BINARY PHASE SHIFT KEYING MODULATOR

OBJECTIVES:

1. To observe the output phase-versus-input voltage characteristics of a balanced differential amplifier.
2. To observe the operation of a phase shift keying modulator.
3. To observe the operation of a binary phase shift keying modulator.
4. To observe the operation of a linear integrated-circuit phase shift keying modulator.

INTRODUCTION:

Phase shift keying (PSK) is a form of angle-modulated, constant-envelope digital modulation. PSK is similar to conventional phase modulation except that with PSK the input signal is a binary digital signal and a limited number of output phases are possible. Binary phase shift keying (BPSK) is the simplest form of PSK. With BPSK, only two output phases are possible. One output phase represents a logic 1, and the other a logic 0. As the input signal voltage changes from a logic 0 to a logic 1 and vice versa, the phase of the output carrier signal shifts between two angles that are 180° out of phase. Another name for BPSK is phase reversal keying (PRK). In this experiment the XR-2206 monolithic function generator is used for the BPSK modulator. The functional block diagram for the XR-2206 function generator is shown in Figure 24-1.

MATERIALS REQUIRED:

Equipment:

1 - protoboard
1 - dual dc power supply (+12 V dc and 0 V to +10 V dc)
1 - low frequency function generator (25 kHz)
1 - standard oscilloscope (10 MHz)
1 - assortment of test leads and hookup wire

Parts List:

1 - XR-2206 function generator
4 - 4.7 k-ohm resistors
1 - 6.8 k-ohm resistor
1 - 10 k-ohm resistor
1 - 47 k-ohm resistor
1 - 1 k-ohm variable resistor
1 - 10 k-ohm variable resistor
2 - 0.001 μF capacitors
2 - 1 μF capacitors
1 - 10 μF capacitor

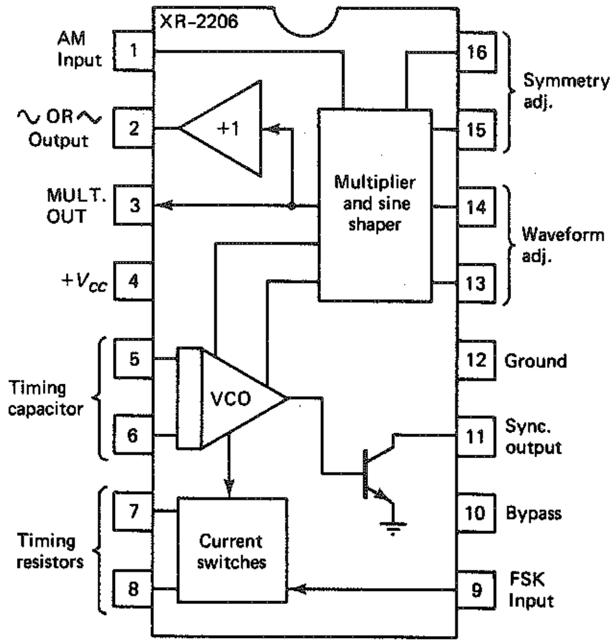

FIGURE 24-1 XR-2206 Function generator block diagram.

SECTION A Output Amplitude- and Output Phase-versus-Input Voltage

In this section both the output amplitude and the output phase-versus-input voltage characteristics of the XR-2206 function generator are examined. The schematic diagram for the function generator circuit used in this section is shown in Figure 24-2. Pin 1 of the XR-2206 is one input to the function generator output differential amplifier. The other input is internally biased at V+/2. Therefore, the function generator output voltage can be varied by applying a dc control voltage (V_C) to pin 1. As V_C increases from 0 V toward V+/2, the output amplitude decreases. When V_C = V+/2, the output voltage goes to approximately 0 V (V_{out} nulls); and as V_C is increased beyond V+/2, the output amplitude increases except with opposite phase. This property is suitable for both BPSK and suppressed-carrier amplitude modulation.

Procedure

1. Construct the function generator circuit shown in Figure 24-2 (set V_C to 0 V).

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

3. Adjust R_x until the output frequency f_o = 100 kHz.

4. Slowly increase the dc control voltage until V_C = V+/2, and describe what effect V_C to V+/2 has on the output waveform.

5. Increase the dc control until V_C = +10 V, and describe what effect increasing V_C above V+/2 has on the output waveform.

