ECE478 Lab 4 Report

Amplitude Modulation and Demodulation using TIMS

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Abstract:

The following lab explores amplitude modulation (AM) via TIMS modules, where a single-tone signal is added onto a carrier signal, then demodulated at the output. The experiment also highlights the effects of the level of modulation (μ) and two different methods for demodulating.

Amplitude Modulation

We took a 2-kHz sine-wave from the TIMS device, added a 1-V bias signal, and then multiplied it by a 100-kHz carrier sine-wave, to get the following:

$$s(t) = A\,(1 + \mu \sin(2\pi f_m\, t))Bsin(2\pi f_c\, t)$$

Where $f_m = 2kHz$ and $f_c = 100kHz$.

The terms A and μA refer to g and G on the TIMS "Adder" module, respectively. Where A should be unity, and then μ can be the modulation index.

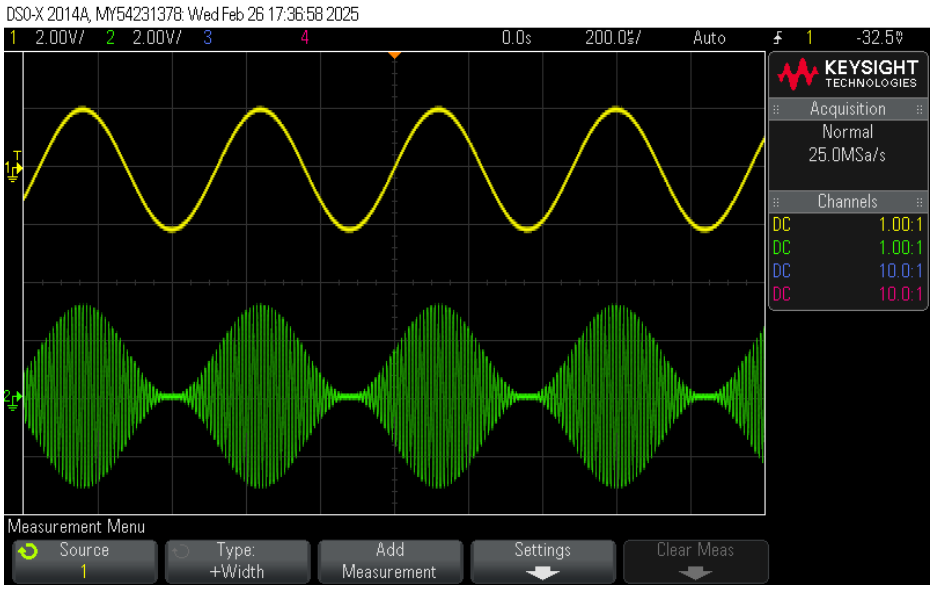

Figure 1: 100% AM Modulation

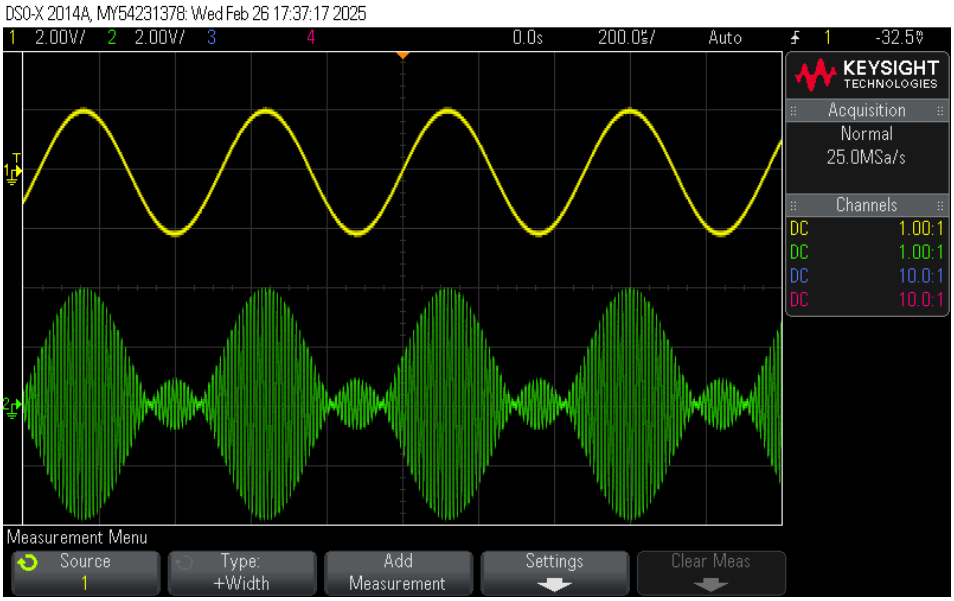

Figure 2: Over-modulated AM Modulation

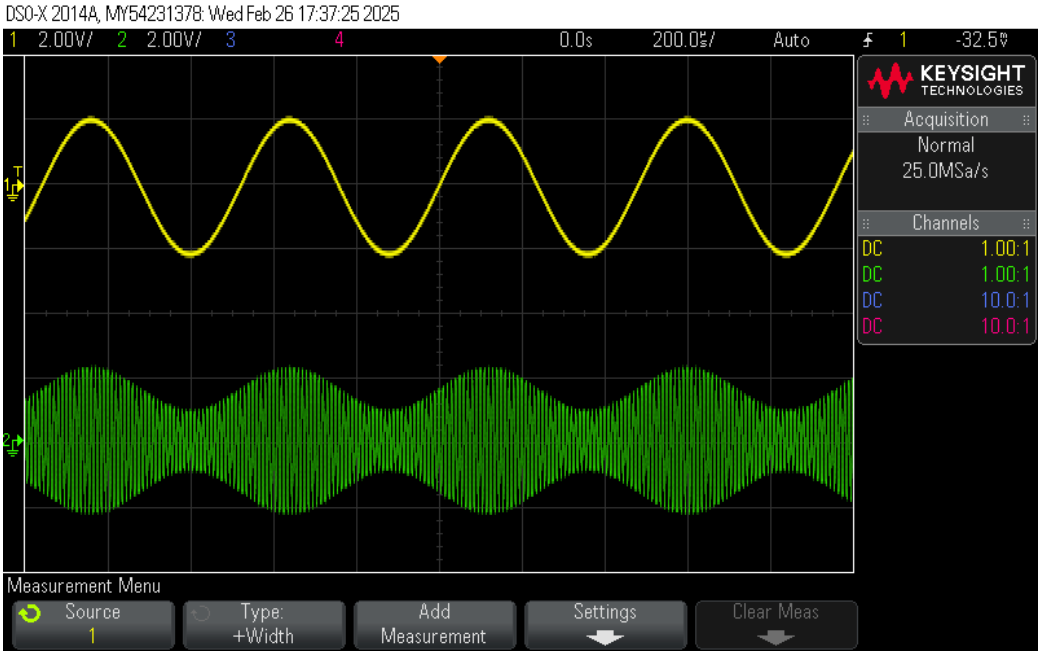

Figure 3: Under-modulated AM modulation

Envelope Detection

"Rectifier" + "Tunable LPF"

