ECE 395A Lab3 Report

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Contents

1 Introduction

This time we are supposed to build the transmitter-receiver circuit, which is based on Chua's circuit we have tried on Lab2. Here is the circuit we used during Lab 3.

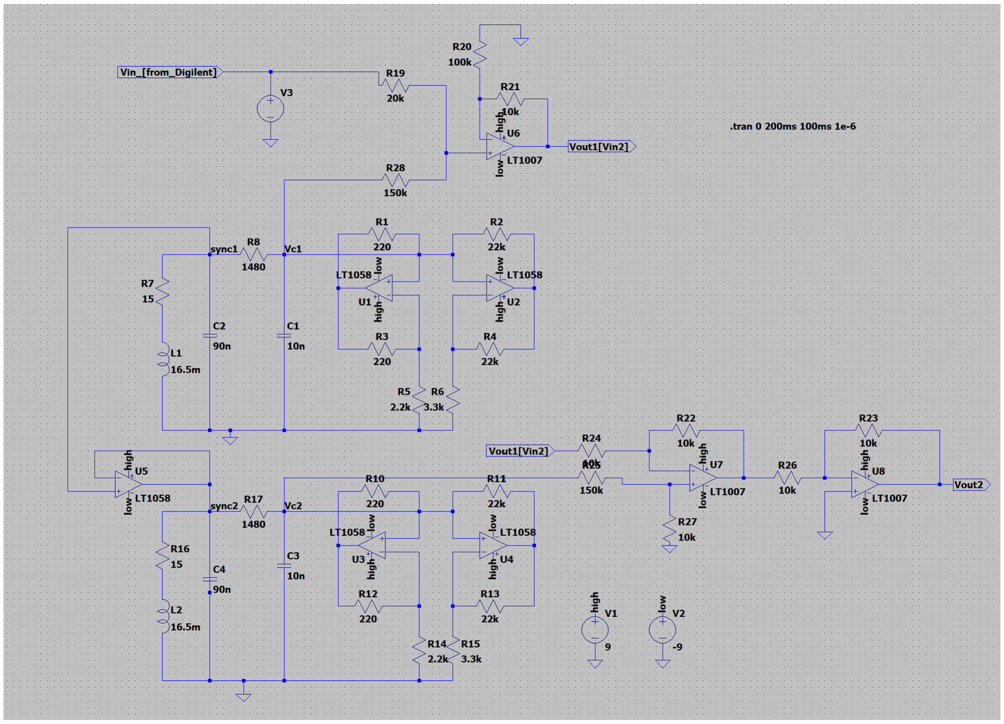

Figure 1: Transmitter-receiver Circuit

The goal for Lab 3 is to build this circuit and test it using sinusoidal signals generated by the Digilent module (amplitude 500 mV, frequencies of 0.5, 2, and 10 kHz). You will have to measure and capture the input, transmitted, and output signals, and evaluate quantitatively the quality of your reconstruction using SNR.

2 Body

2.1 Simulation part

In order to get familiar with this circuit, simulation is our best choice.

At first, we may check if the Chua's circuit part work as oscillator, and can clearly publish the double scroll.

