UM–SJTU Joint Institute

Electronic Circuits Summer (ECE3110J)

Lab3 Report

Common-Source with Source Degeneration Amplifier and Source Follower

Instructed by

Dr. Xuyang Lu

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Name	ID
Cao Yanzhuo	520370910021

1 Exercise 3.1.1

I use R_D = 30kΩ and R_S = 5kΩ. The circuit diagram and resulting graph of V_{OUT} vs. V_{IN} is shown in Figure 3.1.1. From the curve, we can find that when V_{IN} = 1.49V , V_{OUT} = 1.77V and when V_{IN} = 1.51V, V_{OUT} = 1.65V. Therefore, we can get the magnitude of slope approximately at V_{IN} = 1.5V,

$$\left| \frac{1.76 - 1.65}{1.49 - 1.51} \right| = 5.5 \tag{1}$$

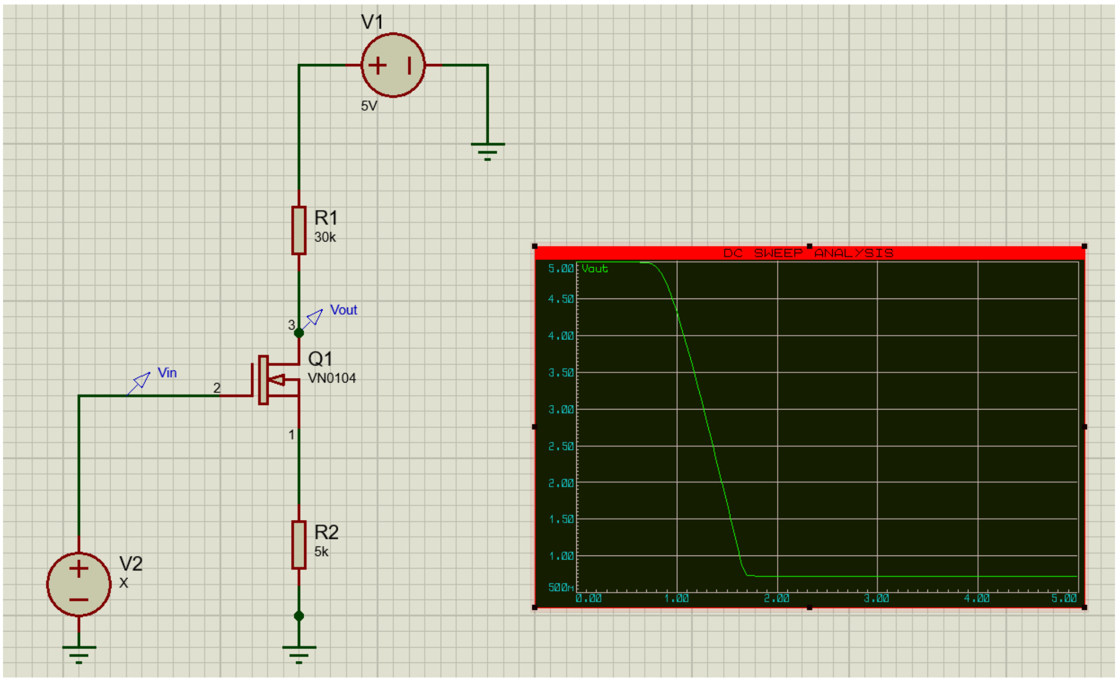

Figure 1: Simulation Circuit of 3.1.1

So when V_{IN} = 1.5V , A_V = 5.5, which is close to $\frac{R_D}{R_S} = 6$. Now since $V_D > V_{IN} - V_{TH}$ so the NMOS is indeed in saturation region.