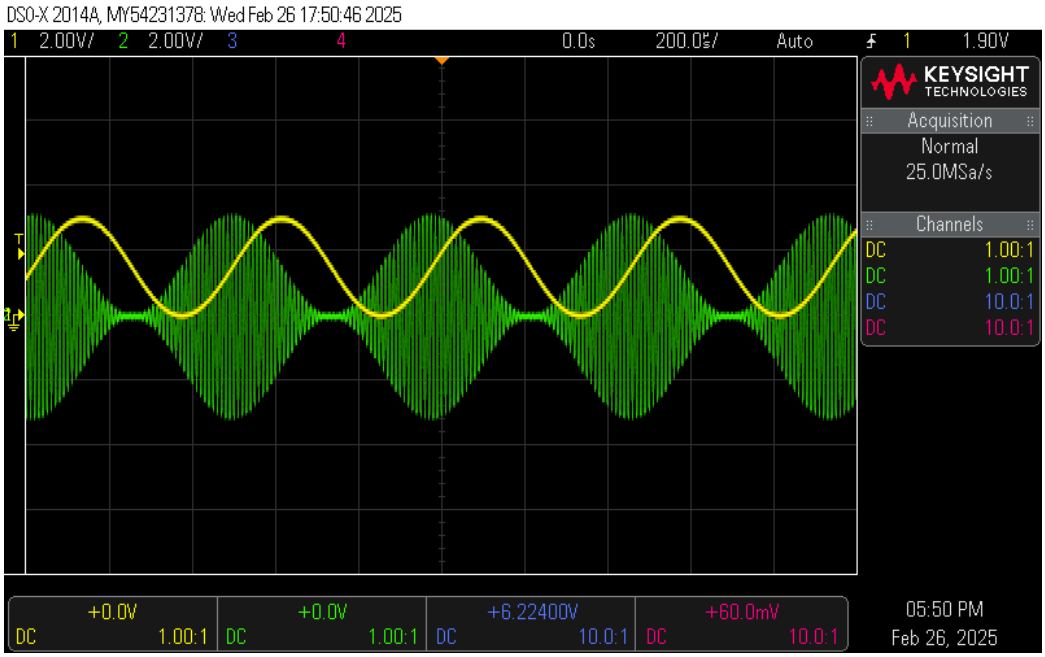

Figure 4: 100% AM Modulated Signal, Ideal Envelope Detector

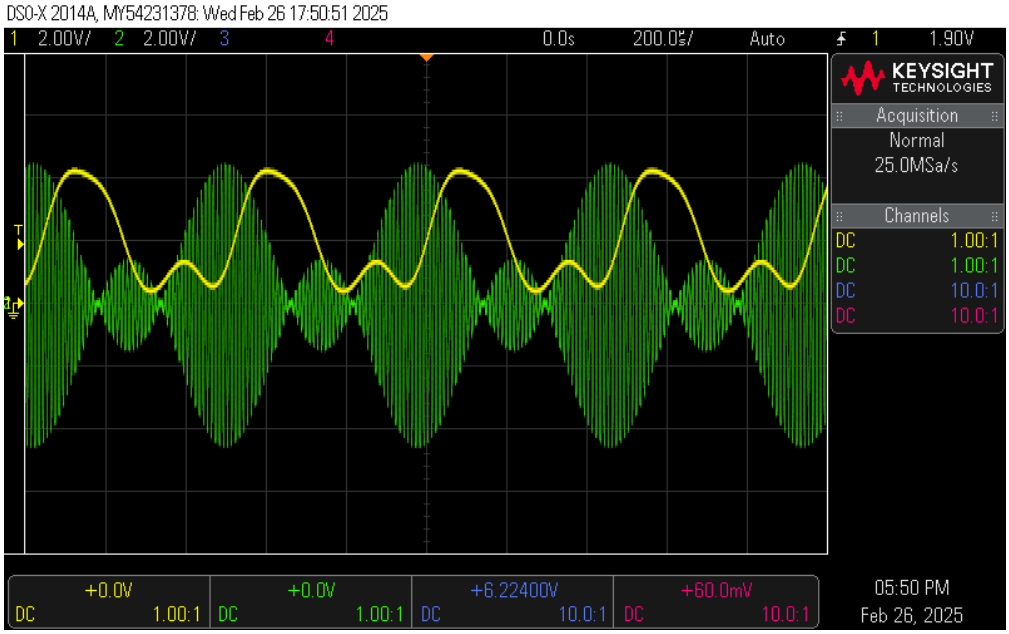

Figure 5: >100% AM Modulated Signal, Ideal Envelope Detector

Now, we see above in Figure 5 the over-modulated envelope is heavily distorted as compared to the message signal, however below in Figure 6, we see that opening the "Tunable LPF" to ~10kHz, we can find the original message in the envelope.

