

IEEE Standard Radar Definitions

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inside front cover

ANSI/IEEE Std 686-1982



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An American National Standard

**IEEE Standard
Radar Definitions**

Sponsor

**Radar Systems Panel of the
IEEE Aerospace and Electronic Systems Society**

Approved May 21, 1981

IEEE Standards Board

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American National Standards Institute

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Foreword

(This Foreword is not a part of IEEE Std 686-1982, IEEE Standard Radar Definitions.)

This standard is published for the purpose of promoting clarity and consistency in the use of radar terminology. The definitions represent the consensus (reached after several rounds of review, comment, and revision) of a panel of radar experts, including authors of several books on radar. It is intended that these definitions shall serve as a guide to standardization of meanings.

Originally, radar definitions were included in ANSI/IEEE Std 172-1971, Navigation Aid Terms. The Radar Systems Panel of the IEEE Aerospace and Electronic Systems Society undertook, beginning in 1974, to create a separate standard devoted to radar definitions alone. The result was the first edition of this standard, ANSI/IEEE Std 686-1977, Radar Definitions. In order to avoid overlap and conflict with the radar definitions then existing in ANSI/IEEE Std 172-1971, the IEEE Standards Board allowed only new radar terms, not already in that standard, to be included in ANSI/IEEE Std 686-1977.

The publication of this new edition provides for the first time a clean separation of radar from navigation aids. Radar terms formerly found in ANSI/IEEE Std 172-1971 are now included in this standard and are deleted from the forthcoming revision of ANSI/IEEE Std 172-1971, with the exception of a few terms that are common to both fields. Not only have the radar definitions been combined in this one volume but they have been updated and improved, new terms have been added, and some old terms have been dropped. Further additions are planned in future revisions.

The Radar Systems Panel of the IEEE Aerospace and Electronic Systems Society had the following membership at the time this standard was approved:

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The entire membership of the Radar Systems Panel participated in reviewing successive drafts and recommending revisions, additions, and deletions. The work of preparing the drafts, integrating all the comments, resolving differences, and coordinating with other IEEE standards was done by the Terminology Committee, composed of the following:

Samuel M. Sherman, *Chairman*

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When the IEEE Standards Board approved this standard on May 21, 1981, it had the following membership:

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IEEE Standard Radar Definitions

acquisition. The process of establishing a stable track on a target which is designated in one or more coordinates. A search of a given volume of coordinate space is usually required because of errors or incompleteness of the designation.

acquisition probability. The probability of establishing a stable track on a designated target.

A-display. A type of radar display format. *See: display.*

AEW. Abbreviation for airborne early warning; describing an early warning radar carried by an airborne or spaceborn vehicle. *See: early warning radar.*

aided tracking. A tracking technique in which the manual correction of the tracking error automatically corrects the rate of motion of the tracking mechanism.

AI radar. Abbreviation for airborne intercept radar.

airborne intercept radar (AI radar). A fire-control radar for use in interceptor aircraft.

airport surface detection equipment (ASDE).¹ A ground-based radar for observation of the positions of aircraft and other vehicles on the surface of an airport.

airport surveillance radar (ASR). A medium-range (for example, 60 nautical miles) surveillance radar used to control aircraft in the vicinity of an airport.

air-route surveillance radar (ARSR). A long-range (for example, 200 nautical miles) surveillance radar used to control aircraft on airways beyond the coverage of airport surveillance radar (ASR).

ambiguity function. The squared magnitude $|\chi(\tau, f_d)|^2$ of the function which describes the

response of a radar receiver to targets displaced in range delay τ and Doppler frequency f_d from a reference position, where $|\chi(0, 0)|$ is normalized to unity. Mathematically,

$$\chi(\tau, f_d) = \int u(t) u^*(t + \tau) \exp(2\pi j f_d t) dt$$

where $u(t)$ is the transmitted envelope waveform, suitably normalized, positive τ indicates a target beyond the reference delay, and positive f_d indicates an incoming target. Used to examine the suitability of radar waveforms for achieving accuracy, resolution, freedom from ambiguities, and reduction of unwanted clutter.

amplitude-comparison monopulse. A form of monopulse employing receiving beams with different amplitude-versus-angle patterns. If the beams have a common phase center, the monopulse is pure amplitude-comparison; otherwise it is a combination of amplitude-comparison and phase-comparison. *See also: monopulse and phase-comparison monopulse.*

amplitude noise. Used variously to describe target fluctuation and scintillation error. Use of one of these specific terms is recommended to avoid ambiguity.