2 Exercise 3.1.2

The circuit diagram and simulation circuit will be like this. According to Figure 2, the amplitude of V_{OUT} is,

$$\left| \frac{56m + 56m}{2} \right| = 0.056 \tag{2}$$

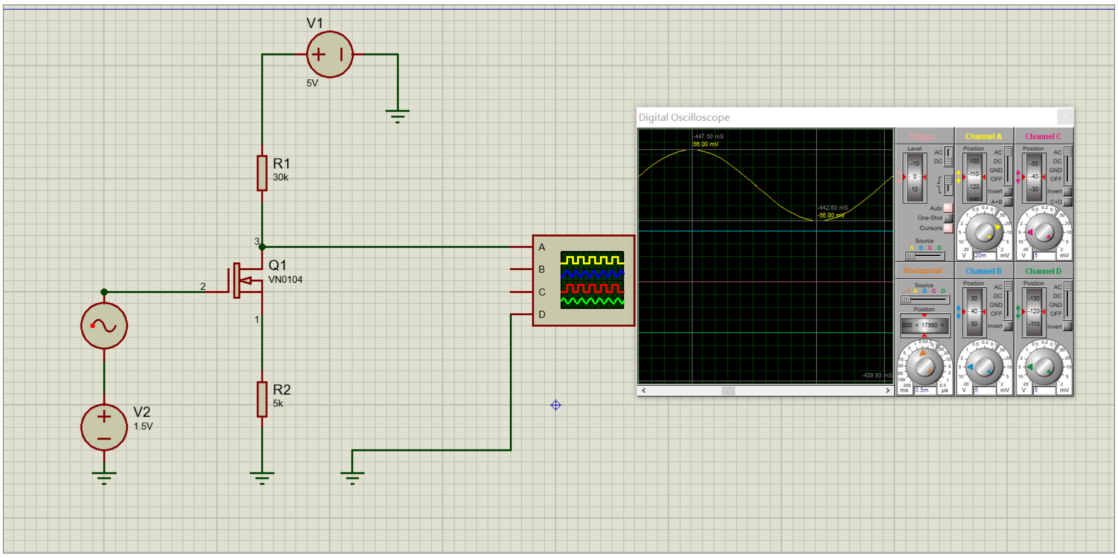

Figure 2: Simulation Circuit of 3.1.2

This value is very close to $0.01A_V = 0.055$ so the amplitude of V_{OUT} is equal to $0.01A_V$ is confirmed.

The result in lab is shown below.

