



Experiments in Amplitude Modulation and Detection

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Abstract:

To study the operation of AM theory, its modulator and detector. Time domain and frequency domain will be used to analyze AM system

Equipment:

- Agilent 54600 series oscilloscope with FFT option
- arbitrary function generator Agilent 33120A
- breadboard

Components:

- Diode 1N4148
- Resistors 470k, 5.6 k ohm, 56k ohm , 560 k ohm
- Capacitors 0.01 μ F, 0.1 μ F

Background:

Amplitude modulation of a sinusoidal carrier is widely used in radio and line communications systems. The modulator can permit the modulating signal to amplitude modulate the carrier wave without generating extra unwanted frequencies. The following diagram shows the setup of AM modulator in the teaching lab.

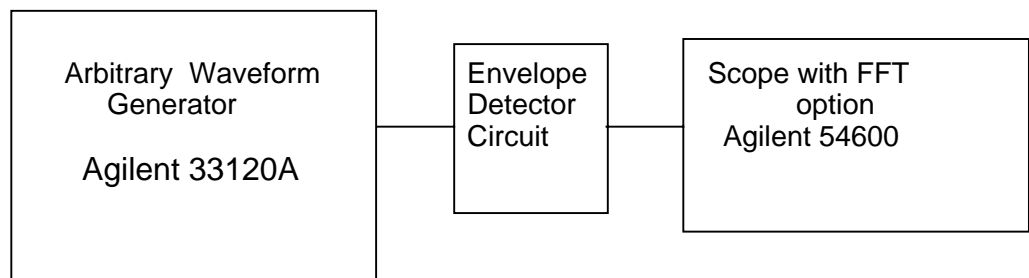


Fig. 1: Setup of AM Modulation

Demodulation or detection is the process of recovering the information carried by a modulated wave. Fig. 2 shows the circuit of a diode detector, consisting of a diode in series with a parallel resistor-capacitor network. The basic circuit is a diode rectifier, with a RC time constant, followed by a DC blocking high pass filter RC filter of which R2 is the load. The product RC is chosen so that the rectified signal follows the modulating envelope closely but does not follow much more rapid carrier changes. A useful rule of thumb is that $\omega RC = 1$ where w is the highest frequency modulating signal being detected. C_2 is much larger than C_1 such that it allows all baseband signals to pass through. R_2 is also much higher than R_1 so that it does not load R_1C_1 . The criteria is to arrange for the rate of discharge of C_1 to be slow enough for it not to fall much between carrier peaks, yet large enough for it to be able to follow the fastest rate of decrease of the envelope voltage.

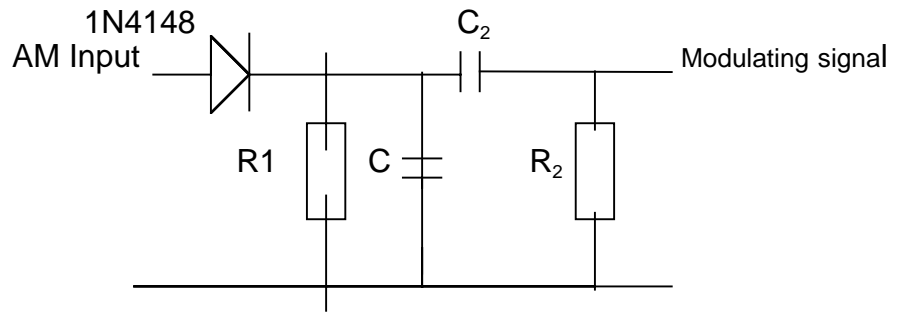


Fig. 2: Basic Envelope Detector Circuit

Procedures :

1. Modulation Index

- 1) Turn on the arbitrary waveform generator.
- 2) Press AMP and set the amplitude of the carrier to be 300 mv.
- 3) Press FREQ and set the carrier frequency to be 10 KHz.
- 4) Press SHIFT and FREQ and set the modulating frequency to 300 Hz.
- 5) Press SHIFT and AMP so that the modulation index can be adjusted. Set the modulation index to 0, 40 100, 120% respectively.
- 6) Record and sketch the waveform from the DSO.



0 % modulation



40 % modulation



100 % modulation



120 % modulation



1.7 Verify the modulation index formula as follows:

$$m = (v_1 - v_2) / (v_1 + v_2)$$

where v_1 and v_2 are the maximum and minimum of the composite waveform envelope

1.8 Comment on the output waveform when the index exceeds 100%
