# EXPERIMENT 5: AM DETECTOR

## *INTRODUCTION:*

The ability to modulate a carrier wave is useless unless we can recover the information at some later time. The detector circuit constructed in this experiment will demodulate the incoming AM wave from the modulator stage of the previous experiment; the output of the circuit will be a *replica* (or copy) of the original intelligence signal.

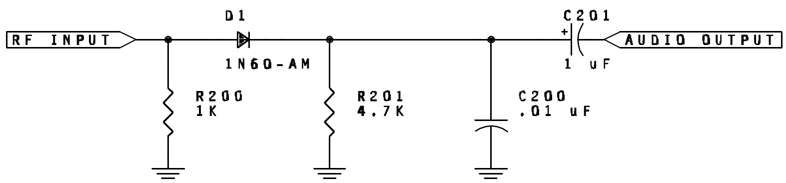


Figure 1 - AM Detector Circuit

## *CIRCUIT THEORY*

The simplest (and most common) AM demodulator circuit is shown above in figure 1. This is a *diode* detector.

The basic operation of this detector is as follows: D1 serves to rectify the incoming carrier wave, such that only the *positive* half-cycle gets through. The output of D1 is a series of positive pulses, whose peak amplitude is proportional to the envelope's original instantaneous value.

By itself, the pulsating DC coming from D1 is not very useful. Capacitor C200 smooths it, thus producing an output waveform that is a close approximation of the original information signal. Resistor R201 is called a *bleeder* resistor. Its purpose is to allow C200 to discharge when the envelope amplitude decreases. Without R201, C200 would charge up to the maximum value and stay there!

Together, R201 and C200 form the detector time-constant. Normally, this is made *shorter* than 1/10 the period of the highest intelligence frequency to pass. Mathematically:

$$R_{201}C_{200} \leq \frac{1}{10F_{m(max)}}$$

If the detector time-constant is excessively large, the signal will become distorted on the negative-portions of the wave, because the capacitor does not discharge rapidly enough to keep up with the falling portions of the envelope.

Conversely, too short a time constant typically allows RF to pass from the detector to the audio amplifier; a highly undesirable situation!

R200 functions as a *DC return* for D1. Without R200, the capacitor that is in the output of the modulator stage would simply charge up in one direction as D1 conducted, eventually reverse-biasing D1! When *transformer coupling* is used at the detector, the DC return resistor isn't needed, since the RF transformer secondary will act as a DC short to ground for the diode current.

Incidentally, the detector's operation can also be explained in the *frequency domain* using Fourier concepts. The pulsating DC coming from the detector diode contains three energies. These are a DC level, the intelligence (or information) frequency, plus the RF carrier frequency and harmonics of the RF carrier frequency. The RC network comprised of R201 and C200 really acts as a *low-pass filter*, which removes all energy except for the DC component and information frequency. Capacitor C201 blocks the DC component -- leaving only the intelligence frequency at the output of the circuit.

## LABORATORY PROCEDURE

1. Design and build the circuit of figure 1; connect the AM OUTPUT of LAB #4 to the input of the detector circuit. Apply a 50 % modulated signal with Fm = 1 Khz.

2. Connect the *Audio Monitor* circuit to the detector's output so that you can hear the detected audio signal.

3. Record the AUDIO OUTPUT from the *detector's output* with respect to the intelligence input. (To do this, remember to use the intelligence input as a "reference" -- you MUST trigger from the 'scope channel connected to the intelligence!)

4. Repeat step 3 for Fm = 10 KHz and Fm = 20 KHz; *note in your conclusion* what happens to the amplitude of the AUDIO OUTPUT as Fm increases.

5. Change Fm back to 1 KHz, and adjust your modulator for an *overmodulated* condition. Record the detected output of the overmodulated wave.

6. A complete communications system uses a microphone instead of a signal generator as the information source. Construct the circuit of figure 2 on the next page and couple it to the AM modulator.

*Note: You will have to calculate the values for the unmarked resistors and capacitors, as well as choosing an appropriate operational amplifier IC. The circuit should have a minimum voltage gain of 20 V/V.*

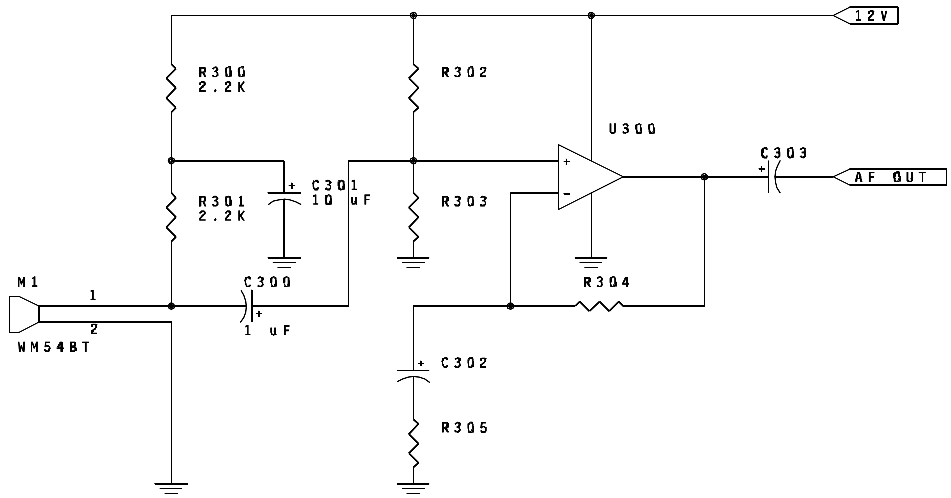


Figure 2 - Microphone Amplifier

7. Demonstrate the operation of your system. Microphone audio should now be audible in the audio monitor connected to the detector output. Audio should also appear in a radio receiver placed close to the circuit. When this step works, you are ready for sign-off.