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(Revision of IEEE Std 686-1990)

IEEE Standard Radar Definitions

Sponsor

Radar Systems Panel
of the
IEEE Aerospace and Electronic Systems Society

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IEEE Standards Board

Abstract: Definitions for the purpose of promoting clarity and consistency in the use of radar terminology are provided. The definitions represent the consensus of a panel of radar experts.
Keywords: radar, terminology

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Introduction

(This introduction is not a part of IEEE Std 686-1997, 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 serve as a guide to standardization of meanings.

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

The second edition, IEEE Std 686-1982, included terms formerly found in IEEE Std 172-1971, with the exception of a few terms that are common to both fields, and new or updated terms. IEEE Std 686-1982 updated, added, and/or deleted standard radar definitions. The third edition, IEEE Std 686-1990, continued the updating process. The current edition, IEEE Std 686-1997, adds new terms, revises others, and deletes a number of obsolete terms that no longer appear in radar literature or usage. As radar technology and literature evolve, new terms will appear; further updating at approximately five-year intervals is planned.

The work of preparing the drafts of this standard, integrating all the comments, resolving differences, and coordinating this standard with other IEEE standards was accomplished by the Terminology Committee of the Radar Systems Panel of the IEEE Aerospace and Electronic Systems Society. The Terminology Committee had the following membership at the time this standard was approved:

David K. Barton, *Chair*

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The Radar Systems Panel of the IEEE Aerospace and Electronic Systems Society participated in reviewing successive drafts of this standard and recommending revisions, additions, and deletions. The Radar Systems Panel comprised the balloting group of this standard and had the following membership at the time this standard was approved:

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IEEE Standard Radar Definitions

acquisition: The process of establishing a stable track on a target that is designated in one or more coordinates. A search of a limited 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.

AEW[1]**:** Acronym for airborne early warning; describing an early-warning or air-surveillance radar carried by an airborne or spaceborne vehicle. *See also:* **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: *See*: **airborne-intercept radar.**

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

airborne moving-target indication (AMTI) radar: An MTI radar flown in an aircraft or other moving platform with corrections applied for the effects of platform motion, which include the changing clutter Doppler frequency and the spread of the clutter Doppler spectrum. *See also:* **displaced phase center antenna; space-time adaptive processing; time-averaged-clutter coherent airborne radar.**

airport surface detection equipment (ASDE): A high-resolution radar usually located on the airport control tower or other high point and used for observation of the positions of aircraft and other vehicles on the surface of an airport.

airport-surveillance radar (ASR): A medium-range (e.g., 100 km) surveillance radar used to control aircraft in the vicinity of an airport.

air-route-surveillance radar (ARSR): A long-range (e.g., 350 km) surveillance radar used to control aircraft on airways beyond the coverage of airport-surveillance radar (ASR).

air-surveillance radar: A surveillance radar whose function is to detect and track aircraft over a volume of space.

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

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ambiguity function: The squared magnitude $|\chi(\tau,f_d)|^2$ of the function that 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 waveform, suitably normalized
positive τ	indicates a target beyond the reference delay
positive f_d	indicates an approaching target

Ambiguity function is 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 in which the angular deviation of the target from the antenna axis is measured as the amplitude ratio of the target as received by two antenna patterns. The patterns may be a pair of beams displaced on opposite sides of the antenna axis, or a difference-channel beam having odd symmetry about the axis and a sum beam having even symmetry. In the latter case the ratio may have positive and negative values (0° or 180° phase shift, or in some cases +90° and –90°). Distinguished from phase-comparison monopulse, in which the relative phase of the two patterns carries the information on target displacement. *See also*: **phase-comparison monopulse.**

amplitude fluctuation: *See*: **target fluctuation.**

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

AMTI: *See:* **airborne moving-target indication.**

angel: A radar echo caused by birds, insects, and atmospheric clear-air turbulence not usually visible to the eye. Often a term applied to any unknown radar echo that does not appear to be related to conventional targets. *Synonym:* **angel echo.**

angel echo: *See:* **angle.**

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 multiple, unresolved target-scattering sources. *Note:* Includes both glint and scintillation errors. *See also:* **glint; scintillation errors.**

angular resolution: The ability to distinguish between two targets solely by the measurement of their angle, usually expressed in terms of the minimum angle separation by which two targets at a given range can be distinguished. *Note:* The required separation should be specified for targets of given relative power level at the receiver. Equal powers are often assumed, but where resolution of targets of different powers is important it may be necessary to specify the separation at two or more power ratios.

antenna-pattern loss: *See:* **beamshape loss.**

anticlutter circuits: Circuits that attenuate undesired reflections from the natural environment (clutter) to permit detection of targets otherwise obscured by such reflections. *See also:* **clutter.**

antisubmarine warfare (ASW) radar: A radar used in ASW. It includes radars for the detection of submarines and submarine effects as well as radars on ships or aircraft employed in ASW operations to obtain situational awareness of the surface ships and aircraft in the vicinity of ASW operations.

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

area moving-target indication (MTI): A method of MTI based upon amplitude changes in corresponding resolution cells for radar returns obtained at different times.

ARSR: *See*: **air-route surveillance radar.**

ASDE: *See*: **airport surface detection equipment.**

ASR: *See*: **airport-surveillance radar.**

ASW radar: *See:* **antisubmarine warfare radar.**

ATR switch: *See*: **anti-transmit-receive switch.**

automatic detection and tracking (ADT): In a surveillance radar, the computer-based ADT of targets based on target locations obtained from scan-to-scan. *See also:* **track-while-scan**.

automatic tracking: Tracking with the use of electronic circuitry rather than a human operator in which a system employs some feedback mechanism, (e.g., 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.**

automatic video noise leveling†: A constant-false-alarm-rate (CFAR) technique in which the receiver gain is readjusted to maintain a constant video noise level. The noise level is sampled at the receiver output at the end of each range sweep, prior to the next transmission. The resulting receiver gain is fixed throughout the next sweep. Under some jamming conditions, a fixed video noise can be maintained at the display.

†Obsolete

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

azimuth markers: *See:* **azimuth marks.**

azimuth marks: Calibration marks used on a display for azimuth. *Synonym:* **azimuth markers.**

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

background return*: *See:* **clutter.**

*Deprecated

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

backscatter coefficient: A normalized measure of radar return from a distributed scatterer. For area targets, such as ground or sea clutter, it is defined as the average *monostatic* radar cross section per unit surface area. *Note:* The backscatter coefficient for area targets, often expressed in decibels and denoted by σ^0, is dimensionless but is sometimes written in units of m^2/m^2 for clarity. For volume scatter, such as that from rain, chaff, or deep snow cover, it is defined as the average monostatic radar cross section per unit volume and is expressed in units of m^2/m^3 or m^{-1}. The volume backscatter coefficient is often expressed in decibels and denoted by the symbol η_v.

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backscatter 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 r/s. 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, and β is sometimes called effective bandwidth.

Barker code: A binary phase code used for pulse compression, in which a long pulse is divided into *n* subpulses with the phase of each subpulse being 0 or π radians. Barker coded pulses have the property that after matched filter processing there are $(n - 1)/2$ sidelobes, or $n/2$ for *n* even, on each side of the main response, each at a voltage level $1/n$ relative to the main response. Barker codes exist with $n = 2, 3, 4, 5, 7, 9$, and 13. *See also*: **coded pulse.**

beacon: *See:* **radar beacon.**

beacon equation: An equation that gives the maximum detection range 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. *Synonym:* **antenna-pattern loss.**

bias error: A systematic error, whether due to equipment or propagation conditions. A nonzero mean component 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. *Note*: Coherent detection produces one type of bipolar video. *See also:* **coherent signal processing.**

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

bistatic radar: A radar using antennas for transmission and reception at sufficiently different locations that the angles or ranges from those locations to the target are significantly different.

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

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blind phase: In moving-target indication (MTI) radars, when the echo of interest is in quadrature to the reference signal. It occurs in systems that detect only the in-phase signal component. *See also:* **moving-target indication.**

blind range: A range corresponding to the time delay of an integral multiple of the interpulse period plus a time less than or equal to the transmitted pulse length. *Note*: A radar usually cannot detect targets at a blind range because of interference by a subsequent transmitted pulse. *See also:* **eclipsing.**

blind speed [radar using moving-target indication (MTI)]: Radial velocity of a target with respect to the radar for which the MTI response is approximately zero. *Note*: 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 for which a blip is observed at a given range. *Synonym***: single-scan probability of detection.**

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.

box-car detector[†]**:** In radar, a detector whose output is held at the amplitude of the last sample until the next sample arrives. *Note*: Functionally the same as a sample and hold.

[†]Obsolete

burst: *See*: **pulse burst.**

calibration markers: *See:* **calibration marks.**

calibration marks: Indications superimposed on a display to provide a numerical scale of the parameters displayed.

canceled video: In moving-target indication (MTI), the video output remaining after the cancellation process. *See also:* **clutter residue; moving-target indication**.

canceler: 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.

cancellation ratio: (A) In moving-target indication (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. *Note*: This measure of MTI performance, in which high performance is represented by a low numerical value, has been largely replaced by the MTI improvement factor. *See also:* **moving-target indication**. **(B)** In interference-reduction techniques other than MTI**,** the cancellation ratio is the ratio of interference output power in the absence of the technique to that when the technique is applied, when the system gains for the two cases are adjusted to provide equal noise outputs. *Note*: High performance is indicated by a high numerical value, generally expressed in decibels to avoid ambiguity between power and voltage ratios.

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

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carrier-controlled approach (CCA) system: An aircraft carrier radar system providing information that facilitates direction of aircraft via radio communication.

