CMPE314: Principles of Electronic Circuits

Dr. Yan

Lab 03 Report:

Clippers and Clampers

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1. **Objective**

   Construct and measure clipper and clamper circuits and study their characteristics.

2. **Equipment**
   a. Resistors; 2 × 10 kΩ, 1 × 100 kΩ
   b. Capacitors; 1 × 0.22 μF
   c. Diodes; 2 × 1N4738, 1 × 1n4740
   d. Oscilloscope, DC power supply, digital multi-meter, function generator, breadboard

3. **Background**

   Clipper circuits limit or constrain signals by clipping off part of the signal in some region or compressing it in that region using a resistive voltage divider. Clamper circuits set a minimum and maximum value on an output AC waveform by shifting the DC level of the steady-state AC signal instead of altering its shape.

4. **Procedures**

4.1 Part A. Clipper Circuit I

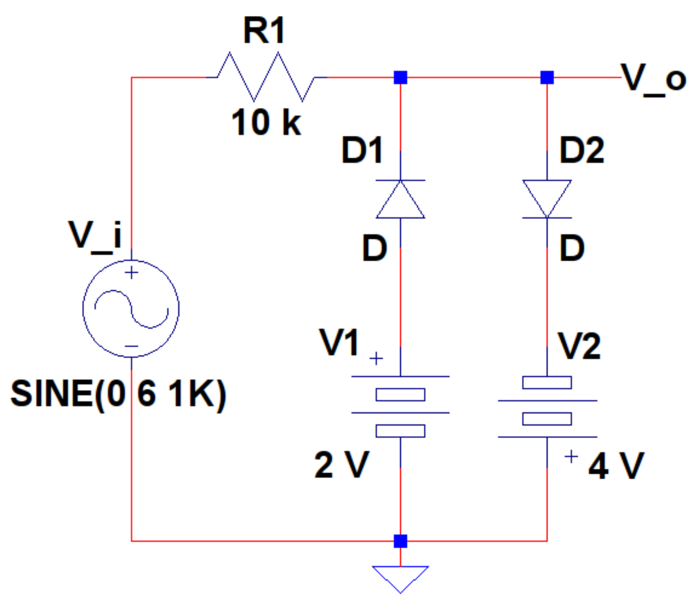

Figure 1: Clipper Circuit Without Resistor

a. Use a 1N4738 diode to construct the circuit from Figure 1.
b. Set the input signal amplitude to be 6 V and frequency to be 10 kHz.
c. Capture the input and output voltages on the oscilloscope with the input being a sinusoidal, square and saw-tooth waveform, respectively.
d. Save the sinusoidal input and output waveform data to plot alongside their theoretical computation.

4.2 Part B. Clipper Circuit II

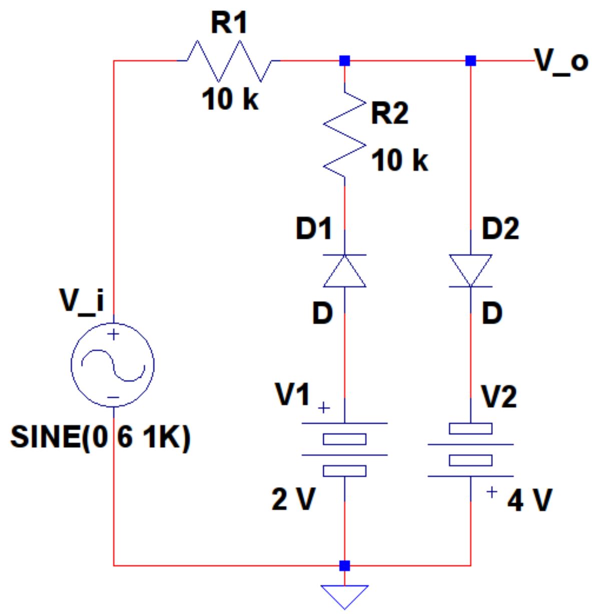

Figure 2: Clipper Circuit with Resistor

a. Repeat Part A with Figure 2.

4.3 Part C. Clamper Circuit

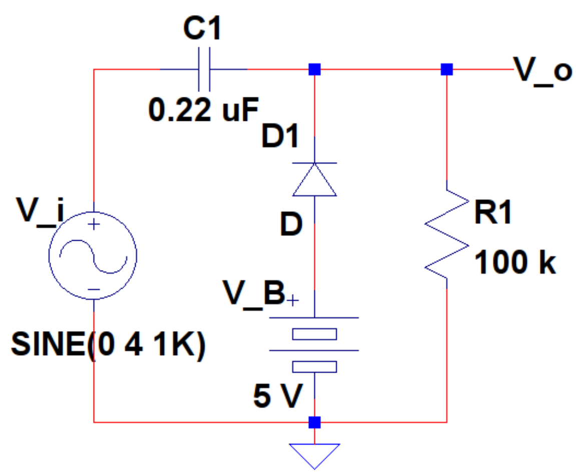

Figure 3: Clamper Circuit with V_B = 5 V

a. Use a 1N4740 diode to construct the circuit from Figure 3.
b. Set the input signal amplitude to be 4 V and frequency to be 10 kHz.
c. Capture the input and output voltages on the oscilloscope with the input being a sinusoidal and a square wave with +2 V peaks and -4 V valleys, respectively.
d. Save the sinusoidal input and output waveform data to plot alongside their theoretical computation.

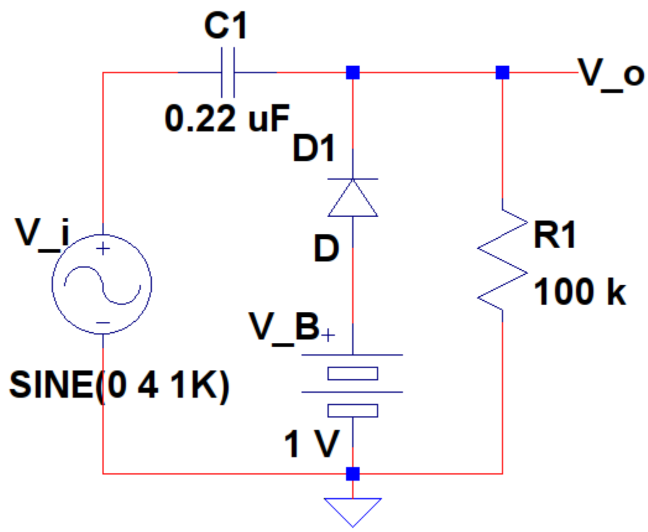

Figure 4: Clamper Circuit with V_B = 1 V

e. Repeat steps a. to d. with V_B = 1 V as in Figure 4.

