Experiment No. 1
Characterization of Op-Amp Circuits
ECE 311

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February 11, 2014

Date Performed:	February 4
Instructor:	Professor Saletta

1 Introduction

Operational Amplifiers (Op-Amps) are a critical component in many electronic circuits. Op-Amps are named after the mathematical functions, or "operations" they can provide. This lab explores a some of those operations, namely the comparator, Schmidt Trigger, buffer, inverting amplifier, non-inverting amplifier, differentiator and integrator circuits

2 Procedure

a. Use scope to record wave forms for all operations listed.

3 Equipment

- Oscilloscope
- Function generator
- LM1458
- resistors and capacitors

4 Observations

The wave forms predicted by the preliminary work differed on the comparator circuits (Section 7.1) when the input waveform was changing rapidly enough to run into the slew rate of the Op-Amp.

The Schmidt Trigger (Section 7.3) had some odd "die-off" characteristics that were not understood.
The wave forms predicted by the preliminary work differed on the diffrentiator circuits at the discontinuities. This is due to the fact that the predictions were doing the differential on "perfect" input functions which had actual discontinuities at the corners of the square and sawtooth waves (Section 6.7). "real world" wave forms are not actually discontinuous, and therefore can be differentiated. The slope at these corners is very high, so the amplifier ran against its rails at these points.

5 Conclusions

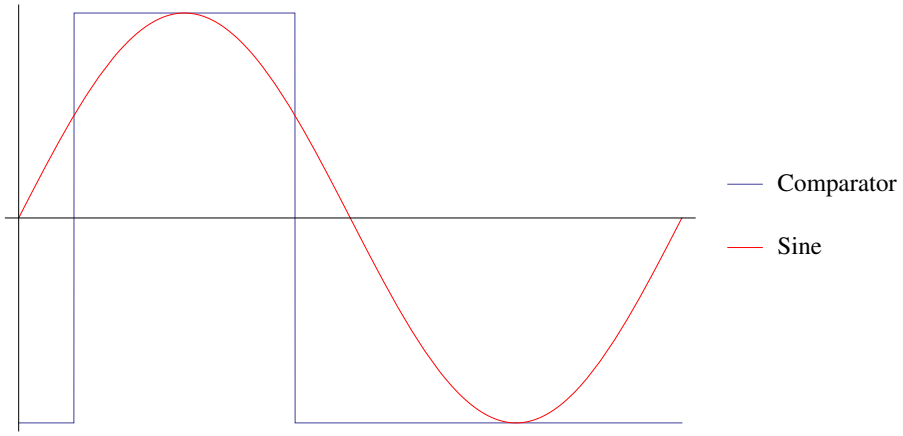
The purpose of this lab was achieved. A number of circuits were built and their transfer functions measured and recorded. The measurements generally complied with the calculated values.

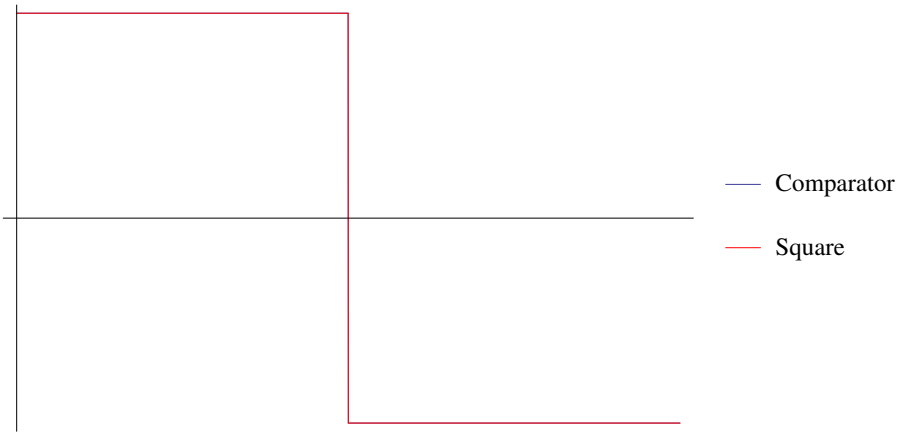
6 Appendix: Preliminary Questions

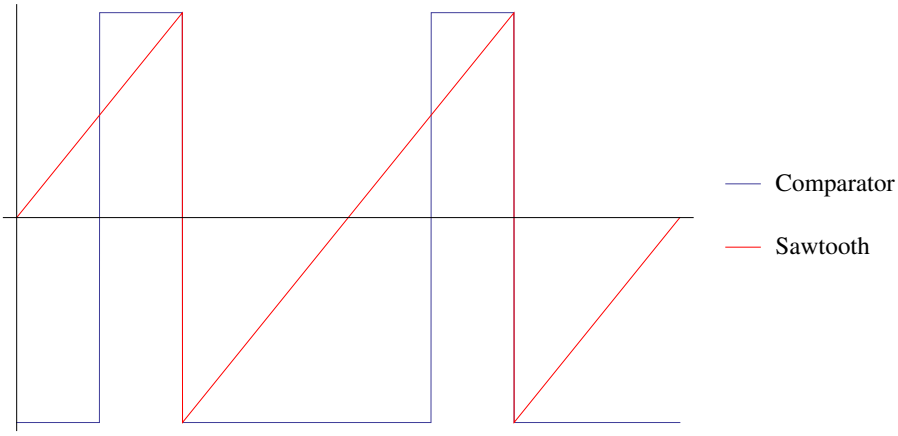
The Preliminary questions for the lab ask for Vin/Vout plots of the eight named circuits.

6.1 Comparator 1

The trigger is +5 Volts.