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

CFAR: *See*: **constant-false-alarm rate.**

chaff: Strips of lightweight metal or metallized material that are dispensed in large numbers (bundles) so as to simulate a true target, or, more usually, to create a large clutter signal that masks the detection of wanted targets. *Notes*: 1. Each bundle may contain thousands of individual reflectors whose lengths are related to the wavelength of the radar. 2. Chaff for use at HF and VHF frequencies is sometimes called "rope." 3. During WWII, chaff was called "window" in Great Britain and "Dueppel" in Germany.)

chirp: A form of pulse compression that uses frequency modulation (usually linear) during the pulse.

clutter: Unwanted echoes, typically from the ground, sea, rain or other precipitation, chaff, birds, insects, meteors, and aurora. *Synonym:* **background return.**

clutter attenuation (CA): In moving-target indication (MTI) or Doppler radar, the ratio of the clutter-to-noise ratio at the input to the processor, to the clutter-to-noise ratio at the output. *Note*: In MTI, a single value of CA will be obtained, while in Doppler radar the value will generally vary over the different target Doppler filters. In MTI, CA will be equal to MTI improvement factor if the targets are assumed uniformly distributed in velocity. *See also*: **MTI improvement factor.**

clutter detectability factor: The predetection signal-to-clutter ratio that provides stated probability of detection for a given false alarm probability in an automatic detection circuit. *Note*: In MTI systems, it is the ratio after cancellation or Doppler filtering.

clutter fence: A barrier surrounding a ground-based radar to serve as an artificial horizon and suppress ground clutter.

clutter filter: A filter or group of filters (filter bank) included in a radar for the purpose of rejecting clutter returns and passing target returns at Doppler frequencies different from the Doppler frequencies of clutter. *Note*: Moving-target indication (MTI) and pulsed-Doppler processors are examples.

clutter improvement factor: *See:* **moving-target indication improvement factor.**

clutter map: Computer-stored values of radar-measured clutter for each range-azimuth resolution cell or local region, used to set thresholds for each cell in a constant-false-alarm rate (CFAR) detection system or to adjust other processing parameters.

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

clutter residue: The uncanceled clutter power remaining at the output of an moving-target indication (MTI) or Doppler signal processor. *See also:* **canceled video.**

clutter visibility factor: The predetection signal-to-clutter ratio that provides stated probability of detection for a given false alarm probability on a display. *Note*: In moving-target indication (MTI) systems, it is the ratio after cancellation or Doppler filtering.

coast: A radar memory feature that causes the range or angle tracking systems to continue to move in the same direction and at the same rate that an original target was moving. *Note*: Coast is invoked manually or automatically when the tracked target approaches a stronger echo (target or clutter) to prevent capture of the track by that echo or to maintain track over brief periods of signal loss.

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coded pulse: A pulse compression waveform in which a long pulse is divided into many subpulses, with the phase of each subpulse assuming a discrete value (often 0 or π radians) chosen in a deterministic manner (as in Barker codes, which result in all time sidelobes being equal) or chosen in a pseudorandom manner (such as with linear recursive or maximal-length sequences). *See also:* **Barker code.**

coherent integration: Integration of radio frequency (RF), intermediate frequency (IF), or bipolar envelope signals over an interval in which phase or polarity is preserved. *Note*: Sometimes called "predetection integration." *See also:* **integration.**

coherent moving-target indication (MTI): The usual form of MTI in which a moving target is separated from large clutter echoes as a result of a pulse-to-pulse change in echo phase relative to the phase of a coherent reference oscillator. *See also:* **moving-target indication**.

coherent processing interval: The time during which the radar signal is received and processed coherently. *Note*: Such processing is usually for Doppler filtering.

coherent signal processing: Integration, filtering, or detection of an echo signal using the amplitude of the received signal and its phase referred to that of a reference oscillator or to the transmitted signal.

coherent video: Bipolar video obtained from a synchronous (coherent) detector.

coho: A term derived from coherent oscillator, coho designates an oscillator used in a coherent radar to provide a reference phase by which changes in the phase of successively received pulses may be recognized. *Note*: In practice, a coho usually operates at the receiver intermediate frequency.

collapsing loss: The increase in required input signal-to-noise ratio to maintain given probability of detection for a given false alarm probability when resolution cells or samples containing only noise are integrated along with those containing signal and noise. *Note*: This type of loss occurs, for example, when radar returns containing range, azimuth, and elevation information are constrained to a two-dimensional display.

collapsing ratio: The ratio

$$(m + n)/n$$

where

m is number of noise-only samples
n is number of signal-plus-noise samples

combination monopulse: A form of monopulse employing amplitude comparison in one angular coordinate plane and phase comparison in the orthogonal coordinate plane.

complex target: A target composed of more than one scatterer within a single radar resolution cell. A target may be both complex and distributed. *See also:* **distributed target.**

conical scanning: A form of angular tracking in which the antenna beam is offset from the tracking axis of the antenna. Rotation of the beam about the axis generates a cone whose vertex angle is of the order of the beamwidth. *Note*: Such scanning may be either rotating or nutating, according to whether the direction of polarization rotates or remains unchanged. The variation of signal amplitude as the beam scans provides information on the amount and direction of displacement of the target from the axis of rotation.

conical-scan-on-receive-only (COSRO): A method of angle tracking in which only the receiving beam is conically scanned.

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conopulse: A tracking radar that uses two simultaneous squinted beams that are rotated around the antenna boresight to produce, on a time-shared basis, monopulse angle-error signals in two orthogonal coordinates (such as azimuth and elevation). *Notes*: 1. Only two receivers are required rather than three as in the usual monopulse tracker. 2. Also called "konopulse" and "scan with compensation."

constant-false-alarm rate (CFAR) receiver: A radar receiver that maintains the output false-alarm rate constant in spite of the varying nature of the receiver noise level, echoes from the clutter environment, or from electronic countermeasures. *Note*: CFAR is usually achieved by establishing a threshold level that varies according to the local noise and/or clutter environment measured in the near vicinity of the target echo.

continuous wave (CW) Doppler radar: A radar that transmits a continuous-wave signal and discriminates desired targets from other targets or clutter on the basis of the Doppler shift due to radial motion. *See also:* **CW radar***;* **Doppler radar.**

continuous wave (CW) radar: A radar that transmits a continuous-wave signal. *See also:* **continuous wave Doppler radar.**

corner reflector: Two (dihedral) or three (trihedral) orthogonal conducting surfaces, designed to return an incident electromagnetic wave toward its source. *Note*: A corner reflector is often used to provide a conspicuous radar target as a safety measure for a small sailboat, to enhance the detectability of a radar target on which it is mounted, or to calibrate a radar.

cosecant-squared pattern: A vertical-plane antenna pattern in which the transmitting and receiving power gains vary as the square of the cosecant of the elevation angle. *Note*: The unique property of this pattern is that it results in the received echo signal being independent of range if

— The target is of constant radar cross section
— The target moves at constant altitude
— The earth's surface can be considered flat

See also: **modified cosecant-squared antenna pattern.**

Costas code: A frequency-hopping pulse compression waveform in which a long pulse is divided into *n* subpulses with the frequency of each subpulse chosen from *n* contiguous frequencies in a manner first suggested by John P. Costas.

crossover loss: For a tracker that uses an offset beam, such as a conical scan tracker, the reduction in signal-to-noise ratio for a target on the tracking axis relative to that for a target on the peak two-way antenna gain of the beam. *Note*: The crossover loss factor is the ratio of the signal-to-noise ratio for a target on the peak two-way antenna gain to that for a target on the tracking axis. *See also:* **conical scanning.**

cross polarization electronic countermeasures (ECM): An ECM technique that transmits with a polarization orthogonal to the principal polarization of the victim radar. *Note*: Since cross-polarized antenna patterns are often very different from the normal, copolarized patterns, tracking might be disrupted. *See also:* **electronic countermeasures.**

cross section: Often used as a shortened form of radar cross section. *Note*: This term should be avoided when there is a possibility of confusion with geometric cross section.

cumulative detection probability: The probability that a target is detected on at least one of *n* successive scans or detection opportunities of a surveillance radar.

CW Doppler radar: *See:* **continuous wave Doppler radar.**

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CW radar: *See:* **continuous wave radar.**

defruiter: Equipment that deletes random asynchronous unintentional returns in a beacon system. *Note*: Commonly used in secondary surveillance radars.

depth of focus: In synthetic-aperture radar (SAR), the range interval over which the cross-range resolution is maintained without introducing or changing the focusing correction in signal processing.

designation: Selection of a particular target and transmission of its approximate coordinates from some external source to a radar. *Note*: Designation is usually intended to initiate tracking.

detectability factor: In pulsed radar, the ratio of single-pulse signal energy to noise power per unit bandwidth that provides stated probability of detection for a given false alarm probability, measured in the intermediate-frequency amplifier bandwidth and using an intermediate-frequency filter matched to the single pulse and followed by optimum video integration.

detection probability: The probability that a signal, when actually present at the input to the receiver, will be correctly declared a target signal based on observation of the receiver output. *See also:* **false-alarm probability.**

Dicke fix: An electronic counter-countermeasures (ECCM) technique designed to counter impulsive jamming and some types of swept-frequency jamming. *Note*: The usual configuration is a broadband intermediate frequency (IF) amplifier followed by a limiter and then an IF amplifier of optimum bandwidth for the radar signal.

difference channel (monopulse radar): A receiving channel in which the response, as a function of a given radar coordinate, approximates the first derivative of the response of the main (sum) channel, to indicate the displacement of the target from the center of the main channel. *Note*: This term was originally applied to monopulse radar, in which the difference between two offset beams or antenna phase centers was used to generate an error signal for tracking. In more modern radars the difference channel in angle can be generated by a feed network producing an aperture illumination function with odd symmetry. Similar channels in range and Doppler coordinates can be generated by suitable gates and filters.

difference pattern: The curve of antenna gain versus angle for the difference channel of a monopulse antenna. *See also*: **difference channel.**

difference slope: In a monopulse radar, the slope of the difference-pattern voltage (normalized with respect to the sum-pattern voltage) as a function of target angle from the tracking axis. *Note*: The slope is usually specified at the point on the curve where the difference-pattern voltage is zero, which corresponds to the tracking axis. In range and Doppler coordinates, it is the corresponding slope of the difference channel voltage normalized to that of the sum channel.

diffuse multipath: Propagation between radar and target for which one path is direct and the other(s) involve scattering from a rough surface or an atmospheric volume.

discrimination: Separation or identification of the differences between similar (but not identical) signals.

discriminator: A circuit in which the output is dependent upon how an input signal differs in some aspect from a standard or from another signal.

dish: A colloquial term for the reflecting surface of a paraboloidal-reflector antenna.

displaced phase center antenna (DPCA): An antenna and signal processing method used in airborne moving-target indication (AMTI) radar to compensate for the spread of the clutter Doppler spectrum caused by

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platform motion. *Note*: An example of a popular DPCA method is to employ two squinted antenna beams, take their sum and their difference on each of two successive pulses, and combine them in such a manner that the radar antenna appears to be stationary from pulse to pulse (a stationary antenna does not cause widening of the clutter spectrum). *See also:* **airborne moving-target indicaiton radar; space-time adaptive processing.**

distributed target: A target composed of a number of scatterers, where the target extent in any dimension is greater than the radar resolution in that dimension. *See also:* **complex target.**

diversity gain: The reduction in predetection signal-to-interference energy ratio required to achieve a given level of performance, relative to that of a nondiversity radar, resulting from the use of diversity in frequency, polarization, space, or other characteristics.

