

SEVENTH EDITION

M O D E R N
DICTIONARY
of
ELECTRONICS

RUDOLF F. GRAF



**MODERN
DICTIONARY
of
ELECTRONICS**

SEVENTH EDITION

REVISED AND UPDATED



Rudolf F. Graf is an author whose name is well-known to engineers, technicians, and hobbyists around the world. He graduated as an electronics engineer from Brooklyn Polytechnic Institute and did his graduate work New York University. Mr. Graf has been active in the electronics industry for more than fifty years in capacities ranging from design and consulting engineer, chief engineer, chief instructor at electronics and television schools, and consulting editor. He also held various sales and marketing positions. Mr. Graf is the author or co-author of more than 150 technical articles published by major magazines. He has written about 50 books on electricity and electronics, with more than 2 million copies in print, including the best-selling *Video Scrambling & Descrambling for Satellite & Cable TV, Second Edition* and the *Circuits* series of books, both published by Newnes. A number of his books have been translated into several European languages as well as Chinese, Japanese, and Russian.

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Boston Oxford Auckland Johannesburg Melbourne New Delhi

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*It gives me great pleasure to dedicate this edition to
Allison, Sheryl, Daniel, David, Russell and Scott,
the loveliest children this side of heaven.*

Preface

When the first edition of this dictionary was published in 1961, today's everyday items like color TVs, VCRs, CD players, computers, FAX machines, ATMs, cordless and cell phones, pagers, tape recorders, digital watches, pocket calculators, lasers, and many others too numerous to mention, were non-existent or mere laboratory curiosities. Since then, electronics has undergone significant changes based primarily on the meteoric expansion of integrated circuits and their apparently limitless applications. Vacuum tubes were replaced by semiconductors, and numerous technologies like ferrite core or bubble memories were relegated to the electronics graveyard. No other industry has ever grown so much and matured so fast, paced by technological advances that occur at a feverish pace. The first edition of this dictionary contained about 10,000 definitions of then current terms. And now, a scant 38 years later, this seventh edition contains approximately 25,000 terms—a clear indication of the phenomenal growth of our industry.

As technologies evolve and fresh products and concepts are introduced, suitable terminology must be developed to be able to communicate. The originators of the new words give them their initial meaning, but their exact definitions change with technological advances and through actual use by others. The contents of this dictionary is thus an analysis of words and their meanings as determined by common usage, written in a modern and popular style to provide clear and concise explanations of each entry. Continual updating of a work such as this is vital, so that those involved in the world of electronics have the power to communicate with those about them and to grasp new concepts as they emerge.

All entries are allowed as much space as is necessary for complete and meaningful definitions. Terms are explained clearly and precisely without excessive technical jargon. Original entries from the previous edition have been reviewed and many were revised to keep pace with current usage. Where more than one definition exists for a term, they are arranged numerically. This method, however, does not necessarily imply a preferred order of meanings. Important words from formative technologies that are no longer in use are retained in this edition for their historical interest.

My thanks go out to Ms. Tara Troxler Thomas and to Charles Thomas whose dedication to this project and skill at the word processor made it possible to deliver the manuscript for this work to the publisher in a timely fashion.

Industry and technical sources—notably the IEEE and the ASA—generously aided in defining many terms during the preparation of earlier editions of this work.

While this volume is as up-to-date as possible at the time of writing, the field of electronics is expanding so rapidly that new terms are constantly being developed and older terms take on broader or more specialized meanings. It is the intention of the publisher to periodically issue revised editions of this dictionary; thus suggestions for new terms and definitions are always welcome.

Rudolf F. Graf
February 1999

being plated by the substrate. Thickness of the plating is limited to 10 to 50 microinches (0.254 to 1.27 μm). 2. The chemical deposition of a thin metallic coating over certain base metals by a partial displacement of the base metal.

immersion pyrometer—An instrument for determining molten-steel temperature and normally consisting of a platinum-platinum rhodium bimetal thermocouple junction and a recording device for transposing the millivoltage into degrees of temperature.

immittance—A term that denotes both impedance and admittance. It is commonly applied to transmission lines, networks, and certain kinds of measuring instruments.