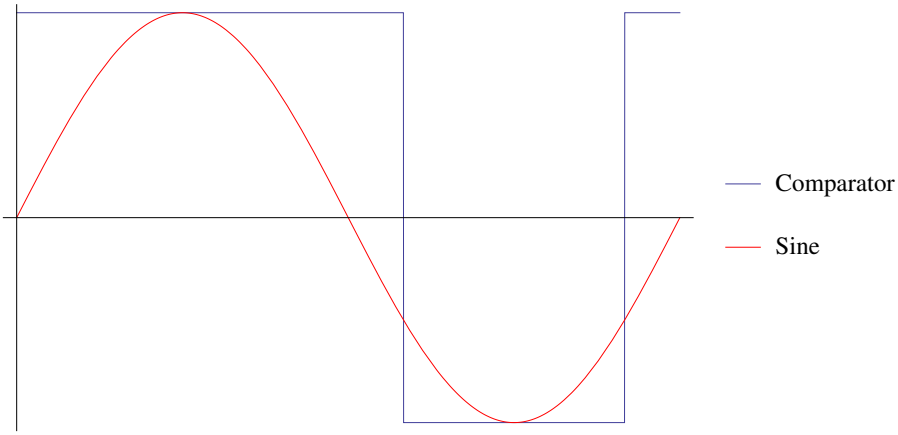


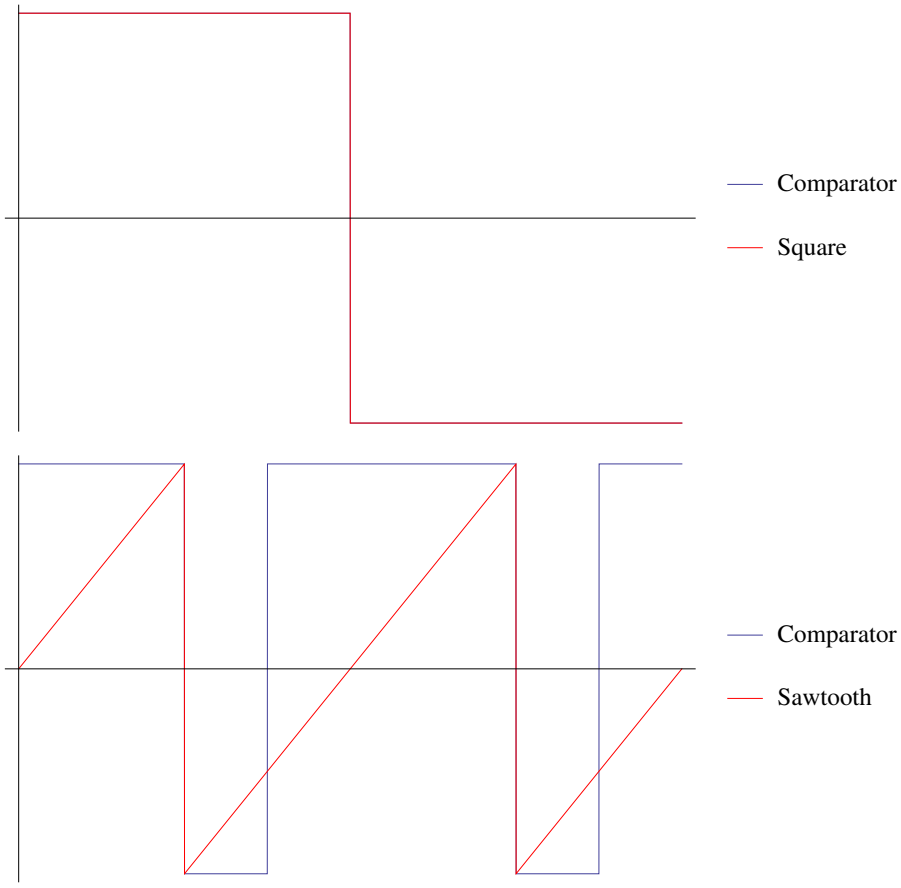




6.2 Comparator 2

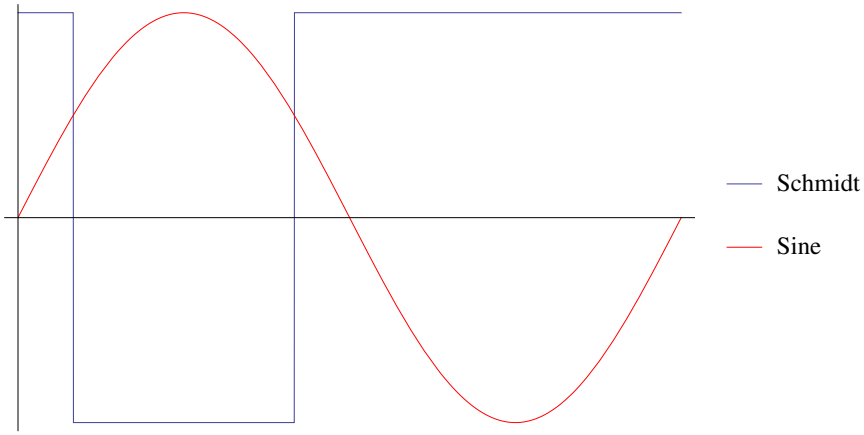
The trigger is -5 Volts.

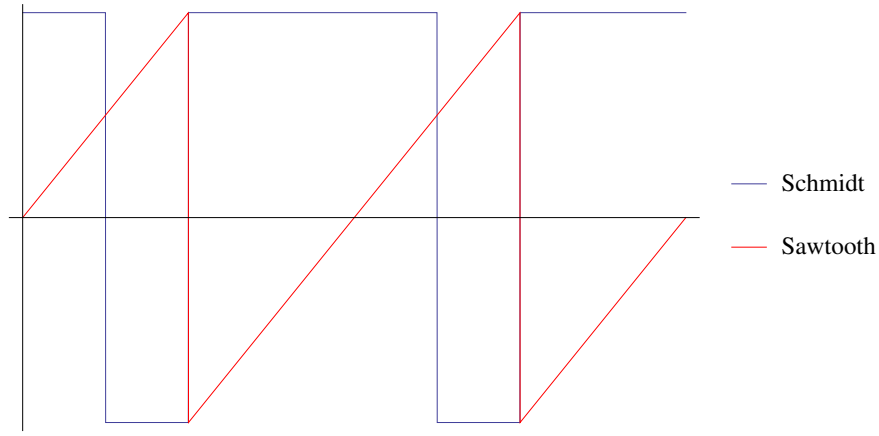




6.3 Schmidt Trigger

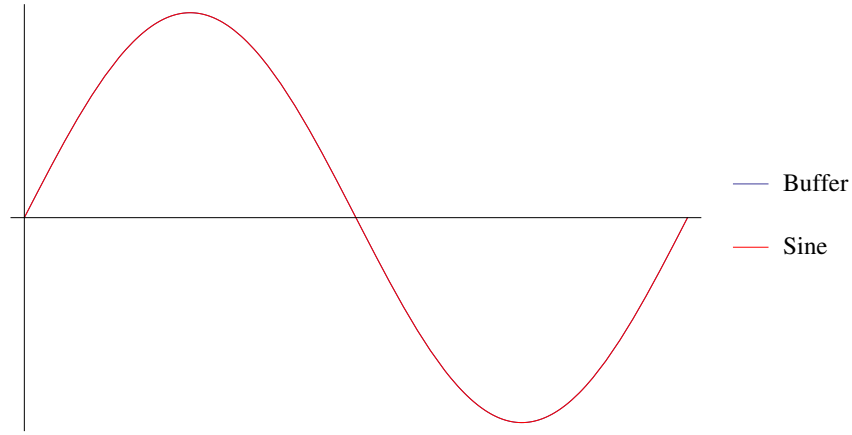
The trigger voltages are +/- 5v.

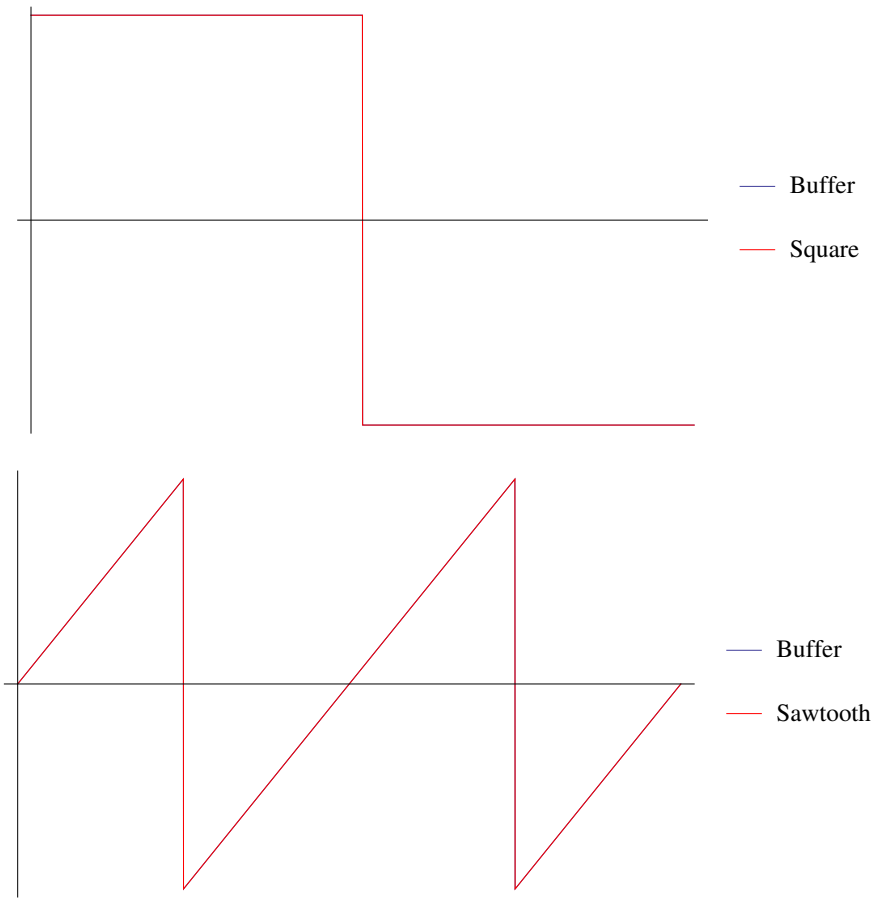




6.4 Buffer

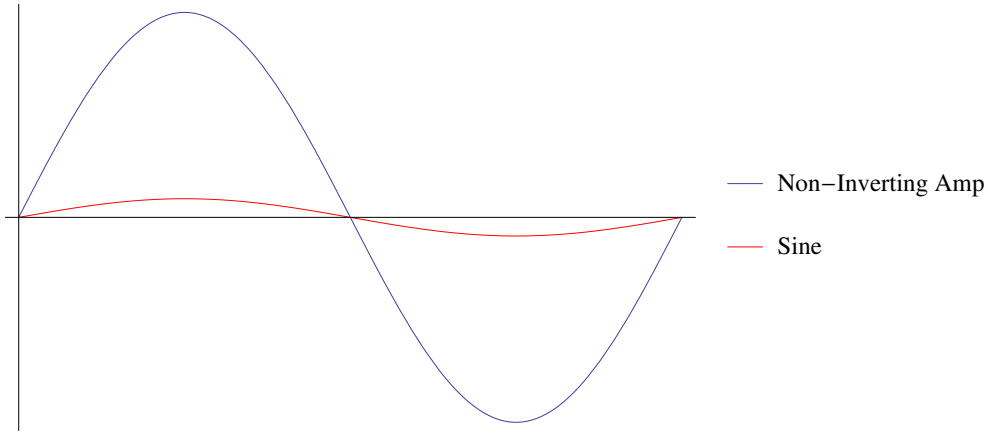
V_{out} is equal to V_{in}, with a minor phase delay.

