LINEAR INTEGRATED-CIRCUIT AM MODULATOR

OBJECTIVES:

1. To observe the operation of a linear integrated-circuit function generator.
2. To observe the output amplitude-versus-input voltage characteristics of a linear integrated-circuit function generator.
3. To observe the operation of a linear integrated-circuit AM DSBFC modulator.

INTRODUCTION:

Linear integrated-circuit (LIC) function generators are ideally suited for communications and instrumentation applications requiring a low output power, amplitude modulated signal. LIC AM modulators offer excellent frequency stability, linear amplitude modulation characteristics, circuit miniaturization, and simplicity of design. In this experiment the operation of the XR-2206 monolithic function generator as an AM DSBFC modulator is examined. The block diagram for the XR-2206 function generator is shown in Figure 15-1. The XR-2206 function generator comprises four functional blocks: a voltage-controlled oscillator, an analog multiplier and sine shaper, a unity gain buffer amplifier, and a set of current switches.

MATERIALS REQUIRED:

Equipment:

1 - protoboard
1 - dual dc power supply (+12 V dc and 0 to +5 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
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

SECTION A Output Amplitude-versus-Input Control Voltage

In this section the output amplitude-versus-input voltage characteristics of the XR-2206 linear integrated-circuit function generator are examined. The output amplitude of the XR-2206 function

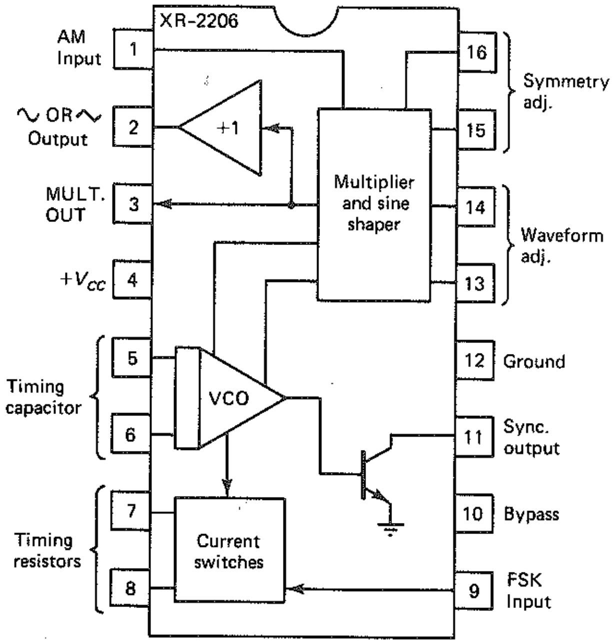

FIGURE 15-1 XR-2206 Functional block diagram

generator can be varied by applying a control voltage to pin 1. The output amplitude varies linearly with the control voltage for values within ±4 volts of $V_+/2$. The schematic diagram for the function generator circuit used in this section is shown in Figure 15-2.

Procedure

1. Construct the function generator circuit shown in Figure 15-2. Set the dc control voltage V_C to 0 Vdc.

2. Calculate the VCO free-running frequency using the following formula.

$$f_o = \frac{1}{RC}$$

where
f_o = VCO free-running frequency (hertz)
$R = R_1$ (ohms)
$C = C_1$ (farads)

3. Adjust R_2 until a sine wave with minimum distortion is observed at V_{out}.

4. Measure the frequency and amplitude of the sine wave observed in step 3.

5. Increase the amplitude of the control voltage in one-volt steps for values between 0 and +8 V dc. Measure the amplitude of the sine wave observed at V_{out} for each value of control voltage.

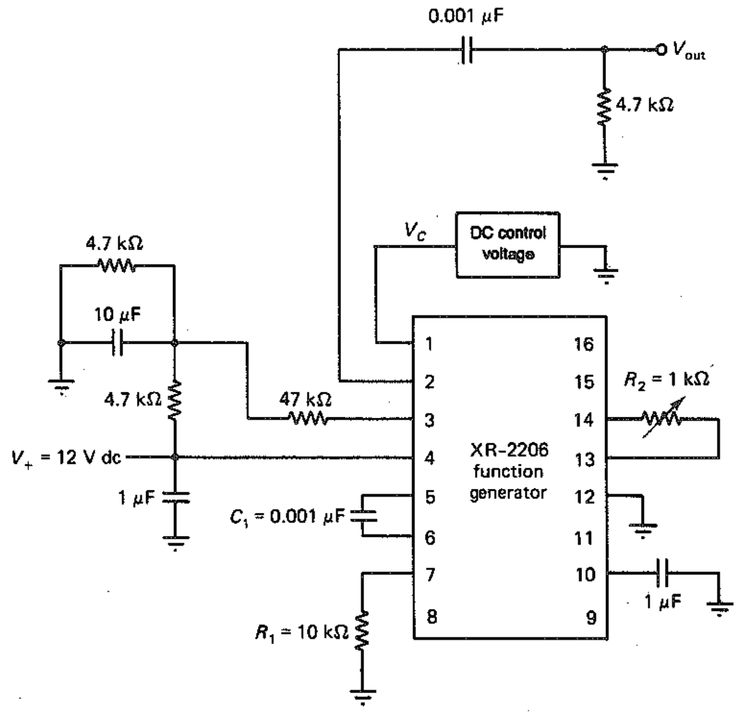

FIGURE 15-2 Output amplitude-versus-bias voltage

6. Construct a graph showing the output amplitude-versus-control voltage for the control voltages and amplitudes used in step 5.