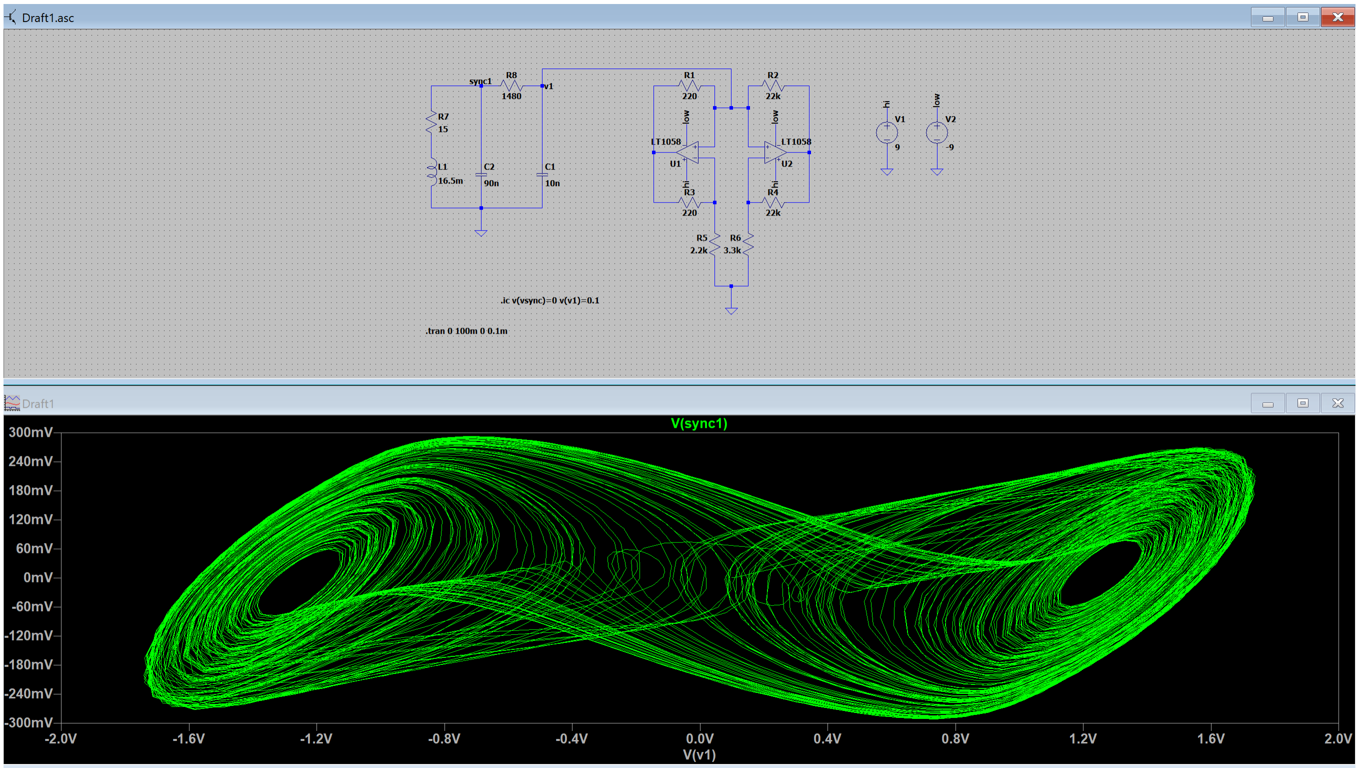

Figure 2: Double Scroll of Chua's Circuit

After build the circuit on LTspice, we change the voltage signal in V3 as sinusoidal signal (amplitude 500 mV, frequencies of 0.5, 2, and 10 kHz), and compare the signal wave Vin(input signal), Vout1(transmitted signal), Vout2(output signal). Here is the result.