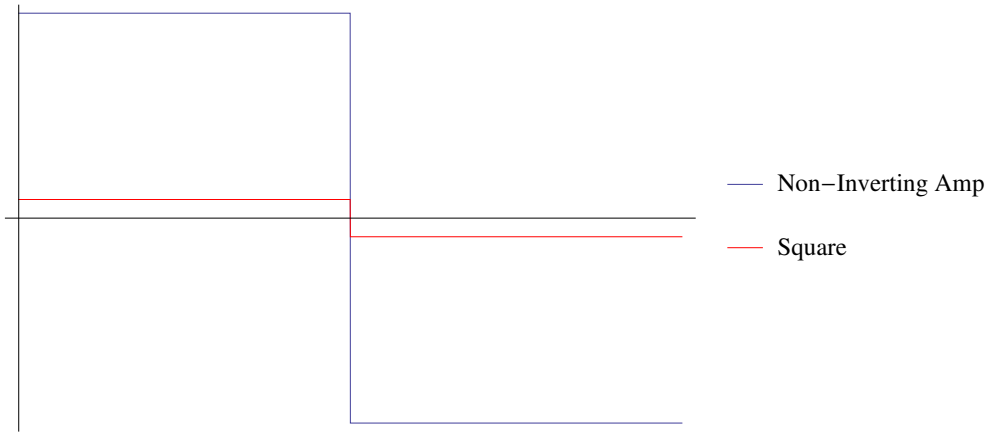


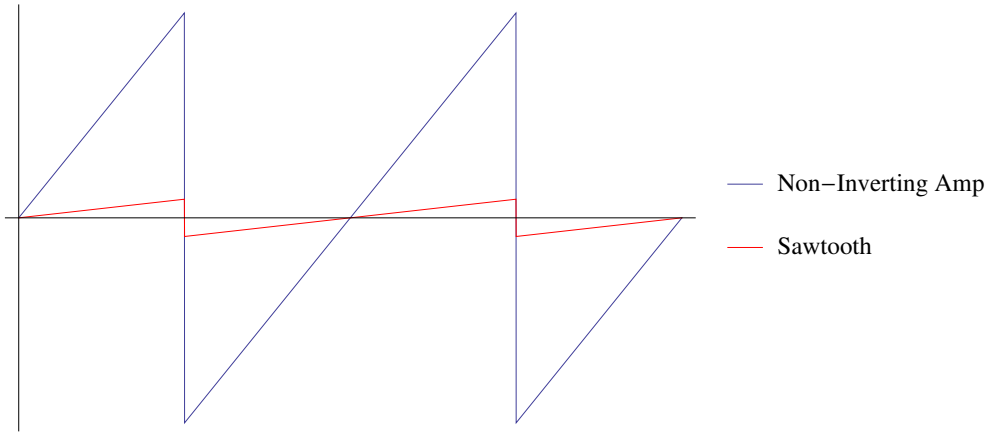


6.5 Non-inverting Amplifier

For a non-inverting amplifier, $V_{out} = (1 + \frac{R_2}{R_1}) * V_{in}$. In this case, $R_2 = 100k\Omega$, and $R_2 = 10k\Omega$, so $V_{out} = (11) * V_{in}$.

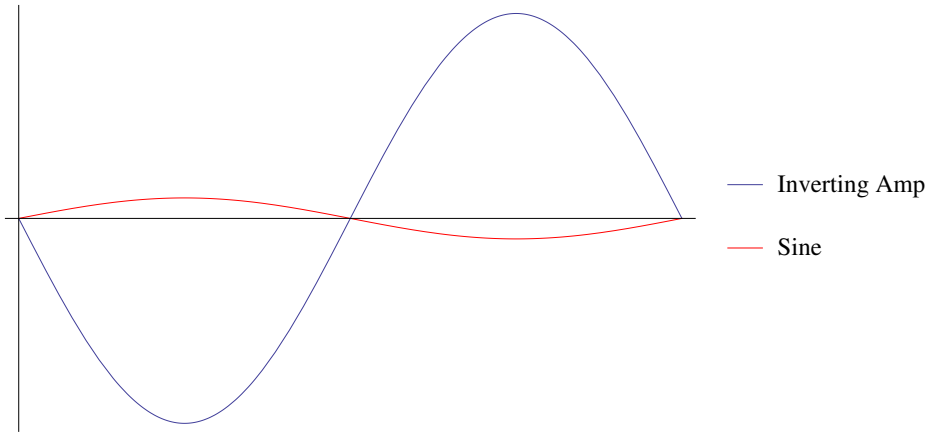

Non−Inverting Amp
Sine

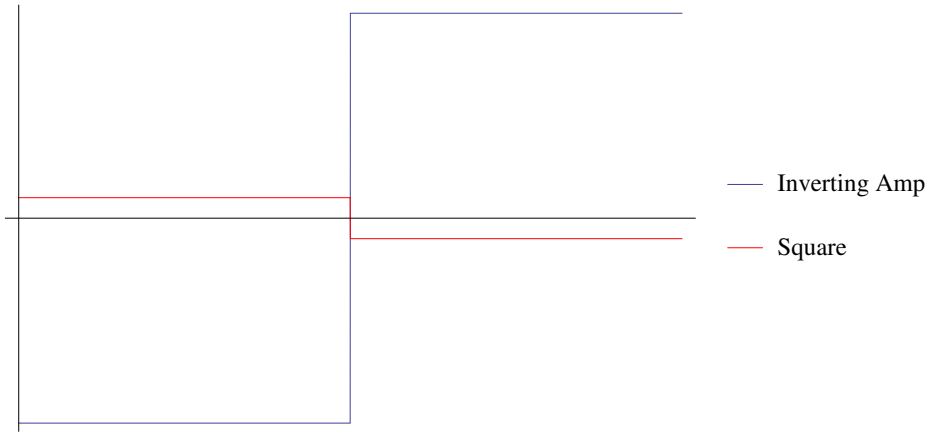

Non−Inverting Amp
Square

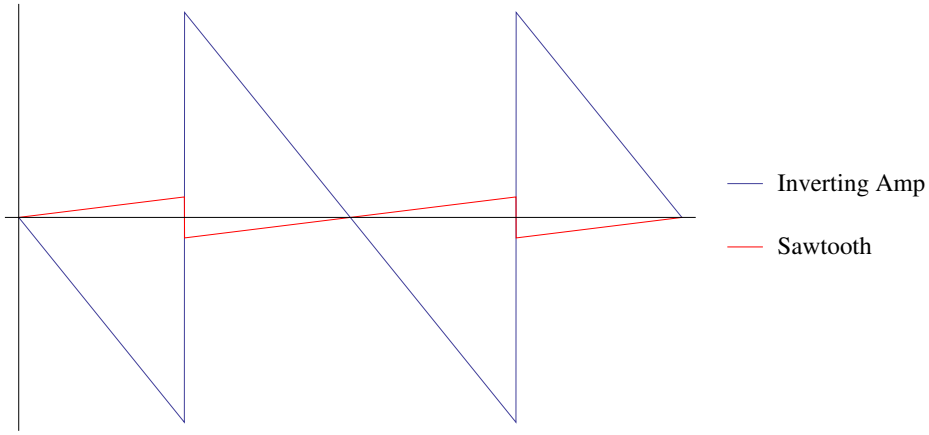

Non−Inverting Amp
Sawtooth

6.6 Inverting Amplifier

For an inverting amplifier, $V_{out} = (-\frac{R_2}{R_1}) * V_{in}$. In this case, $R_2 = 100k\Omega$, and $R_2 = 10k\Omega$, so $V_{out} = (-10) * V_{in}$.