Doppler beam sharpening (DBS): A form of squint-mode synthetic-aperture radar (SAR) employed in a sector-scanning air-to-ground radar. *Note*: It usually has less resolution than a conventional SAR, since it employs a shorter processing (integration) time and varies this time as a function of beam squint angle so as to keep the resolution constant. Often displayed in near-real time on a plan-position indicator (PPI).

Doppler filter: A filter used in continuous wave (CW) radar, moving-target indication (MTI), or pulsed-Doppler radars for the purpose of separating moving target echo signals from stationary clutter echo signals. Also may be used to separate one moving target from another moving target due to a different Doppler frequency shift**.**

Doppler radar: A radar that utilizes the Doppler effect to determine the radial component of relative radar-target velocity or to select targets having particular radial velocities.

DPCA: *See*: **displaced phase center antenna.**

ducting: Confinement of near-horizontally directed electromagnetic waves to a restricted horizontal layer in the atmosphere, resulting from a sufficiently steep negative vertical gradient of the atmospheric refractive index in a limited altitude region. *Note*: The region of steep gradient is not necessarily identical to the dimensions of the duct. *Synonyms:* **superrefraction; trapping.**

duty cycle: The ratio of the active or ON time within a specified period to the duration of the specified period. *Note*: For a pulsed radar, the ratio of transmitted pulse width to pulse repetition interval.

duty factor*: *See*: **duty cycle.**

*Deprecated

early-warning radar: Radar employed to search for distant enemy aircraft or missiles.

ECCM: *See*: **electronic counter-countermeasures**.

echo: The portion of energy of the radar signal that is reflected to a receiver.

echo box: A high-Q resonant cavity that stores part of the transmitted pulse power and feeds the resulting exponentially decaying power into the receiver after completion of the pulse transmission.

eclipsing: The loss of information on radar echoes at ranges when the receiver is blanked because of the occurrence of a transmitter pulse. Numerous such blankings can occur in radars having high pulse-repetition frequencies. *See also*: **blind range.**

ECM: *See*: **electronic countermeasures.**

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effective echoing area: *See:* **radar cross section.**

electronic counter-countermeasures (ECCM): Any electronic technique designed to make a radar less vulnerable to electronic countermeasures (ECM).

electronic counter-countermeasures (ECCM) improvement factor (EIF): The power ratio of the electronic countermeasures (ECM) signal level required to produce a given output signal-to-interference ratio from a receiver using an ECCM technique to the ECM signal level producing the same output signal-to-interference ratio from the same receiver without the ECCM technique. *Notes*: 1. The principal application is the representation of the performance of certain ECCM techniques in the analysis of radar performance in hostile electromagnetic environments. 2. The EIF is not a measure of the overall efficacy of an ECCM technique.

electronic countermeasures (ECM): Any electronic technique designed to deny detection or accurate information to a radar. *Note*: Screening with noise, confusion with false targets, and deception by affecting tracking circuits are typical ECM.

electronic-warfare support measures (ESM): Actions taken to search for, intercept, locate in angle, record, and analyze radiated electromagnetic energy for the purpose of exploiting such radiations in support of military operations.

elevation angle: In radar, the angle between the line-of-sight in the direction of interest and a horizontal reference plane, measured upwards.

energy ratio: The ratio of signal energy to noise power spectral density in the receiver, at a point where the noise factor has been established and prior to filtering that would exclude components of the input signal. *Note*: Energy ratio also equals the maximum output signal-to-noise power ratio for a matched-filter system.

ESM: *See:* **electronic-warfare support measures.**

EW: Acronym for early warning; electronic warfare.

exponential reference atmosphere: A mathematical model of atmospheric refraction in which the refractivity is approximated by an exponential function of height:

$$N = N_s \exp(-c_e h)$$

where

N is refractivity = $(n - 1) \times 10^6$
n is atmospheric refractive index
N_s is value of N at the surface
h is height in km above the surface

In Bean and Thayer [B1][2] the exponential coefficient c_e is given by

$$c_e = -\ln\left[1 - \frac{7.32}{N_s}\exp(0.005577 N_s)\right]$$

Note: The average value of N_s in the United States is 313, and the value for a "4/3 earth radius" is 301.

[2]The numbers in brackets correspond to those of the bibliography in Annex A.

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false alarm: An erroneous radar target detection decision caused by noise or other interfering signals exceeding the detection threshold.

false-alarm number: The number of possible independent detection decisions during the false-alarm time. *Note*: When there is no pulse integration, it is equal to the reciprocal of the false-alarm probability.

false-alarm probability: The probability that noise or other interfering signals will erroneously cause a target detection decision. *See also:* **detection probability.**

false-alarm time: The average time between false alarms; that is, the average time between crossings of the target decision threshold by signals not representing targets. *Note*: In the early work of Marcum, false-alarm time is defined as the time in which the probability of one or more false alarms is one-half. Marcum's definition is no longer commonly used.

fast-time-constant (FTC) circuit: A circuit with short time-constant (such as a differentiator or high-pass filter) used to emphasize signals of short duration and reduce the receiver response to signals from extended clutter, long-pulse jamming, or noise. It is a form of pulsewidth discriminator (PWD).

fence: (A) A line or network of early-warning radars. **(B)** The locus of the positions of a surveillance radar beam that describes the search area covered by space-based radar. *See also*: **clutter fence.**

filter bank (Doppler processing): A contiguous set of filters covering the Doppler frequency range of interest, used to separate moving targets. Commonly used in continuous wave (CW) and pulsed-Doppler radars and in the moving target detector (MTD) for detecting moving targets in clutter.

filter mismatch loss: The loss in output signal-to-noise ratio of a filter relative to the signal-to-noise ratio from a matched filter. *Note*: Filter mismatch loss is caused by using a filter whose response is not matched to the transmitted signal.

fire-control radar: A radar whose prime function is to provide information for the manual or automatic control of artillery or other weapons.

fluctuating target: A radar target whose echo amplitude varies as a function of time. *See also:* **target fluctuation.**

fluctuation: *See:* **target fluctuation.**

fluctuation loss: The change in radar detectability or measurement accuracy for a target of given average echo return power due to target fluctuation. *Note*: It may be measured as the change in required average echo return power of a fluctuating target as compared to a target of constant echo return, to achieve the same detection probability or measurement accuracy.

FM-CW radar: *See*: **frequency-modulated continuous wave radar.**

forward-scattering cross section: *See:* **radar cross section.**

frequency-agile radar: A pulse radar in which the transmitter-carrier frequency is changed between pulses or between groups of pulses by an amount comparable to or greater than the pulse bandwidth.

frequency diversity radar: A radar that operates at more than one frequency, using either parallel channels or sequential groups of pulses. *Note*: Parallel channels may have complete duplicate transmitters and receivers, or may divide the transmitted pulse into subpulses at different frequencies, to which parallel receiver channels are tuned.

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frequency-modulated continuous wave (FM-CW) radar: A radar transmitting a continuous carrier modulated by a periodic function such as a sinusoid or sawtooth wave to provide range data.

frequency-modulated (FM) ranging: A technique in which a continuous carrier is frequency modulated by a sinusoidal or triangular waveform, permitting the echo time delay to be measured as the phase shift of the sinusoid or the difference between transmitted and received frequencies.

frequency resolution: The ability of a receiver or signal processing system to detect or measure separately two or more signals that differ only in frequency. *Note*: The classic measure of frequency resolution is the minimum frequency separation of two otherwise identical signals that permits the given system to distinguish that two frequencies are present and to extract the desired information from each of them. When the separation is done by means of a tunable bandpass filter system, the resolution is often specified as the width of the frequency-response lobe measured at a specific value (such as three decibels) below the peak response. *See also:* **angular resolution, (Note).**

FTC circuit: *See:* **fast-time-constant circuit.**

gate: (A) An interval of time during which some portion of a circuit or display is allowed to be operative. **(B)** The circuit that provides gating.

gating: The application of enabling or inhibiting pulses during part of a cycle of equipment operation.

Gaussian distribution: A probability distribution characterized by the probability density function

$$f(x) = \frac{1}{\sqrt{2\pi}\,\sigma} \exp\left[-\frac{(x-m)^2}{2\sigma^2}\right]$$

where

x is the random variable
m is the mean
σ is the standard deviation

The Gaussian distribution is often used for analytical modeling of radar noise and various measurement errors. *Synonym:* **normal distribution.**

GCA radar: *See*: **ground-controlled approach radar.**

GCI radar: *See*: **ground-controlled intercept radar.**

GDOP: *See*: **geometric dilution of precision.**

geometric dilution of precision (GDOP): An increase in measurement errors in certain regions of coverage of a measurement system that combines several surface-of-position measurements, such as range only, angle only, or range difference (hyperbolic) to locate the object of interest. *Note*: When two lines of position cross at a small acute angle, the measurement accuracy is reduced along the axis of the acute angle.

ghost target: An apparent target in a radar that does not correspond in position or frequency or both to any real target, but which results from distortion or misinterpretation by the radar circuitry of other real target signals that are present. *Note*: It may result from range-Doppler ambiguities in the radar waveform used, from intermodulation distortion due to circuit amplitude nonlinearities, or from combining data from two antenna systems or waveforms.

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glint: The inherent component of error in measurement of position and/or Doppler frequency of a complex target due to interference of the reflections from different elements of the target. *Notes*: 1. Glint may have peak values beyond the target extent in the measured coordinate. 2. Not to be confused with scintillation error.

grass: A descriptive colloquialism referring to the appearance of noise on certain displays, such as an A-display.

ground clutter: Clutter resulting from the ground or objects on the ground. *Synonym:* **ground return.**

ground-controlled approach (GCA) radar: A ground radar system providing information by which aircraft approaches to landing may be directed via radio communications. The system consists of a precision-approach radar (PAR) and an airport-surveillance radar (ASR).

ground-controlled intercept (GCI) radar: A military radar system by which a controller on the ground may direct an aircraft to make an interception of another aircraft.

ground range: Distance along the ground between the points directly beneath the radar and the target.

ground return: *See:* **ground clutter.**

guard channel: One or more auxiliary parallel processing channels to control the main processing channel in order to reject interference that is partly in, but not centered on, the main channel. *Note*: Guard channels may be displaced in time (range), Doppler frequency, carrier frequency, or angle. Sometimes called "guard gates," "guard bands," or "sidelobe blanking" (not cancellation). Guard channel is used against range gate stealers, velocity gate stealers, sidelobe jamming, and to enhance apparent angle resolution in identification, friend or foe (IFF). May use auxiliary displays. *See also:* **sidelobe blanker.**

height-finding radar: A radar whose function is to measure the range and elevation angle to a target, thus permitting computation of altitude or height. *Note*: Such a radar usually accompanies a surveillance radar that determines other target parameters. *See also:* **nodding-beam height finder; three-dimensional (3-D) radar.**

high-pulse-repetition-frequency (HPRF) waveform: A waveform whose pulse-repetition frequency (PRF) is high enough to have no Doppler ambiguities for a given maximum-speed target. *See also:* **low-pulse-repetition-frequency waveform; medium-pulse-repetition-frequency waveform.**

hit: A target echo from one single pulse.

