

MODULATION SYSTEMS

1. Introduction

a. In the Microbroadcasting services, a reliable radio communication system is of vital importance. The swiftly moving operations of modern communities require a degree of coordination made possible only by radio. Today, the radio is standard equipment in almost all vehicles, and the handie-talkie is a common sight in the populace. Until recently, a-m (amplitude modulation) communication was used universally. This system, however, has one great disadvantage: Random noise and other interference can cripple communication beyond the control of the operator. In the a-m receiver, interference has the same effect on the r-f signal as the intelligence being transmitted because they are of the same nature and inseparable.

b. The engines, generators, and other electrical and mechanical systems of modern vehicles generate noise that can disable the a-m receiver. To avoid this a different type of modulation, such as p-m (phase modulation) or f-m (frequency modulation) is used. When the amplitude of the r-f (radio-frequency) signal is held constant and the intelligence transmitted by varying some other characteristic of the r-f signal, some of the disruptive effects of noise can be eliminated.

c. In the last few years, f-m transmitters and receivers have become standard equipment in America, and their use in mobile equipments exceeds that of a-m transmitters and receivers. The widespread use of frequency modulation means that the technician must be prepared to repair a defective f-m unit, align its tuned circuits, or correct an abnormal condition. To perform these duties, a thorough understanding of frequency modulation is necessary.

2. Carrier Characteristics

The r-f signal used to transmit intelligence from one point to another is called the carrier. It consists of an electromagnetic wave having amplitude, frequency, and phase. If the voltage variations of an r-f signal are graphed in respect to time, the result is a waveform such as that in figure 2. This curve of an unmodulated carrier is the same as those plotted for current or power variations, and it can be used to investigate the general properties of carriers. The unmodulated carrier is a sine wave that repeats itself in definite intervals of time. It swings first in the positive and then in the negative direction about the time axis and represents changes in the amplitude of the wave. This action is similar to that of alternating current in a wire, where these swings represent reversals in the direction of current flow. It must be remembered that the plus and minus signs used in the figure represent direction only. The starting point of the curve in the figure 2 is chosen arbitrarily. It could have been taken at any other point just as well. Once a

starting point is chosen, however, it represents the point from which time is measured. The starting point finds the curve at the top of its positive swing. The curve then swings through 0 to some maximum amplitude in the negative direction, returning through 0 to its original position. The changes in amplitude that take place in the interval of time then are repeated exactly so long as the carrier remains unmodulated. A full set of values occurring in any equal period of time, regardless of the starting point, constitutes one cycle of the carrier. This can be seen in the figure, where two cycles with different starting points are marked off. The number of these cycles that occur in 1 second is called the frequency of the wave.