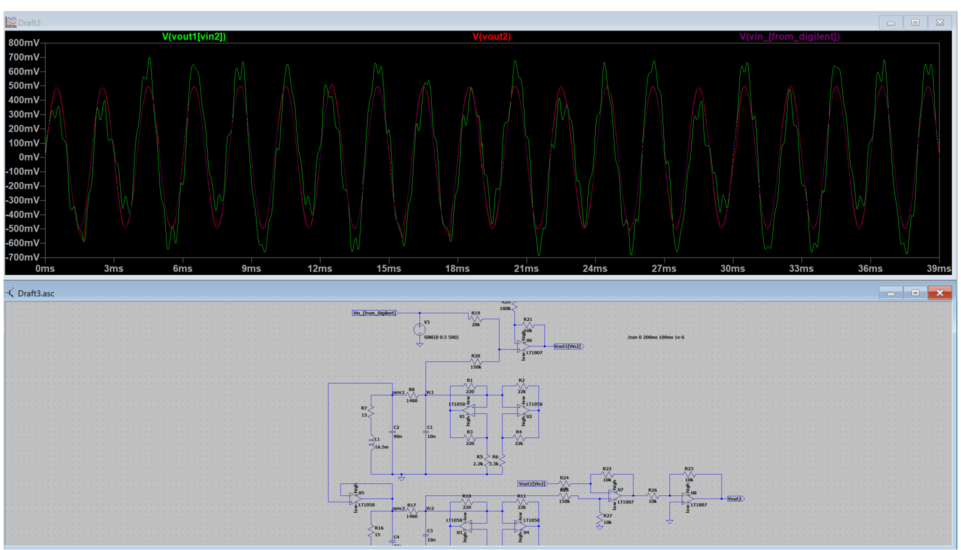

Figure 3: Result of 500Hz

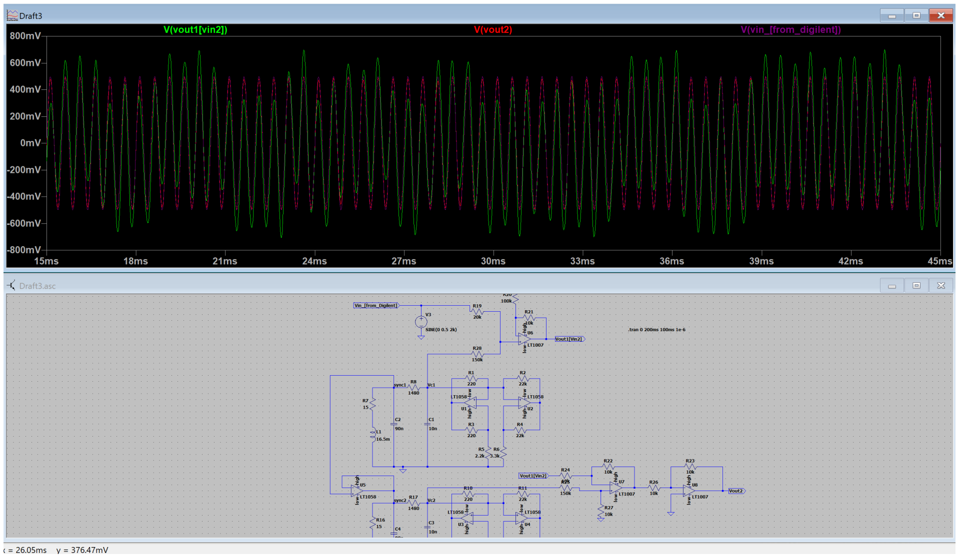

Figure 4: Result of 2kHz

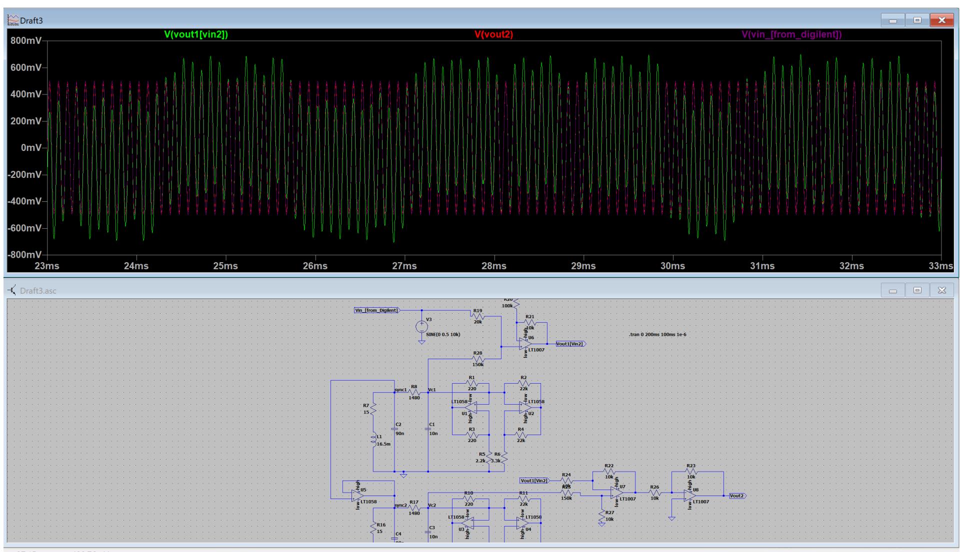

Figure 5: Result of 10kHz

Also I output the wave at point "sync". Since sync1 and sync2 is connected by amplifier while $A_v = \frac{V_{out}}{V_{in}} = \frac{sync1}{sync2} = 1$

