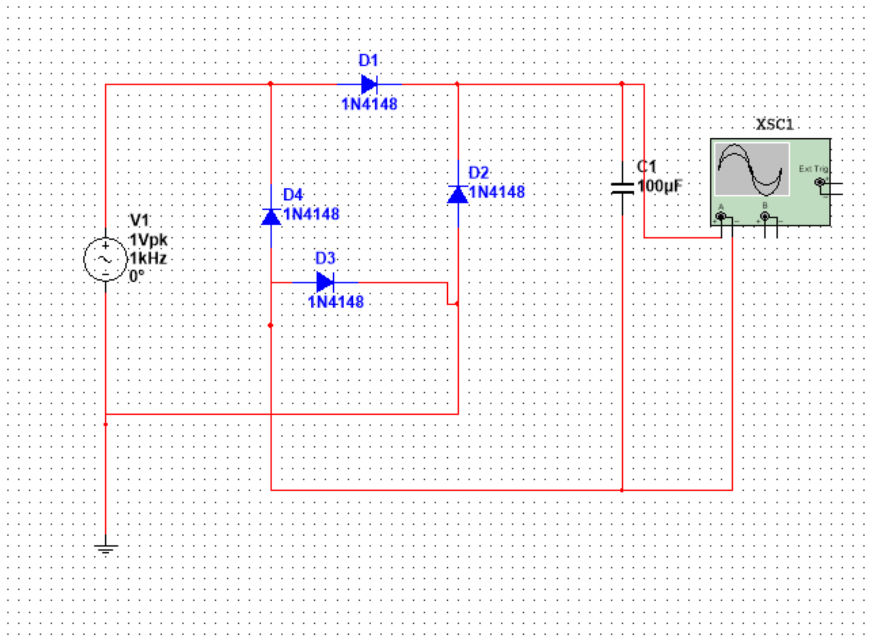
#	A	B
1.	-0.000354	2.82134713
2.	-0.0003575	2.82182675
3.	-0.0003535	2.82182675
4.	-0.00035325	2.82134713
5.	-0.000353	2.82134713
6.	-0.00035275	2.82182675
7.	-0.0003525	2.82134713

4. The screenshots of my oscilloscope:



Simulation:

1. Circuit schematic:



2. Netlist:

Netlist Report (From Document: Design1)

	Net	Sheet	Component	Pin
1	0	Design1	Ground	1
2	0	Design1	Ground	1
3	0	Design1	D3	K
4	0	Design1	V1	2
5	0	Design1	D2	A
6	1	Design1	D4	K
7	1	Design1	D1	A
8	1	Design1	V1	1
9	2	Design1	D2	K
10	2	Design1	D1	K
11	2	Design1	C1	1
12	4	Design1	D3	A
13	4	Design1	D4	A
14	4	Design1	C1	2

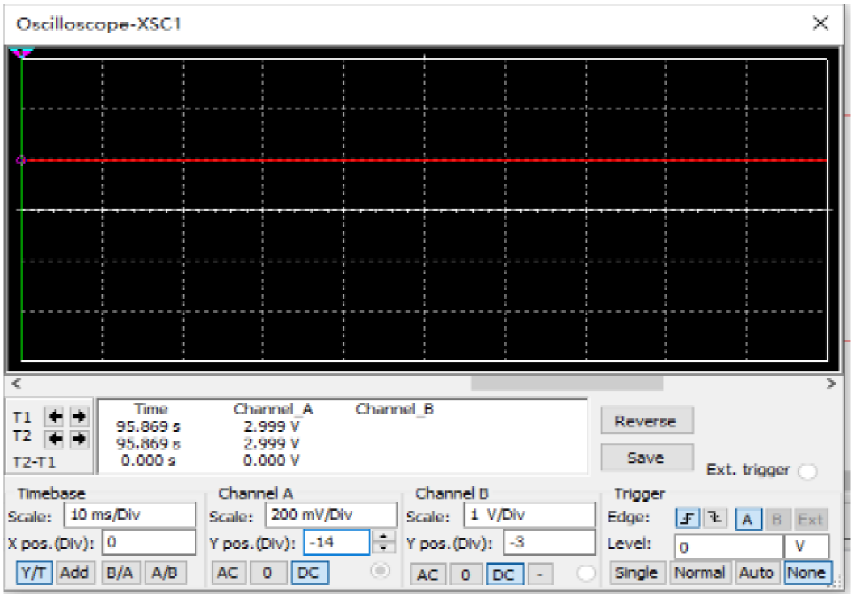
3. Simulation conditions:

   Start time:0s

   End time:100s

   Step time:160us

4. Simulation outputs:



Discussion:

1. Comparisons between the theoretical result of my design and the experimental results of simulations and measurement:

   The result of calculation, simulation and measurement basically matches with each other. The voltages are all in the range from 2.9V to 3.1V.

2. Some discrepancies observed:

   The result of the simulation is almost like the theoretical value(3v). However, the experimental result (2.821v) is a bit off with the theoretical value(3v).

3. The limitations:

Theoretically, the resistor in my design is 300 ohms because it can get 10 mA by using this resistor. However, I could not find 300 ohms resistor, so I used 1k ohms instead.

4. The problems:

   I met tuns of problems by connecting all the components on the breadboard. For example, at first, I mistakenly put the wrong directions of two of four diodes to make my graph look extremely weird. However, I took a long time overcome this problem.