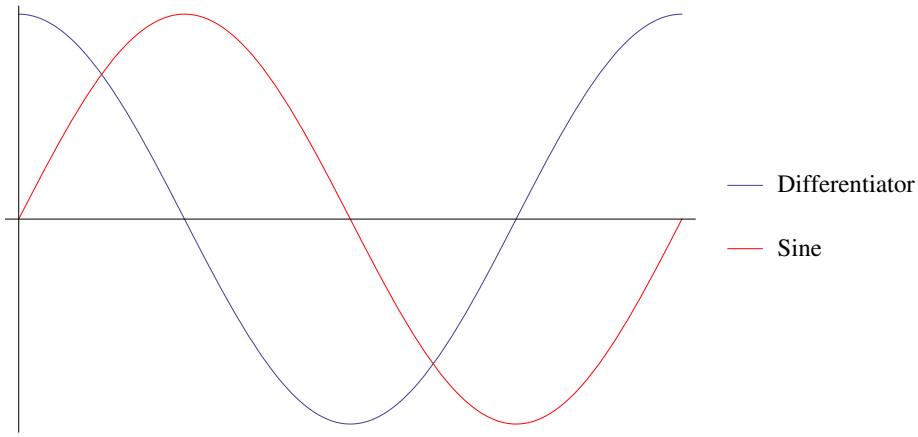


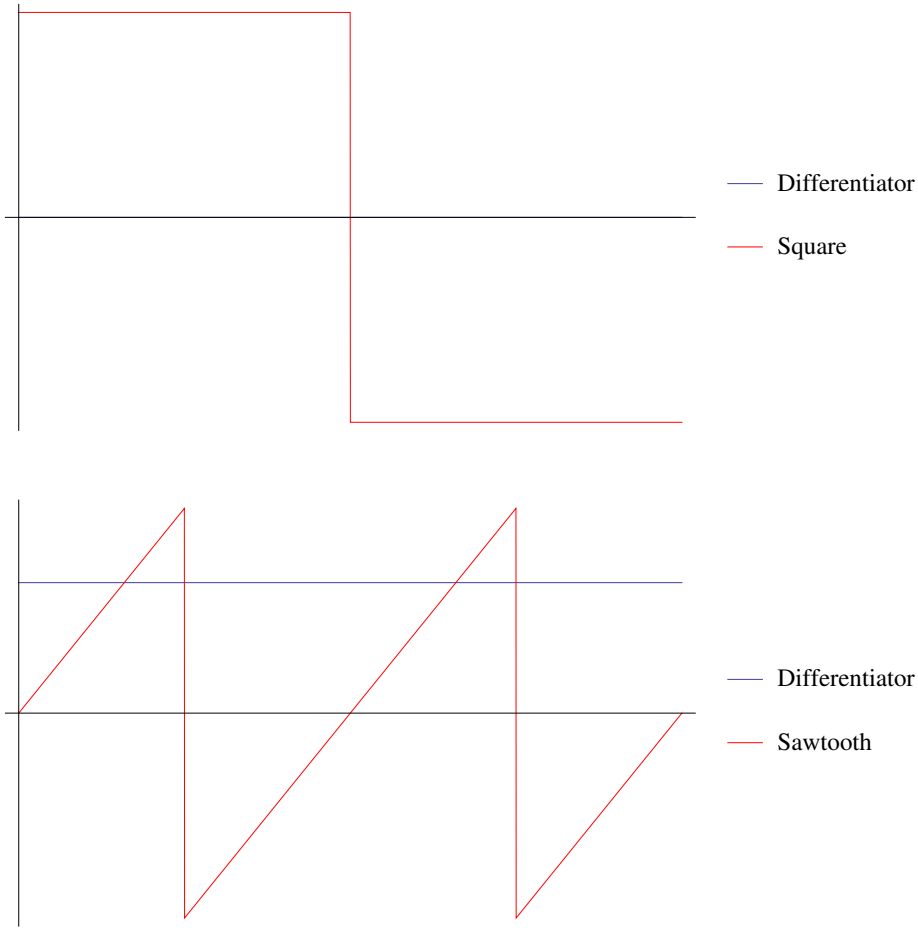




6.7 Differentiator

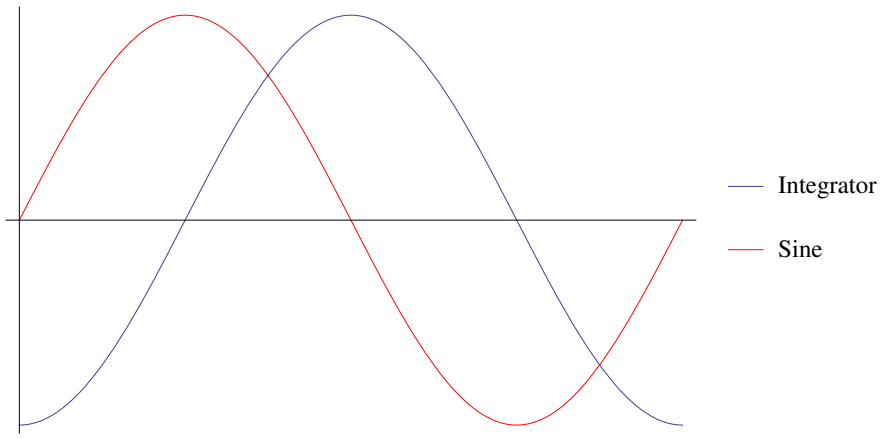
V_{out} is equal to the differential of V_{in} with respect to time. It does make sense to plot V_{out} and V_{in} by plotting both with respect to time.

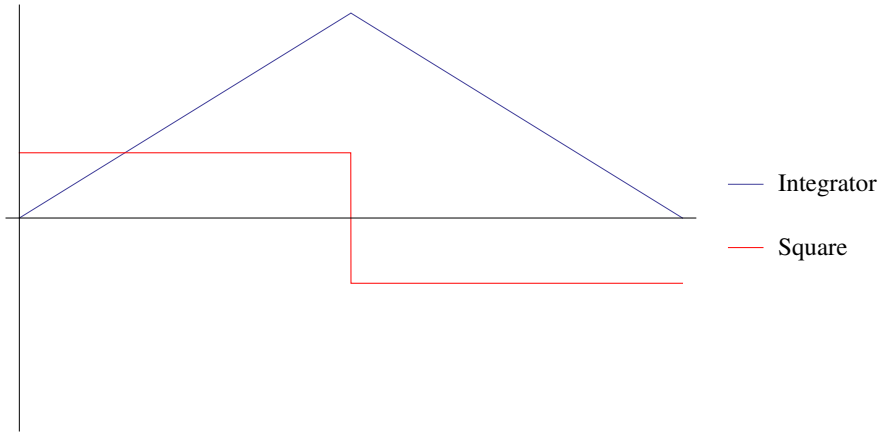


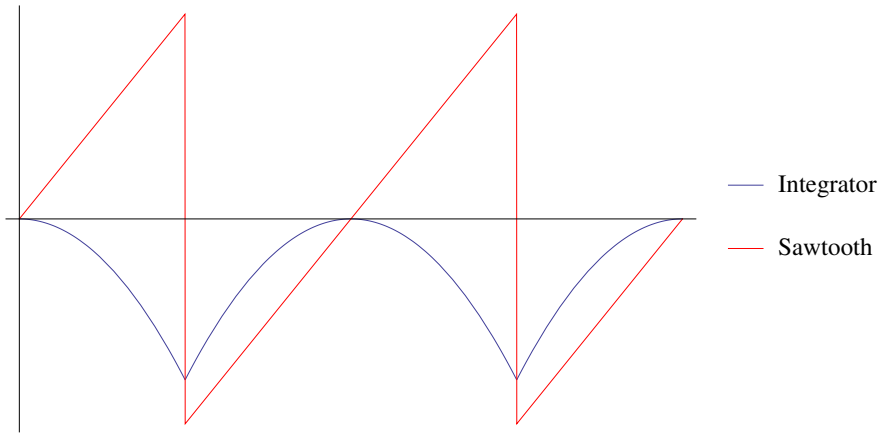


6.8 Integrator

V_{out} is equal to the integral of V_{in} with respect to time.