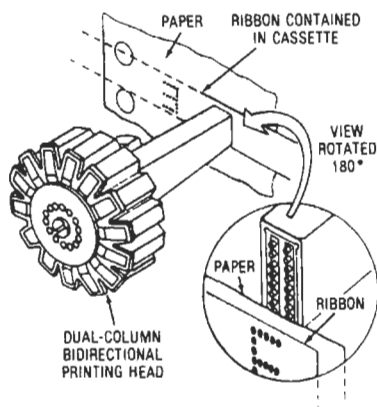
IMOS—See ion-implanted MOS.

impact excitation—The starting of damped oscillations by a sudden surge, such as by a spark discharge.

impact modulator amplifier—A fluidic device in which the impact plane position of two opposed streams is controlled to alter the output.

impact predictor—A device that can determine, in real time, the point on the earth's surface where a ballistic missile will impact if thrust is instantaneously terminated.

impact printer—1. Any type of printer that generates characters by using some form of stamping or inking through a ribbon by some sort of character slug, element, or hammer-needle. (Daisy-wheel printers are impact printers.) 2. Any mechanical imprinting device that forms characters by striking characters against a ribbon onto paper. 3. A mechanical printer operating at relatively low speeds—from 150 lines per minute to 1800 lines per minute. Has multiple copy capability and normally is capable of producing an original plus three copies. Impact printers are identified as letter-quality, dot-matrix, and line-printing types. No longer in common use.



Impact printer (dot-matrix).

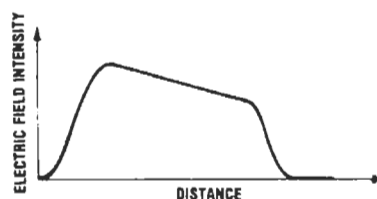
impact printing—Printing that is produced by the impact of a key on an inked ribbon, transferring the impression of a character onto the paper located behind the ribbon.

impact resistance—Resistance to fracture under shock force.

IMPATT—Acronym for impact avalanche and transit time.

IMPATT diode—Impact avalanche and transmit time diode. 1. A pn-junction diode operated with heavy back bias so that avalanche breakdown occurs in the active region. To prevent burnout, the device is so

constructed that the active region is very close to a good heat sink. For the same reason, the bias supply must be a constant-current type. 2. A device whose negative resistance characteristic is produced by a combination of impact avalanche breakdown and charge-carrier transit-time effects. Avalanche breakdown occurs when the electric field across the diode is high enough for the charge carriers (holes or electrons) to create electron-hole pairs. With the diode mounted in an appropriate cavity, the field patterns and drift distance permit microwave oscillations or amplification. 3. A semiconductor microwave diode that, when its junction is biased onto avalanche, exhibits a negative resistance over a frequency range determined by the transit time of charge carriers through the depletion region.



IMPATT diode.

IMPATT oscillator—An oscillator in which the active element is an IMPATT diode operating in a negative resistance mode. Dc to rf conversion efficiencies are normally less than 20 percent. Present devices operate above 5 GHz.

impedance—1. The total opposition (i.e., resistance and reactance) a circuit offers to the flow of alternating current at a given frequency; the ratio of the potential difference across a circuit or element of a circuit to the current through the circuit or element. It is measured in ohms, and its reciprocal is called admittance. Symbol: Z . 2. The combination of resistance and reactance. 3. Combined opposition to current resulting from resistance, capacitance, and inductance. 4. The sinusoidal terminal voltage of a circuit divided by the current through it. 5. A speaker's resistance to an alternating current, which varies with frequency. A speaker's rated impedance is usually the value measured at 400 Hz. 6. The opposition to alternating current in a circuit, generally categorized as either high or low, and measured in ohms. 7. The total opposition that a circuit offers to the flow of alternating current or any other varying current at a particular frequency. It is a combination of resistance, R , and reactance, X , measured in ohms.

impedance angle—Angle of the impedance vector with respect to the resistance vector. Represents the phase angle between voltage and current.

impedance at the intermediate frequency—In a mixer semiconductor diode, the impedance measured at the output terminals of a mixer circuit when the device is driven by a local oscillator under specified conditions.

