ECE 4705 Lab
Experiment 7 – Demodulation of AM Wave
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ECE4705L_03

ECE 4705L **EXPERIMENT 7**

DEMODULATION OF AM WAVE

INTRODUCTION

The objective of this week's experiment is to become familiar with the envelope detection of an Amplitude Modulated (AM) signal. An AM wave uses a carrier signal, usually one of high frequency, to modulate a message signal of lower frequency. Envelope detection of an AM wave is a process of demodulation in which the original message signal is detected and recovered from the modulated signal. The demodulation of an AM wave involves a number of steps and can be implemented using a combination of basic circuit elements. By placing capacitors, resistors, and a diode in the arrangement in Fig. 1 below, a circuit that functions as a simple envelope detector can be made. Here $y_1(t)$ is the generated AM signal, $y_2(t)$ is the diode half wave rectified signal, $y_3(t)$ is the signal after the DC component is filtered out, and $y_4(t)$ is the signal after passing through a lowpass filter. The values of the resistor and capacitors needed for this specific circuit to function properly for the given AM signal must first be determined from the time constant τ, where τ is equal to RC or $\frac{1}{2\pi f_c}$. An AM modulated signal is denoted by the equation,

$$y(t) = A_c[1 + \mu\cos(2\pi f_m t)]\cos(2\pi f_c t).$$

If the resistance is set to a reasonable constant value, the specified carrier frequency can be substituted into the time constant equation to determine the appropriate values for the capicitors. If the values of R_1 and C_1 are too large then the lowpass filter's frequency is too slow to properly follow the message, and if they are too high, the frequency is too fast and only the carrier signal will follow. R_2 and C_2 create a highpass filter that act like a DC block eliminating any DC component in the signal, and R_3 and C_3 create a final lowpass filter that helps reduce the ripple of the demodulated signal.

LAB

A simple envelope was created in the lab to become more familiar with AM demodulation. In Fig. 1, there are multiple voltages that will be measured to observe the process of envelope detection for the given AM signal. As described earlier, $y_1(t)$ is the generated AM wave, $y_2(t)$ is the diode half wave rectified signal, $y_3(t)$ is the signal after the DC component is filtered out, and $y_4(t)$ is the signal after passing through a lowpass filter. After choosing appropriate values for the resistors and capaictors, the following time domain waveforms were recovered. Observing the circuit shown in Figure 1, we generated the following AM wave:

$$y_1(t) = A_c\left[1 + m\cos(2p \times 5{,}000t)\right]\cos(2p \times 80{,}000t),$$

using the HP 3312A function generator. After finding suitable values for the capacitors and resistors, we built the envelope detector one stage at a time, using the calculated values of resistance and capacitance. It is helpful to first find a capacitance that works well, and then fine tune the resistance.

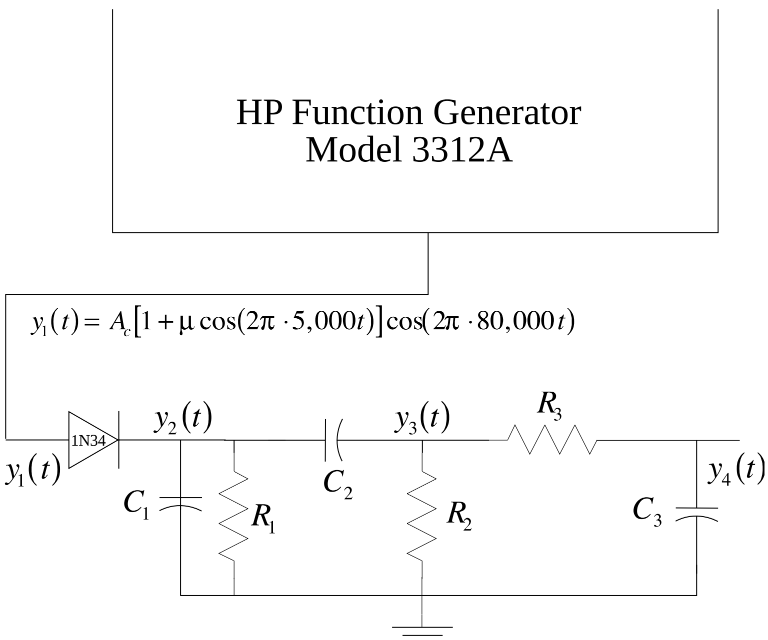

Fig. 1 – Envelope Detector for AM Modulated Signal

After measuring the voltages at each given stage, $y_1(t)$, $y_2(t)$, $y_3(t)$, and $y_4(t)$, with the oscilloscope, the following graphs were obtained showing the time-domain waveforms at each stage.

