Lab 1: Characterization of Op-Amp Circuits

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ECE 311-03
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Due Date: 9/26/14

1 Introduction

The purpose of this experiment is to successfully construct multiple configurations of Op-Amp circuits to observe the relationship between V_{in} and V_{out} in each situation. The scope of this experiment covers the eight circuits built in the lab.

2 Theory

An ideal operational amplifier is a three terminal device which consists of two high impedance inputs and an output. In most circuits, Op-amps are used as voltage amplifiers, however, they have many purposes. These purposes include, but are not limited to comparator circuits, the Schmidt trigger circuit, buffer circuits, non-inverting amplifiers, inverting amplifiers, differentiators, and integrators. To accurately analyze circuits that involve operational amplifiers, it's necessary to use ideal Op-Amp assumptions. These assumptions state that there is no current flowing through either input terminal of the Op-Amp, and also that the voltage at the negative input terminal is equivalent to the voltage at the positive input terminal. By applying this knowledge to whatever Op-Amp circuit is presented, it is possible to solve for V_{in} and V_{out} of the Op-Amp. In preparation for this lab, the relationship between V_{in} and V_{out} of each of the eight circuits was calculated.

3 Experimental Procedure

The equipment used in the lab was:

- Breadboard
- 10kΩ resistors
- 1kΩ resistors
- 100Ω resistors
- 0.1μF capacitor
- Oscilloscope with probe
- Power Supply

Schematics:
Shown in Section 6.

The procedure in this lab involved constructing the circuits shown in Figures 1 through 7 using a breadboard, Op-Amp IC chip, necessary resistors and capacitors. From here V_{in} and V_{out} were measured using the oscilloscope and a probe. Three types of waves were used in each circuit. They consisted of a *sin* wave, a square wave, and a ramp wave. The results are shown in Figures 8 through 28. The results from the schematics of circuits in Figures 1 through 5 were then used to graph V_{in} vs V_{out}. These results are shown in Figures 29 through 34.

4 Interpretation

The results calculated in the preliminary questions were similar to the actual results

obtained, however there were some differences. These difference are due to human error, as not all predictions were mathematically correct. Specifically, the results from the integrator did not match up with the expected results.

5 Conclusion

In conclusion, this lab was a success. The goal was to construct different types of Op-Amp circuits and to compare the values of V_{out} and V_{in} in each situation. Each relationship accurately supported the Ideal Op-Amp characteristics, thus further proving that it is mathematically correct to use them in the analysis of circuits that incorporate operational amplifiers.