Integrator
Sine

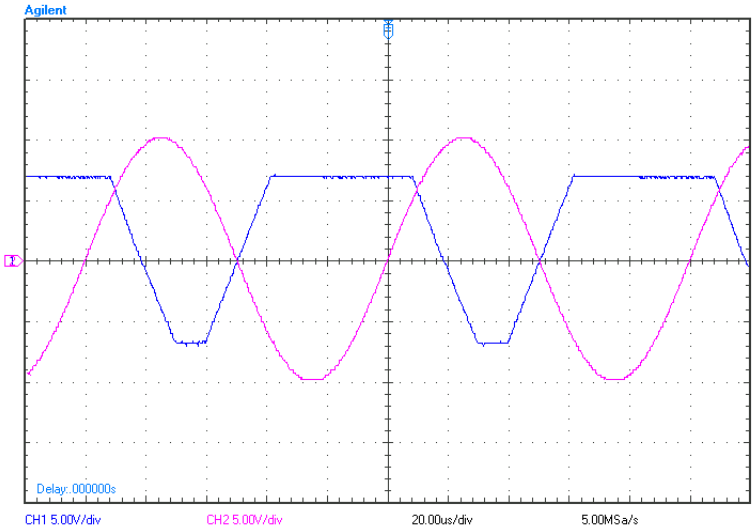

Integrator
Square

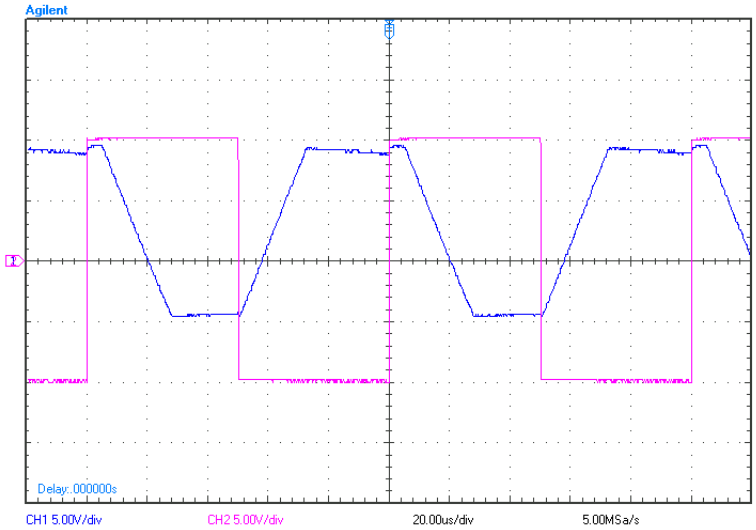

Integrator
Sawtooth

7 Appendix: Lab Data

In all of the following images, the Y-axis has units of Volts, and the X-Axis has units of time. The specific scaling varies and is marked on each image. Pink is the input signal, and blue is the output.

7.1 Comparator 1

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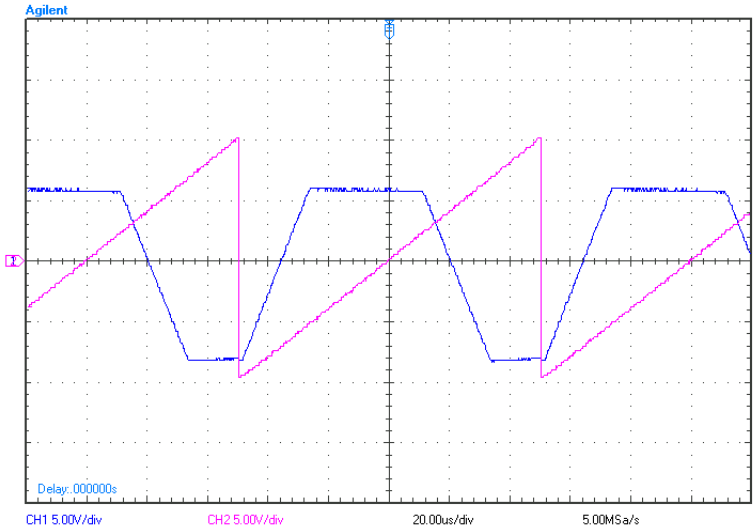
CH2 5.00V/div
20.00us/div
5.00MSa/s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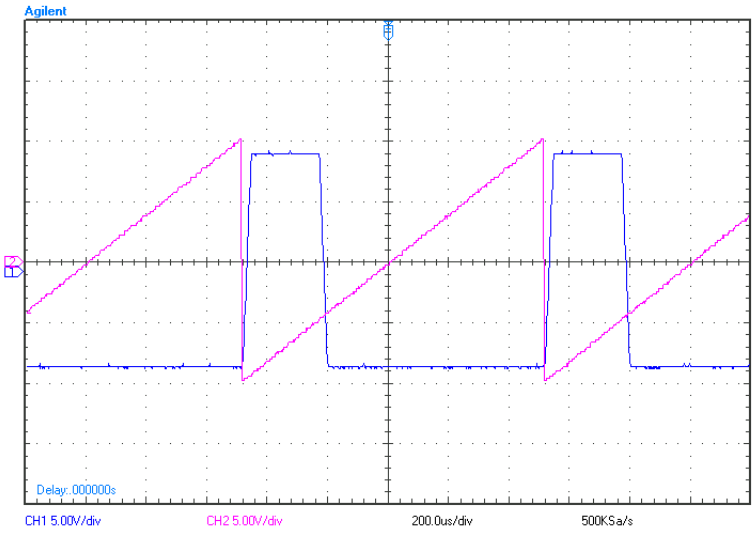
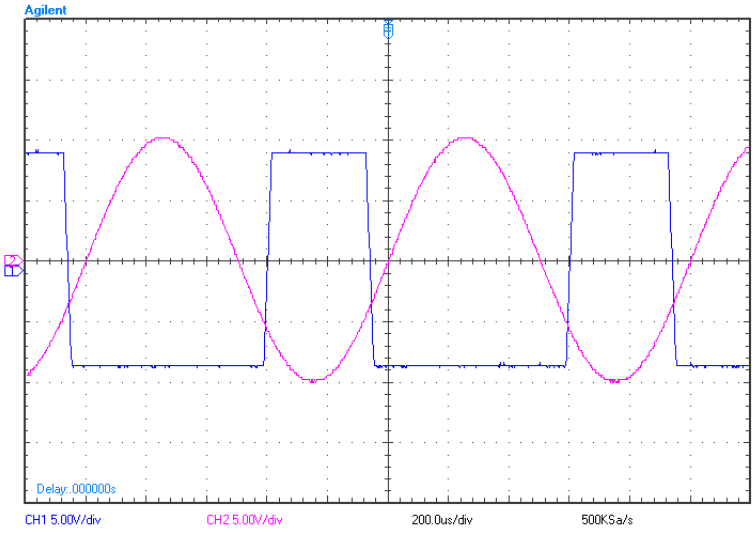
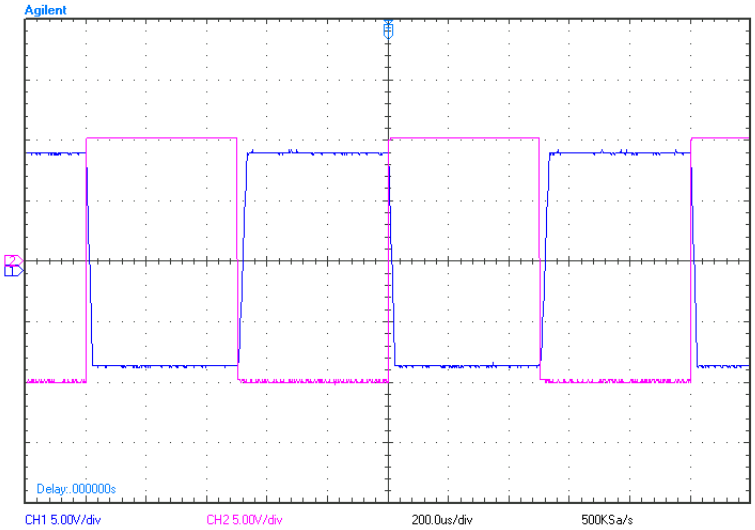
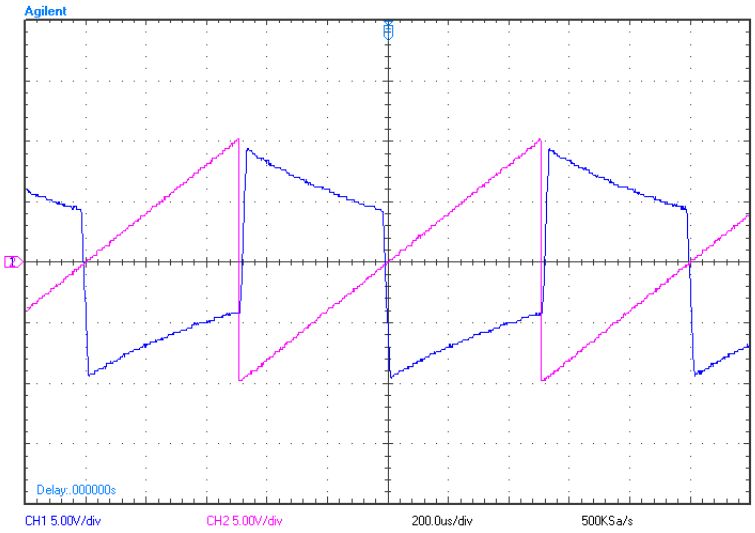
7.2 Comparator 2