IAGC: *See*: **instantaneous automatic gain control.**

identification (of a target): The knowledge that a particular radar return signal is from a specific target. This knowledge may be obtained by determining size, shape, timing, position, maneuvers, rate of change of any of these parameters, signal modulation characteristics, or by means of coded responses through secondary radar. *Note*: Distinguished from target classification, in which only the type of target is determined (and which is often the intended meaning), and from target recognition, a more general term that encompasses identification and classification.

illuminator: That part of a semiactive guidance missile weapon system that radiates electromagnetic waves in the direction of a designated target so that echo signals reflected from the illuminated target can be used by another sensor (the missile seeker) for purposes of homing.

imaging radar: A high-resolution radar whose output is a representation of the radar cross section within the resolution cell (backscatter coefficient) from the object or scene resolved in two or three spatial dimen-

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sions. *Note*: The radar may use real aperture (such as a sidelooking airborne radar), synthetic-aperture radar (SAR), inverse synthetic aperture radar (ISAR), interferometric SAR, or tomographic techniques.

impulse radar: A radar whose transmitted pulse consists of one or a few cycles of carrier, usually generated by application of a short video pulse to a wideband radio frequency (RF) amplifier (e.g., a traveling-wave tube) or directly to a wideband antenna (e.g., a dipole).

in-phase video: One of a pair of coherent, bipolar video signals derived from the RF or IF signal by a pair of synchronous detectors with a 90° phase difference between the coherent oscillator (coho) reference inputs used for each. Note: The in-phase component is often identified as *I* and the other of the pair as quadrature video or *Q*. *See also:* **quadrature video.**

instantaneous automatic gain control (IAGC): (A) That part of a receiver system that automatically adjusts the gain of an amplifier within the time duration of each pulse so that a substantially constant output pulse peak amplitude is obtained when the input pulse peak amplitudes are varying, the adjustment being sufficiently fast to operate during the time a pulse is passing through the amplifier. **(B)** A quick-acting automatic gain control that responds to variations of mean clutter or jamming level over different range or angular regions, avoiding receiver saturation.

integration (of radar signals): The combination by addition (or the logical equivalent) of echo pulses or signal samples obtained by a radar as it illuminates a target so as to increase the output signal-to-noise ratio beyond that available from a single pulse or sample.

integration loss: The loss incurred by integrating a signal noncoherently (postdetection) instead of coherently.

intended polarization: The polarization of the radio wave for which an antenna system is designed.

intensity modulation: A process used in certain displays whereby the luminance of the signal indication is a function of the received signal strength.

interclutter visibility: The ability of a radar to detect moving targets that occur in resolution cells among patches of strong clutter; usually applied to moving-target indication (MTI) or pulsed-Doppler radars. *Note*: The higher the radar range and/or angle resolution, the better the interclutter visibility.

interferometer: An antenna and receiving system that determines the angle of arrival of a wave by phase comparison of the signals received at widely separated antennas. *Note*: In radar, the angle measurement made by an interferometer is generally ambiguous, and means must be used to resolve the ambiguities.

interrogation: In a transponder system, the signal or combination of signals intended to trigger a response.

interrogator: The transmitter of a secondary radar system.

interrogator-transponder: A combined interrogator and transponder.

inverse-synthetic-aperture radar (ISAR): An imaging radar in which cross-range resolution (angular resolution) of a target (such as a ship, aircraft, or other reflecting object) is obtained by resolving in the Doppler domain the different Doppler frequencies produced by echoes from the individual parts of the object, when these different Doppler frequencies are caused by the object's own angular rotation relative to the radar.

ISAR: *See*: **inverse-synthetic-aperture radar.**

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jamming: A form of electronic countermeasures (ECM) in which interfering signals are transmitted at frequencies in the receiving band of a radar for the purpose of obscuring the radar signal (as in noise jamming) or causing confusion in interpreting the radar signal (as in repeater jamming).

jam strobe: Indication of jammer azimuth bearing, one form being a marker on the radar plan-position indicator (PPI) display. It can also show the jammer signal strength and severity of main and sidelobe jamming.

jet-engine modulation (JEM): Amplitude and/or frequency modulation of the radar echo from a jet-powered aircraft by motion of the compressor or turbine blades. *Note*: These modulations may cause errors in measuring the Doppler frequency of the target, but they also provide information useful in noncooperative target recognition. *See also:* **target recognition.**

jitter: (A) Small, rapid variations in the size, shape, or position of observable information, frequently caused by mechanical and electronic switching systems or faulty components. It also refers to zero-mean random errors in successive target position measurements due to target echo characteristics, propagation, or receiver thermal noise. **(B)** Intentional variation of a radar parameter, for example, pulse interval.

K_a-band: A radar-frequency band between 27 GHz and 40 GHz, usually in the International Telecommunication Union (ITU) allocated band 33.4–36 GHz.

K-band: A radar frequency band between 18 GHz and 27 GHz, usually in the International Telecommunication Union (ITU) allocated band 23–24.2 GHz.

keep-alive circuit: In a transmit-receive switch (TR switch), a circuit for producing residual ionization for the purpose of reducing the initiation (breakdown) time of the main discharge.

K_u-band: A radar-frequency band between 12 GHz and 18 GHz, usually in one of the International Telecommunication Union (ITU) allocated bands 13.4–14.4 GHz or 15.7–17.7 GHz.

laser radar: A radar whose carrier frequency is produced by a laser, usually in the infrared or visible light region.

L-band: A radar-frequency band between 1 GHz and 2 GHz, usually in the International Telecommunication Union (ITU) allocated band 1.215–1.4 GHz.

leading-edge tracking: A radar range tracking technique in which the range error signal is based on the range delay of the leading edge of the received echo. *Note*: Leading-edge tracking provides the ability to reject delayed interference, chaff, and more distant sources.

lin-log receiver: A receiver having a linear amplitude response for small-amplitude signals and a logarithmic response for large-amplitude signals. *Note*: The lin-log reciever is a practical method of approximating a logarithmic receiver.

lobe switching: A means of direction finding in which a directive radiation pattern is periodically shifted in position so as to produce a variation of the signal at the target. *Note*: The signal variation provides information on the amount and direction of displacement of the target from the pattern mean position. *Synonym:* **sequential lobing.**

logarithmic receiver: A receiver whose output is proportional to the log of the input. *Note*: A logarithmic receiver is often used to prevent receiver saturation by large signals. Sometimes called log receiver or logarithmic detector. *See also*: **lin-log receiver; log-fast-time-constant receiver.**

log fast-time-constant (FTC) receiver: A receiver whose video amplifier has a logarithmic input-output characteristic and which is followed by a high-pass filter, or FTC. Its purpose is to suppress distributed clut-

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ter or to help achieve a constant-false-alarm-rate (CFAR) for clutter whose statistics can be described by a Rayleigh distribution.

log-normal distribution: A probability distribution characterized by the probability density function:

$$f(x) = \frac{1}{x\sigma\sqrt{2\pi}} \exp\left[-\frac{(\ln x - \ln x_m)^2}{2\sigma^2}\right], \quad x \geq 0$$

$$= 0, \quad x < 0$$

where

x is the random variable
σ is the standard deviation of $\ln x$
x_m is the median value of x

Note: This function is often used for statistical modeling of the radar cross section of certain types of radar targets and clutter.

look: A colloquial expression for a single attempt at detection of a target.

low-pulse-repetition-frequency (LPRF) waveform: A pulsed-radar waveform whose pulse-repetition frequency is such that targets of interest are unambiguously resolved with respect to range. *See also:* **high-pulse-repetition-frequency waveform; medium-pulse-repetition-frequency waveform.**

main bang: The transmitted pulse of a radar, especially its amplitude trace as viewed on an A-display at the start of transmission.

matched filter: A filter that maximizes the output ratio of peak signal power to mean noise power. *Note*: For white noise, a matched filter has a frequency response function that is the complex conjugate of the transmitted spectrum. Its impulse response is the time inverse of the transmitted waveform.

MDS: *See*: **minimum detectable signal.**

MDV: *See*: **minimum detectable velocity.**

medium-pulse-repetition-frequency (MPRF) waveform: A pulsed-radar waveform whose pulse-repetition frequency (PRF) is such that targets of interest are ambiguous with respect to both range and Doppler shift. *See also:* **high-pulse-repetition-frequency waveform; low-pulse-repetition-frequency waveform.**

microwave plumbing: *See:* **plumbing.**

millimeter-wave radar: A radar whose carrier frequency is from 30–300 GHz (wavelength is 1–10 mm).

minimum detectable signal (MDS): The minimum signal level that gives reliable detection in the presence of white Gaussian noise. *Note*: MDS must be described in terms of a probability of detection and a probability of false alarm, due to its statistical nature.

minimum detectable velocity (MDV): In a Doppler processing radar for detection of moving targets, the minimum target velocity that can be detected.

minimum discernible signal: The minimum detectable signal for a system using an operator and display or aural device for detection.