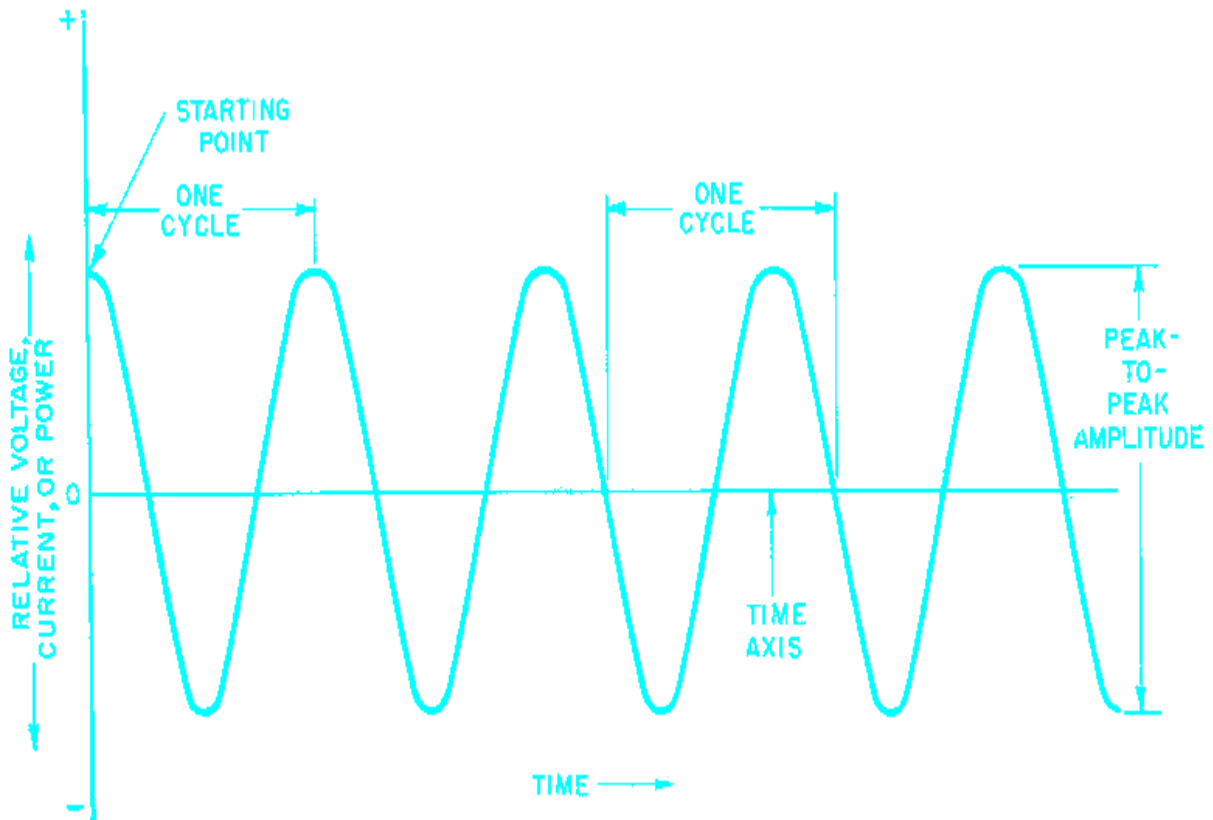


Figure 2. Graph of typical unmodulated carrier.

3. Amplitude Modulation

a. General. The amplitude, phase, or frequency of a carrier can be varied in accordance with the intelligence to be transmitted. The process of varying one of these characteristics is called modulation. The three types of modulation, then are amplitude modulation, phase modulation, and frequency modulation. Other special types, such as pulse modulation, can be considered as subdivisions of these three types. With a sine-wave voltage used to amplitude-modulate the carrier, the instantaneous amplitude of the carrier changes constantly in a sinusoidal manner. The maximum amplitude that the wave reaches in either the positive or the negative direction is termed the peak amplitude. The positive and negative peaks are equal and the full swing of the cycle

from the positive to the negative peak is called the peak-to-peak amplitude. Considering the peak-to-peak amplitude only, it can be said that the amplitude of this wave is constant. This is a general amplitude characteristic of the unmodulated carrier. In amplitude modulation, the peak-to-peak amplitude of the carrier is varied in accordance with the intelligence to be transmitted. For example, the voice picked up by a microphone is converted into an a-f (audio-frequency) electrical signal which controls the peak-to-peak amplitude of the carrier. A single sound at the microphone modulates the carrier, with the result shown in figure 3. The carrier peaks are no longer because they follow the instantaneous changes in the amplitude of the a-f signal. When the a-f signal swings in the positive direction, the carrier peaks are increased accordingly. When the a-f signal swings in the negative direction, the carrier peaks are decreased. Therefore, the instantaneous amplitude of the a-f modulating signal determines the peak-to-peak amplitude of the modulated carrier.

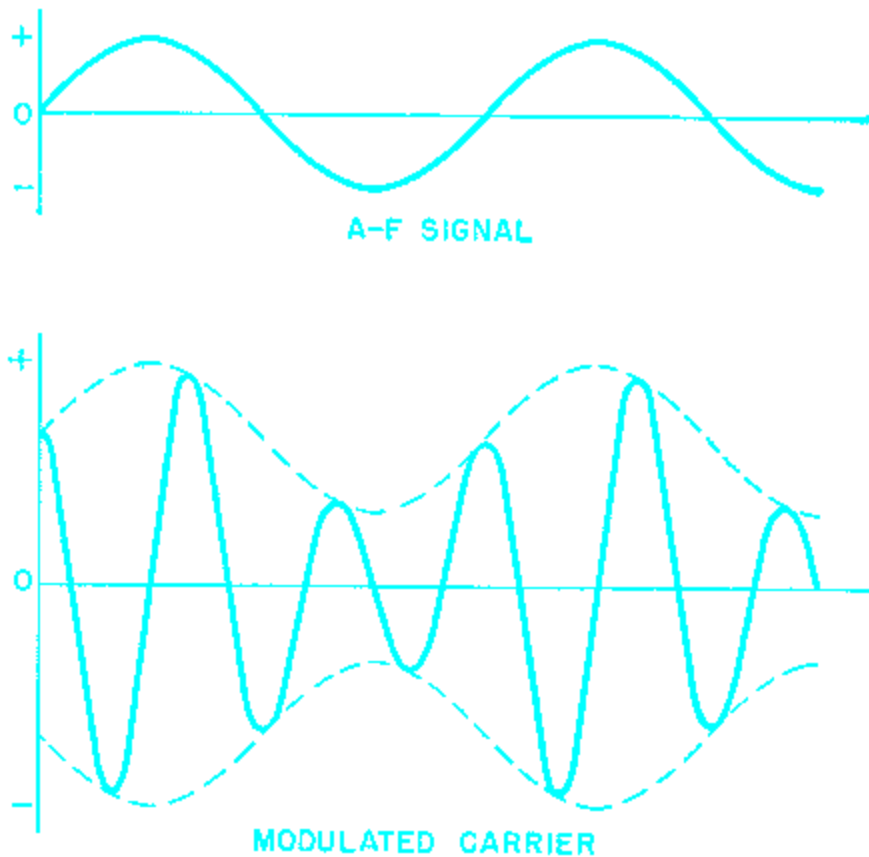


Figure 3. Effect of a-f signal on carrier in amplitude modulation.