5. Results

The clipper circuit from Figure 1 was constructed and the waveform on the oscilloscope was captured.

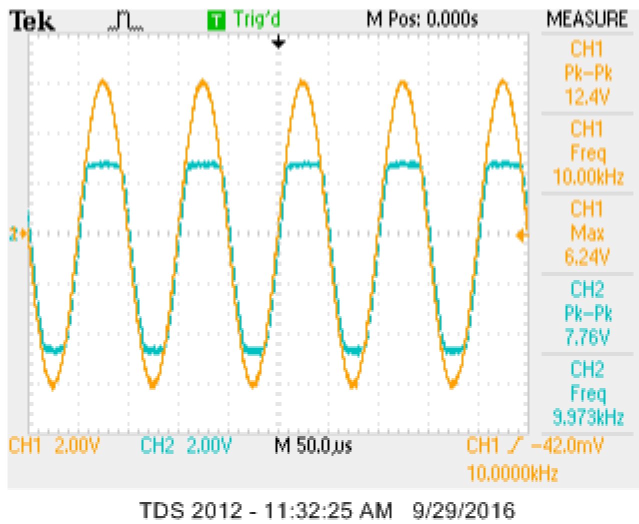

Figure 5: Waveform of Figure 1 on the Oscilloscope with Sinusoidal Inputs

The plot data was dumped and simulated as shown below in Figure 6.

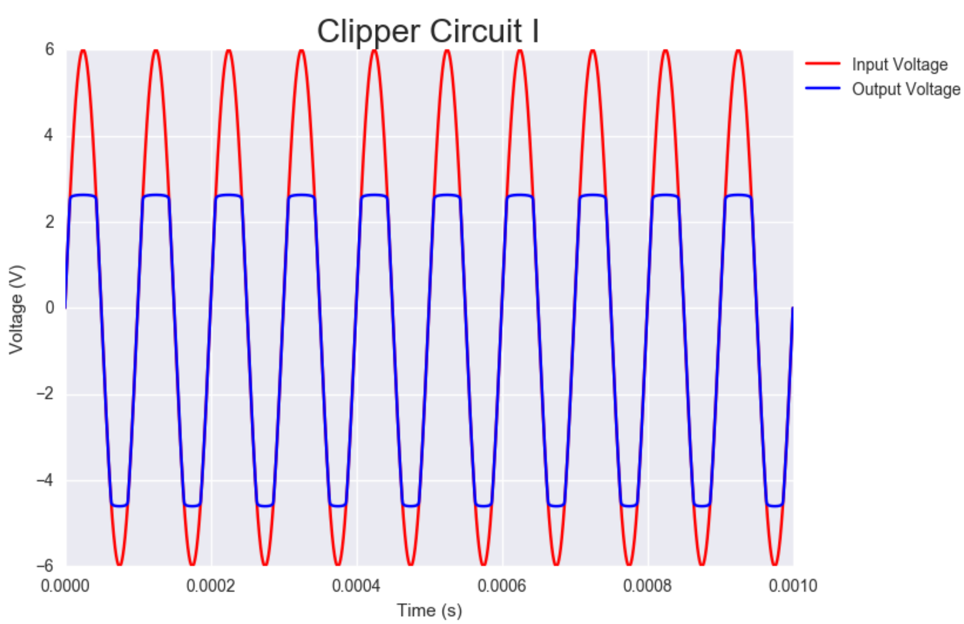

Figure 6: Simulation of the Figure 1 Waveform

The waveform was computed theoretically and simulated as well. The input sinusoidal was $V_{amp} \times sin(2\pi f) \rightarrow 6\sin(2\pi \times 10kHz) \rightarrow 6\sin(20000\pi)$. The output waveform was constructed as a piecewise function, where the output was clipped at its peak when it reached $V_{B_1} + V_\gamma = 2.7\ V$ and at its valley when $V_O = -\left(V_{B_2} + V_\gamma\right) = -4.7\ V$. The following output was constructed.