6 Appendix

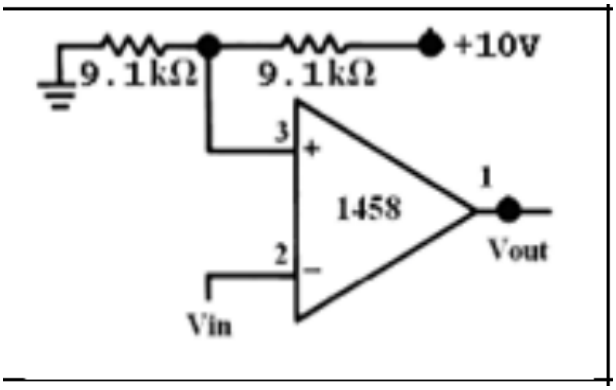

Figure 1: Comparator Circuit Schematic

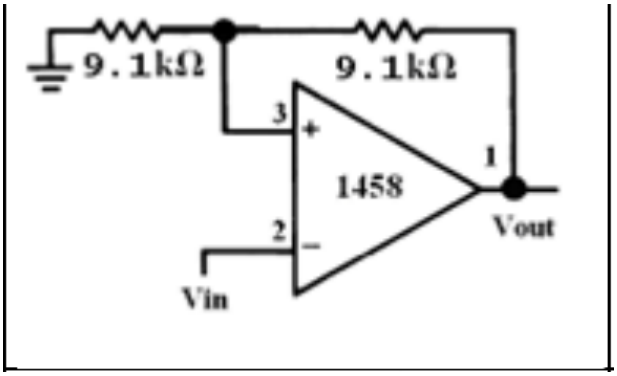

Figure 2: Schmidt Trigger Schematic

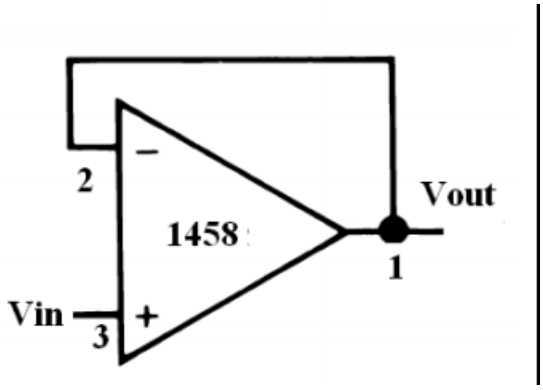

Figure 3: Buffer Circuit Schematic

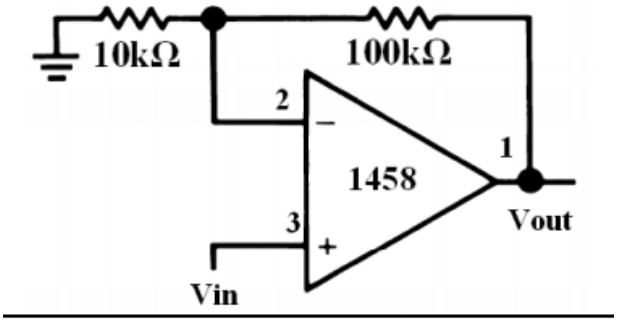

Figure 4: Non-Inverting Amplifier Schematic

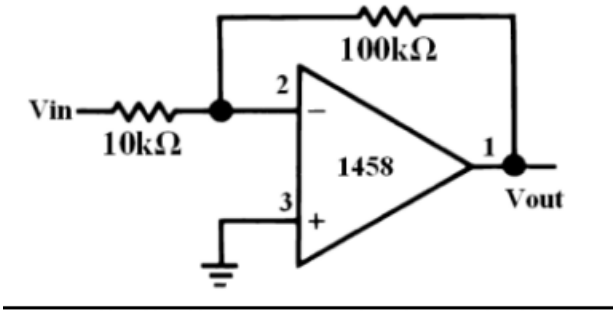

Figure 5: Inverting Amplifier Schematic

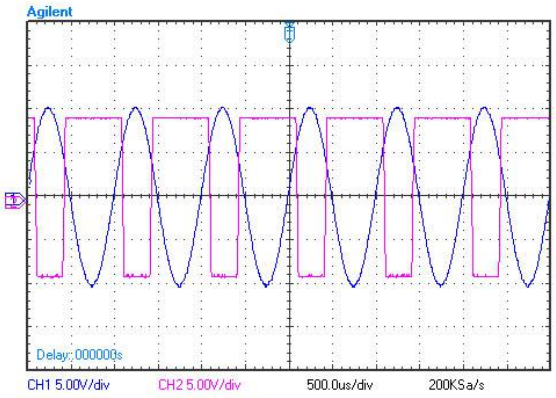

