Amplitude Modulation

1 Objectives

1. Study and understand how amplitude modulation (AM) works.
2. Understand superheterodyne receiver

2 Theory

2.1 Amplitude Modulation

Amplitude modulation (**AM**) is a modulation technique used in electronic communication, most commonly for transmitting information via a radio carrier wave. AM works by varying the strength (amplitude) of the carrier in proportion to the waveform being sent. That waveform may, for instance, correspond to the sounds to be reproduced by a loudspeaker, or the light intensity of television pixels. This contrasts with frequency modulation, in which the frequency of the carrier signal is varied, and phase modulation, in which its phase is varied, by the modulating signal.

In amplitude modulation, the amplitude or "strength" of the carrier oscillations is what is varied. For example, in AM radio communication, a continuous wave radio-frequency signal (a sinusoidal carrier wave) has its amplitude modulated by an audio waveform before transmission. The audio waveform modifies the amplitude of the carrier wave and determines the *envelope* of the waveform. In the frequency domain, amplitude modulation produces a signal with power concentrated at the carrier frequency and two adjacent sidebands. Each sideband is equal in bandwidth to that of the modulating signal, and is a mirror image of the other. Standard AM is thus sometimes called **"double-sideband amplitude modulation" (DSB-AM)** to distinguish it from more sophisticated modulation methods also based on AM.

Single-SideBand modulation (**SSB**) or **Single-SideBand Suppressed-Carrier** (**SSB-SC**) is a refinement of amplitude modulation which uses transmitter power and bandwidth more efficiently. Amplitude modulation produces an output signal that has twice the bandwidth of the original baseband signal. Single-sideband modulation avoids this bandwidth doubling, and the power wasted on a carrier, at the cost of increased device complexity and more difficult tuning at the receiver.

2.2 Superheterodyne receiver

The superheterodyne receiver operates by taking the signal on the incoming frequency, mixing it with a variable frequency locally generated signal to convert it down to an intermediate frequency(455 kHz) where it can pass through a high performance fixed frequency filter before being demodulated to extract the required modulation or signal.

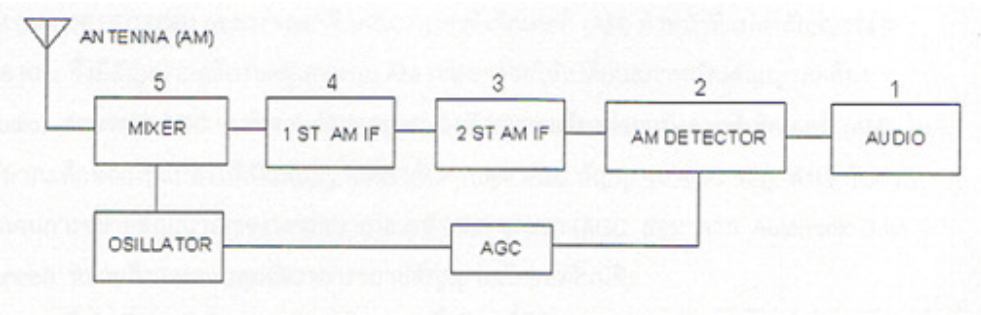

Figure 1: Superheterodyne receiver

3 Equipment

1. Spectrum Analyzer
2. Function Generator
3. Oscilloscope
4. AM experiment set
5. DC power supply

4 Experiment

Experiment 1 Amplitude Modulation

Experiment Procedure **Turn off the power supply during circuit connection**

1. Connect the DC power supply to the AM transmitter board using the diagram shown in figure 2.
2. On the AM transmitter board, set AUDIO input Select to Int, MODE to DSB and Tx Output to Ant.
3. Adjust the signal from the audio oscillator to 1.5 kHz, 0.5 V_{pp}, then use the oscilloscope to record the signal at the test point 14.
4. Use the oscilloscope and the spectrum analyzer to record the signal from the 455 kHz crystal oscillator at the test point 16.
5. At the balanced modulator, adjust the balance knob to obtain the AM signal. Use the oscilloscope and the spectrum analyzer to record the signal. (HINT: Set the center frequency of the spectrum analyzer at 455 kHz)
6. Use the oscilloscope and the spectrum analyzer to record the signal at the test point 13.
7. Connect test point 17 to the test point 28, and set the switch detector to Diode. Use the oscilloscope to record the output.
8. At the balanced modulator, adjust the balance knob to obtain the DSB signal. Use the oscilloscope and the spectrum analyzer to record the signals at the test points 3 and 13.
9. Repeat steps 7.