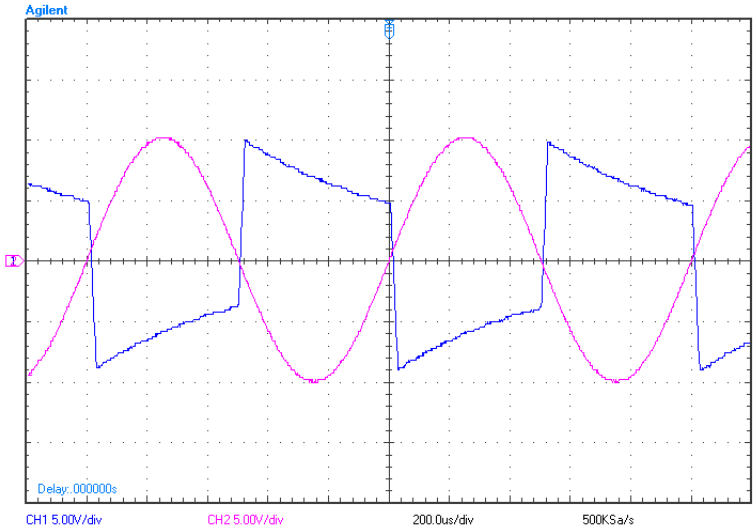






7.3 Schmidt Trigger

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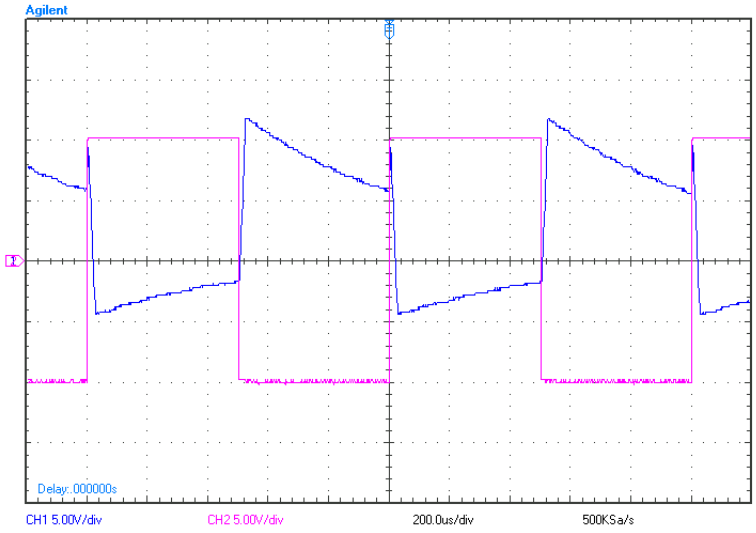
CH2 5.00V/div
200.0us/div
500KSa/s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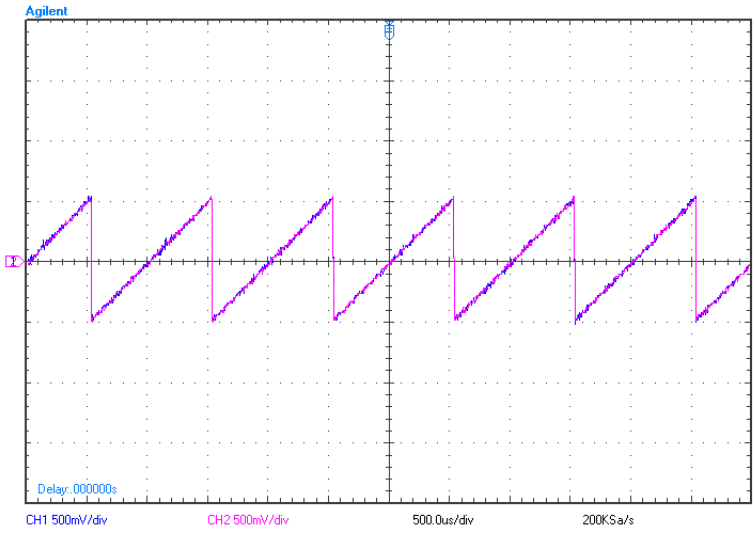
CH2 5.00V/div
200.0us/div
500KSa/s

