GLP-F020

اسم القسم: هندسة تقنيات الأجهزة الطبية / اسم المختبر: نظم الاتصالات الطبية / المرحلة: الثالثة / رمز المختبر: BL 407

سجل التجارب للعام الدراسي 2023-2024

رقم التجربة: - Experiment No.3

اسم التجربة: - Phase Modulation and Demodulation (PM)

الغرض من التجربة: - Understand communication theory, including phase modulation and demodulation.

الاجهزة والمعدات: -

1- Analog Communication Trainer

2- Oscilloscope

Definition: Phase modulation (PM) is a modulation pattern for conditioning communication signals for transmission. It encodes a message signal as variations in the instantaneous phase of a carrier wave. Phase modulation is one of the two principal forms of angle modulation, together with frequency modulation.
In phase modulation, the instantaneous amplitude of the baseband signal modifies the phase of the carrier signal keeping its amplitude and frequency constant. The phase of a carrier signal is modulated to follow the changing signal level (amplitude) of the message signal. The peak amplitude and the frequency of the carrier signal are maintained constant, but as the amplitude of the message signal changes, the phase of the carrier changes correspondingly.

The equation of a PM signal is represented by:

$$V(t) = A\cos[w_c(t) * \emptyset)\, t)]$$

Where,

w_c is the carrier frequency (constant).

A is the amplitude (constant).

ϕ(t) is the phase angle, which is not constant. It is a function of the baseband signal.

Let's first discuss the message signal and the carrier signal.

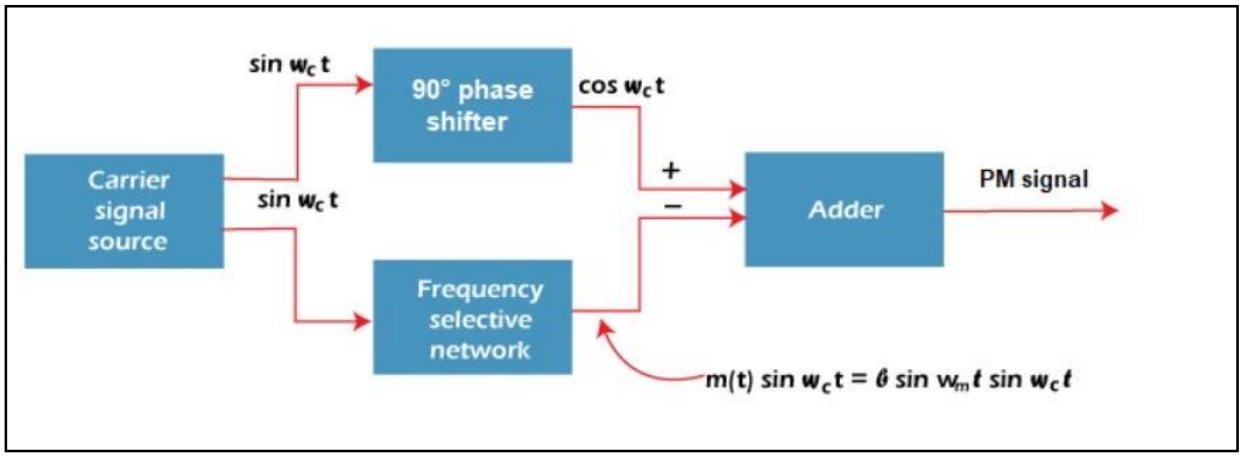
Message signal: A message signal contains information or a message. It is the **original signal** that needs to be transmitted from the **transmitter to the receiver**. The transmitter converts the signal into a suitable form and sends it through the communication channel to the receiver. The communication channel is a **medium** for the signal to travel from one end to the other. The receiver perceives the signal, which is converted back to its original form.

A message signal suffers from attenuation and various noise factors. It is essential to modulate the message signal to remove the noise. It also helps in improving the **efficiency** of the signal. Hence, a message signal is often known as a *modulated signal*. Another name of the message signal is the baseband signal.

Carrier signal: The carrier signal is the same sinusoidal waveform signal as the message signal with greater frequency. It means that the frequency of the carrier signal is higher than the message signal. The Carrier signal is sent with the message signal on the same communication channel during the modulation process. When sent with the message signal, the high-frequency carrier signal increases the frequency of the message signal. It is used in applications where the incoming message signal is low frequency, and the required output signal is high frequency.

Phase Modulators: Modulation refers to converting the information signal to a suitable form of transmission. Here, the incoming message signal is converted to radio waves, which is a suitable mode of transmission for the communication system.

The modulation process of PM is similar to the FM modulation process except for the integrator. FM requires an integrator before the modulated signal is applied to the balanced modulator. The integrator block in FM is present before the balance modulator block. But in PM modulation, no integrator block is required. The block diagram of the PM modulator is shown below:



The circuit consists of a carrier signal source, balance modulator, adder, and a 90-degree phase shifter. The carrier signal source generates a carrier sinωct with the carrier frequency ωc. The 90-degree phase shifter converts the carrier signal sinωct to cosωct, which is the carrier with a phase shift of 90°. A balance modulator generates a double sideband amplitude modulated signal by superimposing the message and the carrier signal sinωct. The output signal is generally a suppressed carrier signal. The output of the balance modulator and the output of the phase shifter are sent to the adder, which adds these two outputs. The carrier shifted by

a phase of 90° when added to the output of the balanced modulator forms a phase-modulated signal.