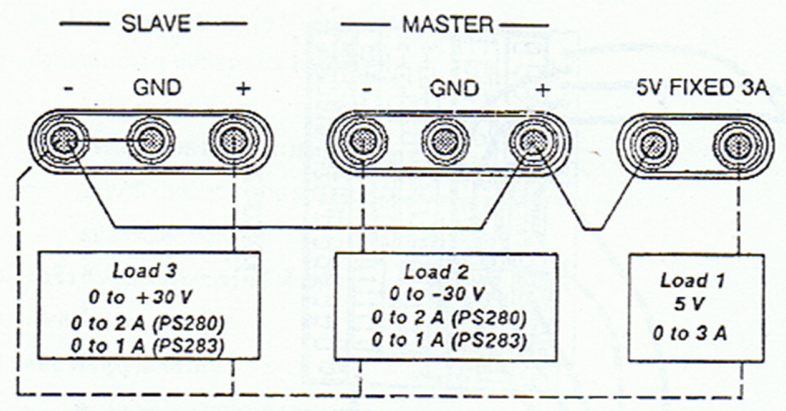

Figure 2: DC power supply configuration

Experiment 2 superheterodyne receiver

1.Connect the DC power supply to the AM **superheterodyne** board and connect the circuit.

2. Turn on DC power supply.

3. Select an AM channel by turning the rotating switch number 1.

4. Record signal at point 4 5 6 7 and 8

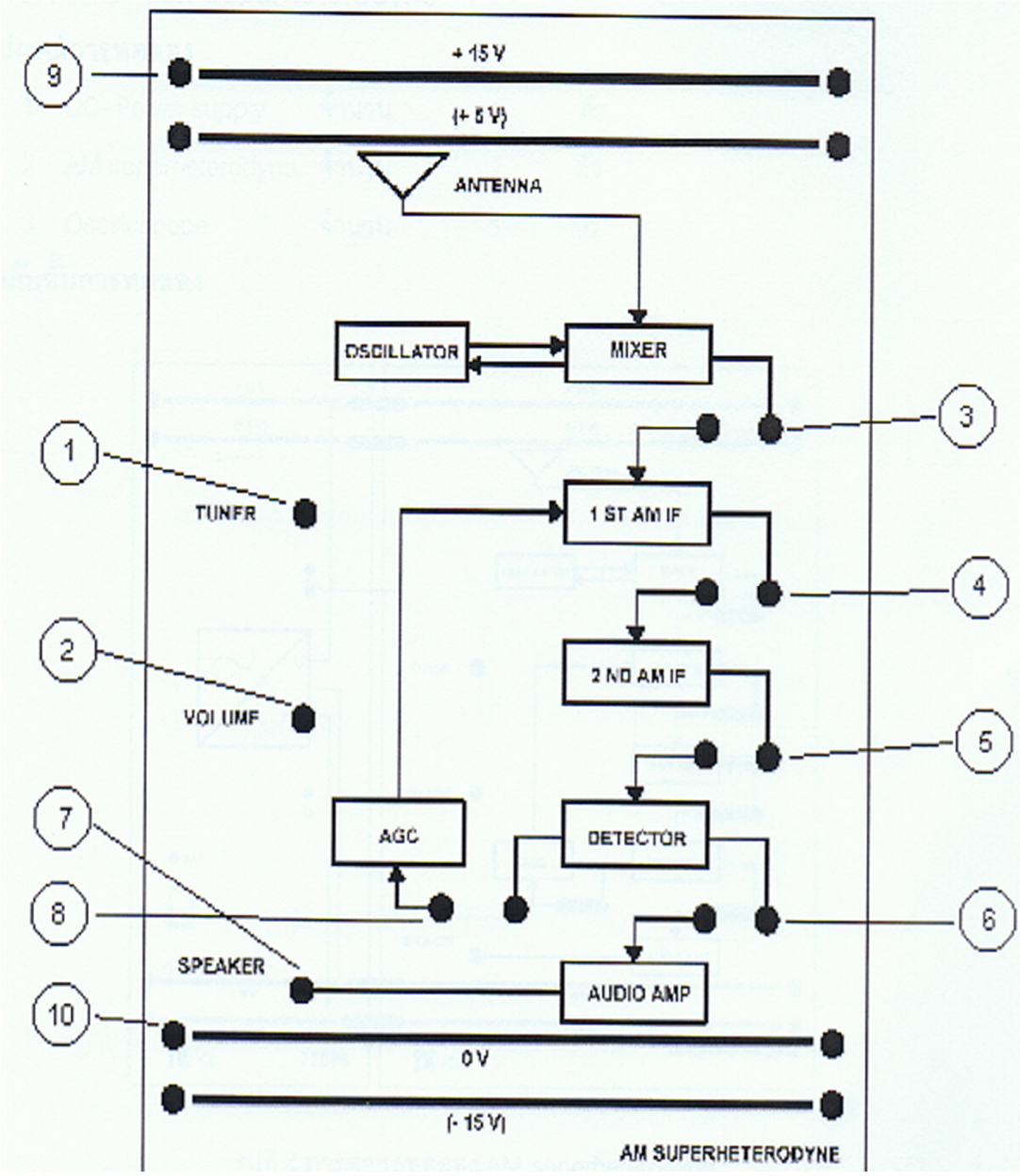

Figure 3 **AM superheterodyne**

5 Postlab Questions

1. What is an envelope detector? What are the advantage and the disadvantage of this detector? Also state its limitations.
2. What is a superheterodyne receiver?