Figure 8: Comparator Sine Wave

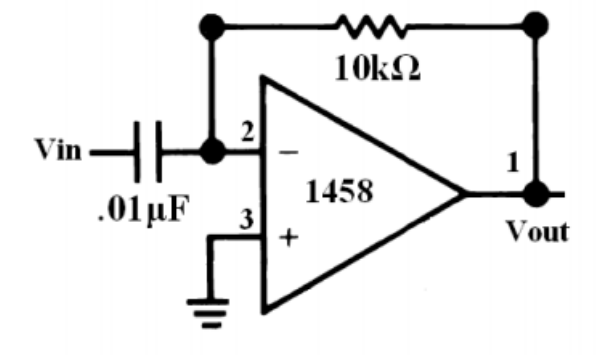

Figure 6: Differentiator Circuit Schematic

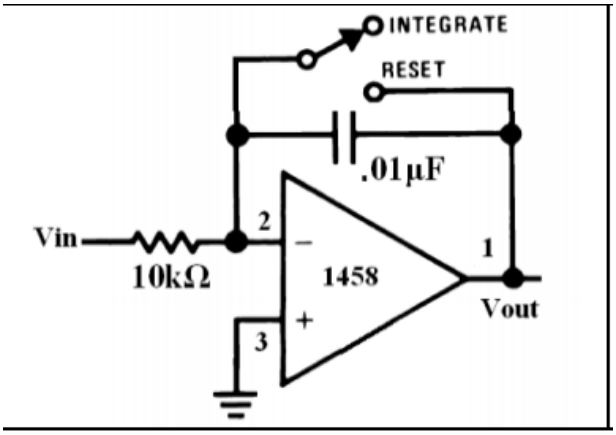

Figure 7: Integrator Schematic

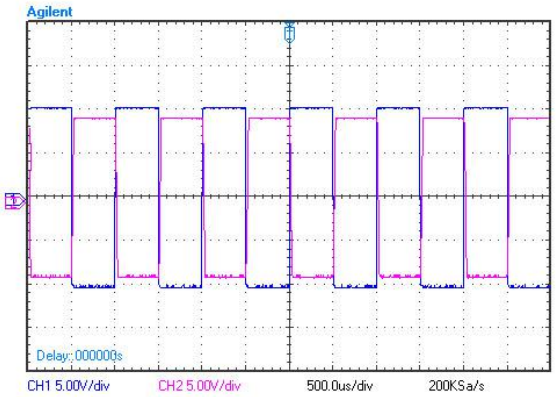

Figure 9: Comparator Square Wave

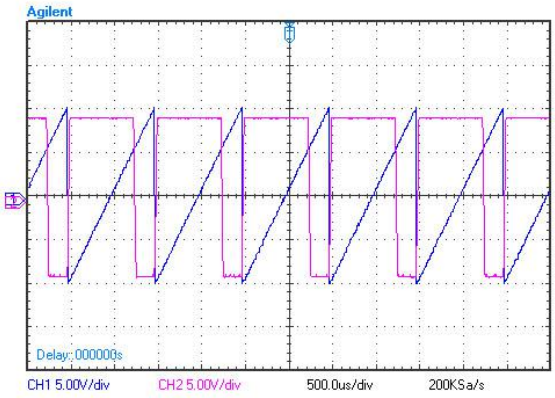

Figure 10: Comparator Ramp Wave

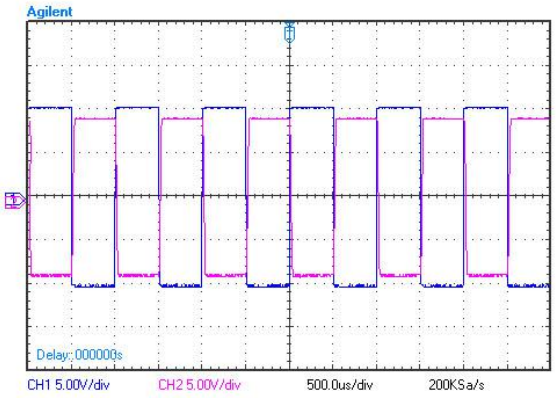

Figure 12: Schmidt Trigger Square Wave

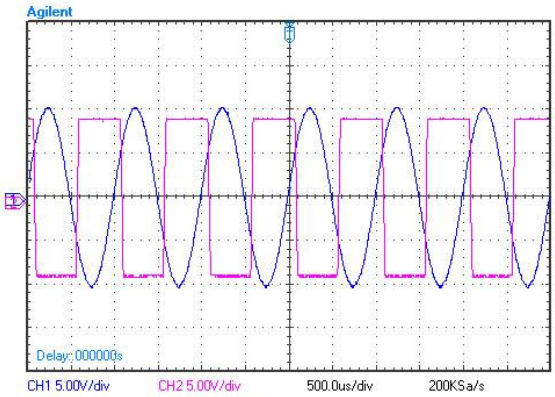