7.4 Buffer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CH2 500mV/div
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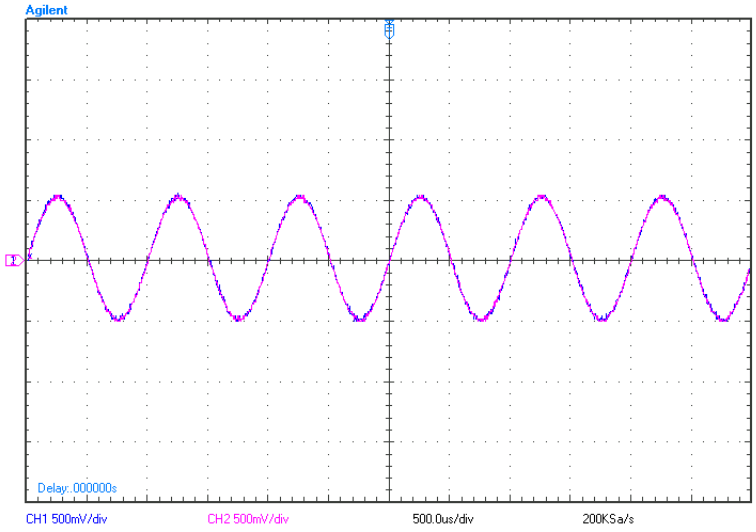
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CH2 500mV/div
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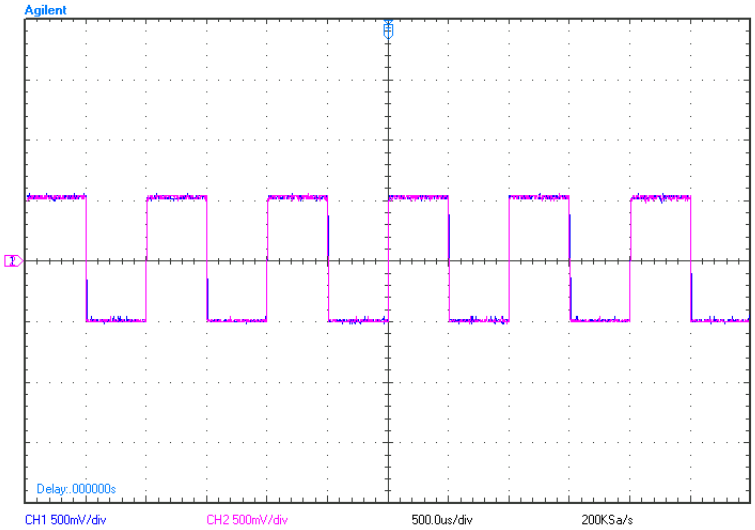
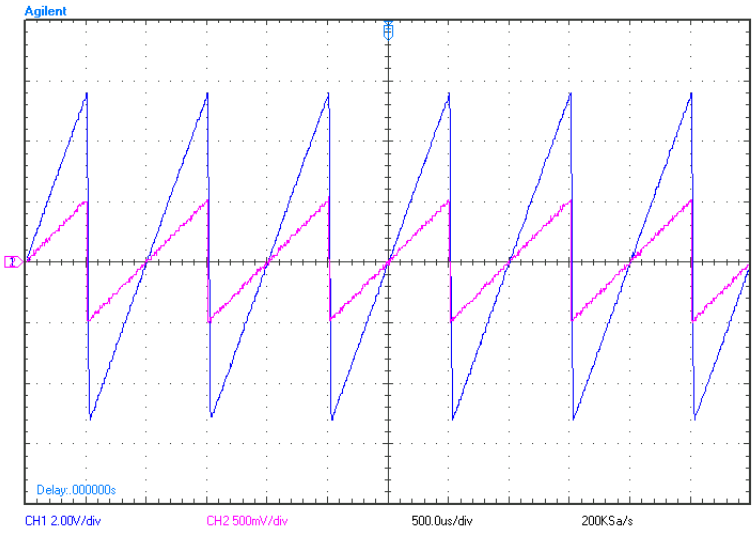
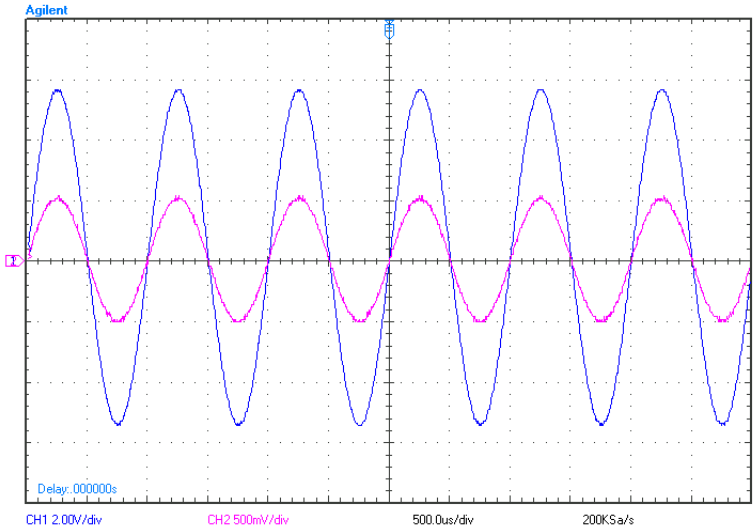


7.5 Non-inverting Amplifier




Agilent
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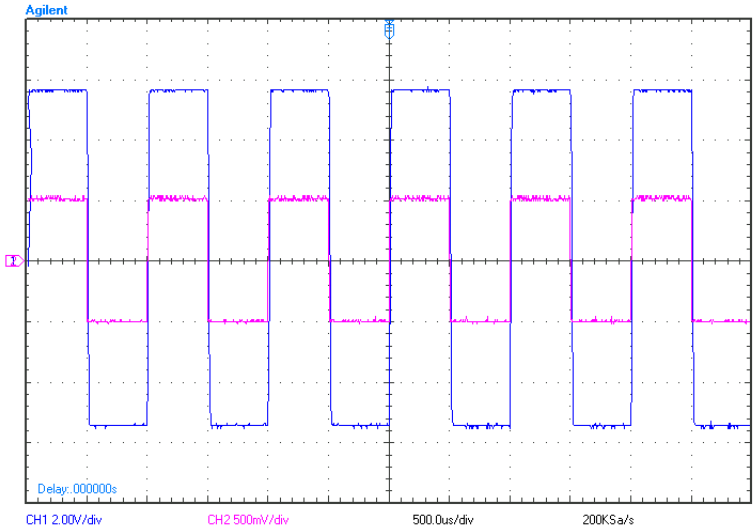
CH1 2.00V/div
CH2 500mV/div
500.0us/div
200KSa/s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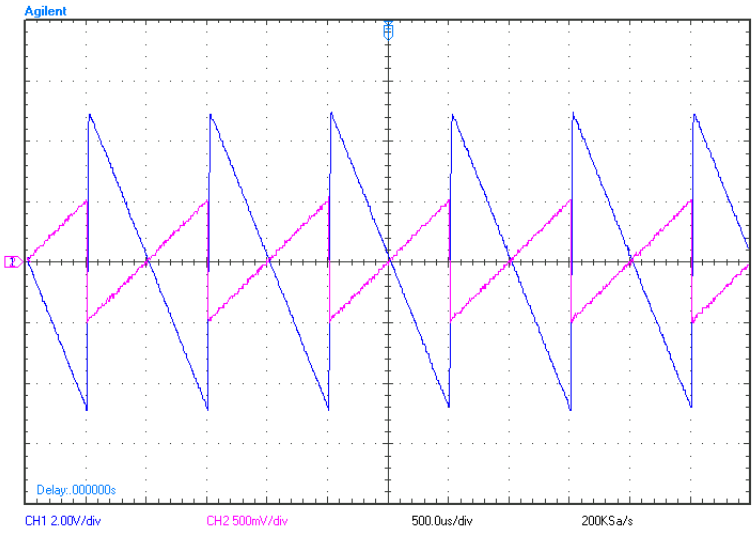
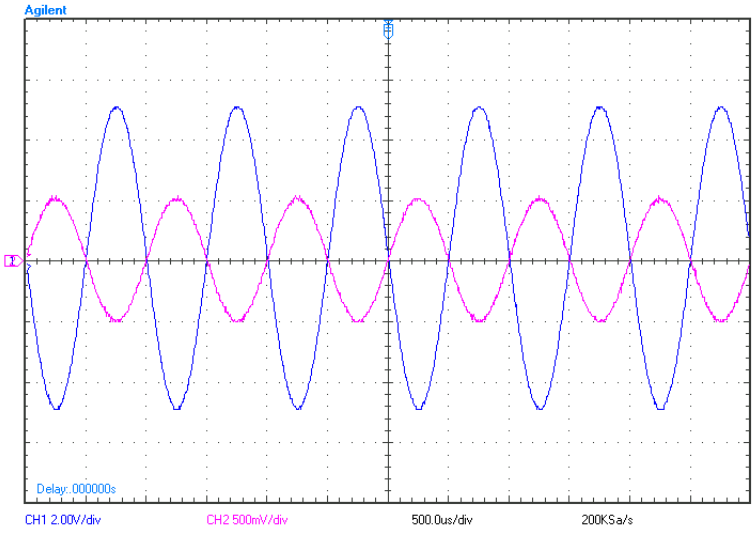
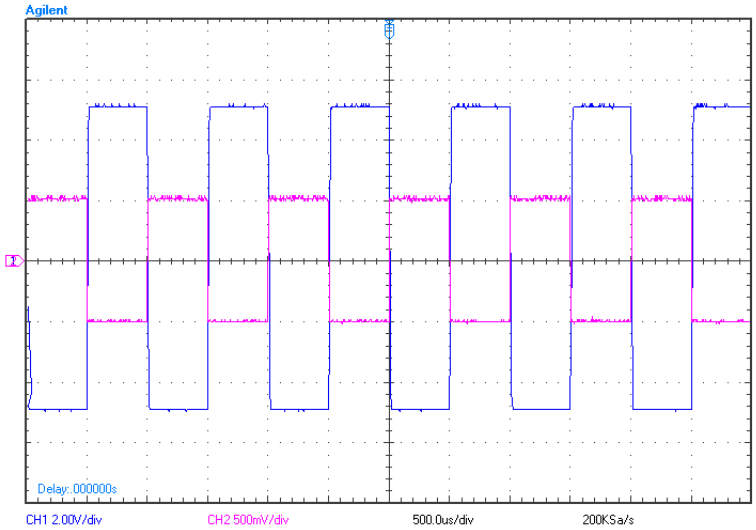
CH2 500mV/div
500.0us/div
200KSa/s