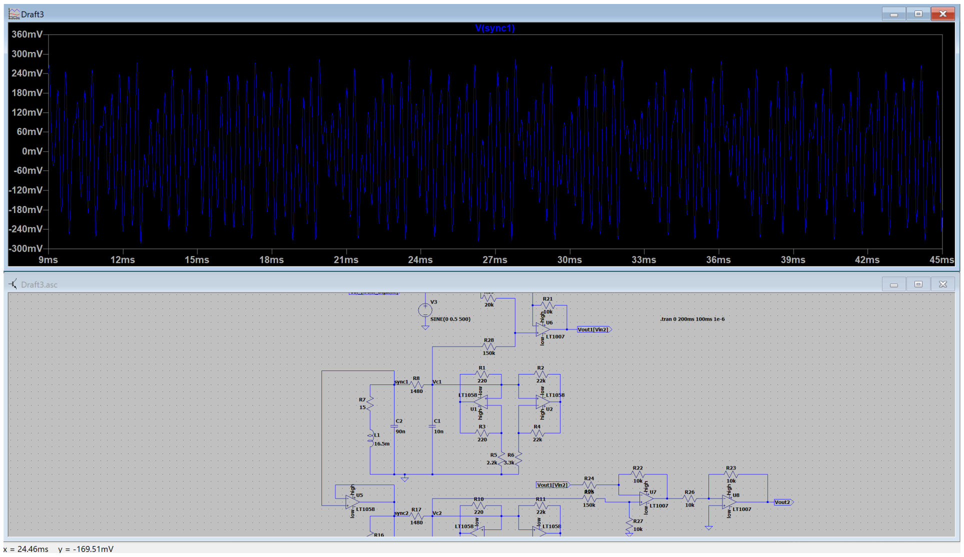

Figure 6: Sync Signal at 500Hz

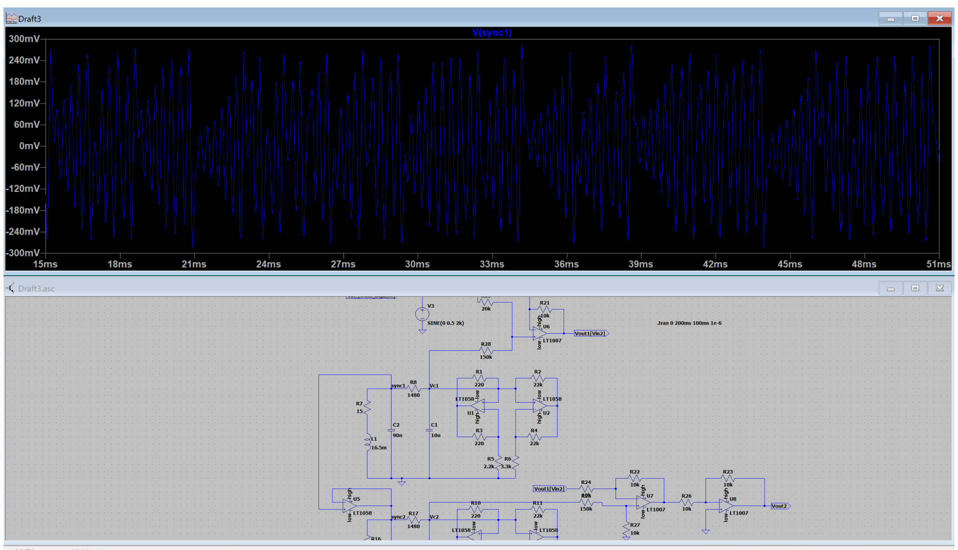

Figure 7: Sync Signal at 2kHz

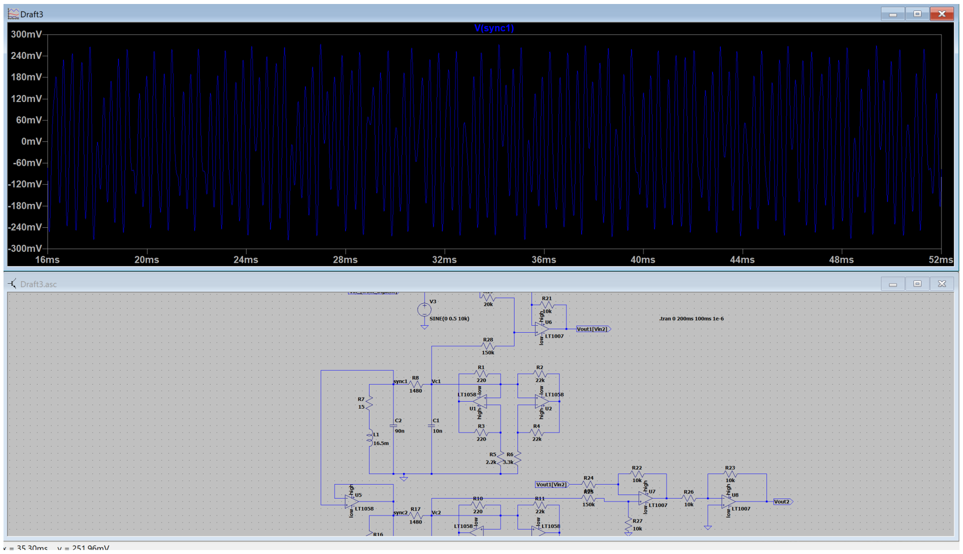

Figure 8: Sync Signal at 10kHz

2.2 Experiment part

2.2.1 Signal Combine

Then is the most important part. Because the circuit wiring is complicated, we need to carefully connect the circuit in order.