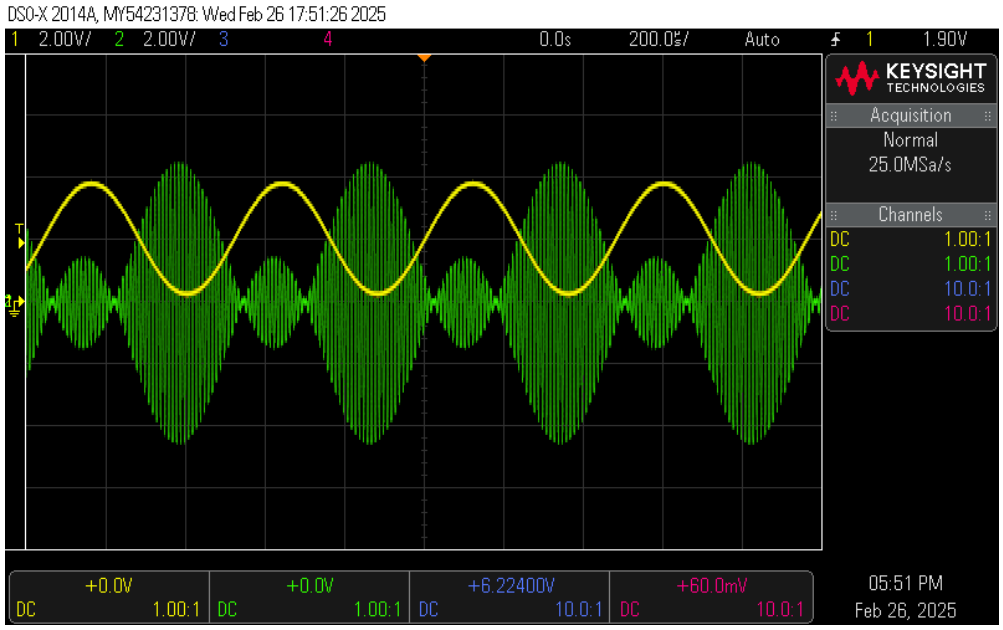

Figure 6: >100% AM Modulated Signal, Ideal Envelope Detector; 10-kHz LPF

The "Diode Detector"

Now, we switched to using the "Diode+LPF" on the TIMS "Utilities" module to detect our envelope. This scheme only has a single diode and RC filter. As this cannot be tuned for modulation index, we experience losses in the message detected for >100% modulation, and the lower capacitance value causes noticeable ripple in the message detected.