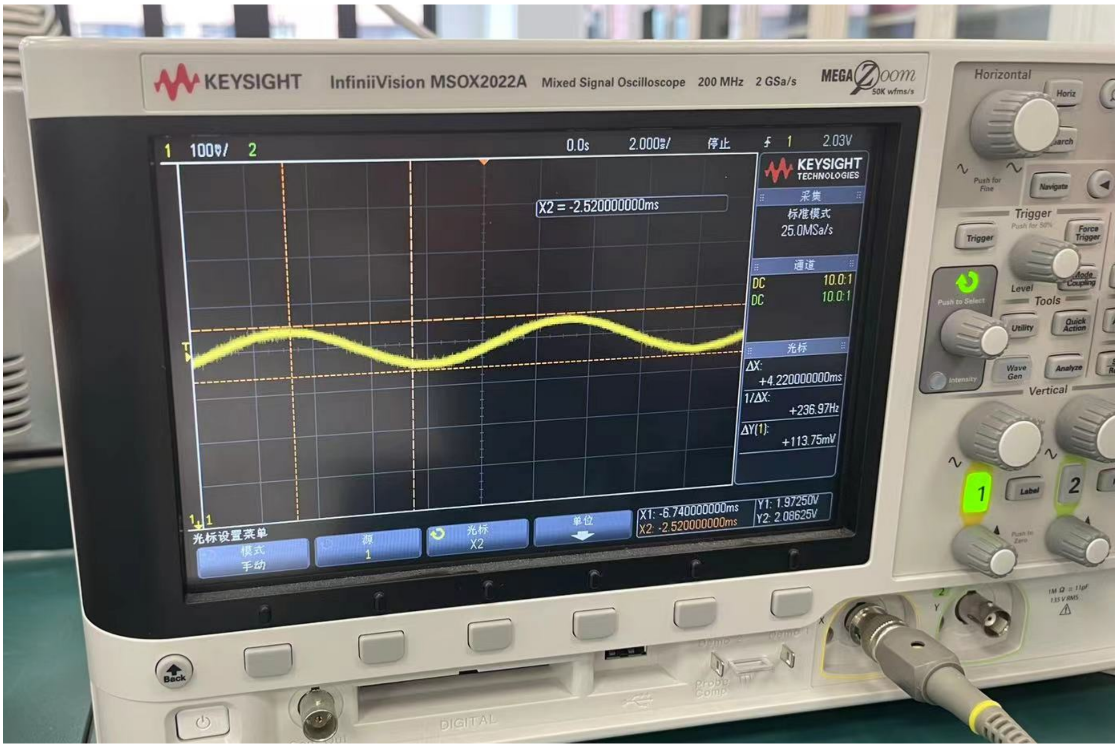

Figure 3: Lab Results of 3.1.2

3 Exercise 3.1.3

The circuit diagram and simulation circuit will be like this. According to Figure 4, the amplitude of V_{OUT} is,

$$\left| \frac{35.5m + 35.5m}{2} \right| = 0.0355 \tag{3}$$

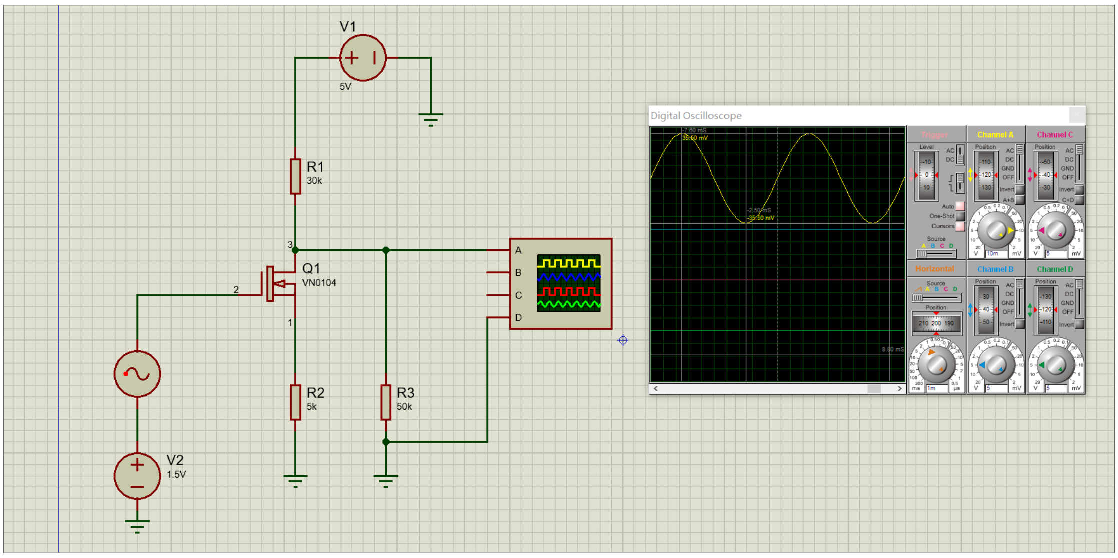

Figure 4: Simulation Circuit of 3.1.3

This value is much smaller than $0.01A_V = 0.055$. The reason is that the actual gain is $G_m\ R_{out}$ and the resistance R_{out} at gate in small signal model is reduced as $R_D||R_L < R_D$. The decrease of g_m and r_o may also lead to the drop of amplitude.

The result in lab has too much noise due to the equipment.