1 Measure the parts you will use to build both Chua oscillators to make sure they are as close as possible within the parts that you purchased;

2 Build the circuit carefully following the schematic. Print a paper copy and make sure you highlight or cross out all connections as you go;

3 Test both oscillators independently to make sure they both work;

4 Set the potentiometer of the oscillator in the transmitter side to a value where you clearly see the double scroll;

5 Turn on the signal generator of the Digilent module (500 mV, 500 Hz);

6 While monitoring the output signal, tweak the potentiometer of the oscillator in the receiver side to get the least possible distortion at the output.

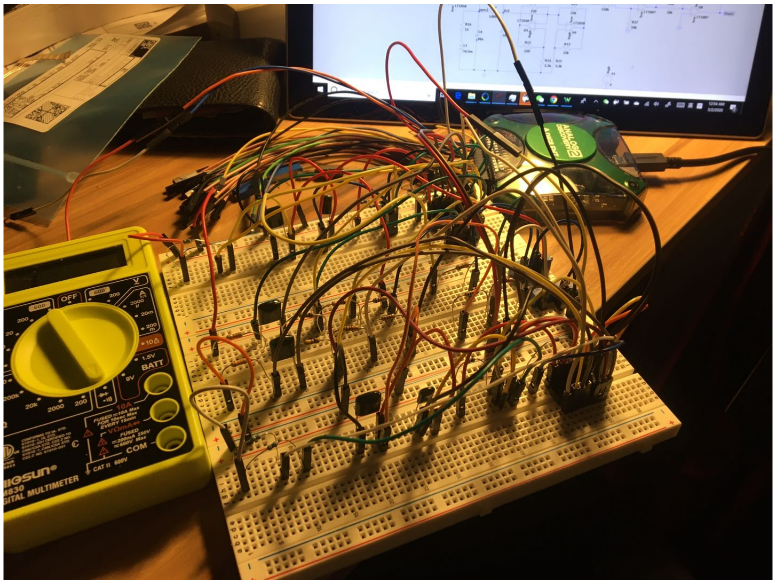

Figure 9: Building circuit in half

Same as simulation, we need to check both two Chua's circuit can work at good situation.

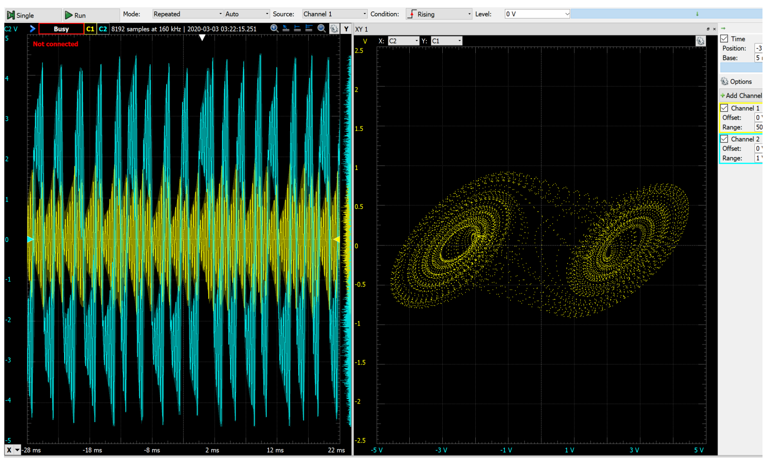

Figure 10: Chua's Circuit Situation

After that, connecting all the part circuit together, total circuit is finished.