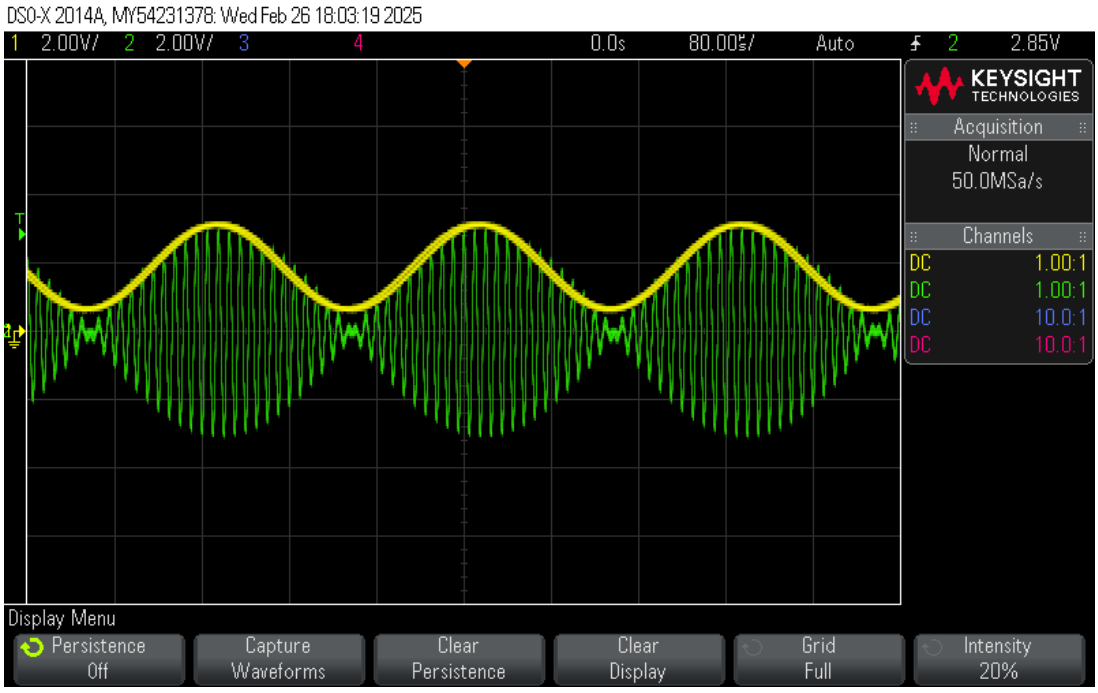

Figure 7: 100% Modulated Signal; Diode+LPF Detector

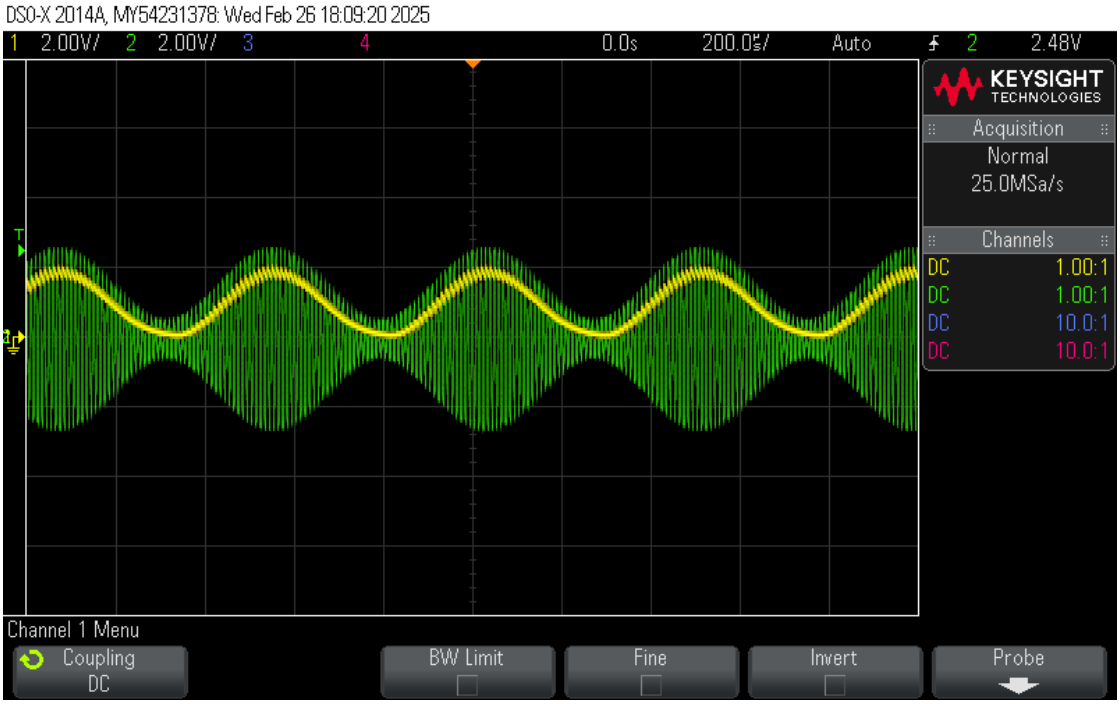