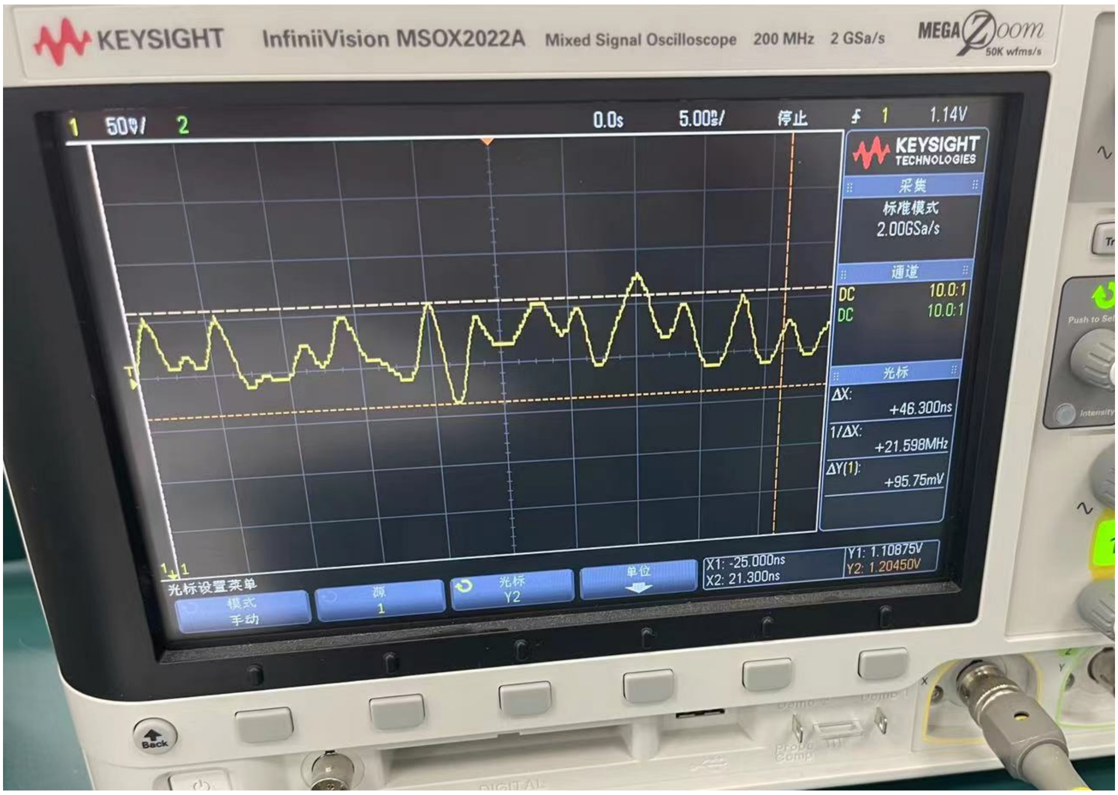

Figure 5: Lab Results of 3.1.3

4 Exercise 3.2.1

I use R_S=30kΩ and R_S = 50kΩ. The circuit diagram and resulting graph of V_{OUT} vs. V_{IN} is shown in Figure 6. From the curve, we can find that when V_{IN} = 2.99V , V_{OUT} = 2.07V and when V_{IN} = 3.01V, V_{OUT} = 2.09V. Therefore, we can get the magnitude of slope approximately at V_{IN} = 3V,