AMTI. Abbreviation for airborne moving target indication. *See: moving target indication (MTI).*

angel (or angel echo). A false radar target echo caused by an atmospheric inhomogeneity, atmospheric refraction, insects, birds, or unknown phenomena.

angle noise. The noise-like variation in the apparent angle of arrival of a signal received from a target, caused by changes in phase and amplitude of target scattering sources and including angular components of both glint and scintillation error.

angular resolution. The ability to distinguish between two targets solely by the measurement of angles; generally expressed in terms of the minimum angle by which two targets of equal

¹The abbreviations capitalized in this standard are in accordance with prevailing radar usage. Lower-case abbreviations are an acceptable alternative (and are preferred by some authors and editors) provided they are used in a consistent manner.

strength within the same range resolution cell must be spaced to be separately distinguishable and measurable.

anticlutter circuits. Circuits which attenuate undesired reflections to permit detection of targets otherwise obscured by such reflections.

anti-transmit-receive switch (ATR switch). A radio-frequency switch that automatically decouples the transmitter from the antenna during the receiving period; it is employed when a common transmitting and receiving antenna is used.

area MTI. A moving target indicator (MTI) system in which the moving target is selected on the basis of its change in time delay or angle between looks, rather than its Doppler frequency.

ARSR. Abbreviation for air-route surveillance radar.

A-scope. A cathode-ray oscilloscope arranged to present an A-display.

ASDE. Abbreviation for airport surface detection equipment.

ASR. Abbreviation for airport surveillance radar.

ATC. Abbreviation for air traffic control.

ATR switch. Abbreviation for anti-transmit-receive switch.

automatic tracking. Tracking in which a system employs some feedback mechanism, for example a servo or computer, to follow automatically some characteristic of a signal or target, such as range, angle, Doppler frequency, or phase. *See also:* tracking, tracking radar.

azimuth. The angle between a horizontal reference direction (usually north) and the horizontal projection of the direction of interest, usually measured clockwise.

azimuth marks (or markers). Calibration marks for azimuth.

azimuth-stabilized plan position indicator. A plan position indicator (PPI) on which the reference direction remains fixed with respect to the indicator, regardless of the vehicle orientation.

background return. Same as clutter.

backscatter. Energy reflected in a direction opposite to that of the incident wave.

backscatter coefficient. A normalized measure of radar reflection from a distributed scatterer; usually applied to clutter. For area clutter, such as ground or sea clutter, it is defined as the monostatic radar cross section per unit surface area, which is dimensionless but is sometimes written in units of m^2/m^2 for clarity. For volume clutter, such as rain or chaff, it is defined as the monostatic radar cross section per unit volume; the units are m^2/m^3 , or m^{-1} .

backscattering cross section. *See:* radar cross section.

bandwidth, root-mean-square. The root-mean-square (rms) deviation of the power spectrum of the received signal relative to zero frequency or the spectral center, in units of radians per second. This bandwidth, β , is defined as the square-root of

$$\beta^2 = \frac{\int_{-\infty}^{\infty} [2\pi(f - f_0)]^2 |S(f)|^2 df}{\int_{-\infty}^{\infty} |S(f)|^2 df}$$

where $S(f)$ is the Fourier transform of the signal $s(t - \tau_0)$ with true time delay τ_0 and f_0 is the center frequency of the spectrum.

NOTE: β^2 is the normalized second moment of the spectrum $|S(f)|^2$ about the mean. *See also* ANSI/IEEE Std 100-1977, IEEE Standard Dictionary of Electrical and Electronics Terms.