impedance bridge—A device for measuring the combined resistance and reactance of a component part of a circuit.

ratio meter—1. An instrument that measures electrically the quotient of two quantities. It generally has no mechanical control means such as springs. Instead, it operates by the balancing of electromagnetic forces, which are a function of the position of the moving element. 2. Instrument for measuring the ratio of transformation of a transformer by means of a resistance bridge arrangement. 3. Moving-coil type of instrument in which the deflection is proportional to the ratio of the current sent through two coils.

ratio of transformation—The ratio of the secondary voltage of a transformer to the primary voltage under no-load conditions, or the corresponding ratio of currents in a current transformer.

ratio squelch—*See* squelch circuit.

ratio-type telemeter—Also called a position-type telemeter. A telemeter in which the relative phase position between, or magnitude relation of, two or more electrical quantities is the translating means.

rat race—A magic-T modification for the acceptance of higher power. A circular loop of coaxial line closed upon itself and having four branching connections. *See also* hybrid ring.

raw data—1. Data that has not been processed. 2. Data as received, which has not been processed by a machine and which may not yet be in the form that a machine can accept.

raw tape—Also called virgin tape or blank tape. A term sometimes used to describe tape that has not been recorded. *See also* blank tape.

ray—1. A line of propagation of any form of radiant energy. 2. In fiber optics, a straight line, representing light, perpendicular to the light wavefront and traveling in the same direction. At a boundary surface or interface, such as the surface between a fiber core and cladding, the ray may change direction suddenly, but it remains a straight line. 3. A line of light extending between two points.

ray angle—The angle between a light ray and a reference line or plane.

ray-control electrode—An electrode that controls the position of the electron beam on the screen of a cathode-ray tuning-indicator tube.

Raydist—A system using cw transmission to provide hyperbolic lines of position through rf phase comparison techniques. The system is used for surveying or ship positioning in a two-dimensional array. The frequency band is 1.7 to 2.5 MHz. Similar to LORAC in principle.

Rayleigh disc—A special acoustic radiometer used for the fundamental measurement of particle velocity.

Rayleigh distribution—Frequency distribution for an infinite number of quantities of the same magnitude, but of random phase relationships. Sky-wave field intensities follow the Rayleigh distribution for intervals of one minute or less.

Rayleigh distribution (fading)—A statistical distribution describing the magnitude of a phasor composed of the sum of many component phasors randomly distributed in amplitude and phase. Fading of signals caused by cancellation and reinforcement of contributions received over separate paths often exhibits a Rayleigh distribution.

Rayleigh line—In scattered radiation, a spectrum line that has the same frequency as the corresponding incident radiation.

Rayleigh reciprocity theorem—The reciprocal relationship for an antenna when transmitting or receiving. The effective heights and the radiation resistance and pattern are alike, whether the antenna is transmitting or receiving.

ratio meter — reactance frequency multiplier

Rayleigh scattering—Scattering of radiation by minute particles suspended in air (e.g., by dust).

Rayleigh wave—A surface wave associated with the free boundary of a solid. The wave is of maximum intensity at the surface, but diminishes quite rapidly as it proceeds into the solid.

ray path—An imaginary line, perpendicular to the wavefront, that describes the path along which the energy associated with a point on a wavefront moves.

Rayistor—Raytheon trade name for a device that contains a photosensitive semiconductor element and a light source that can be used to control the conductivity of the semiconductor.

RBOC—Abbreviation for Regional Bell Operating Company. Also called Bell Operating Companies (BOC). Local telephone operating companies that were split off from AT&T and which provide most local and intrastate telephone service in the United States.

RC—Symbol for resistance-capacitance, resistance-coupled, or ray-control electrode.

RC amplifier—Abbreviation for resistance-capacitance coupled amplifier.

RC circuit—A time-determining network of resistors and capacitors in which the time constant is defined as resistance times capacitance.

RC constant—The time constant of a resistor-capacitor circuit, equal in seconds to the resistance value in ohms multiplied by the capacitance value in farads.

RC coupling—*See* resistance-capacitance coupling.

RC filter—*See* resistance-capacitance filter.

RC network—A circuit containing resistances and capacitances arranged in a particular manner to perform a specific function.