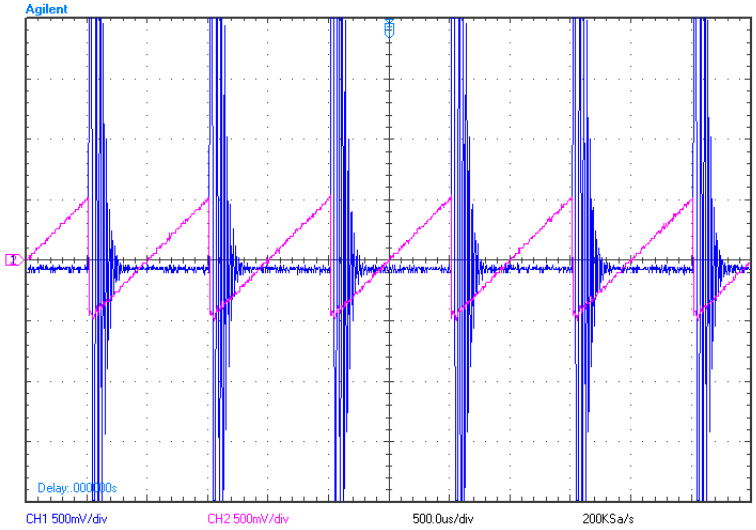
7.6 Inverting Amplifier

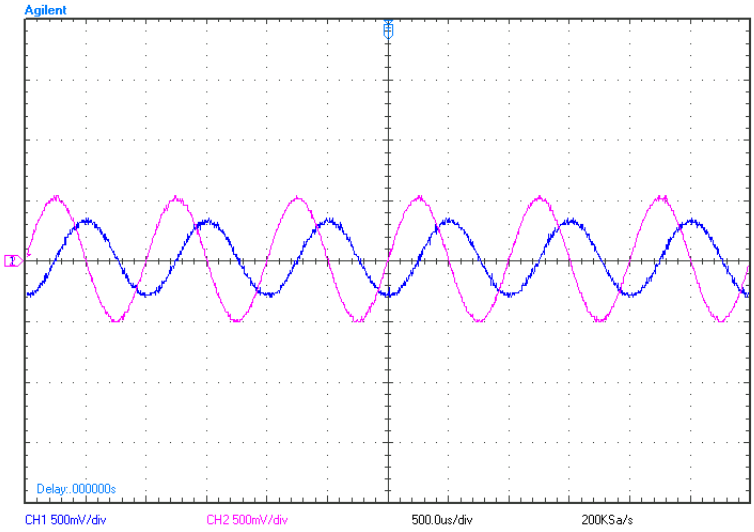






7.7 Differentiator




Agilent
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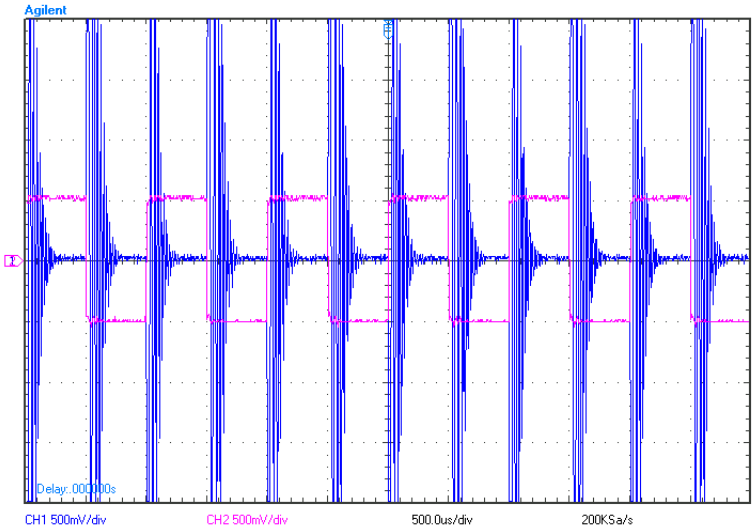
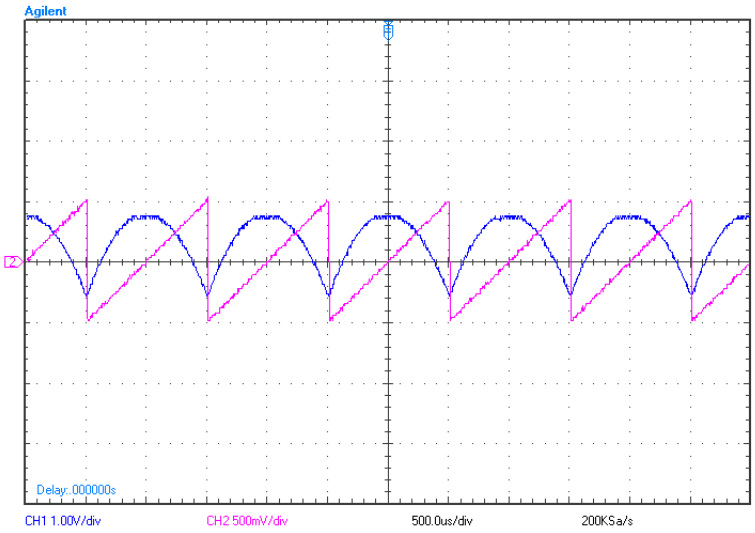
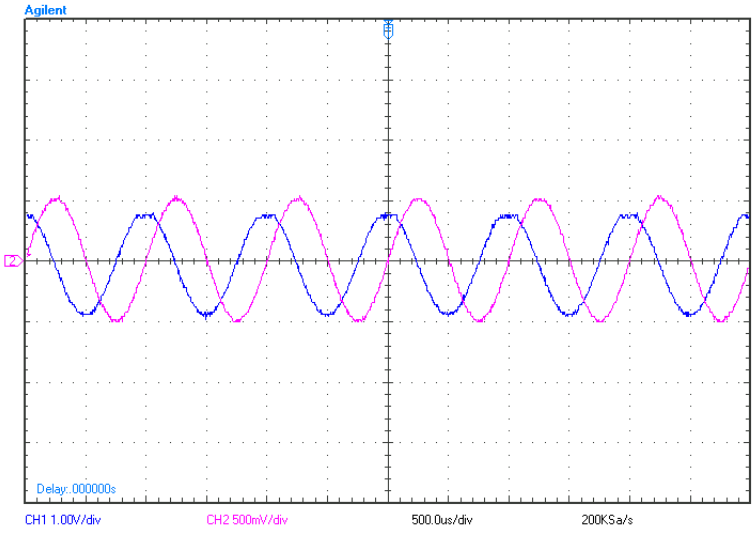
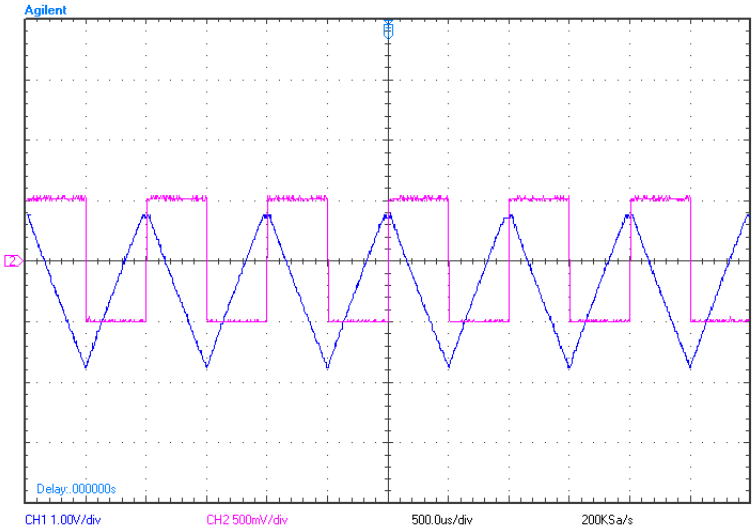
CH1 500mV/div
CH2 500mV/div
500.0us/div
200KSa/s


Agilent
Delay: 000000s
CH1 500mV/div
CH2 500mV/div
500.0us/div
200KSa/s

7.8 Integrator






Agilent
Delay: 000000s
CH1 1.00V/div
CH2 500mV/div
500.0us/div
200KSa/s