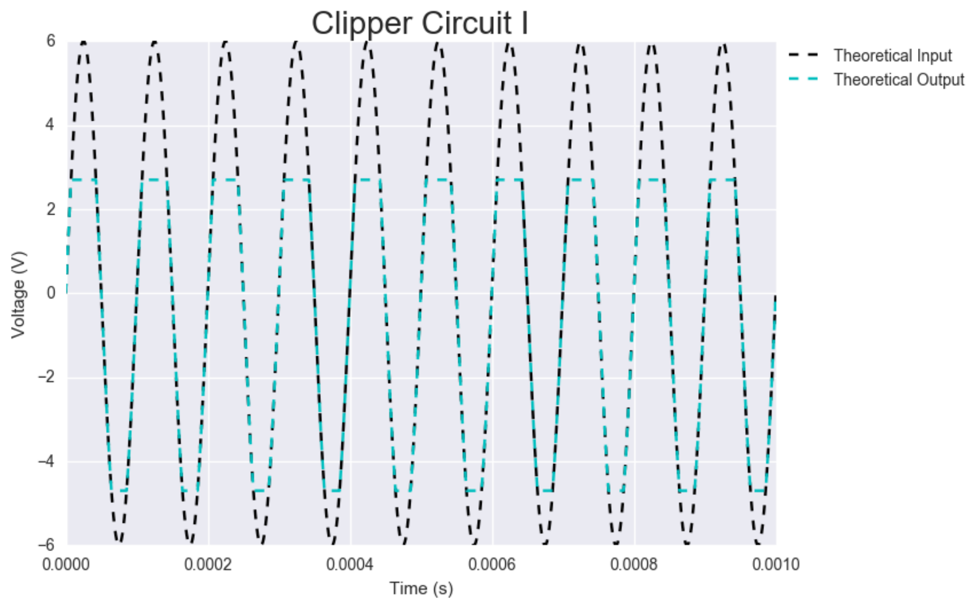

Figure 7: Simulation of the Theoretical Waveforms of Figure 1

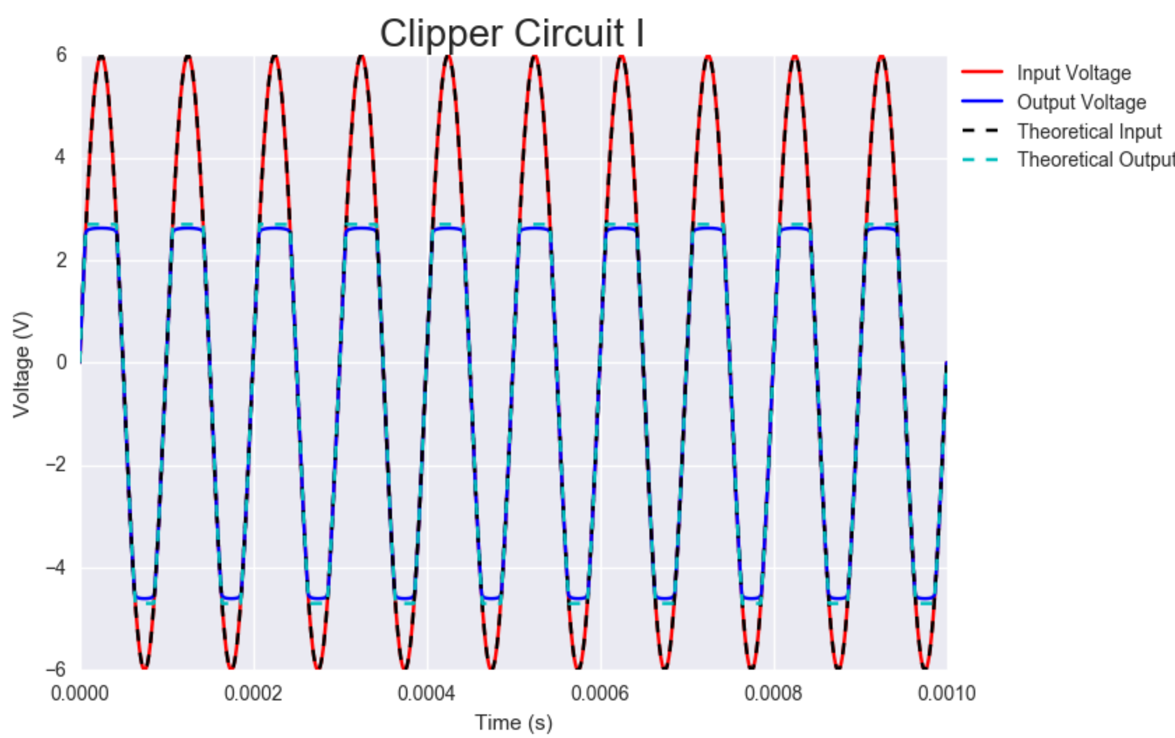

Figure 8: Simulation of Both the Dumped and Theoretically Computed Waveforms of Figure 1

The procedure was repeated with a square wave and a saw tooth input and captured on the oscilloscope.

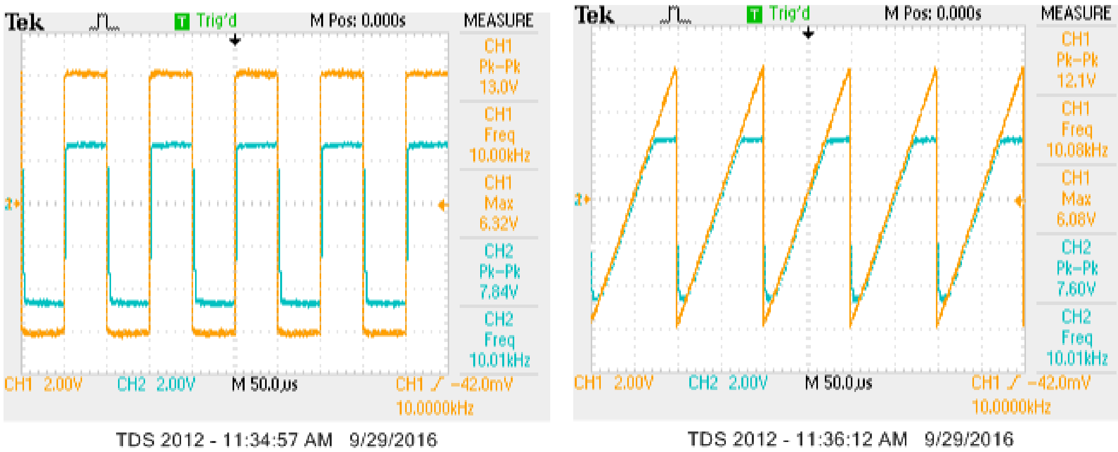

Figure 9: Waveforms of Figure 1 on the Oscilloscope with Square and Saw-tooth Wave Inputs

Identical steps were taken to generate waveforms for the clipper in Figure 2.

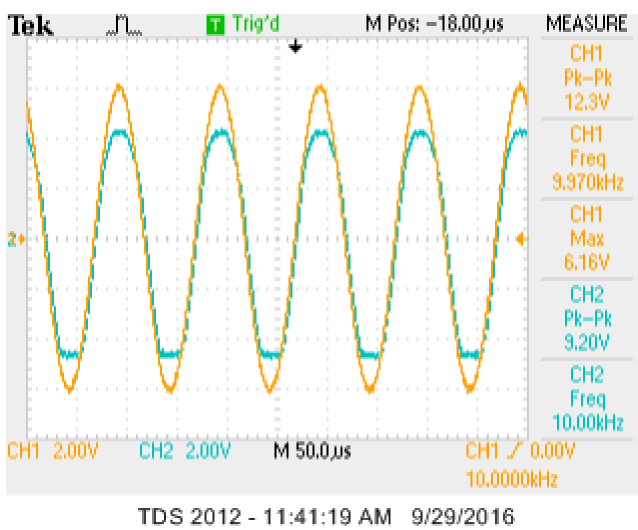

Figure 10: Waveform of Figure 2 on the Oscilloscope with Sinusoidal Inputs

The plot data was dumped and simulated as shown below in Figure 11.