Figure 11: Schmidt Trigger Sine Wave

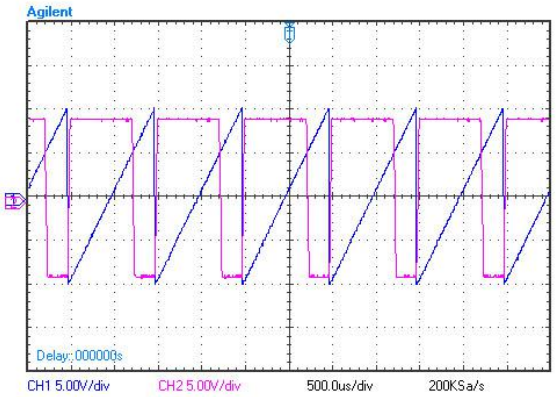

Figure 13: Schmidt Trigger Ramp Wave

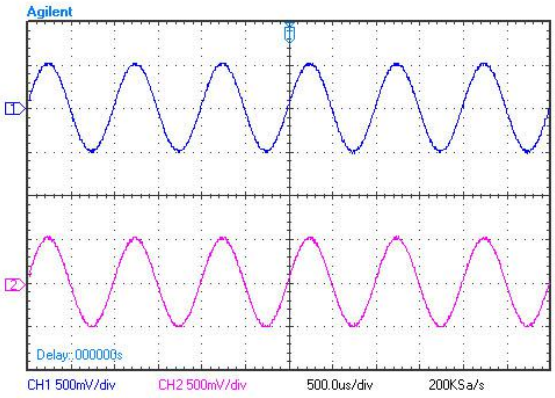

Figure 14: Buffer Sine Wave

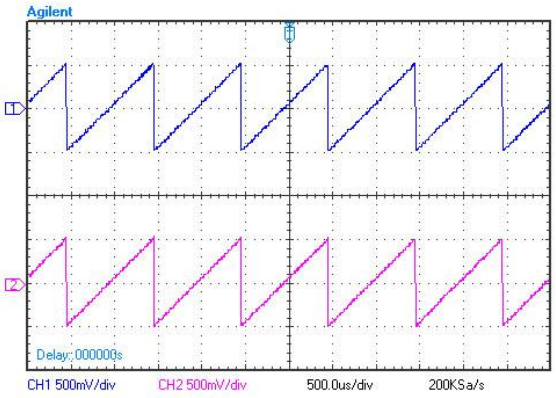

Figure 16: Buffer Ramp Wave

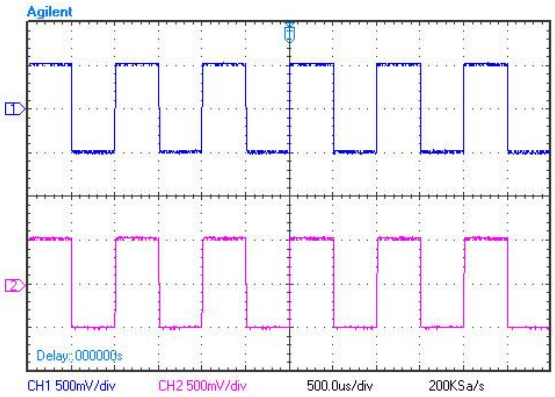

Figure 15: Buffer Square Wave

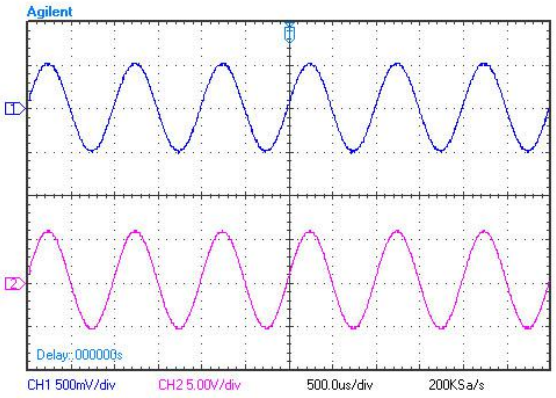

Figure 17: Non-Inverting Amplifier Sine Wave

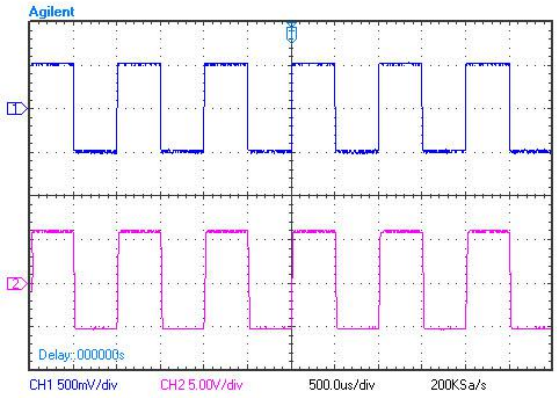