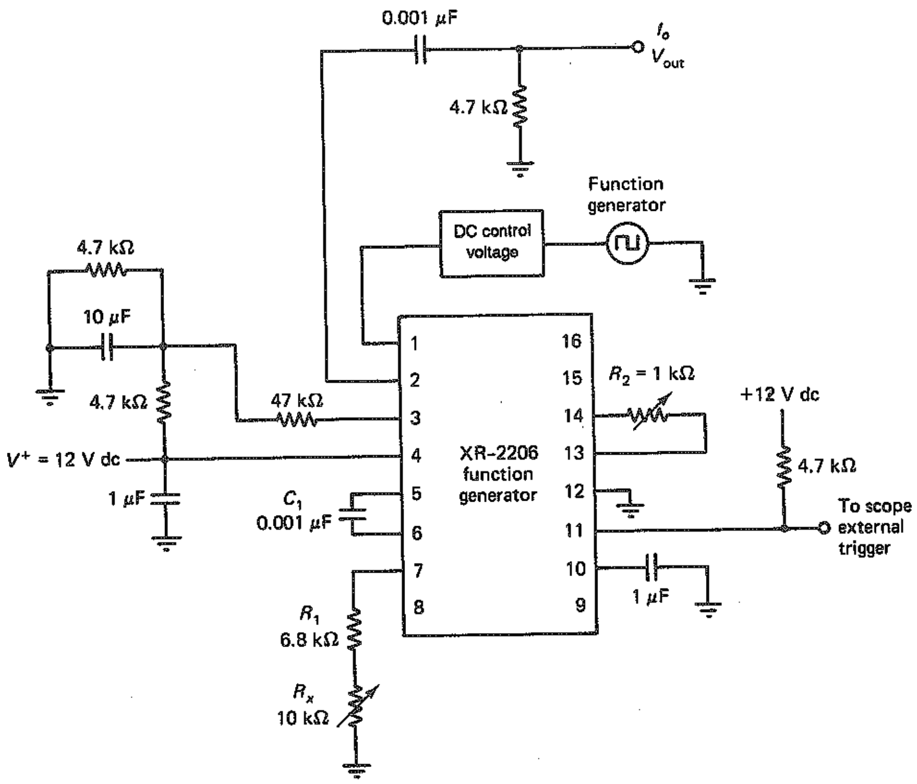

FIGURE 24-2 BPSK modulator.

6. Set the dc control voltage to 0 V, and connect the oscilloscope external trigger input to pin 11 of the XR-2206. (Pin 11 is a square wave output signal with a frequency equal to the VCO output frequency. Synchronizing the oscilloscope to this signal establishes a phase reference for V_{out}.

7. Calculate the dc control voltage where the output signal undergoes a 180° phase reversal using the following formula.

$$V_X = \frac{V+}{2}$$

where V_X = control voltage value where an output phase reversal occurs (volts)

V+ = function generator supply voltage (volts)

8. Slowly increase the dc control voltage from 0 to +10 V dc while observing V_{out}.

9. What was the actual voltage level where the output signal reversed phase?

SECTION B Binary Phase Shift Keying Modulator

In this section the operation of a BPSK modulator is examined. The same circuit that is shown in Figure 24-2 is used for the modulator except that a function generator is placed in series with the dc control voltage supply. The function generator simulates a binary digital input signal. The XR-2206 acts like a phase reversing switch that is controlled by the external input voltage applied to pin 1. If the input voltage has an average voltage equal to V+/2 and varies above and below this value, the phase of the output signal will reverse phase proportionally.

Procedure

1. Construct the BPSK modulator circuit shown in Figure 24-2.
2. Set the dc control voltage V_C to V+/2 then fine tune V_C until V_{out} goes to 0 V (i.e., carrier null occurs).
3. Set the amplitude of the function generator output voltage to a 2 Vp-p square wave with a frequency equal to 10 kHz (i.e., the combined input voltage should vary between +5 and +7 V).
4. Observe the waveform at V_{out} (you may have to fine tune the function generator output frequency to observe a stable BPSK waveform).
5. Adjust V_C for a BPSK output waveform with uniform amplitude.
6. Sketch the waveform observed in step 5.
7. Describe the waveform sketched in step 6.
8. Increase the function generator output voltage to 4 Vp-p and repeat steps 4 through 6.
9. Vary the function generator output frequency, and describe what effect varying it has on the BPSK waveform.
10. Vary the function generator output voltage, and describe what effect varying it has on the BPSK waveform.

SECTION C Summary

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

1. The relationship between a BPSK modulator output phase and its input-signal level.
2. The relationship between a BPSK modulator output phase and its input signal frequency.
3. The basic operation of the XR-2206 BPSK modulator