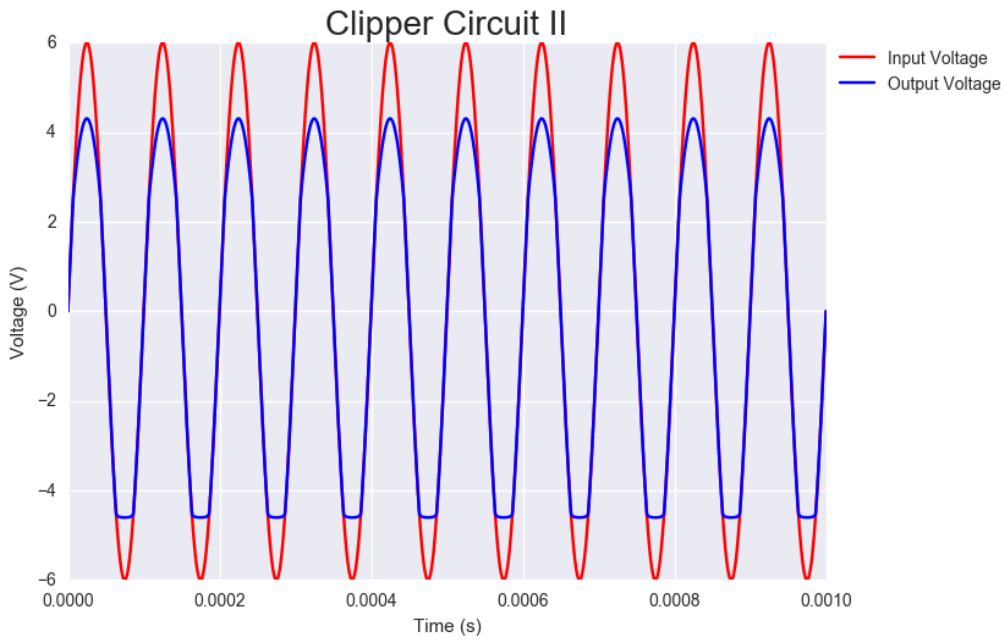

Figure 11: Simulation of the Figure 2 Waveform

The waveform was computed theoretically and simulated as well. The input sinusoidal was $6\sin(20000\pi)$. The output waveform was constructed as a piecewise function, where the output was clipped at its peak when it reached $V_{B_1} + V_\gamma = 2.7\ V$ and at its valley when $V_O = -\left(V_{B_2} + V_\gamma\right) = -4.7\ V$. The following output was constructed.