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modified cosecant-squared antenna pattern: A cosecant-squared antenna pattern modified to obtain increased antenna gain at the higher elevation angles so as to provide larger echo signals from targets at high altitude and short range that would normally be too weak to be detected when sensitivity time control (STC) is used along with the conventional cosecant-squared antenna pattern. *Note*: Sometimes called a thumb pattern. Commonly used in 2-D air-traffic control radars.

monopulse: A radar technique in which information concerning the angular location of a target is obtained by comparison of signals received in two or more simultaneous antenna beams. *Notes*: 1. The simultaneity of the beams makes it possible to obtain a 2-D angle estimate from a single pulse (hence the term "monopulse"), although multiple pulses are usually employed to improve the accuracy of the estimate or to provide Doppler resolution. 2. The simultaneous lobe technique used in continuous wave (CW) radars is also referred to as monopulse, although pulses are not used.

monostatic radar: A radar system that transmits and receives through either a common antenna or through collocated antennas.

moving target detector (MTD): A low pulse-repetition frequency (PRF) pulsed Doppler system usually characterized by employing a filter bank, adaptive thresholds, clutter map, and more than one coherent processing interval at different PRFs.

moving-target indication (MTI): A technique that enhances the detection and display of moving radar targets by suppressing fixed targets. *Note*: Doppler processing is one method of implementation.

moving-target indication (MTI) improvement factor: The signal-to-clutter power ratio at the output of the clutter filter divided by the signal-to-clutter power ratio at the input of the clutter filter, averaged uniformly over all target radial velocities of interest. *Synonym:* **clutter improvement factor.**

MTI: *See*: **moving-target indication**.

multilateration: The location of an object by means of two or more range measurements from different reference points. It is a useful technique with radar because of the inherent accuracy of radar range measurement. *Note*: The use of three reference points to obtain target location is known as trilateration.

multipath: The propagation of a wave from one point to another by more than one path. When multipath occurs in radar, it usually consists of a direct path and one or more indirect paths by reflection from the surface of the earth or sea or from large man-made structures. At frequencies below approximately 40 MHz, it may also include more than one path through the ionosphere.

multipath error: The error in a radar-observed parameter caused by multipath.

multiple-time-around echo: *See:* **second-time-around echo.**

multistatic radar: A radar system having two or more transmitting or receiving antennas with all antennas separated by large distances when compared to the antenna sizes. *See also:* **bistatic radar.**

nodding-beam height finder: A height-finding radar with a fan beam oriented with its narrow beamwidth in elevation, and which mechanically sector scans (nods) in elevation to locate the target and determine its elevation angle.

noncoherent moving-target indication (MTI): A form of MTI radar in which a moving target is detected by using the clutter echo as the reference signal. *Notes:* 1. No internal reference signal is required. 2. Sometimes called externally coherent MTI.

noncooperative target recognition (NCTR): *See:* **target recognition.**

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normal distribution: *See:* **Gaussian distribution.**

north-stabilized plan-position indicator (PPI): A special case of azimuth-stabilized PPI in which the reference direction is north.

nutating feed: A technique of conical scanning in which the polarization remains unchanged.

observation time: The time interval over which a radar echo signal may be integrated for detection or measurement.

offset plan-position indicator (PPI): A PPI that has the zero position of the time base at a point other than the center of the display, thus providing the equivalent of a larger display for a selected portion of the coverage area. *Synonym*: **off-center plan-position indicator.**

open-center plan-position indicator (PPI): A PPI in which the display of the initiation of the time base precedes that of the transmitted pulse.

operator loss: A loss in effective signal-to-noise ratio manifested by reduced detection probability or increased false-alarm rate, when detection is performed by a human operator rather than an ideal thresholding device.

OTH radar: *See:* **over-the-horizon radar.**

over-the-horizon (OTH) radar: Radar using sufficiently low carrier frequencies, usually in the high-frequency (HF) band typically from about 5–30 MHz, so that ionospherically refracted sky-wave propagation can allow detection at ranges (nominally from perhaps 1000–4000 km) far beyond the ranges allowed by line-of-sight propagation. At HF, the surface wave, or ground wave, mode of propagation can allow detection of low-altitude targets at ranges from perhaps 40–200 km, depending on the size of the target and the radar.

PAR: *See*: **precision-approach radar.** *Note*: Sometimes used for perimeter acquisition radar.

passive angle tracking (PAT): A tracking technique that uses a received signal other than the backscattered radar emissions with which to track an object, jammer, or other signal source. Passive homing, home-on-jam (HOJ), and track-on-jam (TOJ) are examples of PAT using a radar receiving system.

pattern-propagation factor: Ratio of the field strength that is actually present at a point in space to that which would have been present if free-space propagation had occurred with the antenna beam directed toward the point in question. This factor is used in the radar equation to modify the strength of the transmitted or received signal to account for the effect of multipath propagation, diffraction, refraction, and pattern of an antenna.

P-band: A letter-band designation no longer applicable and which should not be used. Originally it denoted frequencies in the vicinity of 230 MHz, which are no longer allowed for radar usage. Later it was sometimes applied to denote the 420–450 MHz International Telecommunication Union (ITU) allocated radiolocation band that is now called UHF by IEEE Std 521-1984, IEEE Standard Letter Designations for Radar-Frequency Bands.[3]

pencil beam: Antenna beam with a narrow radiation lobe with approximately equal azimuth and elevation beamwidths (i.e., one with circular or almost circular shape in the plane perpendicular to the direction of propagation).

permanent echo: A signal reflected from an object fixed with respect to the radar site.

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phase-comparison monopulse A form of monopulse employing receiving beams with different phase centers as obtained, for example, from side-by-side antennas or separate portions of an array. *Note*: The information on target displacement from the antenna axis appears as a relative phase between signals received at the two phase centers. *See also:* **amplitude-comparison monopulse; monopulse.**

plan-position indicator (PPI): A type of radar display format. *See also:* **display.**

plumbing: A colloquial expression for pipe-like waveguide circuit elements and transmission lines. *Synonym:* **microwave plumbing.**

polyphase code: A pulse compression waveform in which a long pulse is subdivided into many subpulses and the phase of each subpulse is chosen with a quantization less than π radians. The Frank polyphase code is an example in which the phases are selected so as to obtain a discrete version of the continuous analog linear frequency-modulation waveform.

PPI: *See:* **plan-position indicator.**

precipitation clutter: Unwanted echoes from rain, snow, hail, sleet and other hydrometeorological particles.

precision-approach radar (PAR): A radar system located on an airfield for observation of the position of an aircraft with respect to an approach path and specifically intended to provide guidance to the aircraft during the approach.

PRF: *See*: **pulse-repetition frequency.**

PRI: *See*: **pulse-repetition interval.**

primary radar: A radar system in which the return signals are the echoes obtained by reflection from the target. Since this is the normal method of radar operation, the word *primary* is omitted unless necessary to distinguish it from *secondary. See also:* **secondary radar.**

pulse burst: A sequence of closely spaced pulses. *Note*: Pulse bursts are usually generated coherently and batch-processed for Doppler resolution, and often have a total burst duration much less than the radar echo delay time.

pulse compression: A method for obtaining the resolution of a short pulse with the energy of a long pulse of width T by internally modulating the phase or frequency of a long pulse so as to increase its bandwidth $B >> 1/T$, and using a matched filter (also called a pulse compression filter) on reception to compress the pulse of width T to a width of approximately $1/B$. Used to obtain high range resolution when peak-power limited. *See also*: **chirp; coded-pulse; Costas code.**

pulsed-Doppler radar: A Doppler radar that uses pulsed transmissions. *Synonym:* **pulse-Doppler radar.**

pulse-Doppler radar: *See:* **pulsed-Doppler radar.**

pulse duration: *See:* **pulsewidth.**

pulse-forming line: A passive electric circuit in a radar modulator whose propagation delay determines the length of the modulation pulse.

pulse-repetition frequency (PRF): The number of pulses per unit of time, usually per second. *Synonym:* **pulse-repetition rate.**

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pulse-repetition frequency (PRF) stagger: The technique of varying the time between pulses of a pulse radar. This is useful in compensating for blind speeds in pulsed moving-target indication (MTI) radars.

pulse-repetition interval (PRI): The time duration between successive pulses. *Note*: PRI is the reciprocal of the pulse-repetition frequency (PRF). *Synonym:* **pulse-repetition period.**

pulse-repetition period: *See:* **pulse-repetition interval.**

pulse-repetition rate: *See:* **pulse-repetition frequency.**

pulse train: A sequence of pulses at the pulse repetition frequency used to accomplish a function such as moving-target indication (MTI) or increased effective signal-to-noise ratio. *Note*: A pulse train of duration less than the radar echo delay time is usually referred to as a pulse burst. *See also*: **pulse burst.**

pulsewidth: The time interval between the points on the leading and trailing edges at which the instantaneous value bears a specified relation to the maximum instantaneous value of the pulse, usually the time interval between the half-power points of the pulse. *Synonym:* **pulse duration.**

pulsewidth discriminator (PWD): A device that passes only those video pulses whose duration falls within specified limits.

Q-channel: *See:* **quadrature video.**

quadrature video: One of a pair of coherent, bipolar video signals derived from the RF or IF signal by a pair of synchronous detectors with a 90° phase difference between the coherent oscillator (coho) reference inputs used for each. *Note*: The quadrature component is often identified as *Q* and the other of the pair as in-phase video or *I*. *See also*: **in-phase video.** *Synonym:* **Q-channel.**

quantization error: *See:* **quantizing error.**

quantizing error: An error caused by conversion of an analog variable having a continuous range of values to a quantized form having only discrete values, as in analog-to-digital conversion. The error is the difference between the original (analog) value and its quantized (digital) representation. *Synonym:* **quantization error.**

quantizing loss: (A) In phased arrays, a loss in peak gain that occurs when the beam is phase steered by digitally controlled phase shifters, due to the quantizing errors in the phase shifts applied to the various radiating elements. **(B)** In signal processing, a loss that occurs when elements of a composite signal (for example, complex amplitudes of pulses in a pulse train) are quantized (digitized) before being combined. *See also:* **quantizing error.**

radar: An electromagnetic system for the detection and location of objects that operates by transmitting electromagnetic signals, receiving echoes from objects (targets) within its volume of coverage, and extracting location and other information from the echo signal. *Notes*: 1. Radar is an acronym for radio detection and ranging. 2. Radar equipment can be operated with the transmitter turned off, as a passive direction finder on sources radiating within the band of the receiving system. *See also*: **passive angle tracking.**

radar-absorbent material (RAM): Material used to reduce the radar cross section of an object. *Note*: Also used in anechoic chambers to reduce reflection from the walls.

radar altimeter: *See:* **radio altimeter.**

radar beacon: A transponder used for replying to interrogations from a radar. *See also:* **secondary radar.**

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radar cross section (RCS): A measure of the reflective strength of a radar target; usually represented by the symbol σ and measured in square meters. RCS is defined as 4π times the ratio of the power per unit solid angle scattered in a specified direction of the power unit area in a plane wave incident on the scatterer from a specified direction. More precisely, it is the limit of that ratio as the distance from the scatterer to the point where the scattered power is measured approaches infinity. *Note*: Three cases are distinguished:

a) Monostatic or backscatter RCS when the incident and pertinent scattering directions are coincident but opposite in sense.
b) Forward-scatter RCS when the two directions and senses are the same.
c) Bistatic RCS when the two directions are different. If not identified, RCS is usually understood to refer to case a). In all three cases, radar cross section of a specified target is a function of frequency, transmitting and receiving polarizations, and target aspect angle (except for a sphere). For some applications, e.g., statistical detection analyses, it is described by its average value (or sometimes its median value) and statistical characteristics over an appropriate range of one or more of those parameters.