Graphical Representation of Phase Modulated Wave:

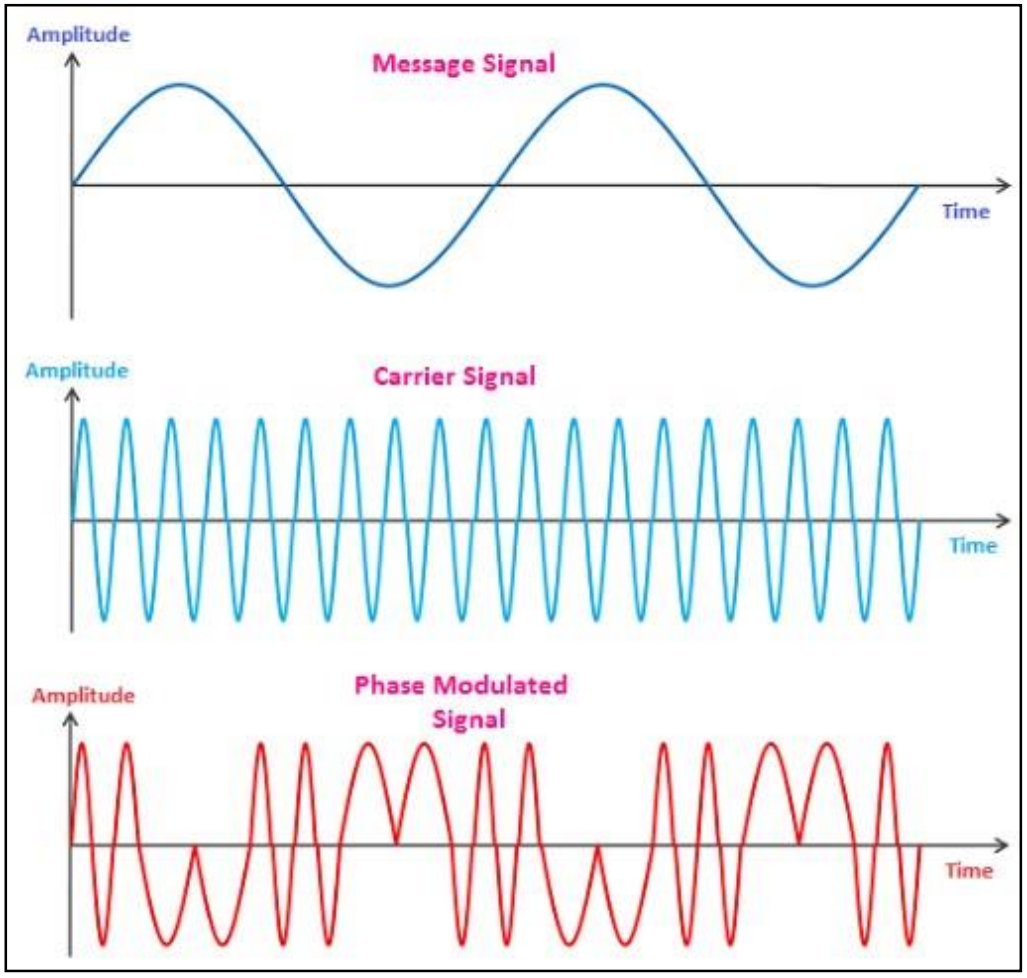


Fig. The output of Phase Modulation.

Advantages of Phase Modulation:

The advantages of Phase Modulation are as follows:

- **High speed**
  Phase modulation is considered as one of the fastest modulation techniques. It is due to the pulse generation at high speed.
- **Low signal power consumption**
  PM requires low signal power consumption due to its better efficiency and fast speed.
- **Simple circuit design**
  The components required in the phase-modulated circuit are less as compared to FM. Hence, it has a simple circuit design.
- **Easy modulation and demodulation**
  Phase modulation and demodulation are easy as compared to PM due to its simple circuit design.

Disadvantages of Phase Modulation:

The disadvantages of Phase Modulation are as follows:

- **Low noise immunity**
  PM has less noise immunity than FM. This is because the frequencies are less affected by external disturbances than phase. Hence, PM has lower noise immunity than FM.
- **Complex circuitry during conversion from FM to PM**
  The conversion process from frequency modulation to phase modulation is complex. This is due to the additional components required for the conversion.
- **Low signal-to-noise ratio**
  PM has a lower signal-to-noise ratio than FM. This is due to the higher bandwidth of FM.

Applications of Phase Modulation:

The applications of Phase Modulation are listed as follows:

- **Sound Synthesis**
  PM is less susceptible to noise interference and popping sounds than AM. Hence, it is suitable for sound broadcasting, commonly referred to as sound synthesis.
- **Digital Synthesizers**
  PM is used in digital synthesizers for the generation of signals and waveform.
- **Telephone communication**
  PM is widely used in telephone communication due to its high-speed transmission.