

IEEE Standard Definitions of Terms for Nonlinear, Active, and Nonreciprocal Waveguide Components

Sponsor
Waveguide Standards Committee
of the
IEEE Microwave Theory and Techniques Society

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Foreword

(This Foreword is not a part of IEEE Std 457-1982, IEEE Standard Definitions of Terms for Nonlinear, Active, and Nonreciprocal Waveguide Components.)

The Waveguide Standards Committee of the Microwave Theory and Techniques Society (MTT-S) was formed in 1968 following direction from the IEEE to associate this work with the appropriate technical group. The committee membership was drawn partly from the original Antenna and Waveguide Standards Committee which produced Definitions of Terms for Antennas and Waveguides, IEEE Std 146-1953, (formerly 531RE 2.S1). The antenna terms were later separated from the waveguide terms and incorporated into Definitions of Terms for Antennas, IEEE Std 145-1973, by the Antenna Standards Committee of the IEEE Antenna and Propagation Society (AP-S).

This standard presents definitions of terms for non-linear, active, and non-reciprocal waveguide components. It is a companion to two other recently published standards, Definitions of Fundamental Waveguide Terms, IEEE Std 146-1980 and Definitions of Terms for Waveguide Components, IEEE Std 147-1979. The latter covers linear and passive waveguide components. This trilogy of definitions should eventually be combined into a single comprehensive standard of waveguide terminology, but was purposely done in separate parts for the convenience of the volunteer subcommittees assigned to their respective tasks by the Waveguide Standards Committee of the Microwave Theory and Techniques Society (MTT-S).

The above mentioned microwave waveguide standards contain definitions of terms which have been coordinated and compared with similar definitions in the vocabularies of other IEEE groups as well as those of international standards commissions. The resulting definitions represent the consensus and judgement of the IEEE MTT Society.

In these definitions, emphasis has been placed on waveguides (hollow uniconductor transmission lines) and only a few apply to the planar transmission lines (stripline, microstrip, slotline, etc) which have dominated microwave circuit technology in recent years. Standardization of terminology for this newer microwave technology is very much needed, and steps are being taken to form subcommittees to generate definitions in this growing area.

Because these standards are generated by volunteer members of MTT-S it takes several years to complete each standard, and by the time of publication a standard may be incomplete because of the rapid growth of technology. This means that the standards must be revised periodically, making the work of our standards committees a continuous process of defining, refining, and revising.

The subcommittee on Definitions of Terms for Non-linear, Active, and Non-reciprocal Waveguide Components was formed in October 1978. It consists of the following contributors to this standard:

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When the IEEE Standards Board approved this standard on March 11, 1982, it had the following membership:

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above threshold firing time (microwave switching tubes). The time to establish an above-threshold discharge in the gas tube after the application of radio frequency power. This time delay is responsible for the spike in the leading edge of the output leakage waveform. *See also* receiver protector; gas tube;*¹ duplexer.

abrupt junction (semiconductor). A semiconductor crystal having a n-region containing a near constant net concentration of donor impurities adjoining a p-region with a near constant net concentration of acceptors; used primarily in microwave frequency multipliers, dividers, and parametric circuits.

absorptive loss. *See* arc loss.

anticlutter gain control (radar). A device that automatically and smoothly increases the gain of a radar receiver from a low level to the maximum, within a specified period after each transmitter pulse, so that short-range echoes producing clutter are amplified less than long-range echoes.

anti-transmit-receive tube.²** A gas-filled radio-frequency switching tube used to isolate the transmitter during the interval for pulse reception. *See also* gas tube.*

arc discharge. Commonly refers to weakly ionized plasma created by a radio-frequency (rf) discharge in gas tubes, receiver protectors, or duplexers.

arc gap (microwave receiver protector). *See* resonant gap.

arc loss (absorptive loss). Power absorbed in an active nonlinear device during above-threshold switching or limiting in gas tubes, duplexers, ferrite limiters, or diode limiters.

attenuator, p-i-n diode. A device that provides a predetermined value of attenuation in a transmission line in response to a precise value of bias.

backward diode. A semiconductor device used primarily as a detector or mixer. Quantum-mechanical tunneling in this diode results in a current-voltage characteristic in which the reverse current is greater than the forward current for equal applied voltages of opposite polarity.