Figure 18: Non-Inverting Amplifier Square Wave

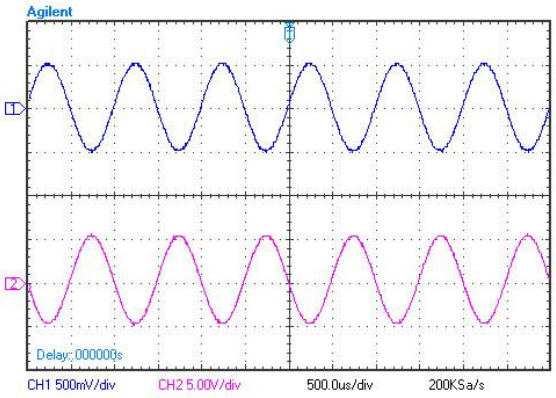

Figure 20: Inverting Amplifier Sine Wave

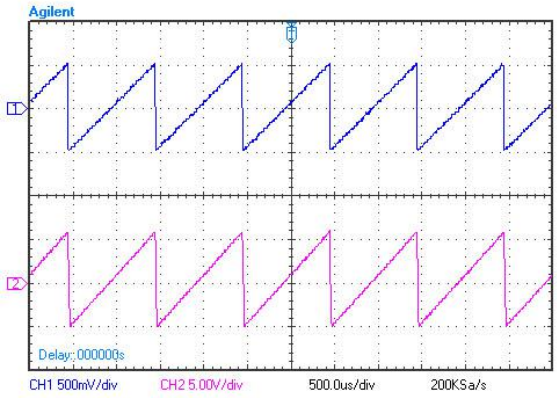

Figure 19: Non-Inverting Amplifier ramp Wave

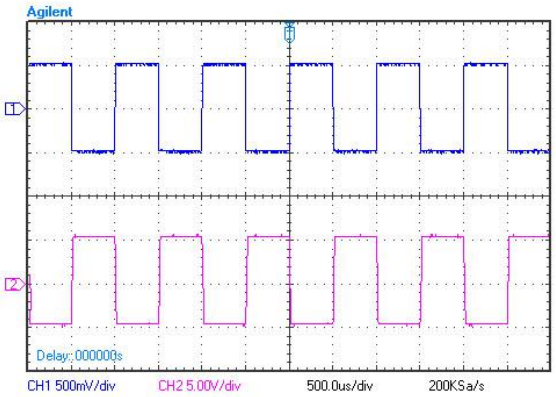

Figure 21: Inverting Amplifier Square Wave

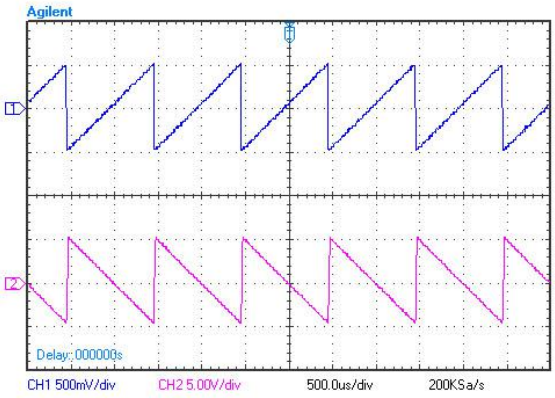

Figure 22: Inverting Amplifier Ramp Wave

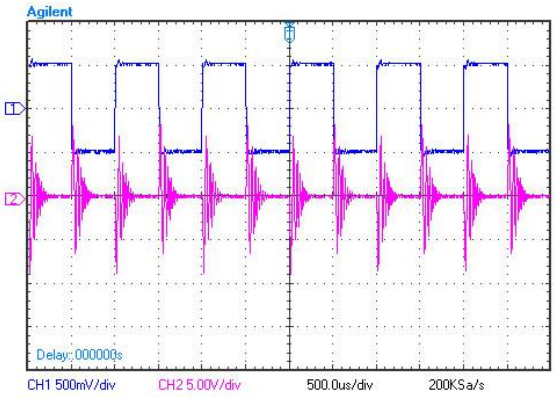

Figure 24: Differentiator Square Wave