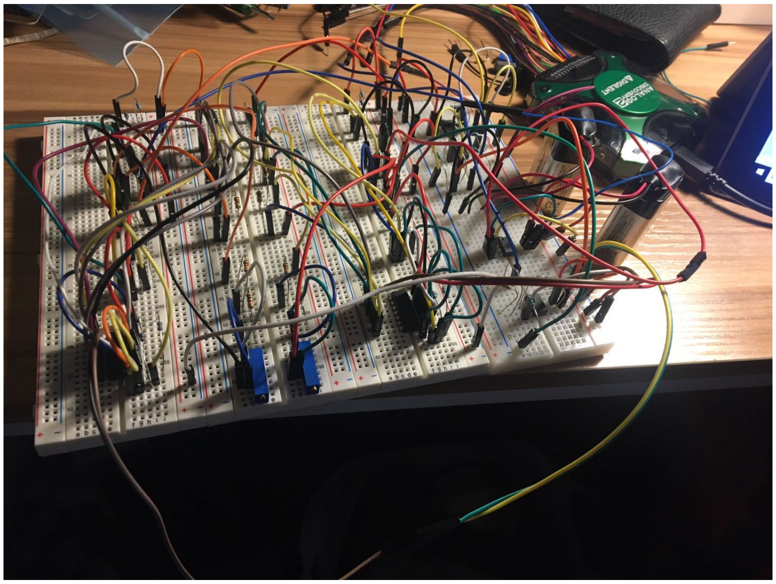

Figure 11: Total Circuit

Set sinusoidal signal at Digilent module as 500mv and different frequency(500Hz, 2kHz, 10kHz). Here is the result I got.