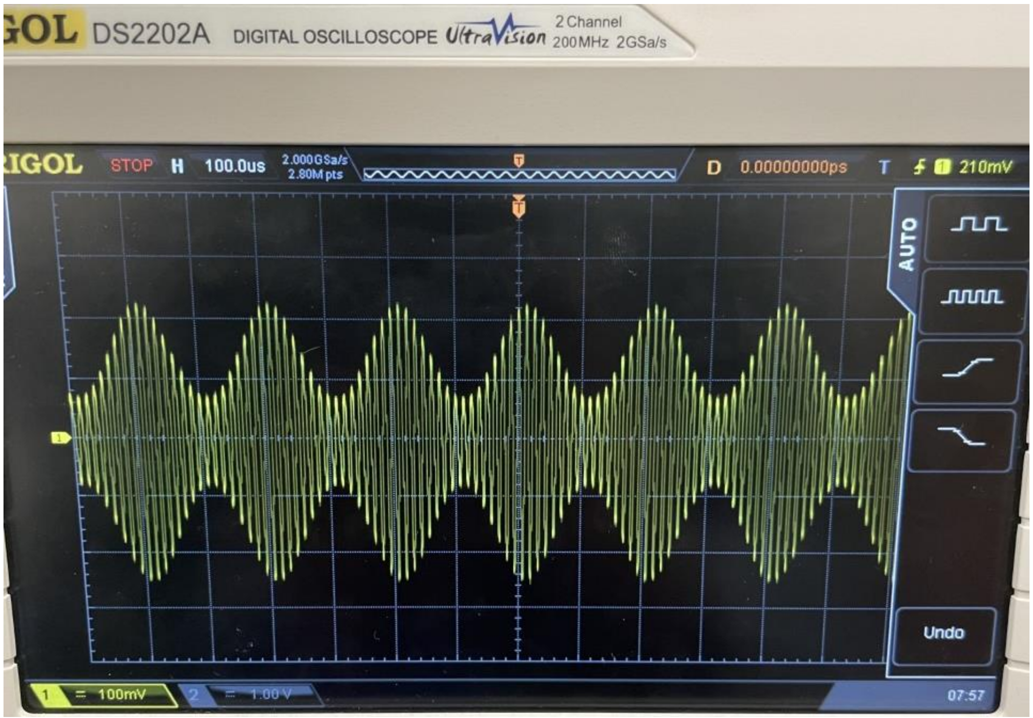

Fig. 2 – Time-Domain Waveform of Voltage at $y_1(t)$

The first time-domain graph is that of the AM modulated signal.

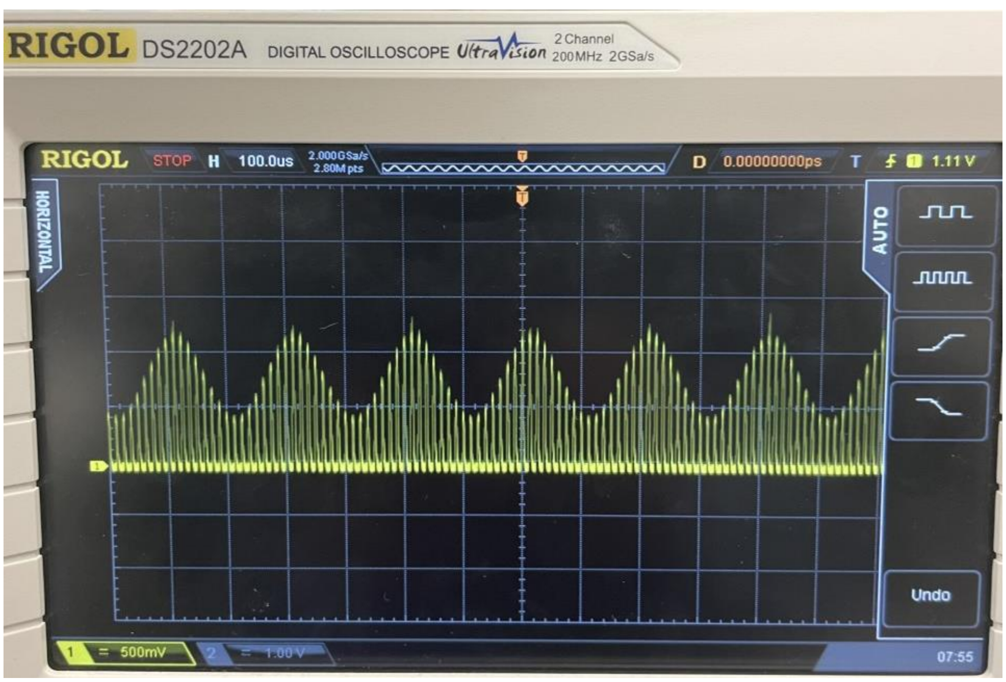

Fig. 3 – Time-Domain Waveform of Voltage at $y_2(t)$

This graph depicts the time-domain behavior of the signal after passing through the diode rectifier, effectively eliminating the values below zero. In doing this, it allows us to single out the positive values, which are the ones that will be used for envelope detection.