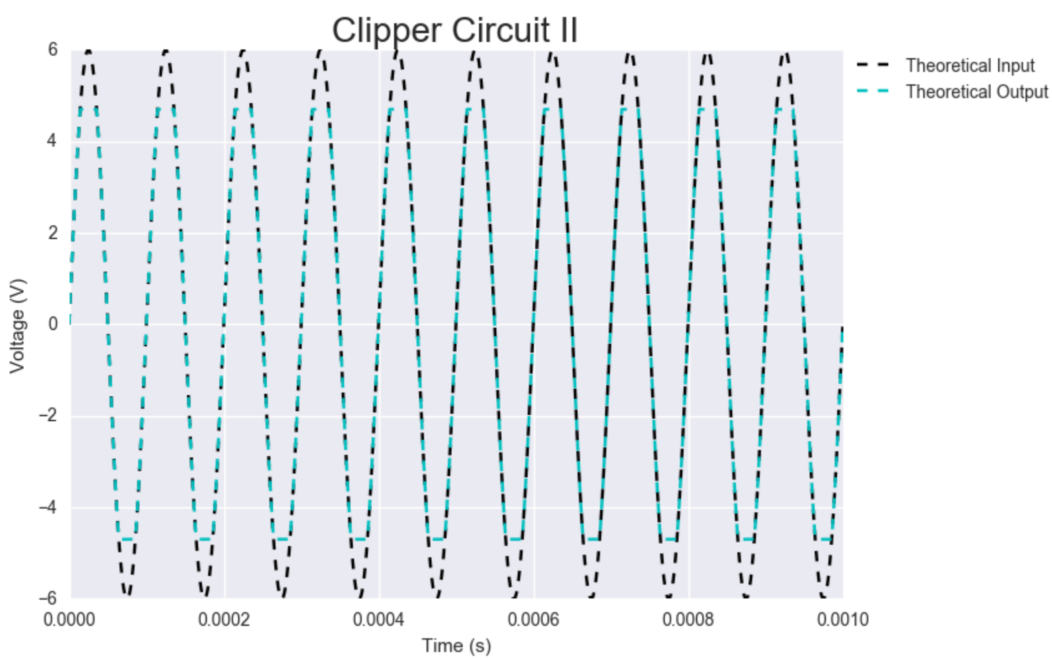

Figure 12: Simulation of the Theoretical Waveforms of Figure 2

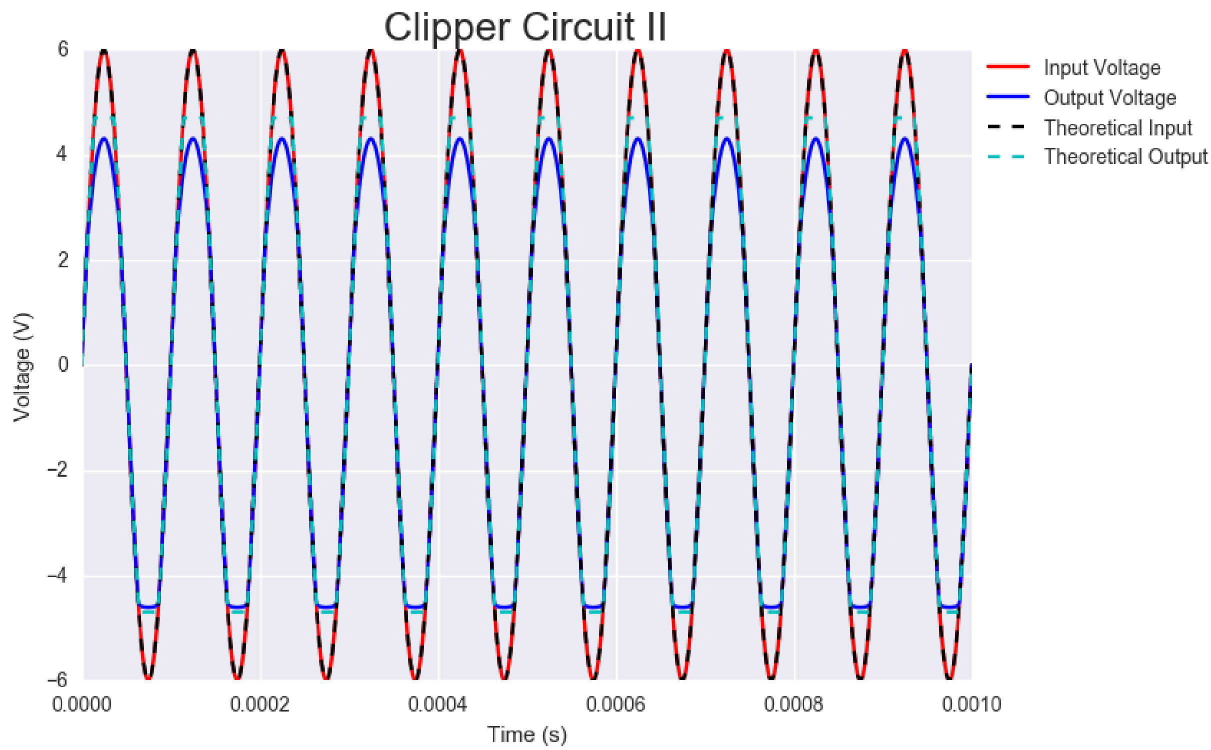

Figure 13: Simulation of Both the Dumped and Theoretically Computed Waveforms of Figure 2

The procedure was repeated with a square wave and a saw tooth input and captured on the oscilloscope.

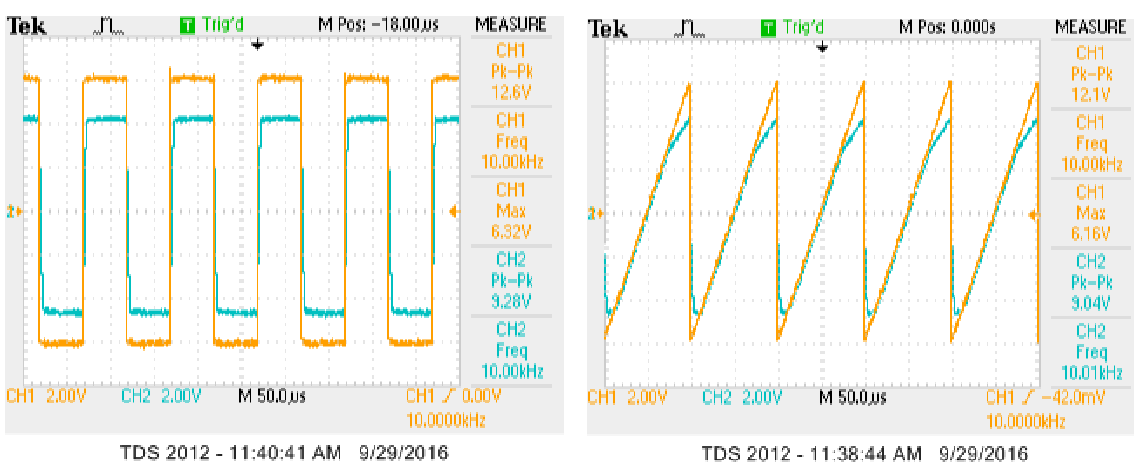

Figure 14: Waveforms of Figure 2 on the Oscilloscope with Square and Saw-tooth Wave Inputs

Identical steps were taken to generate waveforms for the clamper circuit in Figure 3.

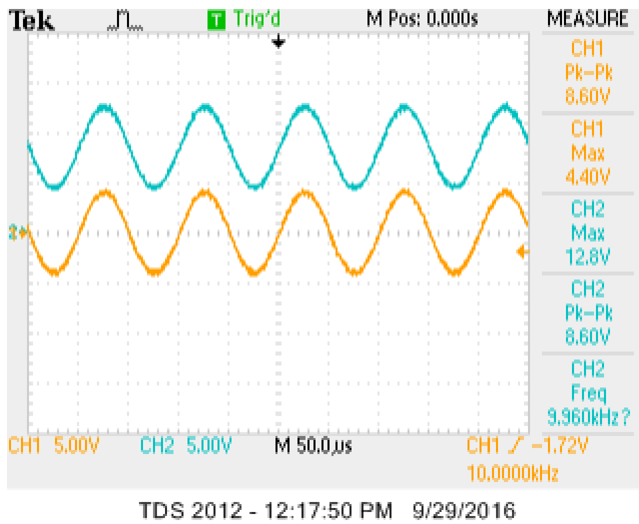

Figure 15: Waveform of Figure 3 on the Oscilloscope with Sinusoidal Inputs

The plot data was dumped and simulated as shown below in Figure 16.