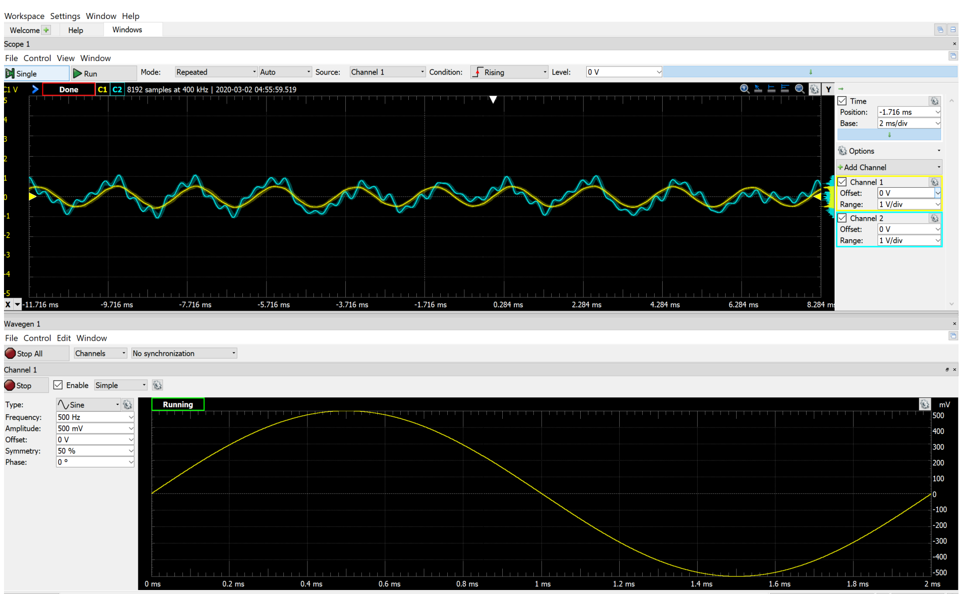

Figure 12: Experiment at 500Hz

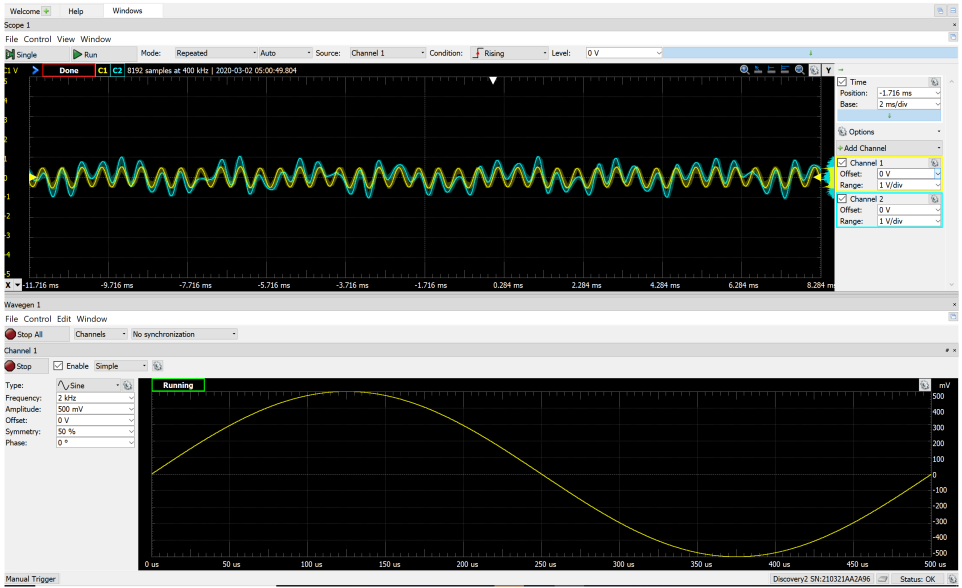

Figure 13: Experiment at 2kHz

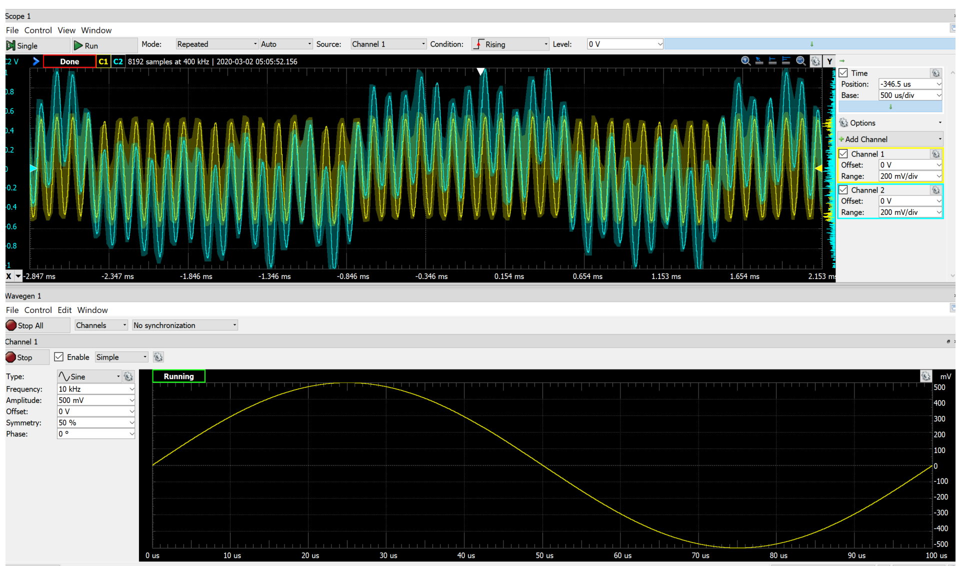

Figure 14: Experiment at 10kHz

Then output csv data and load it to MatLab to do some process. First, I Combine input, output and transmitted signal images together.