RC oscillator—An oscillator in which the frequency is determined by resistance-capacitance elements. *See also* resistance-capacitance oscillator.

RCTL—Abbreviation for resistor-capacitor-transistor logic.

rd—Letter symbol for rutherford.

RDF—Abbreviation for radio direction finder (or finding).

R-display—Essentially an expanded radar A-display in which the trace of an echo can be expanded for more detailed examination.

reach-through voltage—That value of reverse voltage for which the depletion layer in a reverse-biased pn junction spreads sufficiently to make electrical contact with another junction. *See also* punch-through voltage.

reacquisition time—The time required for a tracking radar to relock on the target after the radar's automatic tracking mechanism has been disengaged.

reactance—Symbolized by X . 1. Opposition to the flow of alternating current. Capacitive reactance (X_C) is the opposition offered by capacitors, and inductive reactance (X_L) is the opposition offered by a coil or other inductance. Both reactances are measured in ohms. 2. The opposition offered an alternating flow by a capacitance or inductance related to the frequency of the alternating current. The reactance of a capacitor decreases with increasing frequency, but the reactance of an inductance increases with frequency.

reactance drop—The voltage drop in quadrature with the current.

reactance factor—In a conductor, the ratio of its ac resistance to its ohmic resistance.

reactance frequency multiplier—A frequency multiplier whose essential element is a nonlinear reactor; the nonlinearity of the reactor is used to generate harmonics of a sinusoidal source.

device to its original (normal) condition after an alarm or trouble signal.

reset action — A type of control in which correction is proportional to both the length of time and the amount that a controlled process has deviated from the desired value, and provision is made to ensure that the process is returned to its set point.

reset button — A button that restarts a computer without turning power off and on.

reset pulse — A drive pulse that tends to reset a magnetic cell.

reset rate — The number of corrections made per unit of time by a control system; it usually is expressed in terms of the number of repeats per minute.

reset terminal — Also called clear terminal or zero-input terminal. In a flip-flop, the input terminal used to trigger the circuit from its second state back to its original state.

reset time — 1. A timer that can be reset by electrical means. May be either an on-delay or off-delay type. 2. A timer with one or more circuits that spring-reset to zero when the clutch is disengaged. 3. The period required from the time of the reset command until a timer is fully returned to the before-start conditions ready for the next cycle.

resident assembler — An assembler that runs on the machine for which it generates code. Eliminates the need for another computer system or time-sharing service, as required by a cross assembler.

residual — 1. The difference between any value and some estimate of the mean of such values; e.g., residuals from a curve of regression. (Residual unbalance.) 2. The complement of a set is called a residual set. 3. Pertaining to a measure of the output of a transducer under static conditions and with no stimulus applied.

residual charge — 1. The charge remaining on the plates after an initial discharge of a capacitor. 2. The small charge that remains in the dielectric of a capacitor after a quick discharge.

residual current — 1. The vector sum of the currents in the several wires of an electric supply circuit. 2. Current through a thermionic diode in the absence of anode voltage; it results from the velocity of the electrons emitted by the heated cathode.

residual deviation — Apparent modulation due to noise and/or distortion in the transmitter.

residual discharge — A discharge of the residual charge of a capacitor remaining after the initial discharge.

residual error — The direction-finding errors remaining after errors due to site and antenna effects have been minimized.

residual field — The magnetic field left in an iron field structure after excitation has been removed.

residual flux — 1. The value of magnetic induction that remains in a magnetic circuit when the magnetomotive force is reduced to zero. 2. In a uniformly magnetized sample of magnetic material, the product of the residual flux density and the cross-sectional area. Residual flux is indicative of the output that can be expected from a tape at long wavelengths.

residual flux density — The magnetic flux density that exists at zero magnetizing field strength when a sample of magnetic material has undergone symmetrically cyclical magnetization.

residual FM — See incidental FM.

residual gases — The small amounts of gases remaining in a vacuum tube despite the best possible exhaustion by vacuum pumps.

