

Modulation Glossary for ARRL Handbook Chapter 11

GENERAL

AM — Amplitude modulation.

Angle modulation — Modulation of an RF carrier by varying the phase or frequency.

Emission designator — Official ITU code to specify the bandwidth and modulation type of a radio transmission.

Frequency diversity — The use of a wideband signal to compensate for selective fading. While one band of frequencies is faded, the data can be reconstructed from other frequencies that are not faded.

FM — Frequency modulation.

IMD — Intermodulation distortion. Unwanted frequencies that occur at the sum and difference of the desired frequencies and their harmonics.

ITU — International Telecommunications Union. An agency of the United Nations that coordinates and recommends technical standards for electronic communications.

Modulation — The periodic alteration of some parameter of a carrier wave in order to transmit information.

PM — Phase modulation.

Protocol — A formal set of rules and procedures for the exchange of information within a communications network.

Selective fading — A propagation phenomenon in which closely-spaced frequencies experience markedly different fading at the same time.

Telemetry — The use of telecommunication for automatically indicating or recording measurements at a distance from the measuring instrument.

Telephony — A form of telecommunication primarily intended for the exchange of information in the form of speech.

Telegraphy — A form of telecommunication in which the transmitted information is intended to be recorded on arrival as a graphic document; the transmitted information may sometimes be presented in an alternative form or may be stored for subsequent use.

Television — A form of telecommunication for the transmission of transient images of fixed or moving objects.

AMPLITUDE AND ANGLE MODULATION (INCLUDING IMAGE)

ATV — Amateur fast-scan television.

BFO — Beat frequency oscillator.

In an SSB or DSBSC receiver, the intermediate-frequency oscillator in the receiver that re-inserts the suppressed carrier.

Carson's rule — A rule of thumb to calculate FM bandwidth that says that 98% of the energy is typically contained within a bandwidth equal to two times the sum of the peak frequency deviation and the highest modulating frequency.

Capture effect — The tendency of the strongest signal to suppress other signals in an FM detector, which improves the signal-to-noise and signal-to-interference ratio.

Deviation ratio — The ratio of the maximum permitted peak deviation of an angle-modulated signal to the maximum permitted modulating frequency.

DSB-SC — Double sideband, suppressed carrier. An AM signal in which the carrier has been removed but both sidebands remain.

Frame — In television, one complete scanned image. On systems with interlaced scanning, there are two vertical scans per frame.

Frequency deviation — The amount the RF frequency of an angle-modulated signal deviates from the center (carrier) frequency in response to the modulating signal. The term is often understood to mean the maximum deviation available in a given system.

Limiter — A high-gain amplifier in an FM receiver that limits the peak amplitude of the signal in order to eliminate any AM component.

LSB — Lower sideband. An SSB signal with the upper sideband removed.

Martin — A series of analog SSTV formats, especially popular in Europe.

Modulation index (AM) — The ratio of the peak value of the modulation of an AM signal to the value that just causes the modulation envelope of the RF signal to reach zero on negative peaks and twice the average value on positive peaks.

Modulation index (FM) — The ratio of the peak deviation of an angle-modulated signal to the highest modulating frequency.

Narrowband FM — An FM signal with a modulation index less than or equal to 1.0.

NTSC — National Television System Committee. The analog television standard used in the US, Japan and several other countries.

PAL — Phase alteration line. The analog television standard used in many parts of Europe.

Phasing method — A method of generating an SSBSC signal that does not require a filter to remove the unwanted sideband.

Pixel — Picture element. The dots that make up images on a computer's monitor.

Product detector — A detector that multiplies a BFO signal with the received signal, typically SSB or DSBSC-modulated.

RGB — Red, green and blue. The three primary colors required to transmit a full-color image in many television and facsimile systems.

Scottie — A series of analog SSTV formats, especially popular in the US.

SSB — Single sideband. An AM signal in which one sideband has been removed. The term is usually understood to mean SSBSC.

SSB-SC — Single sideband, suppressed carrier. An AM signal in which one sideband and the carrier have been removed.

SSTV — Slow scan TV, a system for sending and receiving still images.

