



Modulation

COMMUNICATIONS

WRITTEN BY:

The Editors of
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Modulation, in electronics, technique for impressing information (voice, music, picture, or data) on a radio-frequency [carrier wave](#) by varying one or more characteristics of the wave in accordance with the intelligence signal. There are various forms of modulation, each designed to alter a particular characteristic of the carrier wave. The most commonly altered characteristics include amplitude, frequency, phase, pulse sequence, and pulse duration.

AMPLITUDE MODULATION.

In amplitude modulation (AM), auditory or visual information is impressed on a carrier wave by varying the amplitude of the carrier to match the fluctuations in the audio or video signal being transmitted. AM is the oldest method of broadcasting radio programs. Commercial AM stations operate at frequencies spaced 10 kHz apart between 535 and 1,605 kHz. Radio waves in this frequency range are effectively reflected back to the Earth's surface by the ionosphere and can be detected by receivers hundreds of miles away. In addition to its use in commercial radiobroadcasting, AM is employed in long-distance shortwave radio broadcasts and in transmitting the video portion of television programs.

FREQUENCY MODULATION.

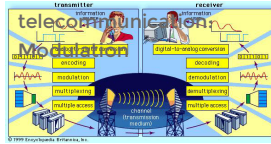
In [frequency modulation](#) (FM), unlike AM, the amplitude of the carrier is kept constant, but its frequency is altered in accordance with variations in the audio signal being sent. This form of modulation was developed by the American electrical engineer [Edwin H. Armstrong](#) during the early 1930s in an effort to overcome interference and noise that affect AM radio reception. FM is less susceptible than is AM to certain kinds of interference, such as that caused by thunderstorms as well as random electrical currents from machinery and other related sources. These noise-producing signals affect the amplitude of a radio wave but not its frequency, and so an FM signal remains virtually unchanged.



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FM is better adapted than is AM to the [transmission](#) of stereophonic sound, audio signals for television programs, and long-distance telephone calls by microwave radio relay. Commercial FM broadcasting stations are assigned higher frequencies than are AM stations. The assigned frequencies, spaced 200 kHz apart, range from 88 to 108 MHz.

PHASE MODULATION.

The phase of a carrier wave is varied in response to the vibrations of the sound source in phase modulation (PM). This form of modulation is often considered a variation of FM. The two processes are closely related because phase cannot be changed without also varying frequency, and vice versa. Also, the rate at which the phase of a carrier changes is directly proportional to the frequency of the audio signal.

Like FM, PM minimizes various types of interference to broadcast reception at frequencies below 30 MHz. The two techniques are commonly used together. FM cannot be applied during the amplification of a sound signal in broadcasting, and so PM is used instead. PM is also utilized in some microwave radio relays and in certain kinds of telegraphic and data-processing systems. Other important applications of PM include communications between mobile radio units employed by the police and military.



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PULSE-CODED MODULATION.

In [pulse-coded modulation](#) (PCM), the intelligence signal converts the carrier into a series of constant-amplitude pulses spaced in such a manner that the desired intelligence is contained in coded form. Continuous signals, such as voice messages, television pictures, and computer data, are commonly transformed into the [Baudot Code](#) or its variations, which are composed of patterns of 5 or 7 "on" and "off" pulses. PCM minimizes transmission losses and eliminates noise and interference problems because the receiving unit need only detect and identify simple pulse patterns. Moreover, the pulses, unlike continuous signals, can be regenerated electronically by repeater stations along the transmission route with virtually no distortion.

PCM, invented by H.A. Reeves of the United States in 1939, is employed by many communications companies and organizations, including Comsat and Intelsat, for telegraph, telephone, and television transmission. The technique has proved especially useful for the exchange of digital information between computer terminals.

PULSE-DURATION MODULATION.

Another kind of pulse modulation is [pulse-duration modulation](#) (PDM), in which intelligence is represented by the length and order of regularly

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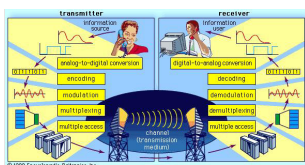




recurring pulses. A familiar example of PDM is the International Morse Code, used in ship-to-shore communications, amateur radio, and certain other forms of radiotelegraphy.

PDM was devised by the American physicist Raymond A. Heising in 1924. Besides its use in telegraphic communications by means of microwave radio relay systems, its chief application is telemetering.

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A carrier wave is a radio-frequency wave that carries information. The information is attached to the carrier wave by means of a modulation process that involves the variation of one of the carrier-frequency characteristics, such as its amplitude, its frequency, or its duration. (All of these processes are discussed in greater detail in the article telecommunication system.)

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- major reference (in [telecommunication: Modulation](#))
- radio (in [radio technology: Modulators and demodulators](#)) (in [radio technology: Tuned circuits and the superheterodyne principle](#))
- telemetry (in [telemetry: Transmission](#))

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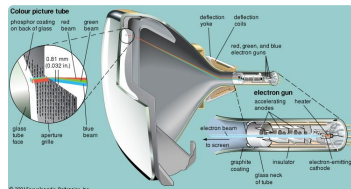


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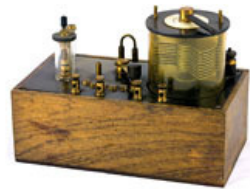
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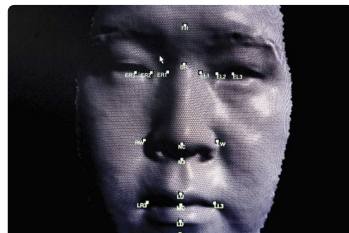
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