AM PEAK DETECTOR

OBJECTIVES:

1. To observe the operation of an AM DSBFC modulator.
2. To observe the operation of a peak detector.
3. To observe the operation of an AM peak detector.

INTRODUCTION:

The simplest circuit available for demodulating AM DSBFC waveforms is a diode peak detector. A diode peak detector is a noncoherent AM demodulator. It detects the peaks of the AM envelope and thus produces an output voltage that is proportional to the shape of either the positive or negative half of the envelope. The output voltage from a peak detector is proportional to both the amplitude and frequency of the modulating signal. Essentially, the carrier component of the AM envelope "*captures*" the diode and forces it to turn on and off (rectify) synchronously. A lowpass filter, placed after the diode, separates the demodulated audio signal from the rectified AM envelope. The block diagram for the test circuit used in this experiment is shown in Figure 16-1.

MATERIALS REQUIRED:

Equipment:

1 - protoboard
1 - dual dc power supply (+12 V dc and 0 to + 8 V dc)
1 - audio signal generator (0 to 20 kHz)
1 - standard oscilloscope (10 MHz)
1 - assortment of test leads and hookup wire

Parts List:

1 - XR-2206 function generator	1 - 100 k-ohm resistor
1 - IN914 diode	1 - 1 k-ohm variable resistor
3 - 4.7 k-ohm resistors	3 - 0.001 µf capacitors
2 - 10 k-ohm resistors	3 - 0.1 µF capacitors
1 - 47 k-ohm resistor	1 - 10 µF capacitor

SECTION A Linear Integrated-Circuit AM DSBFC Modulator

In this section the XR-2206 function generator is used to generate an AM DSBFC waveform. The schematic diagram for the linear integrated-circuit AM DSBFC modulator circuit used in this section is shown in Figure 16-2a, and the block diagram for the XR-2206 function generator is shown in Figure 16-2b.

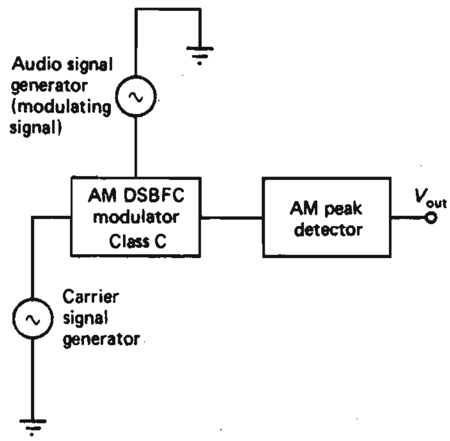

FIGURE 16-1 AM Peak detector

Procedure

1. Construct the function generator circuit shown in Figure 16-2a.
2. Adjust the amplitude of the control voltage V_C to 0 V.
3. Reduce the amplitude of the audio signal generator output voltage to 0 V.
4. Calculate the function generator free-running frequency.
5. Adjust R_1 until a sine wave with minimum distortion is observed at V_{out}.
6. Increase the control voltage to +5 V dc.
7. Set the frequency of the audio signal generator to 1 kHz and adjust its output voltage amplitude until an AM envelope with 100% modulation is observed at V_{out}. Adjust the dc control voltage and the audio signal generator output amplitude for a 100% modulated AM envelope with the minimum distortion and a maximum peak-to-peak amplitude.

Note: Do not disassemble this circuit as it is needed in Section C.

SECTION B Peak Detector

In this section the rectifying action of a peak detector is examined. The schematic diagram for the peak detector used in this section is shown in Figure 16-3. During the positive half-cycle of the signal generator output signal, D_1 conducts, charging C_1 with the polarity shown. During the negative half-cycle, D_1 is off and C_1 discharges slightly through resistor R_1. Therefore, the output waveform is simply a filtered half-wave rectified signal with a positive average value.

Procedure

1. Construct the peak detector circuit shown in Figure 16-3.
2. Set the signal generator output voltage to 4 Vp-p and a frequency of 100 kHz.