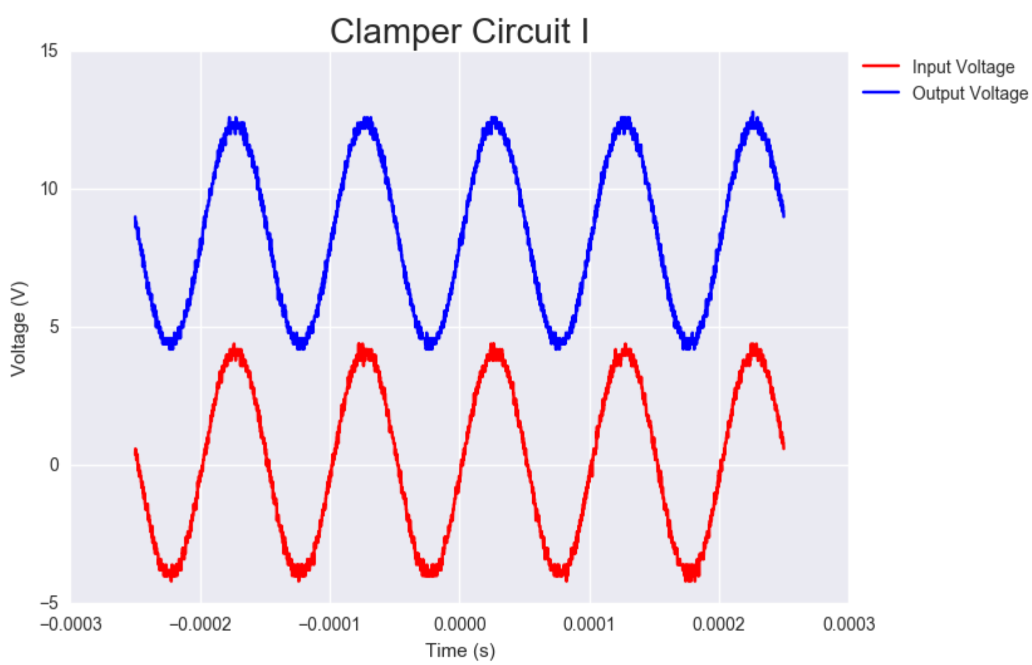

Figure 16: Simulation of the Figure 3 Waveform

The waveform was computed theoretically and simulated as well. The input sinusoidal was $4\sin(20000\pi)$. The output waveform was simply the input function shifted up $V_B + V_\gamma\ + manual\ offest = 5.7 + 2 = 7.7\ V$. The following output was constructed.

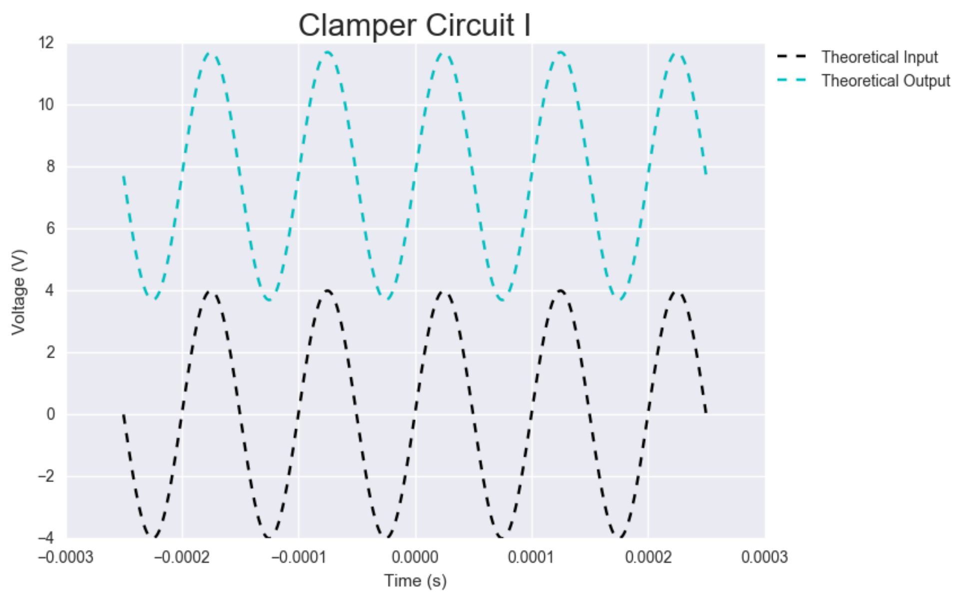

Figure 17: Simulation of the Theoretical Waveforms of Figure 3

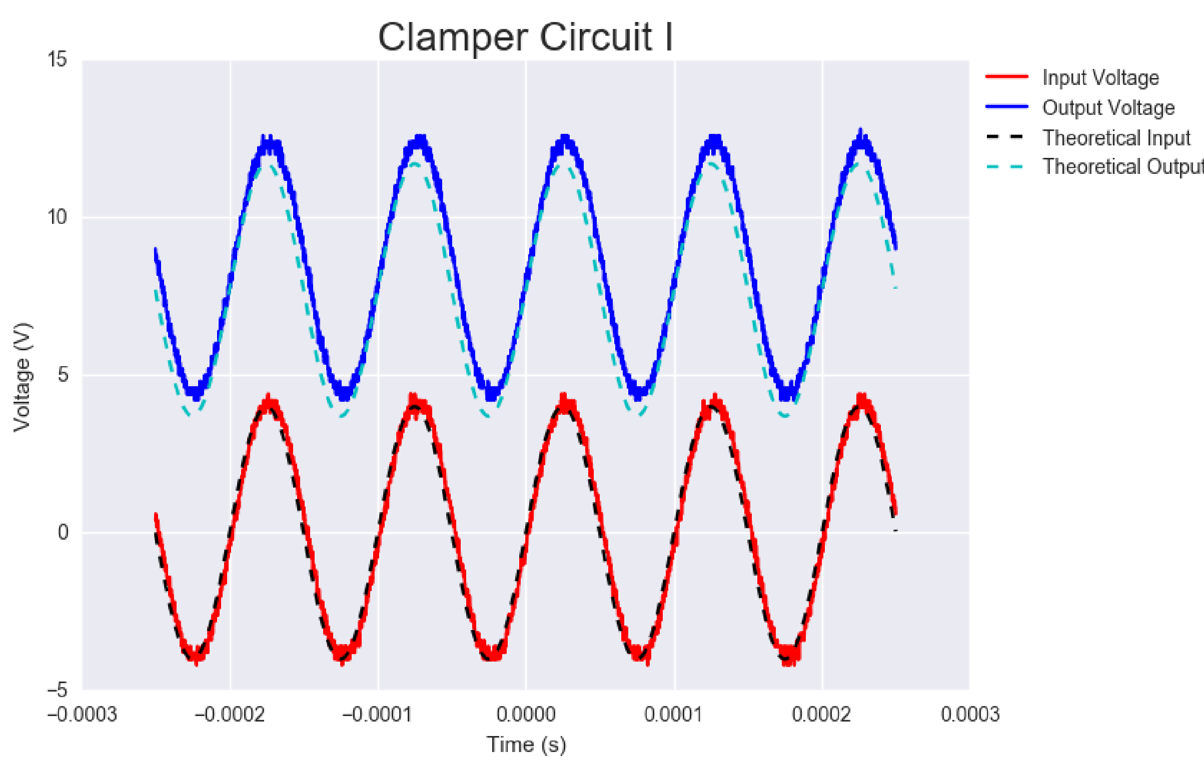

Figure 18: Simulation of Both the Dumped and Theoretically Computed Waveforms of Figure 3

The procedure was repeated with a square wave input with an offset of +2 V and captured on the oscilloscope.