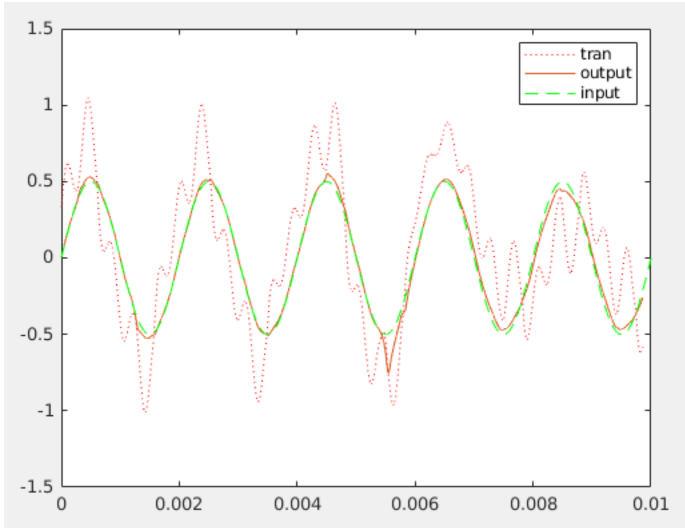

Figure 15: MatLab plot at 500Hz

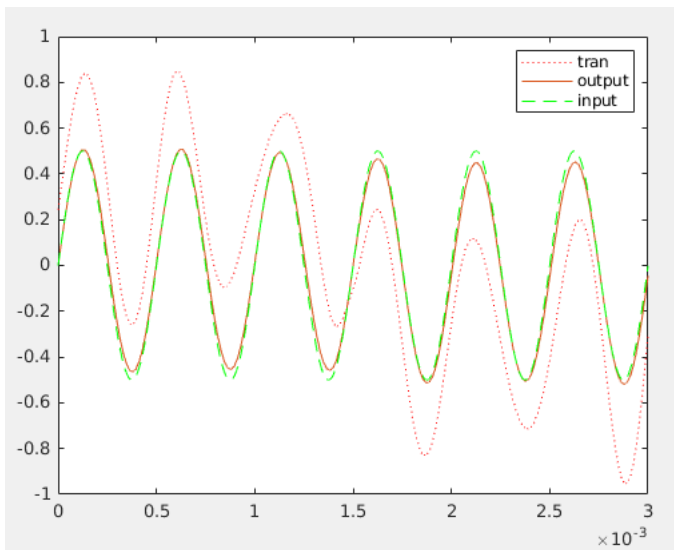

Figure 16: MatLab plot at 2kHz

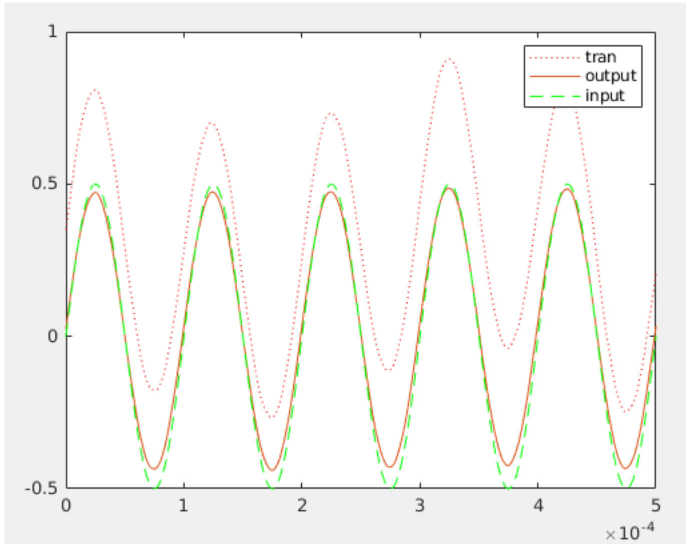

Figure 17: MatLab plot at 10kHz

2.2.2 SNR

Also we are asked to calculate Signal-to-noise ratio (abbreviated SNR or S/N) is a measure used in science and engineering that compares the level of a desired signal to the level of background noise. SNR is defined as the ratio of signal power to the noise power, often expressed in decibels. A ratio higher than 1:1 (greater than 0 dB) indicates more signal than noise.

$$\mathrm{SNR} = \frac{Psignal}{Pnoise} = (\frac{Asignal}{Anoise})^2$$

where A is root mean square (RMS) amplitude. I publish the table of SNR result below.

SNR	500Hz	2kHz	10kHz
Output	1.0418	0.9256	0.8376
Transmitted	1.9731	1.8050	1.7122

2.2.3 MatLab Code

```
lab4_2_ic.m    lab4.m    ece395.m    +
data = dlmread("/home/loserleo//mnt/nas_share/Share_photo/ece395/Lab3/clo500hz.csv")
data1 = dlmread("/home/loserleo//mnt/nas_share/Share_photo/ece395/Lab3/clo500hzinput.csv")
t= data(:,1)
x= data(:,2)
y= data(:,3)
t = t-t(1)
t1= data1(:,1)
tf= [t1;t1+t1(2048);t1+2*t1(2048);t1+3*t1(2048);t1+4*t1(2048);t1+5*t1(2048)]
z= data1(:,2)
zf = [z;z;z;z;z;z]
xlim([0 5*10-3])
plot(t,x,'r:')
hold on
plot(t,y)
plot(tf,zf,"g--")

xlim([0 10*10^-3])
hold off

output_snr = (rms(y) / rms(zf)) ^ 2;
tran_snr = (rms(x) / rms(zf)) ^ 2;
```

Figure 18: MatLab Code

3 Conclusion

Now we can make a conclusion, with the frequency increasing, the SNR of output will more get far away from 1 which means the difference between the input signal and the output signal is constantly increasing. However we will just find the SNR of transmitted signal will close to 1 when the frequency increasing.

In a word, it helps me a lot to understand transmitter-receiver circuit, this lab was a meaningful experience.

4 Recommendation

During lab, I find something strange. It's about Chua's circuit. After tweaking the potentiometer of Chua's circuit to output double scroll successfully, I turn off then turn on the power, the double scroll disappear. However, if I plug out then plug in a random capacitor in circuit when power on, the double scroll is back!

Next time I may check some data to solve this problem.

5 REFERENCE

`https://en.wikipedia.org/wiki/Signal-to-noise_ratio`