$$\left| \frac{2.09 - 2.07}{3.01 - 2.99} \right| = 1 \tag{4}$$

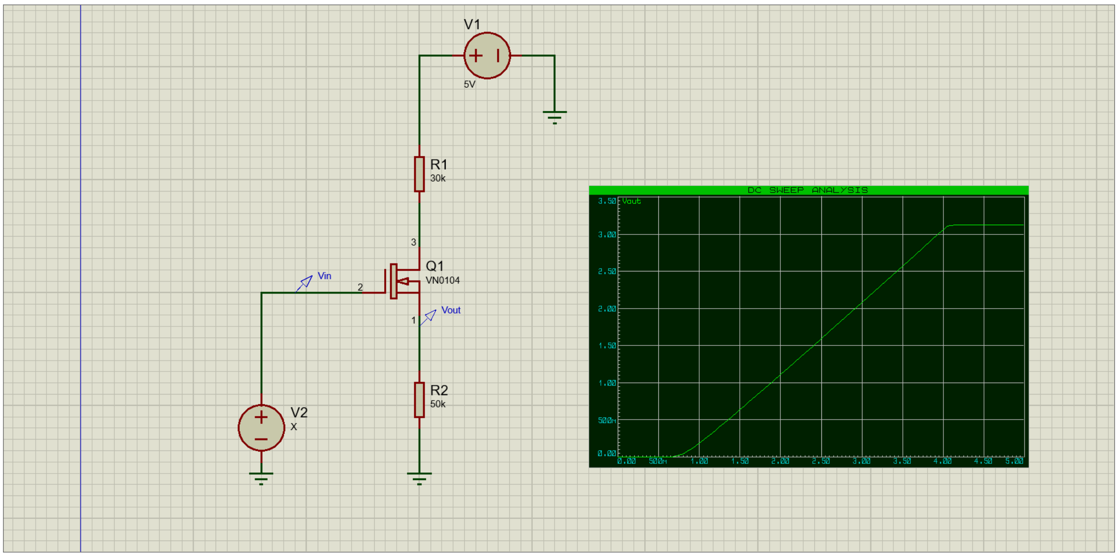

Figure 6: Simulation Circuit of 3.2.1

So when V_{IN} = 3V , A_V = 1, which is close to unity.

5 Exercise 3.2.2

The circuit diagram and simulation circuit will be like this. According to Figure 7, the amplitude of V_{OUT} is,

$$\left| \frac{49m + 49m}{2} \right| = 0.049 \tag{5}$$

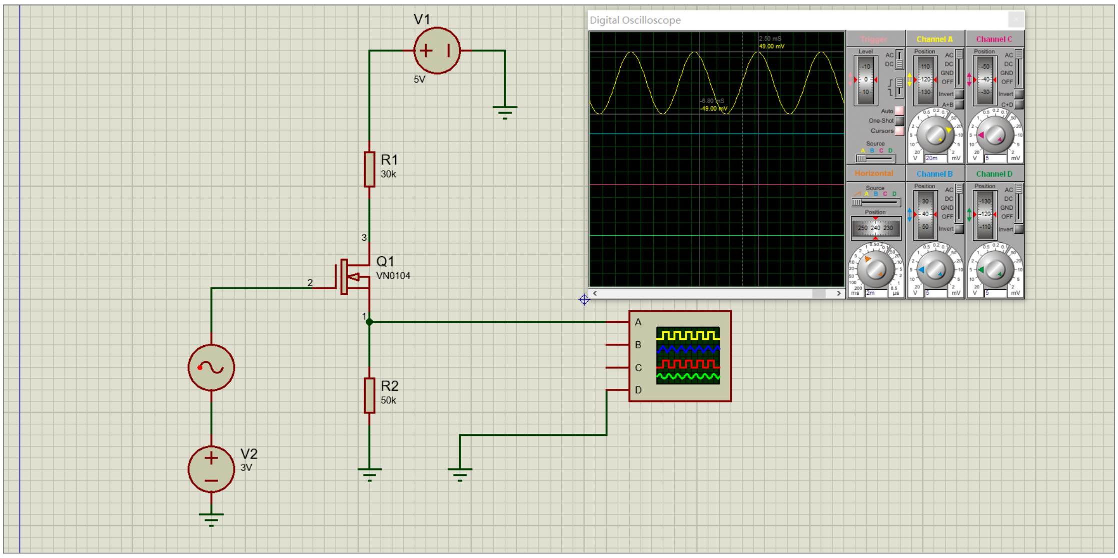

Figure 7: Simulation Circuit of 3.2.2

This value is very close to $0.05A_V = 0.05$ so the amplitude of V_{OUT} is equal to $0.05A_V$ is confirmed.

The result in lab is shown below.