7. Describe the relationship between the control voltage and the output amplitude.

SECTION B Linear Integrated-Circuit AM DSBFC Modulator.

In this section the XR-2206 function generator is used to generate an AM DSBFC waveform. If the control voltage applied to pin 1 of the XR-2206 contains both a dc and an ac component, the amplitude of the output signal on pin 2 will vary proportionately to the ac input voltage component. That is, the sinusoidal component of the control voltage amplitude modulates the output signal to produce an AM DSBFC waveform. The schematic diagram for the linear integrated-circuit AM DSBFC modulator used in this section is shown in figure 15-3. The function generator free-running frequency is the carrier signal, and the audio signal generator is the modulating signal.

Procedure

1. Construct the function generator circuit shown in Figure 15-3.

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_2 until a sine wave with minimum distortion is observed at V_{out}.

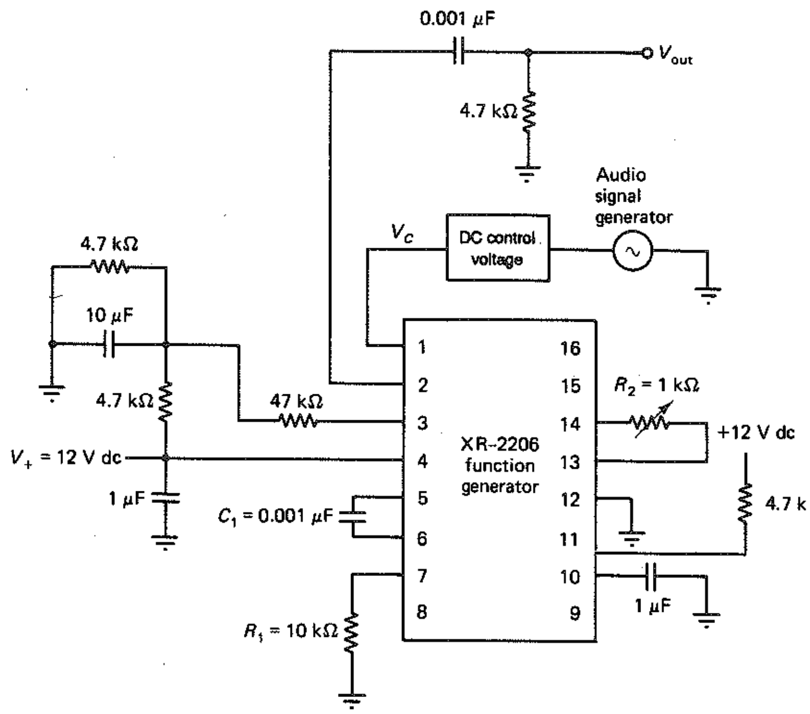

FIGURE 15-3 AM Modulator using the XR-2206 function generator

6. Increase the control voltage to +5 V dc.

7. Increase the amplitude of the signal generator output voltage to 3 Vp-p at 1 kHz.

8. Adjust the amplitude of the audio signal generator output voltage until an AM envelope with 100% modulation is observed at V_{out}.

9. Sketch the waveform observed in step 8.

10. Describe the waveform sketched in step 9 in terms of frequency content, amplitude, shape, and repetition rate.

11. Set the amplitude of the audio signal generator output voltage to 1.5 Vp-p and determine the percent modulation of the output envelope using the following formula.

$$\% M = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$$

where

$\% M$ = percent AM modulation
V_{max} = maximum peak-to-peak envelope amplitude (volts)
V_{min} = minimum peak-to-peak envelope amplitude (volts)

12. Make the necessary connections between the AM modulator and the oscilloscope to display a trapezoidal pattern.

13. Vary the amplitude and frequency of the audio signal generator output voltage and describe what effect varying them has on the AM envelope.

SECTION C Summary

Write a brief summary of the concepts presented in this experiment on linear integrated-circuit AM DSBFC modulators. Include the following items.

1. The relationship between the control voltage and the amplitude of the function generator output voltage.
2. The relationship between the frequency and amplitude of the audio signal generator output voltage and the function generator output waveform.
3. The relationship between a trapezoidal waveform and an AM envelope.