residual induction — 1. The magnetic induction that remains in a magnetized material when the effective magnetizing force has been reduced to zero. When the

material is in a symmetrically cyclic magnetic condition, the residual induction is termed the "normal residual induction." Letter symbol: B_r . 2. The magnetic induction corresponding to zero magnetizing force in a magnetic material that is in a symmetrically cyclically magnetized condition. Note: The European definitions of residual induction and remanence are interchanged. Thus, the meaning of these two words can vary, depending on the author.

residual ionization — Ionization of air or other gas not accounted for in a closed chamber by recognizable neighboring agencies.

residual losses — In a magnetic core, the difference between the total losses and the sum of the eddy-current and hysteresis losses.

residual magnetic induction — Magnetic induction remaining in a ferromagnetic object after the magnetizing force has been removed. The amount depends on the material, shape, and previous magnetic history.

residual magnetism — The magnetism that remains in the core of an electromagnet after the operating circuit has been opened.

residual modulation — See carrier noise level.

residual screw — A brass screw in the center of a relay armature. It is used to adjust the residual air gap between the armature and the coil core to prevent residual magnetism from holding the armature operated after the relay operating circuit has opened.

residual torque — Nonenergized detent torque arising from permanent-magnet effects and bearing friction of a stepper motor.

residual voltage — 1. The vector sum of the voltages to ground of the several phase wires in an electric supply circuit. 2. The voltage caused by dielectric absorption that appears in the capacitor terminations after the capacitor is discharged and then left with the terminations disconnected.

resin — 1. One of a class of solid or semisolid, natural or synthetic organic products, generally with a high molecular weight and no definite melting point. Most resins are polymers. 2. An inorganic substance of natural or synthetic origin that is polymeric in structure and predominantly amorphous.

resist — 1. A material placed on the surface of a copper-clad base material to prevent the removal by etching of the conductive layer from the area covered. 2. A material deposited on conductive areas to prevent plating of the areas covered. 3. Coating that masks areas of a board from the effects of an etchant used during manufacture.

resistance — 1. A property of conductors that—depending on their dimensions, material, and temperature—determines the current produced by a given difference of potential; that property of a substance which impedes current and results in the dissipation of power in the form of heat. The practical unit of resistance is the ohm. It is defined as the resistance through which a difference of potential of 1 volt will produce a current of 1 ampere. 2. A circuit element designed to offer a predetermined resistance to current. 3. Ratio of the applied electromotive force to the resulting current in a circuit. It is a measure of the resistance of the circuit to the passage of an electric current and is measured in ohms. Its value is determined by $R = E/I$, where E is voltage in volts, and I is current in amperes.

resistance balance — The amount of resistance that is required to null the output of certain transducers or input systems.

resistance box — An assembly of resistors and the necessary switching or other means for changing the

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"How do you improve on a classic? Rudy Graf has done just that in the fully updated seventh edition of his **Modern Dictionary of Electronics**. In his elegantly practical style he defines over 28,000 terms drawn from a broad range of fields. In a world where electronics technology is growing so rapidly, this authoritative book belongs on everyone's reference shelf!"

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Included in this fully revised classic are well over 28,000 terms, phrases, acronyms, and abbreviations from the ever-expanding worlds of

consumer electronics, optics, microelectronics, computers, communications, and medical electronics. From the basic elements of theory to the most cutting-edge circuit technology, this book explains it all in both words and pictures.

For easy reference, the author has provided definitions for standard abbreviations and equations as well as tables of SI (International System of Units) units, measurements, and schematic symbols.

Rudolf F. Graf is an author whose name is familiar to electronics professionals and hobbyists alike. Mr. Graf graduated from Brooklyn Polytechnic Institute as an electronics engineer, and did his graduate work at New York University. He has been active in the electronics industry for more than fifty years in capacities ranging from design and consulting engineer to chief instructor at electronics and television schools, as well as in sales and marketing. He currently lives in New York. His many books offer a practical and enjoyable approach to often complex material. Other Newnes titles by Mr. Graf include **Video Scrambling and Descrambling, Second Edition**, and his full five-book series on electronics circuits.

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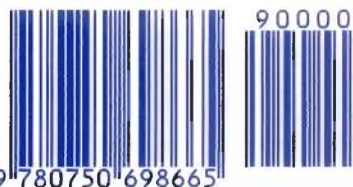
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