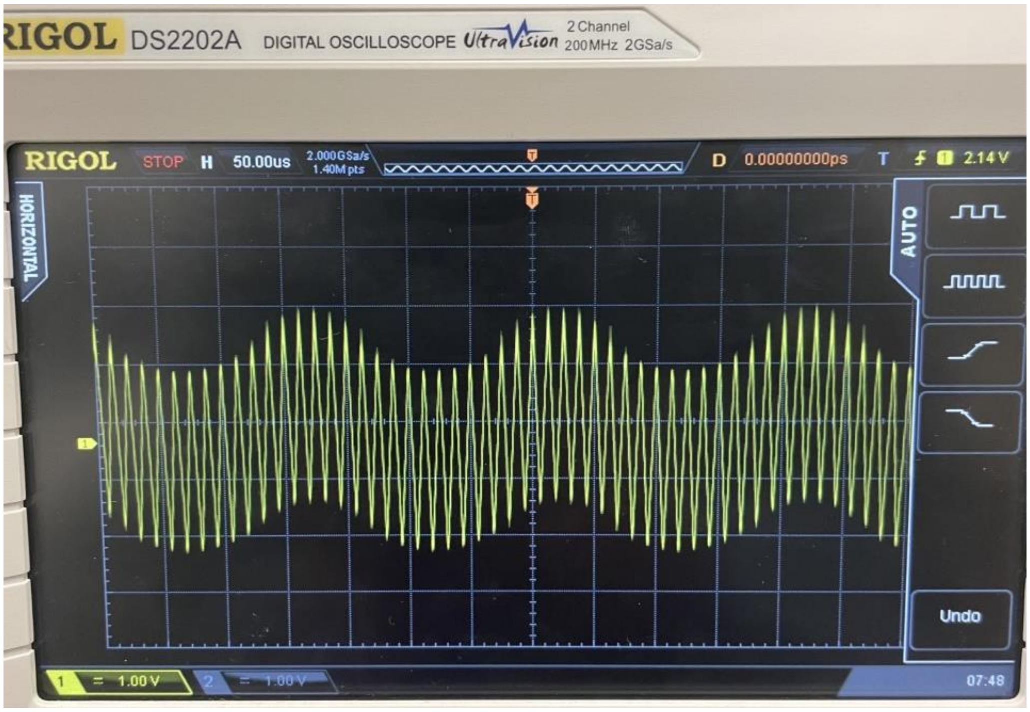

Fig. 4 – Time-Domain Waveform of Voltage at $y_3(t)$

The time divisions for Fig. 4 are reduced making the frequency appear lower than in the other figures.

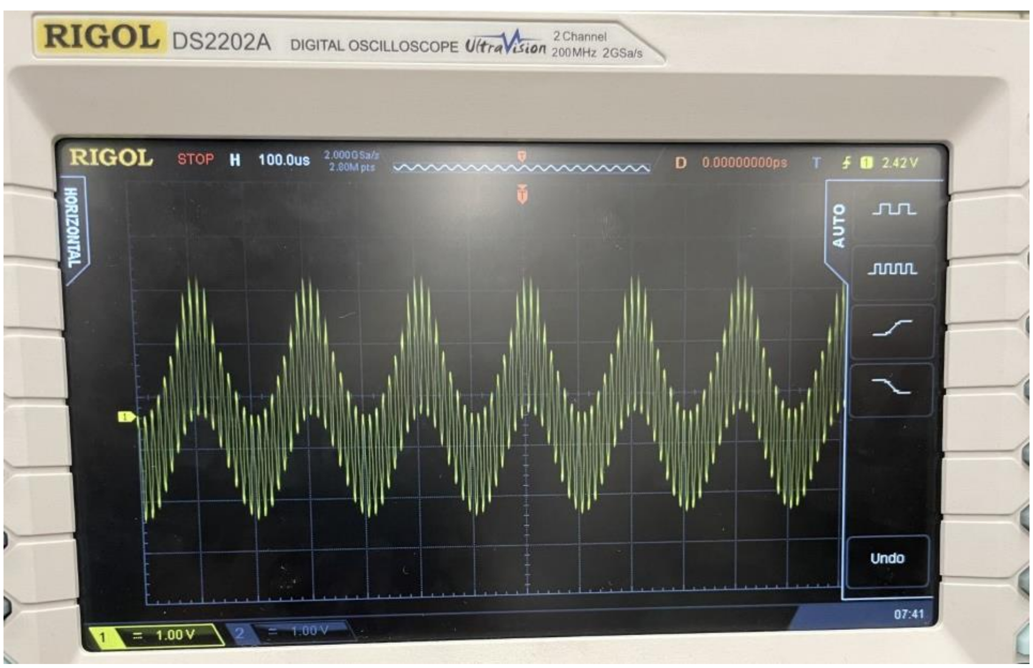

Fig. 5 – Time-Domain Waveform of Voltage at $y_4(t)$

Finally the output of the signal reflects the shape and basic waveform of the demodulated signal and the envelope can be detected from this to recover the original message.

CONCLUSION

In this lab we became familiar with the technique of envelope detection for the purpose of Amplitude Demodulation. By constrcuting a simple envelope detector circuit, a modulated AM signal can be demodulated by removing specific frequency and components of the signal. Here a demodulated envelope of the original unmodulated signal was obtained and we were able to use the oscilloscope to see the time-domain waveforms at the multiple stages of the envelope detector to better understand each one.