Synonyms: **backscatter cross section; bistatic-scatter cross section; effective echoing area; forward-scattering cross section.**

radar display: The visual representation of radar output data. See individual definitions and illustrations of various radar display formats in Table 1. *Note*: The letter designations from A to P, plus R, for radar display formats were devised in the years during and following WWII in an effort to standardize nomenclature. Several of these letter designations are now rarely if ever used, as noted in the individual definitions; but they are still found in some technical literature. The additional designations of plan-position indicator (PPI) and range-height indicator (RHI) are also defined. The standardized type designations do not cover all possible display formats.

radar equation: A mathematical expression that relates the range of a radar at which specific performance is obtained to the parameters characterizing the radar, target, and environment. *Note*: The parameters in the radar equation can include the transmitter power, antenna gain and effective area, frequency, radar cross section of the target, range to the target, receiver noise figure, signal-to-noise ratio required for detection, losses in the radar system, and the effects of the propagation path. *Synonym*: **radar range equation; range equation.**

radar performance figure: The ratio of the pulse power of the radar transmitter to the power of the minimum signal detectable by the receiver. *Note*: Now seldom used as a measure of performance.

radar range equation: *See:* **radar equation.**

radar relay: Equipment for relaying the radar video and appropriate synchronizing signals to a remote location.

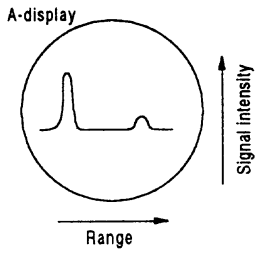
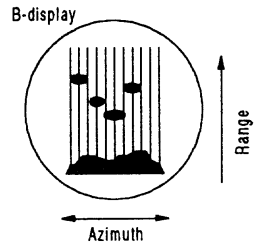
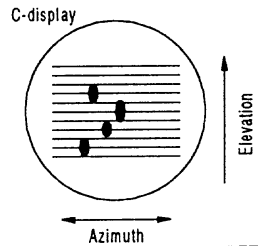
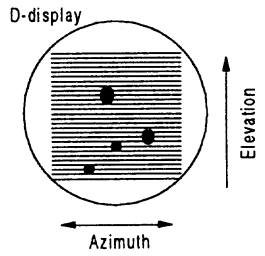
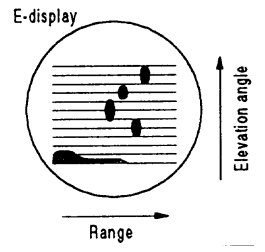
radar shadow: Absence of radar illumination because of an intervening reflecting, diffracting, or absorbing object. *Note*: The shadow is manifested on the display by the absence of blips from targets in the shadow area.

radio altimeter: An altimeter using radar principles for height measurement. Height is determined by measurement of propagation time of a radio signal transmitted from the vehicle and reflected back to the vehicle from the terrain below. *Synonym:* **radar altimeter.**

rain clutter: Radar echoes from rain that impair or obscure the echoes from desired targets. *See also*: **precipitation clutter.**

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Table 1—Radar displays

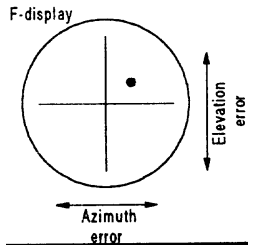
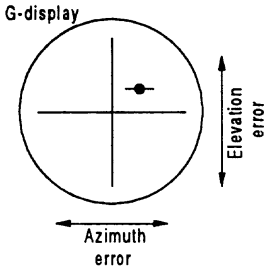
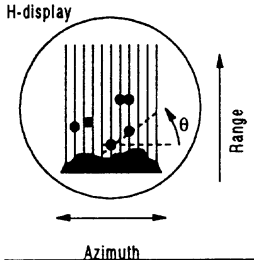
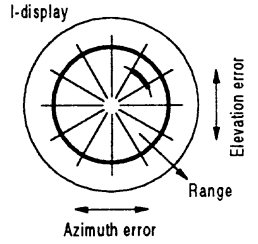
A-display	A display in which targets appear as vertical deflections from a horizontal line representing a time base. Time delay, or target range is indicated by the horizontal position of the deflection from one end of the time base. The vertical deflection is a function of signal amplitude.	
B-display	A rectangular display in which each target appears as an intensity-modulated blip, with azimuth indicated by the horizontal coordinate and range by the vertical coordinate.	
C-display	A rectangular display in which each target appears as an intensity-modulated blip with azimuth indicated by the horizontal coordinate and angle of elevation by the vertical coordinate.	
D-display*	Similar to a C-display, but composed of a series of horizontal stripes representing successive elevation angles. Each stripe is a miniature B-display with compressed vertical scale. Horizontal position of a blip represents azimuth, the gross vertical scale (the stripe in which the blip appears) represents elevation, and vertical position within the stripe represents range.	
E-display	A rectangular display in which targets appear as intensity-modulated blips with range indicated by the horizontal coordinate and elevation angle by the vertical coordinate. *Note*: The term "E-display" has also been applied to a display in which height or altitude is the vertical coordinate. This usage is deprecated because of ambiguity. The preferred term for such a display is "range-height indicator (RHI)."	

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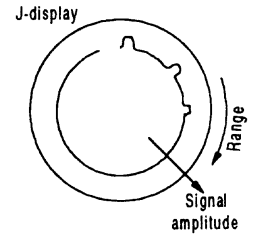
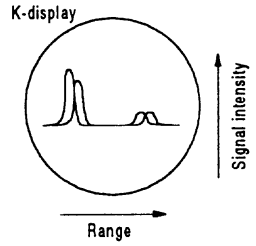
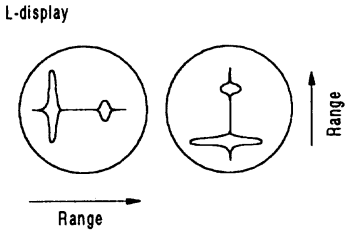
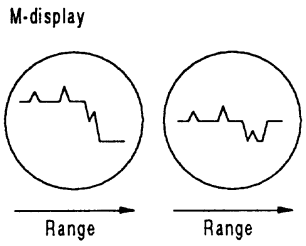
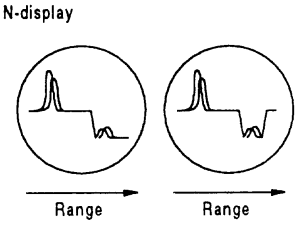
Table 1—Radar displays (continued)

F-display	A rectangular display in which a target appears as a centralized blip when the radar antenna is aimed at it. Horizontal and vertical aiming errors are respectively indicated by horizontal and vertical displacement of the blip.	
G-display*	A modified F-display in which wings appear to grow on the blip, the width of the wings being inversely proportional to target range.	
H-display*	A B-display modified to include an indication of angle of elevation. The target appears as two closely spaced blips approximating a short bright line, the slope of which is in proportion to the tangent of the angle of target elevation.	
I-display*	A display used in a conical-scan radar, in which a target appears as a complete circle when the radar antenna is pointed at it and in which the radius of the circle is proportional to target range. The incorrect aiming of the antenna changes the circle to a segment whose arc length is inversely proportional to the magnitude of the pointing error and the position of the segment indicates the direction in which the antenna should be moved to restore correct aiming.	

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Table 1—Radar displays (continued)

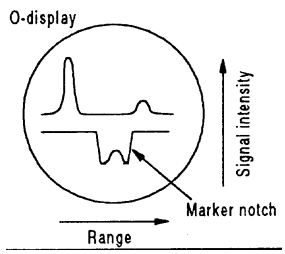
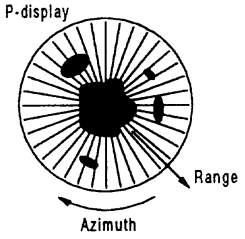
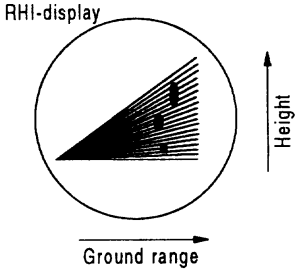
J-display	A modified A-display in which the time base is a circle and targets appear as radial deflections from the time base.	
K-display*	A modified A-display used with a lobe-switching antenna, in which a target appears as a pair of vertical deflections. When the radar antenna is correctly pointed at the target, the deflections (blips) are of equal height, and when not so pointed, the difference in blip height is an indication of the direction and magnitude of pointing error.	
L-display	Deflections are of equal amplitude when the radar antenna is pointed directly at the target, any inequality representing relative pointing error. The time base (range scale) can be vertical, as in the L-display illustration, or horizontal. The L-display is also known as a bearing-deviation indicator.	
M-display*	A type of A-display in which one target range is determined by moving an adjustable pedestal, notch, or step along the baseline until it coincides with the horizontal position of the target-signal deflection; the control that moves the pedestal is calibrated in range. *Note:* This display is usually identified as a variant of an A-display.	
N-display*	A K-display having an adjustable pedestal, notch, or step, as in the M-display, for the measurement of range. *Note:* This display is usually regarded as a variant of an A-display or a K-display rather than as a separate type.	

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Table 1—Radar displays (continued)

O-display†	An A-display modified by the inclusion of an adjustable notch for measuring range.	
P-display†	A name for the type of display commonly known as plan-position indicator (PPI).	
Plan-position indicator (PPI)	A display in which target echoes (blips) are shown in plan position, thus forming a map-like display, with radial distance from the center representing range and with the angle of the radius vector representing azimuth angle.	
R-display	An A-display with a segment of the time base expanded near the blip for greater precision in range measurement and visibility of pulse shape. *Note*: Usually regarded as an optional feature of an A-display rather than being identified by the term "R-display."	
Range-height indicator (RHI)	An intensity-modulated display in which horizontal and vertical distances of a blip from an origin in the lower-left part of the display represent target ground range and target height, respectively. *Note*: The display is generated by successive range weeps starting at the origin and inclined at an angle that varies progressively in accordance with the elevation scan of the radar antenna at a selected azimuth. The height scale of the display is usually expanded relative to the range scale.	