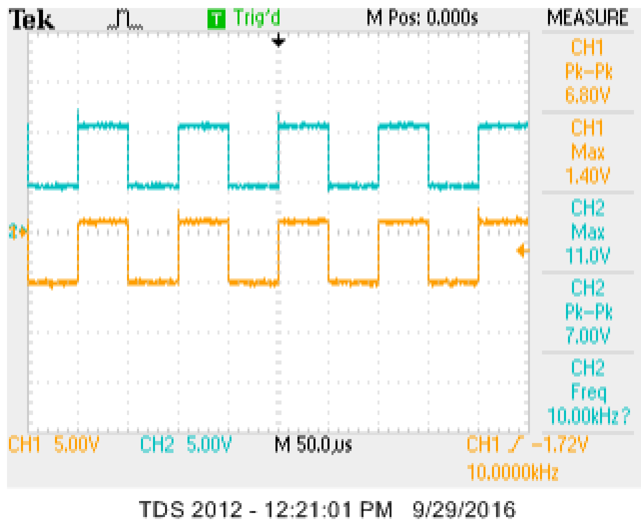

Figure 19: Waveforms of Figure 3 on the Oscilloscope with Square Wave Inputs

Identical steps were taken to generate waveforms for the clamper circuit in Figure 4.

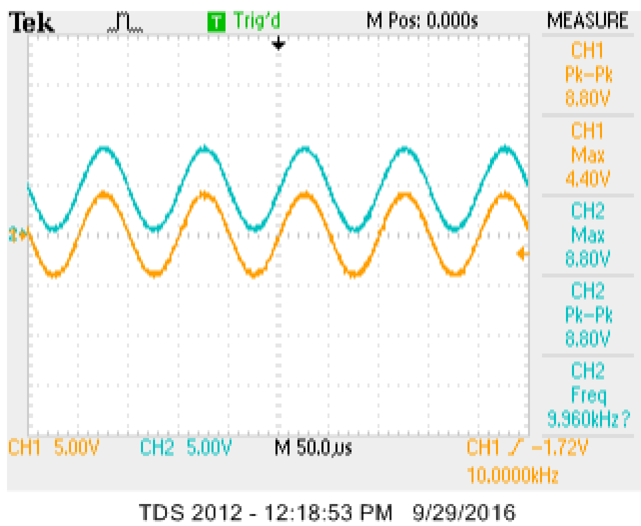

Figure 20: Waveform of Figure 4 on the Oscilloscope with Sinusoidal Inputs

The plot data was dumped and simulated as shown below in Figure 21.

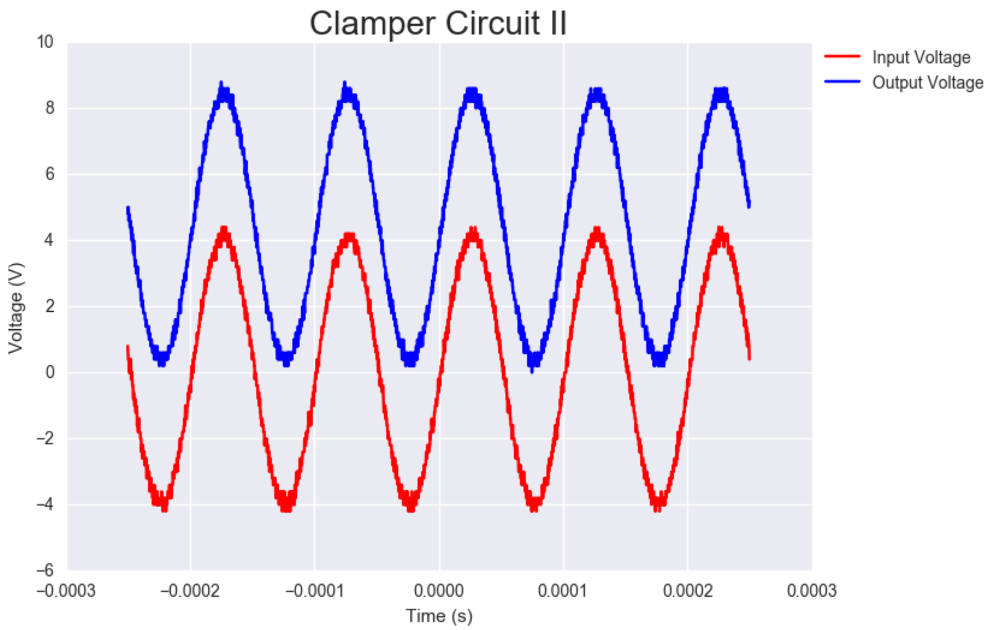

Figure 21: Simulation of the Figure 3 Waveform

The waveform was computed theoretically and simulated as well. The input sinusoidal was $\sin(20000\pi)$. The output waveform was simply the input function shifted up $V_B + V_\gamma + manual\ offest = 1.7 + 2.8 = 4.5\ V$. The following output was constructed.