Figure 8: <100% Modulated Signal; Diode+LPF Detector

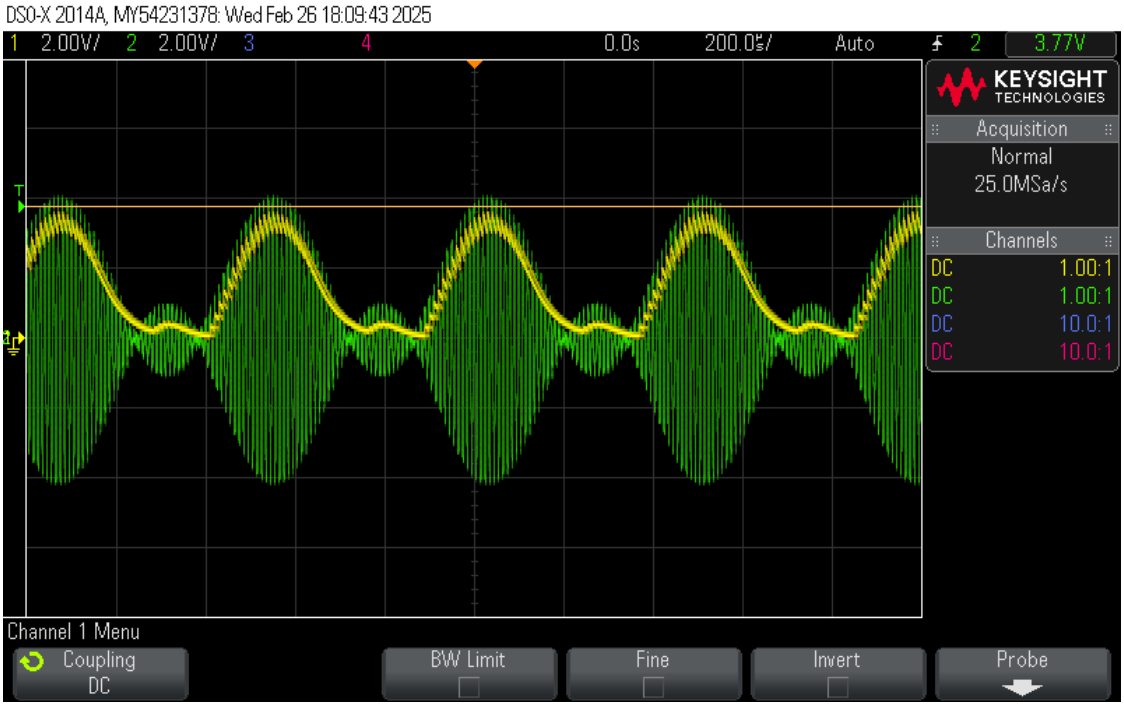

Figure 9: >100% Modulated Signal; Diode+LPF Detector