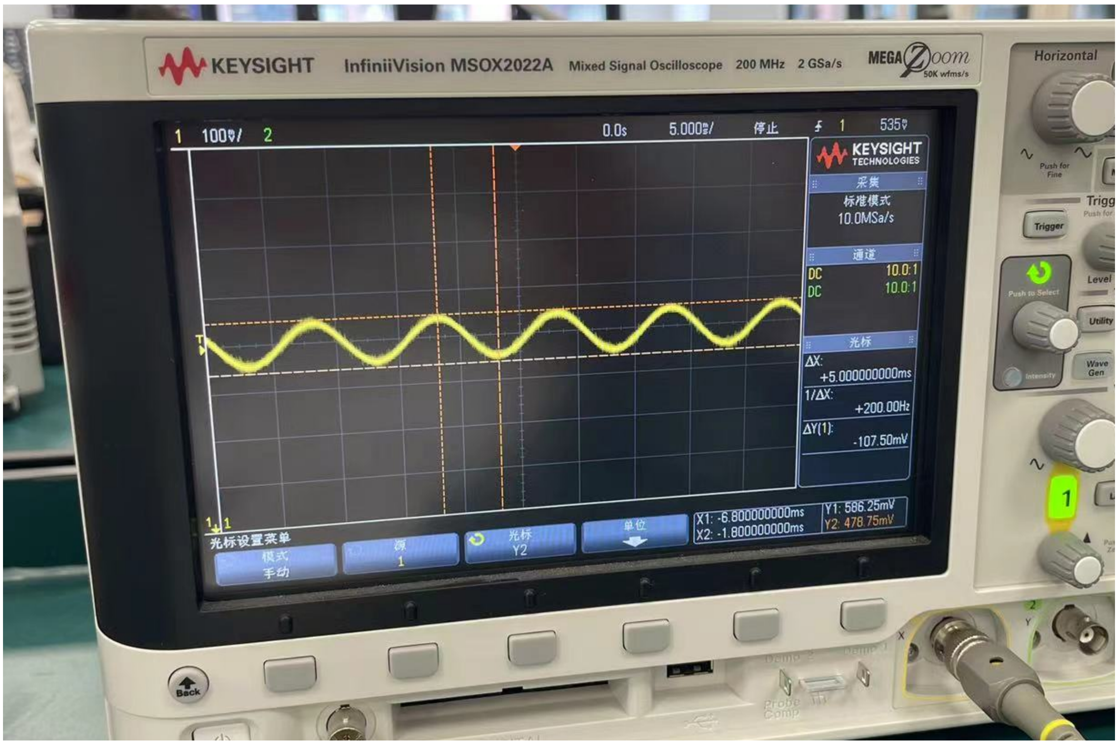

Figure 8: Lab Results of 3.1.3

6 Exercise 3.2.3

The circuit diagram and simulation circuit will be like this. According to Figure 9, the amplitude of V_{OUT} is,