B-display. A type of radar display format. *See:* display.

beacon. *See:* radar beacon.

beacon equation. An equation which gives the maximum detection range or the signal-to-noise ratio (SNR) of a transponder or secondary radar as a function of system parameters for a given set of conditions. It is the one-way counterpart of the two-way radar equation.

beamshape loss. A loss factor included in the radar equation to account for the use of the peak antenna gain in the radar equation instead of the effective gain that results when the received train of pulses is modulated by the two-way pattern of a scanning antenna. *Syn:* antenna-pattern loss.

bias error. A systematic error, whether due to equipment or propagation conditions. A non-zero mean value of a random error.

bipolar video. A radar video signal whose

amplitude can have both positive and negative values; derived from a synchronous phase detection process. Coherent detection produces one type of bipolar video.

bistatic cross section. *See:* **radar cross section.**

bistatic radar. A radar using antennas at different locations for transmission and reception.

blind speed (radar using MTI). Radial velocity of a target with respect to the radar for which the MTI response is approximately zero; in a coherent MTI system using a uniform repetition rate, a blind speed is a radial velocity at which the target changes its distance by one-half wavelength, or a multiple thereof, during each pulse repetition interval.

blip. A deflection or a spot of contrasting luminescence on a radar display caused by the presence of a target.

blip-scan ratio. The fraction of scans on which a blip is observed at a given range.

NOTE: Corresponds to probability of detection when observer's integration time is less than scan period.

blooming. An increase in the blip size on the display as a result of an increase in signal intensity or duration.

boresighting. The process of aligning the electrical and mechanical axes of a directional antenna system, usually by an optical procedure.

B-scope. A cathode-ray oscilloscope arranged to present a B-display.

calibration marks (or markers). Indications superimposed on a display to provide a numerical scale of the parameters displayed.

canceled (or cancelled) video. In MTI, the video output remaining after the cancellation process.

NOTE: The preferred spelling is *canceled* in the US, *cancelled* in Great Britain.

canceler (or canceller). That portion of the system in which unwanted signals such as clutter, fixed targets, and other interference are suppressed by a process of linear subtraction. *See:* spelling note under **canceled video.**

cancellation ratio. In MTI, the ratio of canceler voltage amplification for fixed-target echoes received with a fixed antenna, to the gain for

a single pulse passing through the unprocessed channel of the canceler.

capture effect. The tendency of a receiver to suppress the weaker of two signals within its passband.

carrier-controlled approach (CCA) system. An aircraft-carrier radar system providing information by which aircraft approaches may be directed via radio communication.

C-band. A radar frequency band between 4 GHz and 8 GHz, usually in the International Telecommunications Union (ITU) assigned band 5.2 GHz to 5.9 GHz.

C-display. A type of radar display format. *See:* **display.**

CFAR. Abbreviation for **constant false-alarm rate.**

chaff. An airborne cloud of lightweight reflecting objects, typically consisting of strips of aluminum foil or metal-coated fibers, which produce clutter echoes in a region of space.

chirp. A technique for pulse compression which uses frequency modulation (usually linear) during the pulse.

clutter. Unwanted echoes, typically from the ground, sea, rain or other precipitation, chaff, birds, insects, and aurora.

clutter attenuation. In moving-target indication, the ratio of clutter power at the canceler input to clutter residue power at the output, normalized to the attenuation for a single pulse passing through the unprocessed channel of the canceler. *Syn:* clutter cancellation or suppression. *See:* **MTI improvement factor.**

clutter filter. A filter or group of filters included in a radar for the purpose of rejecting clutter returns and passing target returns at other Doppler frequencies. MTI and pulsed-Doppler processors are examples.

clutter improvement factor. Same as **MTI improvement factor.**

clutter reflectivity. The backscatter coefficient of clutter. *See:* **backscatter coefficient.**

clutter residue. The clutter power remaining at the output of an MTI system; it is the sum of several (generally uncorrelated) components resulting from radar instabilities, antenna scan-