LINEAR INTEGRATED-CIRCUIT AM DSBSC MODULATOR

OBJECTIVES:

1. To observe the operation of a linear integrated-circuit balanced modulator.
2. To observe the operation of a LIC AM DSBFC modulator
3. To observe the operation of a LIC AM DSBSC modulator

INTRODUCTION:

Integrated circuit balanced modulators are ideally suited for applications that require balanced operation. In addition, integrated-circuit balanced modulators offer low power consumption, circuit miniaturization, and simplicity of design. In this exercise the XR-2206 monolithic function generator is used as a balanced modulator to perform product modulation to generate an AM double sideband suppressed carrier (DSBSC) waveform. The block diagram for the XR-2206 function generator is shown in Figure 18-1. The voltage-controlled oscillator in the XR-2206 is a balanced modulator. A balanced modulator is a product modulator which produces an output waveform that contains only the sum and difference frequencies (i.e., the modulating signal and carrier are suppressed). Balanced modulator DSBSC modulators are widely used to produce an AM waveform that is more power efficient than conventional AM. With DSBSC modulation, all of the transmit power is contained within the information carrying portion of the modulated wave (i.e., the sidebands).

MATERIALS REQUIRED:

Equipment:

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

Parts List:

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

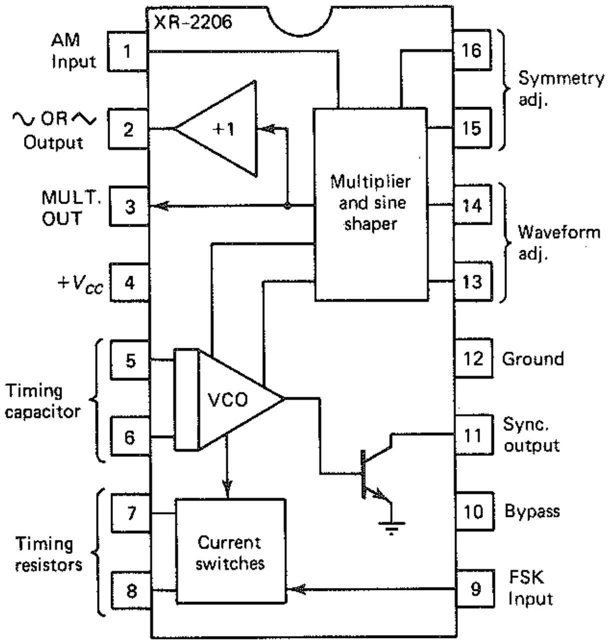

FIGURE 18-1 ZR-2206 Functional block diagram

SECTION A Linear Integrated-Circuit AM DSBFC Modulator

In this section the XR-2206 monolithic function generator is used to produce an AM DSBFC waveform. If the modulating signal in an AM modulator contains a dc component, the product of the modulating signal and the carrier will contain a component at the carrier frequency. The internal reference voltage for the XR-2206 is equal to the dc supply voltage divided by two (i.e., $V_r = V_+/2$). If the modulating signal has an average value that is not equal to half the internal reference voltage, it appears to have dc component and will produce a carrier component in its output. However, if the modulating signal has an average value equal to half the reference voltage, it appears to have a zero dc component and will suppress the carrier at its output.

In this section a modulating signal contains an average voltage of +4 V dc. Consequently, it appears to have a +2 V dc component and will produce an output component at the carrier frequency in addition to the sum and difference frequencies (i.e., the upper and lower side frequencies, respectively). The schematic diagram for the AM DSBFC modulator circuit used in this section is shown in Figure 18-2.

Procedure

1. Construct the AM DSBFC modulator circuit shown in Figure 18-2.

2. Set the dc control voltage VC to 0 V and adjust $R2$ until a sine wave with minimum distortion is observed at V_{out}.