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range: Distance between a radar and a target.

range curvature: A term applied to a number of signal and image effects [for a synthetic-aperture radar (SAR)] that are due to the spherical nature of RF wavefronts. *Note*: These effects include quadratic phase used to synthesize an aperture, range walk, and image keystone distortions for spotlight SAR systems.

range equation: *See:* **radar equation.**

range-height indicator (RHI): A type of radar display format. *See also:* **display.**

range mark: A calibration marker used on a display to aid in measuring target range. *Synonym:* **range marker.**

range marker: *See:* **range mark.**

range noise: The noise-like variation in the apparent distance of a target, caused by changes in phase and amplitude of the target-scattering sources, and including radial components of glint and scintillation error.

range offset processing: Synthetic-aperture processing in which the spectrum is translated from intermediate frequency (IF) to a carrier offset from zero frequency by approximately half the IF bandwidth. *See also:* **synthetic-aperture radar.**

range resolution: The ability to distinguish between two targets solely by the measurement of their ranges. Range resolution is usually expressed in terms of the minimum range separation at which two targets at the same azimuth and elevation angles can be distinguished. *Note*: The required separation should be specified for targets of given relative power level at the receiver. Equal powers are often assumed, but it may be necessary to specify the separation at two or more power ratios where resolution of targets of different powers is important.

range walk: The migration of a point scatterer from range cell to range cell during the signal integration period. *Note*: Range walk can occur in synthetic-aperture radar; typically caused by range curvature and/or target rotational or radar line-of-sight translational motion. Range walk also can occur in a very high resolution radar if the relative range rate between the target and the radar is high, relative to the ratio of the range cell to the integration period.

raster scan: A method of sweeping the electron beam of a cathode-ray tube screen or an antenna beam that is characterized by more than one sweep either from side to side or from top to bottom.

Rayleigh distribution: A probability distribution characterized by the probability density function:

$$f(x) = \frac{x}{\sigma^2}\exp\left(-\frac{x^2}{2\sigma^2}\right), \quad x \geq 0$$

$$= 0, \qquad\qquad x < 0$$

where

x is the random variable
σ^2 is the average value of x^2

Notes: 1. Named after Lord Rayleigh. 2. This function is often used to model the statistics of the amplitude of noise at intermediate frequency (IF) or at video after linear envelope detection. 3. The Rayleigh distribu-

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tion function also describes the distribution of the signal voltage of fluctuating signals consisting of four or more components having similar amplitudes and random phases.

RCS: *See*: **radar cross section.**

receiver gating: The application of enabling or inhibiting pulses to one or more stages of a receiver only during the part of a cycle of operation when reception is either desired or undesired, respectively. *See also:* **gating.**

receiver operating characteristic (ROC) curves: Plots of probability of detection versus probability of false alarm for various input signal-to-noise power ratios and detection threshold settings.

refraction error: Error in angle and/or range due to the bending of one or more wave paths by changes in the refractive index of the propagation medium.

resolution cell: The one-dimensional or multidimensional region related to the ability of a radar to resolve multiple targets. *Note*: The dimensions that involve resolution can include range, angle, and radial velocity (Doppler frequency). The three dimensional spatial resolution cell is, for example:

$$\theta_a \times \theta_e \times (c\tau/2)$$

where

θ_a is azimuth beamwidth
θ_e is elevation beamwidth
τ is pulsewidth
c is velocity of propagation of electromagnetic waves

Synonym: **resolution element.**

resolution element: *See:* **resolution cell.**

RHI: *See*: **range-height indicator.**

ring-around: (A) The undesired triggering of a transponder or repeater by its own transmitter. **(B)** The ring-type (constant-radius echo) presentation on a plan-position indicator (PPI) display that occurs from a very large radar cross section target when the radar has high azimuth sidelobes.

ROC curves: *See*: **receiver operating characteristic curves.**

sampling gate: A device that extracts information from the input wave only when activated by a selector pulse or sampling pulse.

SAR: *See*: **synthetic aperture radar.**

S-band: A radar-frequency band between 2 GHz and 4 GHz, usually in one of the International Telecommunication Union (ITU) allocated bands 2.3–2.5 GHz or 2.7–3.7 GHz.

scanning: A programmed motion given to the main beam of an antenna for the purpose of searching a larger angular region than can be covered with a single position of the beam, or for measuring the angular location of a target; also, the analogous process using range gates or some frequency-domain filters.

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scanning loss: (A) In a radar using a continuously scanning beam, the reduction in sensitivity due to motion of the beam between transmission and reception of the signal (sometimes called transit-time loss). **(B)** In an electronic scanning radar, the reduction in signal power due to scanning of the beam from broadside (the direction normal to the array face). *See also:* **beamshape loss.**

scintillation: Random variations in the received signal from a complex target that can occur due to changes in aspect angle or other causes. *Note*: Because this term has been applied variously to target fluctuation and scintillation error, use of one of these more specific terms is recommended to avoid ambiguity.

scintillation error: Error in radar-derived target position or Doppler frequency caused by interaction of the scintillation spectrum with frequencies used in sequential measurement techniques. *Note*: Not to be confused with glint.

scope: The face of a cathode-ray tube or a display of similar appearance. *Note:* The term *scope* is a colloquial abbreviation of the word *oscilloscope*.

searchlighting: The process of projecting a radar beam continuously at a particular object or in a particular direction as contrasted to scanning.

search radar: A radar used primarily for the initial detection of targets in a particular volume of interest.

sea return: The radar response from the sea surface.

secondary radar: A cooperative target identification system such as the military identification, friend or foe (IFF) Mark XII or the civil air traffic control radar beacon system (ATCRBS) in which an interrogator transmits a coded signal that asks for a reply. The transponder on the vehicle or platform queried answers with a coded reply. *Notes*: 1. The term secondary radar is more widely used in Europe than in the U.S. 2. The interrogator antenna is often mounted on the radar antenna and the reply from the transponder is often included on the radar display with the echo detection. *See also*: **primary radar.**

second-time-around echo: An echo received after a time delay exceeding one pulse-repetition interval but less than two pulse-repetition intervals. *Note*: Third-time-around, etc., echoes are defined in a corresponding manner. The generic term “multiple-time-around” is sometimes used.

sector display: A limited display in which only a sector of the total service area of the radar system is shown. *Note*: Usually the sector to be displayed is selectable.

sector scanning: The repeated scanning of a limited volumetric sector by a radar. *See also*: **sector display.**

self-screening range: Range at which a specified target carrying its own specified active jamming [electronic countermeasures (ECM)] can be detected by a specified radar with specified probabilities of detection and false-alarm. *Note*: Also called “burn-through range.”

semiactive guidance: A bistatic-radar homing system in which a receiver in the guided vehicle derives guidance information from electromagnetic signals scattered from a target which is illuminated by a transmitter at a third location. *See also*: **illuminator.**

sensitivity time control (STC): Programmed variation of the gain (sensitivity) of a radar receiver as a function of time within each pulse-repetition interval or observation time in order to prevent overloading of the receiver by strong echoes from targets or clutter at close ranges. *Note*: Also called swept gain, especially in British usage.

sequential detection: A method of automatic detection in two or more steps. Normally the first step uses a high probability of false alarm and the last uses a low probability of false alarm. *Note*: In radars with control-

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lable scanning, the first detection can be used to order the scan to return to, stop at, or stay longer at the suspected target position.

sequential lobing: *See:* **lobe switching.**

sidelobe blanker: A device that employs an auxiliary wide-angle antenna and receiver to sense whether a received pulse originates in the sidelobe region of the main antenna and if so to gate it from the output signal.

sidelobe canceler: A device that employs one or more auxiliary antennas and receivers to allow linear subtraction of interfering signals from the desired output if they are sensed to originate in the sidelobes of the main antenna.

sidelooking airborne radar (SLAR): A high-resolution (in both range and angle) airborne imaging radar, without synthetic-aperture radar (SAR) processing, directed sidelooking (perpendicular to the line of flight) using large, narrow-beamwidth antennas.

sidelooking radar: A ground mapping radar used aboard aircraft involving the use of a fixed antenna beam pointing out the side of an aircraft either abeam or squinted with respect to the aircraft axis. The beam is usually a vertically oriented fan beam having a narrow azimuth width. The narrow azimuth resolution can either be obtained with a long aperture mounted along the axis of the aircraft [sidelooking airborne radar (SLAR)] or by the use of synthetic-aperture radar (SAR) processing.

signal-to-clutter ratio: The ratio of target echo power to the power received from clutter sources lying within the same resolution element.

signal-to-noise ratio: In radar, the ratio of the power corresponding to a specified target measured at some point in the receiver to the noise power at the same point in the absence of the received signal.

silent lobing: A method for scanning an antenna beam to achieve angle tracking without revealing the scanning pattern on the transmitted signal.

simple target: A target which can be represented by only one major scattering center so that its radar cross section is relatively insensitive to viewing aspect over small angular displacements. *Note*: Examples are a sphere or an object shorter than a half wavelength. Also called a point target.

single-scan probability of detection: *See:* **blip-scan ratio.**

slant distance: The distance between two points which are not at the same elevation. Used in contrast to ground distance.

slant range: The slant distance between a radar and a target.

SLAR: *See:* **sidelooking airborne radar.**

space-time adaptive processing (STAP): In airborne moving-target indication (MTI), a method of processing that compensates for the adverse effects of platform motion by adaptively placing antenna nulls in the directions of large clutter echoes and/or large noise or jamming sources. *Note*: It simultaneously employs the signals received from the multiple elements of an adaptive phased array antenna (spatial domain) and the signals from multiple pulse repetition periods (time domain) to provide adaptive processing in both the time and spatial domains.

speckle: A mottled effect in coherent radar images, such as those from synthetic-aperture radar (SAR) and laser radar caused by random additive and subtractive interference of signals from individual scatterers within each resolution cell. *Note*: This is the same as target fluctuation for isolated targets.

