Experiment 14: Introduction to FM Modulation and Detection

Purpose and Discussion

The purpose of this simulation is to demonstrate the characteristics and operation of a simple frequency modulator and detector. In amplitude modulation we observed the amplitude of the modulated wave vary with changes in the message signal. In frequency modulation (FM), increases in the carrier frequency result when the modulating signal amplitude is increased. The FM modulator used in this experiment is made up of Multisim's Voltage Controlled Sine Wave Oscillator. This sine wave generator acts as a voltage controlled oscillator (VCO). This generator is driven by a 500 Hz modulating frequency which is supplied by the Function Generator as shown in Figure 14-1. The Voltage Controlled Sine wave parameters are set such that a zero volt control voltage produces an output frequency of 200 Hz. A control voltage of 12 V will result in an output frequency of 25 kHz.

The detector circuit of Figure 14-2 is an example of a simple FM demodulator which makes use of a crystal found in the miscellaneous section of the parts bin. This circuit will provide basic demodulation for a signal provided by Multisim's FM modulator and will output a much lower amplitude version of the original modulating signal. This signal normally would be amplified by an audio amplifier for practical purposes.

Parts

Resistors: 50 Ω , 220 Ω , 1 k Ω , 50 k Ω Capacitors: 35 nF, 51 nF, 1.5 μ F, 15 μ F, 20 μ F, 30 μ F Inductors: 12 μ H, 30 μ H, 3 mH Ideal Crystal Ideal Diodes FM Modulator

Test Equipment

- Oscilloscope
- Function Generator

Procedure



Figure 14-1 VCO Detection Example



Figure 14-2 Simple FM Demodulator Example

- 1. Connect the circuit as illustrated in Figure 14-1.
- 2. Double-click the Function Generator to set its parameters. Select Triangle Wave, Frequency = 500 Hz, Duty cycle = 50 %, Amplitude = 6 V and Offset = 7 V.
- 3. Double-click the Voltage Controlled Sine wave generator to set its parameters. Set the first Control Array selection = 12 with an associated Frequency Array = 25000. Set the second Control Array selection = 0 with an associated Frequency Array = 200.

- 4. Start the simulation and observe the frequency modulated signal in the time versus amplitude domain. Draw the associated output waveform in the Data section of this experiment.
- 5. Connect the circuit as illustrated in Figure 14-2.
- 6. Double-click the FM Modulator to set its parameters and set Voltage Amplitude = 20 V, Carrier Frequency = 8 MHz, Modulation Index = 5 and Signal Frequency = 10 kHz.
- 7. Double-click the Oscilloscope to view its display. Set the time base to $100 \,\mu$ s/Div and Channel A to $100 \,\mu$ V/Div. Select Auto triggering and DC coupling. Run the simulation noting the frequency of the sine wave at the output of the detector. Compare this frequency with the input modulation frequency to verify that they are the same.

Data for Experiment 14

FM time versus amplitude sketch

 $f_m =$ _____



Additional Challenge

Figure 14-3 VCO Using a Potentiometer as a Modulating Signal Example

Connect the circuit as illustrated in Figure 14-3. In this configuration, the VCO is controlled by your operation of the potentiometer which will be simulating a low frequency message signal. Run the simulation and, while observing the output on the Oscilloscope, highlight the potentiometer and press the "A" key continuously. You can also, hover your cursor over the potentiometer and drag the slider bar that appears. Observe the simulated frequency modulated output that results.