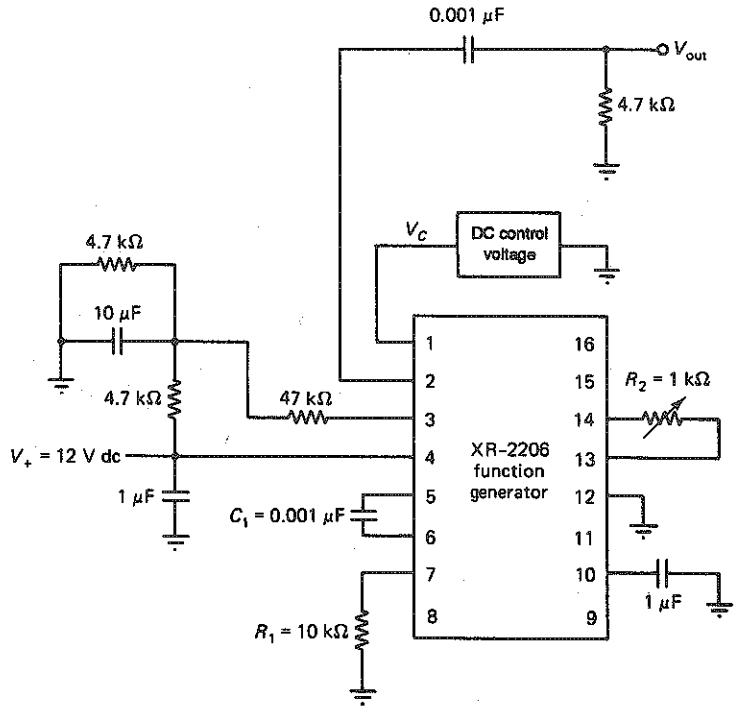

FIGURE 18-2 Output amplitude-versus-input voltage

3. Increase the dc control voltage for +5 V dc.

4. Set the amplitude of the audio signal generator output voltage to +2 Vp-p and adjust its frequency to 1 kHz.

5. Describe the waveform observed at V_{out}.

6. Adjust the amplitude of the audio signal generator output voltage and dc control voltage until a 100% AM modulation waveform with minimum distortion and maximum amplitude is observed at V_{out}.

7. Vary the frequency of the audio signal generator output and describe what effect it has on the output waveform.

SECTION B Linear Integrated-Circuit AM DSBSC Modulator

In this section the XR-2206 function generator is used to generate an AM DSBSC waveform. In Section A, the modulating signal had a +4 V average value. The average value of the modulating signal is compared to the internal reference voltage for the function generator and any difference is equivalent to a dc component. Consequently, the modulating signal used in Section A contained what was equivalent to a +2 V dc component (i.e., 6 - 4 = 2). If the modulating signal contains a +6 Vdc ($V_r/2$) component, it will appear as though it has no dc component and will produce an output waveform that contains only the upper and lower sidebands (i.e., the sum and difference frequencies). The modulator circuit used in this section is the same as the one used in Section A and shown in Figure 18-2.

Procedure

1. Construct the AM DSBSC modulator circuit shown in Figure 18-2. Set the signal generator output amplitude to 0 V.

2. Set the dc control voltage V_C to 0 V and adjust R_2 until a sine wave with minimum distortion is observed at V_{out}.

3. Increase the dc control voltage V_C until the output signal decreases to 0 V (approximately equal to +6 V dc).

4. Set the amplitude of the audio signal generator output voltage to +2 Vp-p and adjust its frequency to 1 kHz.

5. Adjust the dc control voltage and signal generator output voltage until a symmetrical AM DSBSC waveform with maximum amplitude is observed at V_{out}.

6. Describe the waveform observed in step 5.

7. Vary the control voltage slightly above then slightly below +6 Vdc and describe what effect it has on the output waveform.

8. Vary the frequency of the audio signal generator and describe what effect it has on the output waveform.

9. Vary the amplitude of the audio signal generator output voltage and describe what effect it has on the output waveform.

SECTION C Summary

Write a brief summary of the concepts presented in this experiment on DSBSC and DSBFC modulators. Include the following items.

1. The frequency content of an AM DSBSC waveform.
2. The relationship between the modulating signal, carrier, and the output waveform from an AM DSBSC modulator.
3. The concept of carrier suppression.
4. The concept of balanced operation.