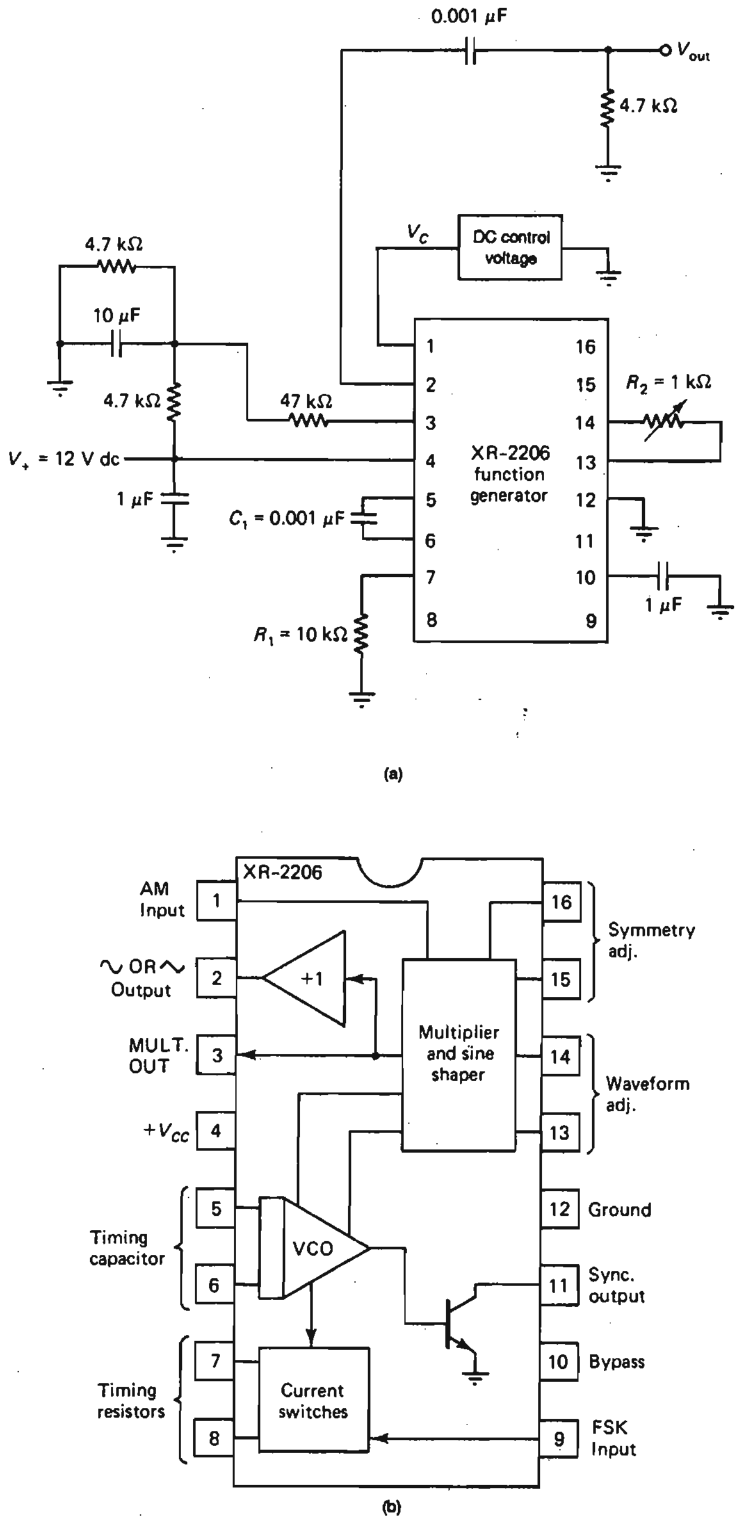

FIGURE 16-2 (a) AM DSBFC modulator. (b) XR-2206 block diagram.

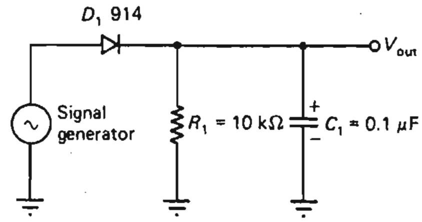

FIGURE 16-3 Peak detector schematic diagram

3. Sketch the waveform observed at V_{out}.
4. Describe the output waveform in terms of its ac and dc components.
5. Vary the amplitude of the signal generator output voltage while observing the waveform at the output of the peak detector.
6. Describe what effect varying the amplitude of the signal generator output voltage has on the output waveform.
7. Slowly decrease the signal generator output frequency to 0 Hz while observing the output waveform.
8. Describe what effect reducing the signal generator frequency has on the output waveform.
9. Reverse the polarity of Diode D_1 and repeat steps 2 through 8 and describe any differences in the output waveform with the diode reversed.

Note: Do not disassemble this circuit as it is needed in Section C.

SECTION C AM Peak Detector

In this section the operation of an AM peak detector is examined. The input waveform to an AM peak detector comprises a carrier frequency and its upper and lower side frequencies (i.e., an AM envelope). A diode is a nonlinear device. Therefore, nonlinear mixing (heterodyning) occurs between the carrier and its associated side frequencies. The difference between the upper side frequency and the carrier and the lower side frequency and the carrier is the modulating signal frequency (audio). The audio is separated from the composite waveform with a simple lowpass filter. The schematic diagram for the peak detector circuit used in this section is shown in Figure 16 -3. The circuit shown is simply the AM modulator examined in Section A connected to the peak detector examined in Section B. The circuit comprises a LIC AM DSBFC modulator and a peak diode detector. During the positive half-cycles of the AM envelope, D_1 is forward biased and on and thus C_1 charges to a voltage equal to the peak envelope voltage minus the barrier potential of the diode. During the negative half cycles, D_1 is reverse biased and off and C_1 discharges slightly through R_1. Each successive peak of the AM envelope has a different peak amplitude. Therefore, C_1 charges and discharges in proportion to the shape of the envelope (i.e., proportional to the modulating signal). Thus, the waveform on the input side of the diode is a clipped envelope, and the waveform on the output side of the diode is the detected audio signal riding on top of a dc voltage. The dc voltage is approximately equal to the peak amplitude of the unmodulated carrier minus the barrier potential of the diode.