Sync — Modulation pulses used in ATV and SSTV to synchronize the horizontal and/or vertical scanning.

Synchronous detector — A type of AM detector in which the carrier is regenerated in the receiver.

Two-tone test — A procedure for testing the IMD of an SSB transmitter. Two equal-amplitude tones are fed to the microphone input and the transmitter RF output is examined with a spectrum analyzer to determine the amplitudes of the IMD products.

USB — Upper sideband. An SSB signal with the lower sideband removed.

Vestigial sideband — The filtering of all but the bottom MHz or so of the lower sideband of an ATV or NTSC television signal.

VIS — Vertical interval signaling. Digital encoding of the transmission mode during the vertical sync interval of an SSTV frame.

Wideband FM — An FM signal with a modulation index greater than 1.0.

DIGITAL MODULATION

AFSK — Audio FSK. The use of an SSB transceiver to transmit and receive FSK using an audio-frequency modem.

ASK — Amplitude-shift keying. Digital amplitude modulation in which the amplitude depends on the modulating code.

Baud — The rate at which a digital signal transitions between symbol states. Symbol rate. Symbols per second. Unit of symbol rate.

Bit rate — The total number of physically transferred bits per second over a communication link. Bit rate can be used interchangeably with **baud rate** only when each modulation transition carries exactly one bit of data.

BPSK — Binary PSK. PSK with only two possible states. The term is usually understood to mean a non-constant-envelope signal in which the two states differ by 180°.

Chirp — Incidental frequency modulation of a carrier as a result of oscillator instability during keying.

CW — Continuous wave. The term used for on-off keying using Morse code.

Constellation diagram — A diagram showing the constellation of possible symbol locations on a polar plot of modulation amplitude and phase.

DBPSK — Differential BPSK.

Decision point — The point, typically in the center of a symbol time, at which the receiver decides which symbol is being sent.

Differential modulation — A modulation technique that encodes the information in the difference between subsequent symbols, rather than in the symbols themselves.

Equalization — Correction for variations in amplitude and/or phase versus frequency across a communications channel.

DQPSK — Differential QPSK.

Eye diagram — An oscilloscope measurement of a digital modulating signal with the horizontal sweep synchronized to the symbol times. With Nyquist filtering, there should be a clear separation, or “eye”, in the trajectories at the symbol decision points.

EVM — Error vector magnitude. A measure of the RMS error in the symbol locations at the symbol decision points in the constellation plot of a digital signal.

FFT — Fast Fourier transform. The Fourier transform is a mathematical function that calculates the frequency spectrum of a signal. The FFT is a software algorithm that does the calculations very efficiently.

FSK — Frequency-shift keying. A form of digital frequency modulation in which the frequency deviation depends on the modulating data.

GMSK — Gaussian MSK. MSK with a Gaussian modulation filter.

I/Q modulation — Quadrature modulation implemented with an I/Q modulator, one that uses in-phase (I) and quadrature (Q) modulating signals to generate the zero-degree and 90° components of the RF signal.

ISI — Inter-symbol interference. Interference of a signal with itself, caused when energy from one symbol is delayed long enough to interfere with a subsequent symbol.

MFSK — Multi-level FSK. FSK with more than two states represented by different frequency deviations.

Modem — Modulator/demodulator. A device that generates and demodulates digital modulation signals, usually at audio frequencies. It connects between the data terminal (usually a computer) and the radio.

MSK — Minimum-shift keying. A form of FSK with a frequency shift equal to one-half the symbol rate.

Nyquist criterion — A principle that states that the sampling frequency must be greater than twice the highest frequency in the sampled signal.

Nyquist frequency — One-half the sampling frequency.

OFDM — Orthogonal frequency-division multiplexing. A transmission mode that uses multiple carriers, spaced such that modulation on each carrier is orthogonal with the others.

OOK — On-off keying. A type of ASK with only two states, on and off.

OQPSK — Offset QPSK. By offsetting in time the symbol transitions of the I and Q channels, symbol trajectories through the origin are eliminated.

Orthogonal — Refers to streams of data that are uncorrelated with each other such that there is no mutual interference.