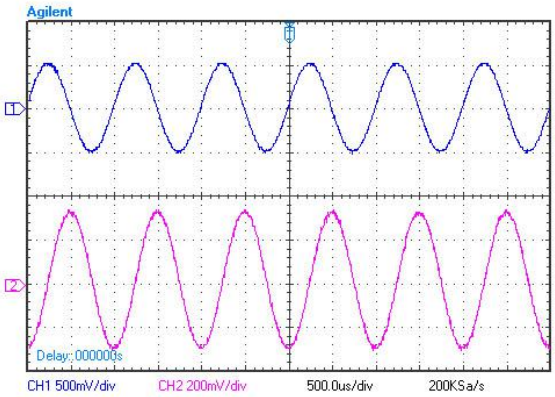

Figure 23: Differentiator Sine Wave

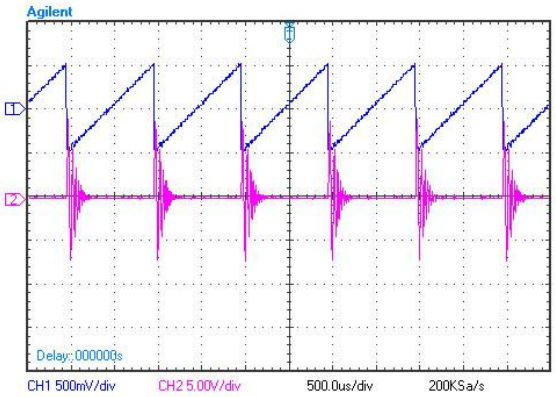

Figure 25: Differentiator Ramp Wave

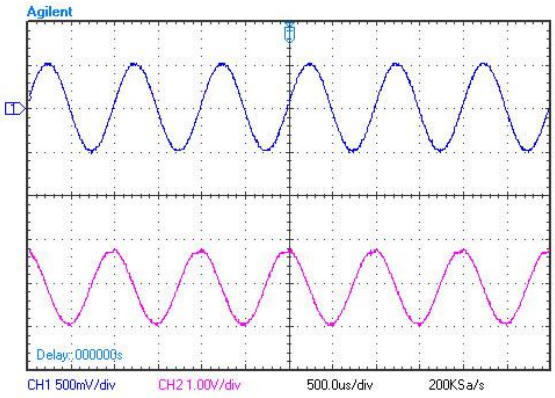

Figure 26: Integrator Sine Wave

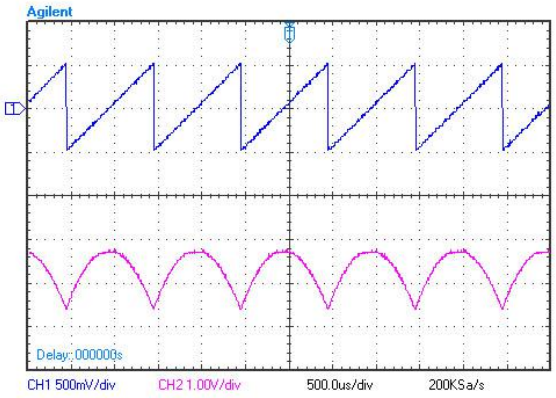

Figure 28: Integrator Ramp Wave

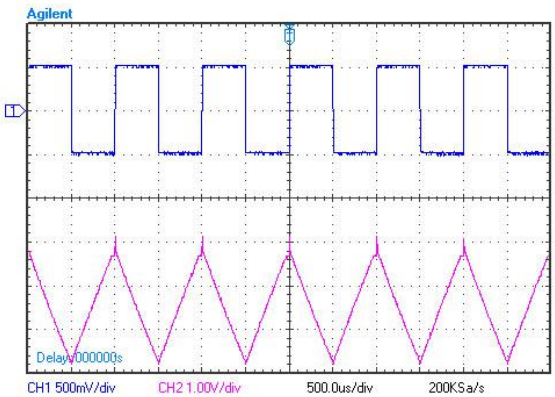

Figure 27: Integrator Square Wave

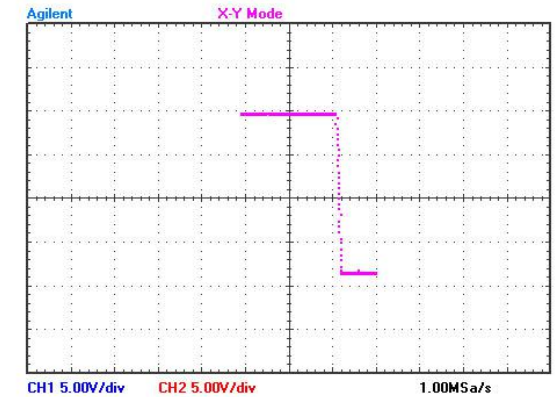

Figure 29: Comparator V_{out} vs V_{in}