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split-gate tracker: A form of range tracker using a pair of time gates called an *early gate* and a *late gate,* contiguous or partly overlapping in time. *Note*: When tracking is established, the pair of gates straddles the received pulse that is being tracked. The position of the pair of gates then gives a measure of the time of arrival of the pulse (i.e., the range of the target from which the echo is received). Deviation of the pair of gates from the proper tracking position increases the signal energy in one gate and decreases it in the other, thus producing an error signal that moves the pair of gates so as to reestablish equilibrium.

spotlight synthetic-aperture radar (SAR): A form of SAR in which very high resolution is obtained by steering the real antenna beam to dwell longer on a scene or target than allowed by a fixed antenna.

squeezable waveguide: A variable-width waveguide for shifting the phase of the radio-frequency wave traveling through it by mechanically squeezing the dimensions of a rectangular waveguide.

squint: (A) The angle between the major lobe axis of each lobe and the central axis in a lobe-switching or simultaneous-lobing (monopulse) antenna. **(B)** The angular difference between the axis of antenna radiation and a selected geometric axis, such as the axis of the reflector, the center of the cone formed by movement of the radiation axis, or the broadside direction of a moving vehicle.

squint-mode synthetic-aperture radar (SAR): A SAR in which the beam is pointed other than at right angles to the flight path of the airborne radar platform.

squitter: Random output pulses from a transponder caused by ambient noise or by an intentional random triggering system, but not by the interrogation pulses.

stacked-beam radar: A radar that forms two or more simultaneous receive beams at the same azimuth but at different elevation angles. *Note*: The beams are usually contiguous or partly overlapping. Each stacked beam feeds an independent receiver channel.

staggered-repetition-interval waveform: A waveform in which the pulse repetition interval (PRI) changes from pulse to pulse, to fill blind speeds or to distinguish echoes having ambiguous range or Doppler shifts. *Note*: Not to be confused with changing PRI from scan to scan or from one group of pulses to another, which can be described as multiple-PRI or PRI-diversity waveforms.

stalo (STALO): Acronym for stable local oscillator. A highly stable radio-frequency local oscillator used for heterodyning signals to produce an intermediate frequency (IF).

STAP: *See*: **space-time adaptive processing.**

STC: *See*: **sensitivity time control.**

subclutter visibility: The ratio by which the target echo power may be weaker than the coincident clutter echo power and still be detected with specified detection and false-alarm probabilities. *Note*: Target and clutter powers are measured on a single pulse return and all target radial velocities are assumed equally likely.

supperrefraction: *See:* **ducting.**

surveillance radar: A radar used to detect, locate, and track targets over a large volume of space.

synchronous detector: A device whose output is proportional to the amplitude of a vector component of an input radio frequency (RF) or intermediate frequency (IF) signal measured with respect to an externally supplied reference signal.

synthetic-aperture radar (SAR): A coherent radar system that generates a narrow cross range impulse response by signal processing (integrating) the amplitude and phase of the received signal over an angular

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rotation of the radar line of sight with respect to the object (target) illuminated. *Note*: Due to the change in line-of-sight direction, a synthetic aperture is produced by the signal processing that has the effect of an antenna with a much larger aperture (and hence a much greater angular resolution).

synthetic-aperture radar-moving-target indication (SAR-MTI): A synthetic-aperture imaging radar that also detects moving targets (especially slow-moving ground vehicles) and displays them on the SAR image.

TACCAR: *See*: **time-averaged-clutter coherent airborne radar.**

target: (A) Specifically, an object of radar search or tracking. **(B)** Broadly, any discrete object that scatters energy back to the radar.

target classification: *See*: **target recognition.**

target fluctuation: Variation in the amplitude of the echo from a complex target caused by changes in target aspect angle, motion of target-scattering sources, or changes in radar wavelength (i.e., the amplitude component of target noise). *Note*: Rapid fluctuation is usually modeled as independent from pulse to pulse within a scan and independent from scan to scan. The terms *scintillation* and *amplitude noise* have been used in the past as synonymous for target fluctuation and also to denote location errors caused by target fluctuation, and should be avoided because of this ambiguity.

target identification: Target identification means identifying a particular target such as the name painted on the side of a ship, an aircraft's side-number, or the flight number of a commercial aircraft. *Note*: Primary radar cannot usually provide the identity of a target, but secondary radar systems including transponders can be used for such cooperative target identification. *See also*: **target recognition.**

target noise: Random variations in observed amplitude, location, and/or Doppler of a target, caused by changes in target aspect angle, rotation or vibration of target-scattering sources, or by changes in wavelength. *See also:* **glint; scintillation error; target fluctuation.**

target recognition: The use of a radar to recognize one class of target from another. Also known as noncooperative target recognition (NCTR) or target classification. *See also:* **target identification.**

terrain-avoidance radar: A radar that provides information about the ground environment so that an aircraft can fly around high ground or obstacles.

terrain echoes: *See*: **ground clutter.**

terrain-following radar: An airborne radar that works with the aircraft flight control system to achieve flight that follows the contour of the earth's surface at some given altitude.

three-dimensional (3-D) radar: A radar capable of producing three-dimensional position data on a multiplicity of targets.

threshold: A value of voltage or other measure that a signal must exceed in order to be detected or retained for further processing.

time-averaged-clutter coherent airborne radar (TACCAR): An airborne moving-target indication (MTI) radar that uses a technique to compensate for the changing Doppler frequency from fixed clutter due to the motion of the aircraft (or other vehicle) carrying the radar or as the moving radar antenna scans in angle. The clutter is sampled over some range interval, the average Doppler frequency of the clutter in the range interval is used to set the frequency of a voltage-controlled oscillator (VCO) in a phase-lock loop to cause the mean Doppler frequency of the clutter echo to coincide with a null of the MTI Doppler frequency response over the range of observation. *Note*: Also known as clutter-locked MTI.

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time-difference-of-arrival: *See:* **time-of-arrival location.**

time-of-arrival (TOA) location: A process whereby the position of a radiating transmitter can be located by means of the relative time delay between its signals as received in multiple receivers of known relative position. *Synonym:* **time-difference-of-arrival.**

TOA location: *See:* **time-of-arrival location.**

tracking: The process of following a moving object or a variable input quantity. In radar, target tracking in angle, range, or Doppler frequency is accomplished by keeping a beam or angle cursor on the target angle, a range mark or gate on the delayed echo, or a narrowband filter on the signal frequency, respectively. *Note*: This process may be carried out manually or automatically for one or more of the above input quantities. The beam, range gate, or filter can be either centered on the input quantity or can be coarsely placed, with interpolation measurements providing accurate data to a computer that does the fine tracking. *See also*: **automatic tracking; tracking radar; track-while-scan.**

tracking radar: A radar whose primary function is the automatic tracking of targets. *See also:* **automatic tracking; tracking.**

track-while-scan (TWS): An automatic target tracking process in which the radar antenna and receiver provide periodic video data from a search scan, together with interpolation measurements, as inputs to computer channels that follow individual targets. *See also:* **tracking.**

transmit-receive (TR) box: See: **transmit-receive switch.**

tranmit-recieve (TR) module: An active TR electronic module, usually with integrated circuits, consisting of an antenna (or direct connection thereto), transmitter, receiver, duplexer, phase shifters, and power conditioner employed at the radiating elements of a phased array radar.

transmit-receive (TR) switch: An RF switch, frequently of the gas discharge type, which automatically decouples the receiver from the antenna during the transmitting period. *Note*: Employed when a common antenna is used for transmission and reception. *Synonym:* **transmit-receive box.**

transponder: Receiver-transmitter equipment, the function of which is to transmit signals automatically when the proper interrogation is received from a radar or an interrogator.

trapping: *See:* **ducting.**

trilateration: *See:* **multilateration.**

TR switch: *See*: **transmit-receive switch.**

true-motion display: A display in a vehicle- or ship-mounted radar that shows the motions of the radar and of targets tracked by that radar, relative to a fixed background. True-motion display is accomplished by inserting compensation for the motion of the vehicle carrying the radar.

two-dimensional (2-D) radar: A radar that provides information in range and one angle coordinate, as in a 2-D air-surveillance radar that uses a fan-beam antenna to obtain range and azimuth angle.

TWS: *See*: **track-while-scan.**

UHF radar: *See*: **ultra-high-frequency radar.**

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ultra-high-frequency (UHF) radar: A radar operating at frequencies between 300 MHz and 1000 MHz, usually in one of the International Telecommunication Union (ITU) bands allocated for radiolocation: 420–450 MHz or 890–942 MHz. *Note*: Radars between 1 GHz and 3 GHz, although within the UHF band as defined by the ITU, are described as L-band or S-band radars, as appropriate.

V-band: A radar-frequency band between 40 GHz and 75 GHz, usually in the International Telecommunication Union (ITU) allocated band 59–64 GHz. Included within the definition of millimeter-wave radar. *See also:* **millimeter-wave radar.**

V-beam radar: A ground-based, three-dimensional radar system for the determination of range, bearing, and, uniquely, the height or elevation angle of the target. It uses two fan-shaped beams, one vertical and the other inclined, that rotate together in azimuth so as to give two responses from the target. The time difference between these responses, together with range, are used in determining the height of the target.

VCO: *See*: **voltage-controlled oscillator.**

velocity response: The clutter filter frequency response defined by the ratio of power gain at a specific target Doppler frequency to the average power gain over all target Doppler frequencies of interest. *Note*: Applied to moving-target indication (MTI) radars.

very-high-frequency (VHF) radar: A radar operating at frequencies between 30 MHz and 300 MHz, usually in one of the International Telecommunication Union (ITU) allocated bands 138–144 MHz or 216–225 MHz.

VHF radar: *See*: **very-high-frequency radar.**

video: Refers to the signal after envelope or phase detection, which in early radar was the displayed signal. Contains the relevant radar information after removal of the carrier frequency.

video integration: A method of utilizing the redundancy of repetitive video signals to improve the output signal-to-noise ratio, by summing successive signals. Also called post-detection integration or noncoherent integration.

video mapping: The electronic superposition of geographic or other data on a radar display.

video stretching: The increasing of the duration of a video pulse.

visibility factor: (A) (pulsed radar) The ratio of single-pulse signal energy to noise power per unit bandwidth that provides stated probability of detection for a given false alarm probability on a display, measured in the intermediate-frequency portion of the receiver under conditions of optimum bandwidth and viewing environment. **(B)** (continuous-wave radar) The ratio of single-look signal energy to noise power per unit bandwidth using a filter matched to the time on target. *Note*: The equivalent term for radar using automatic detection is detectability factor*;* for operation in clutter environment, a clutter visibility factor is defined.

voltage-controlled oscillator (VCO): An oscillator whose frequency is a function of the voltage of a control signal.

volumetric radar: A surveillance radar with coverage extending over a significant sector in two angular coordinates.

W-band: A radar-frequency band between 75 GHz and 110 GHz, usually in one of the International Telecommunication Union (ITU) allocated bands 76–81 GHz or 92–100 GHz. Included within the definition of millimeter-wave radar.

X-band: A radar-frequency band between 8 GHz and 12 GHz, usually in the International Telecommunication Union (ITU) allocated band 8.5–10.68 GHz.

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Annex A

(informative)

Bibliography

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