balanced duplexer (radar). A dualized network using two quadrature hybrids on each side of a pair of self-switching elements used to interconnect the transmitter, receiver, and antenna in a radar. *See also* duplexer.

bang snuffer. A switch used in radar receivers to suppress carrier leakage during the transmit period. *See also* gate (microwave).

breakdown voltage (diode). The reverse voltage at which there is a conduction of current due to the Zener effect or the avalanche multiplication process. This voltage is usually specified at 10 μ A of reverse current.

burnout. The point at which a sensitive receiving device suffers a specified permanent degradation of noise figure or equivalent increase in noise temperature.

capacitance, case (semiconductor). The fixed capacitance of an empty enclosure (neither semiconductor chip nor connecting wires or straps are present).

capacitance, diffusion (semiconductor). A capacitance enhancement effect associated with p-n junctions. Because the diffusion of

¹ Definitions followed by an asterisk are listed in ANSI/IEEE Std 100-1977, IEEE Standard Dictionary of Electrical and Electronics Terms.

² Definitions followed by a double asterisk are deprecated.

electrons and holes takes time, there is a storage effect that is equivalent to adding additional capacitance in shunt with the junction. In the forward bias state, the diffusion capacitance becomes predominant over the space-charge capacitance to the point that the latter can be neglected at lower microwave frequencies. Diffusion capacitance varies inversely with frequency, but increases as minority carrier lifetime increases and must be dealt with in many frequency multiplier and parametric amplifier designs.

capacitance, fringing (semiconductor). The fixed capacitance between the connecting devices (wires and straps) and the pedestal of a diode enclosure.

capacitive gap (microwave receiver protectors). The distance between cone apices in a waveguide resonant structure. *See also resonant gap.*

carrier velocity (semiconductor). The average velocity of the random thermal motion of electrons in *n*-type semiconductors and of holes in *p*-type semiconductors.

charge storage (semiconductor). An electrical property of step recovery, dual mode, and *p-i-n* diodes. As the diode is driven into forward conduction by the first half-cycle of the incident signal, it stores a charge and appears as a low impedance. As the polarity of the incident signal reverses, the charge is extracted, and the diode remains in its low-impedance state until virtually all of the charge is removed, whereupon the diode rapidly switches to a high-impedance state.

chip (semiconductor). A small unpackaged functional element made by subdividing a wafer of semiconductor material. Sometimes referred to as a *die*.

circulator, waveguide. A passive waveguide device of three or more ports in which the ports can be numbered in such an order that, when power is fed into any port, the power is transferred to the next sequentially numbered port. The first port is counted as following the last in order.

circulator, waveguide differential phase. A waveguide circulator based on the use of at least one nonreciprocal differential insertion phase element or gyrator, usually in connec-

tion with other waveguide components such as microwave hybrid junctions.

circulator, waveguide Faraday rotation. A waveguide circulator based on the use of a Faraday rotation element in conjunction with other waveguide components such as dual-mode transducers.

circulator, waveguide junction. A waveguide circulator based on the use of gyromagnetic material at the common junction of several waveguides.

compression point. The level of the output signal at which the gain of a device is reduced by a specified amount, usually expressed in decibels, as in the 1 dB compression point.

controlled plasma switch. A triggered gas switch that uses an electron-beam-excited gaseous plasma in a waveguide to limit or switch radio frequency (rf) power.

conversion loss. In a frequency converter (mixer), the ratio of the output power at the converted frequency to the available input power at the signal frequency; often expressed in decibels.

coupled (isolated) port, circulator. With reference to a particular port of the circulator, a port to which waves pass from the reference port with low (high) insertion loss.

critical field. In a gyromagnetic material, that radio-frequency (rf) magnetic field level above which transfer of energy occurs from the uniform precession mode to spin waves; that is, the field corresponding to nonlinear loss threshold.

cross modulation distortion. A third-order distortion product that can occur when nonlinear devices are exposed simultaneously to two carriers of differing frequency where modulation is present. It is measured by using two separate carriers and providing 100% modulation on one. The cross modulation is defined as the power in one sideband of the unmodulated carrier below the power of the carrier.

current sensitivity (diode). The output current developed by a diode detector for a specified load resistance per unit available radio-frequency (rf) input power. It is expressed in mA/mW.