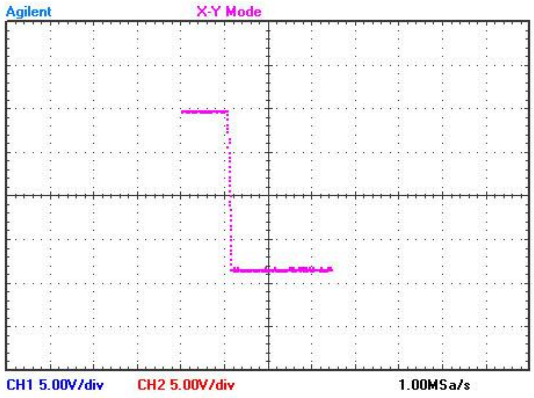

Figure 30: Comparator connected to -10V V_{out} vs V_{in}

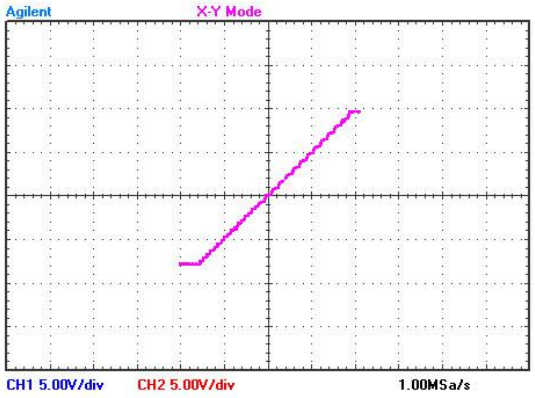

Figure 32: Buffer V_{out} vs V_{in}

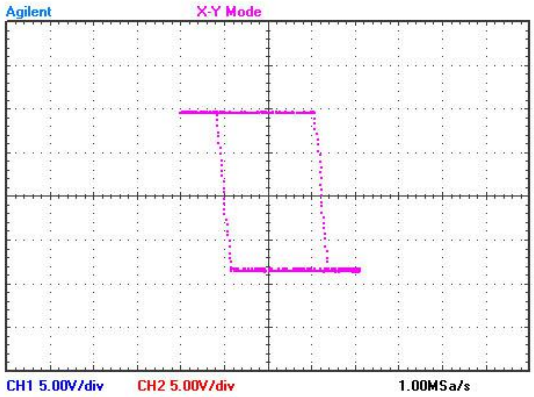

Figure 31: Schmidt Trigger V_{out} vs V_{in}

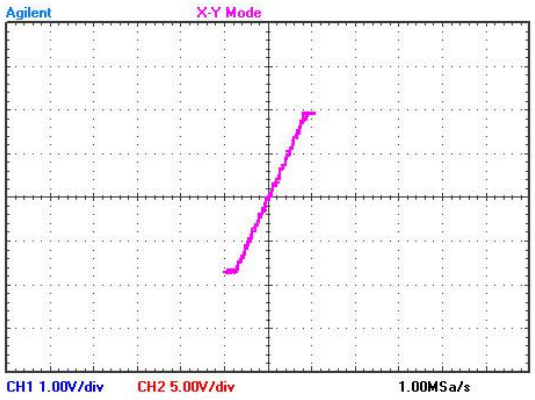

Figure 33: Non-Inverting Amplifier V_{out} vs V_{in}

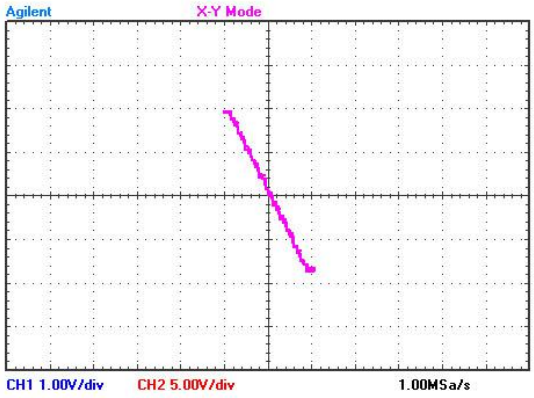

Figure 34: Inverting Amplifier V_{out} vs V_{in}