PAM — Pulse amplitude modulation. A type of pulse modulation where the modulating signal is encoded in the pulse amplitude.

$\pi/4$ DQPSK — PI-over-four differential QPSK. A form of differential 8PSK in which the only allowed transitions are $\pm 45^\circ$ and $\pm 135^\circ$, resulting in four allowed states per symbol.

PPM — Pulse position modulation. A type of pulse modulation where the modulating signal is encoded in the pulse position.

PSK — Phase-shift keying. A form of digital phase modulation in which the phase of the RF signal depends on the modulating code. The term often is understood to refer to BPSK.

Pulse modulation — The modulating signal is sampled at regular intervals to generate a series of modulation symbols in the form of pulses.

PWM — Pulse width modulation. A type of pulse modulation where the modulating signal is encoded in the pulse width.

QAM — Quadrature amplitude modulation. A digital modulation type in which both amplitude and phase are varied. The number that precedes it, for example 64QAM, is the number of different possible states of the amplitude and phase.

QPSK — PSK with four possible states. The term is usually understood to be equivalent to four-level QAM, in which the four states have the same amplitude and differ in phase by 90°.

Quadrature modulation — Refers to modulation using two RF carriers in phase quadrature, that is, 90° out of phase.

Symbol rate — The rate at which a digital signal transitions between different states. Baud rate.

Varicode — A coding method in which the length of each character code depends on its frequency of occurrence. It is used to optimize the ratio of characters per second to baud rate.

SPREAD SPECTRUM

CDMA — Code-division multiple access. A method of allowing several stations to use the same frequency band simultaneously by assigning each station a different orthogonal spreading code.

Chip — The shortest-duration modulation state in a SS system.

De-spreading — Conversion of an SS signal back to its narrowband equivalent by convolving it with the spreading code.

DSSS — Direct-sequence SS. Spreading of a signal by multiplying the data stream by a higher-rate pseudo-random digital sequence.

FHSS — Frequency-hopping SS. Spreading of a signal by means of pseudo-random frequency-hopping of the unspread signal.

Processing gain — The increase in signal-to-noise ratio that occurs when an SS signal is de-spread.

SS — Spread spectrum. A system that intentionally increases the bandwidth of a digital signal by means of a special spreading code.

FILTERING AND BANDWIDTH

ACP — Adjacent channel power. The amount of transmitted power that falls into a communications channel immediately adjacent to the desired one.

Alpha — A design parameter for a Nyquist or root Nyquist filter. The smaller the alpha, the sharper the passband-to-stopband transition at the cutoff frequency.

Cutoff frequency — The frequency at which a filter response changes from the passband to the stopband.

Gaussian filter — A modulation filter with a Gaussian frequency response. The transition between passband and stopband is more gradual than with most Nyquist filters.

Key clicks — Out-of-channel interference from an OOK signal caused by too-sharp transitions between the on and off states.

Nyquist filter — A filter that causes no inter-symbol interference (ISI). It is so-called because the cutoff frequency is at one-half the symbol rate, the Nyquist frequency.

Nyquist criterion — The rule that states that the sample rate must be greater than twice the highest frequency to be sampled.

Occupied bandwidth — The bandwidth within which a specified percentage of the total power occurs, typically 99%.

Raised-cosine filter — A type of Nyquist filter whose passband-to-stopband transition region has the shape of the first half-cycle of a cosine raised so that the negative peak is at zero.

Root Nyquist filter — A filter that, when cascaded with another identical filter, forms a Nyquist filter. The frequency response is the square root of that of the Nyquist filter.

Root raised-cosine filter — A root Nyquist filter with a frequency response that is the square root of a raised-cosine filter.

Shannon-Hartley theorem — A formula that predicts the maximum channel capacity that is theoretically possible over a channel of given bandwidth and signal-to-noise ratio.

Sinc function — The spectrum of a pulse or random series of pulses, equal to $\sin(x)/x$.

Splatter — Out-of-channel interference from an amplitude-modulated signal such as SSB or QPSK caused by distortion, typically in the power amplifier stages.