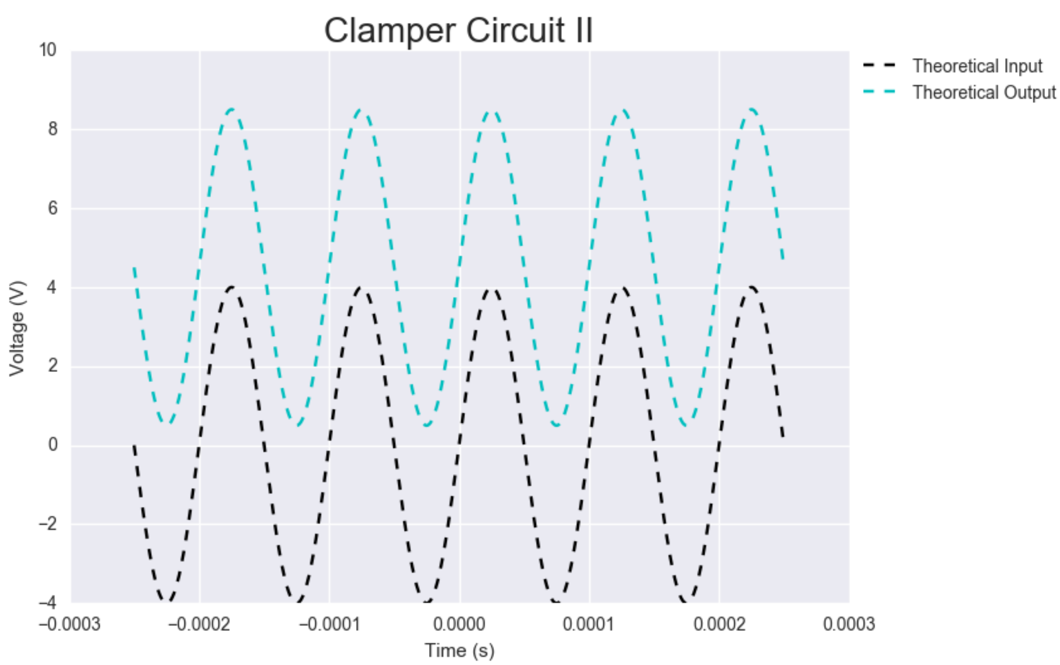

Figure 22: Simulation of the Theoretical Waveforms of Figure 4

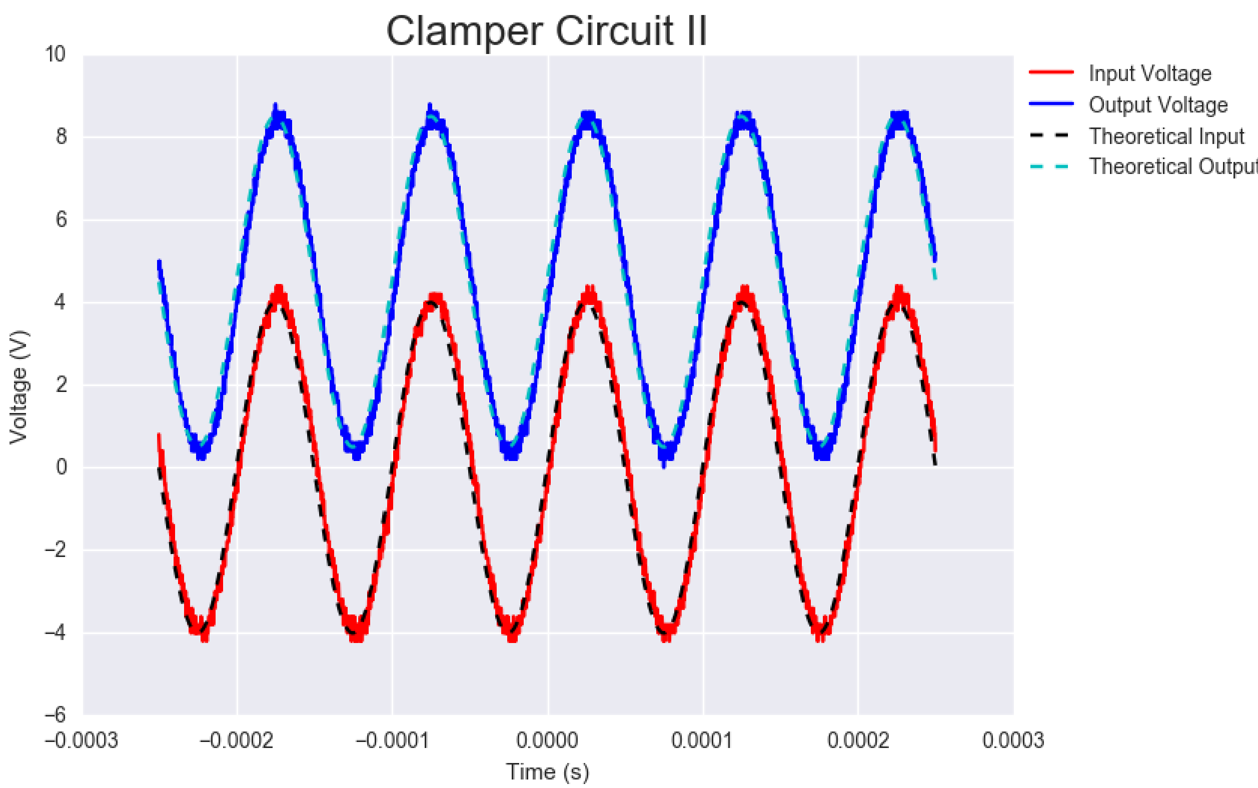

Figure 23: Simulation of Both the Dumped and Theoretically Computed Waveforms of Figure 3

The procedure was repeated with a square wave input with an offset of +2 V and captured on the oscilloscope.

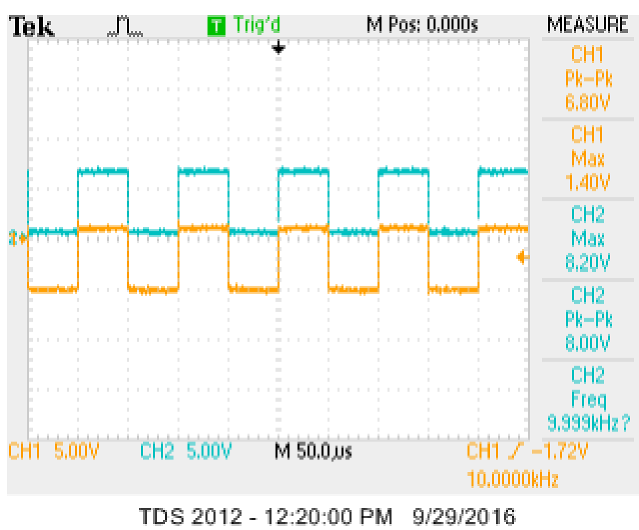

Figure 24: Waveforms of Figure 4 on the Oscilloscope with Square Wave Inputs

6. Conclusion

The characteristics of clipper and clamper circuits, although appear simplistic, have many uses in real world applications. Simulating the waveforms mathematically was possible without much difficulty as demonstrated.