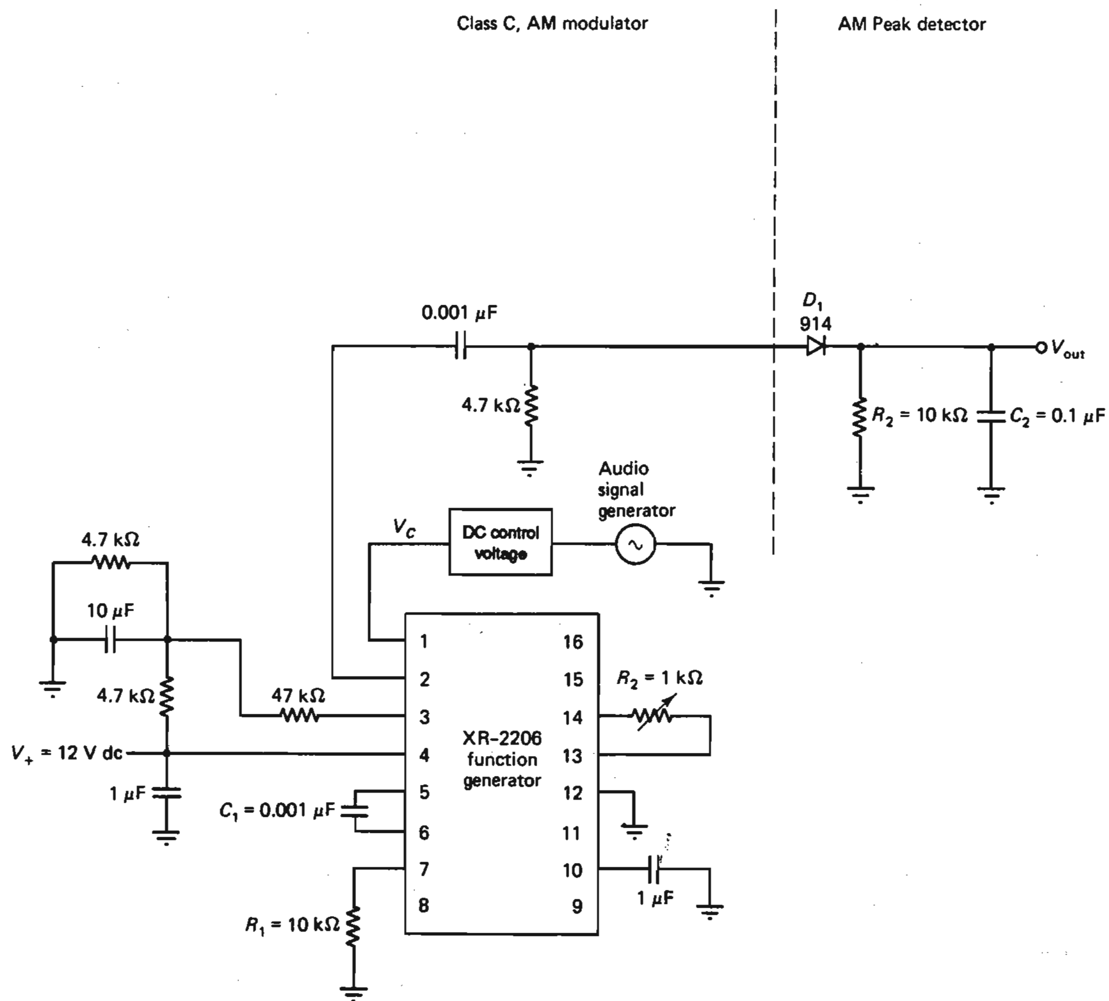

FIGURE 16-4 AM DSBFC Demodulator-peak detector

Procedure

1. Construct the AM modulator and peak detector circuits shown in Figure 16-4. Set the frequency of the audio signal generator to 1 kHz.

2. With jumper wire *J1* disconnected, adjust the dc control voltage and peak amplitude of the audio signal generator for an AM envelope with minimum distortion, maximum amplitude, and 100% modulation at the output of the AM modulator.

3. Connect jumper wire *J1* and observe the waveform at V_{out}.

4. Sketch the waveform observed in step 3 and describe it in terms of frequency content, and ac and dc voltages.

5. Replace *R2* in the peak detector with a 100 k-ohm resistor.

6. Sketch the waveform observed at the peak detector output (V_{out}) and name the distortion present.

7. With the 100 k-ohm resistor for R_2, replace C_2 in the diode detector with a 0.001 µF capacitor.

8. Sketch the waveform observed at the peak detector output (V_{out}) and name the distortion present.

SECTION D Summary

Write a brief summary of the concepts presented in this experiment on AM peak detectors. Include the following items.

1. The relationship between the frequency and amplitude of the carrier and the detector output waveform.
2. The relationship between the frequency and amplitude of the audio signal and the detected output waveform.
3. The relationship between the AM envelope and the detected waveform.
4. The causes and effects of diagonal clipping and rectifier distortion.