$$\left| \frac{48.73m + 48.73m}{2} \right| = 0.04873 \tag{6}$$

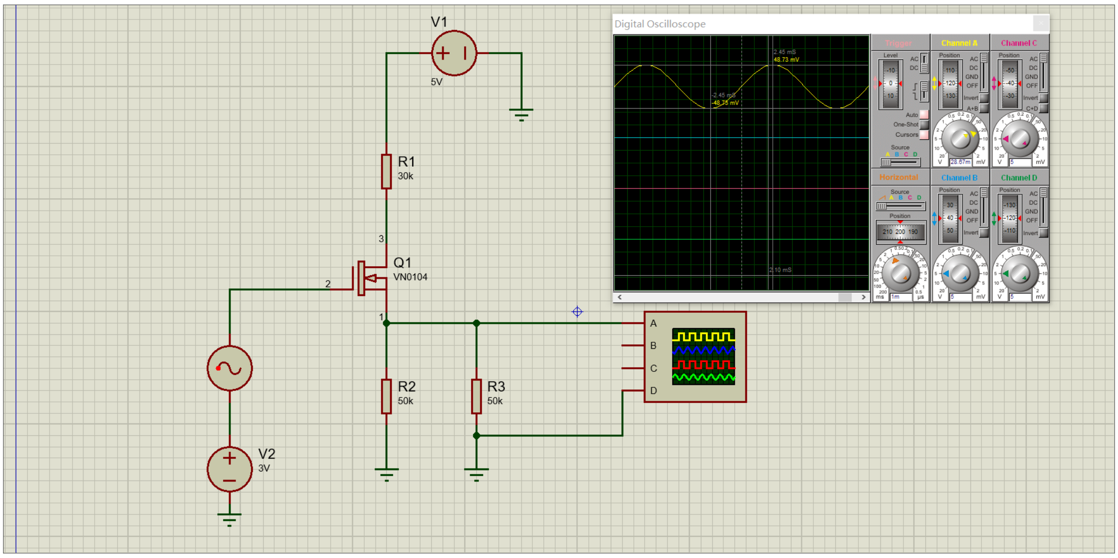

Figure 9: Simulation Circuit of 3.2.3

This value is also very close to $0.05A_V = 0.05$. The reason is that V_{out} changes from

$$\frac{g_m}{\frac{1}{R_s} + g_m + \frac{1}{r_o}} \tag{7}$$

to

$$\frac{g_m}{\frac{1}{R_s||R_L} + g_m + \frac{1}{r_o}} \tag{8}$$

But as V_{IN} is larger enough, we may estimate the actual A_v by $\frac{1}{1+\eta}$, where η is a constant. Thus the two gains does not differ too much.

The result in lab is shown below.

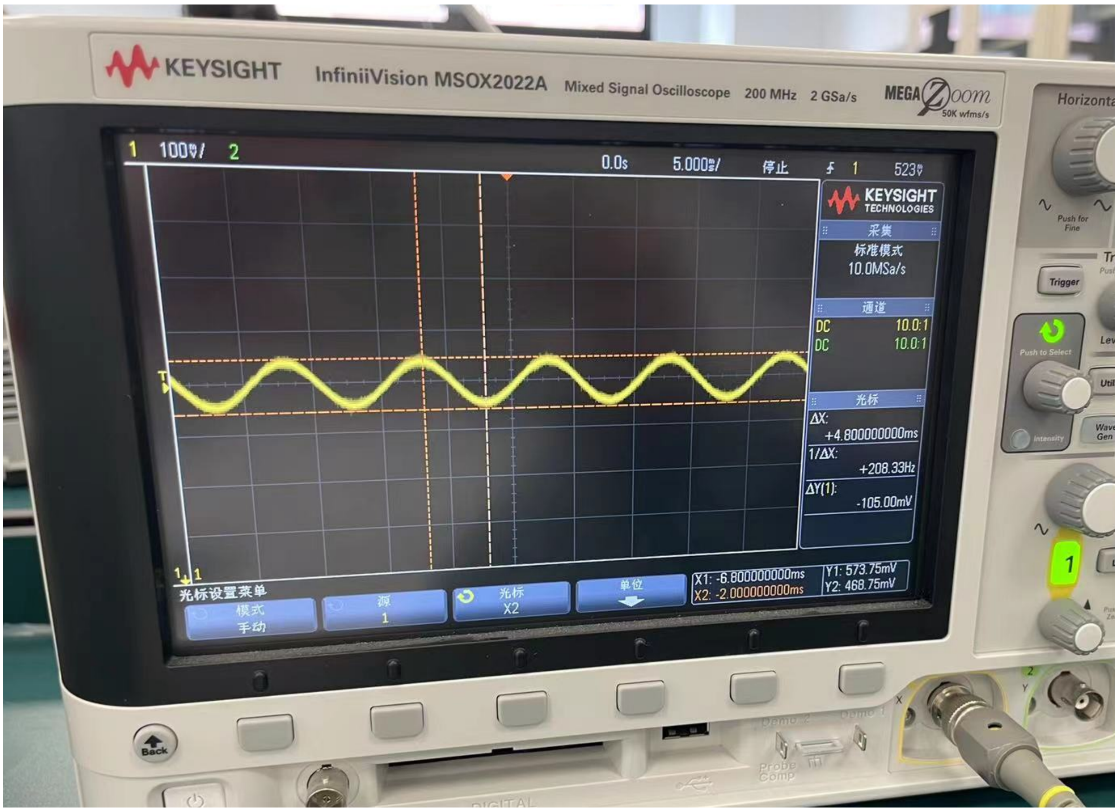

Figure 10: Lab Results of 3.2.3