

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  
ld. He graduated as an electronics engineer from Brooklyn Polytechnic Institute  
duate work New York University Mr Graf has been active in the electronics

InductEV, Inc.  
Exhibit 1042  
InductEV v. WiTricity  
IPR2024-00140  
Ex. 1042-001

Newnes is an imprint of Butterworth-Heinemann.

Copyright © 1999 by Rudolf F. Graf

 A member of the Reed Elsevier Group.

All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher.

 Recognizing the importance of preserving what has been written, Butterworth-Heinemann prints its books on acid-free paper whenever possible.

 Butterworth-Heinemann supports the efforts of American Forests and the Global ReLeaf program in its campaign for the betterment of trees, forests, and our environment.

#### Library of Congress Cataloging-in-Publication Data

Graf, Rudolf F.

Modern dictionary of electronics / Rudolf F. Graf. — 7th ed.,  
revised and updated.

p. cm.

ISBN 0-7506-9866-7 (alk. paper)

1. Electronics — Dictionaries. I. Title

TK7804.G67 1999

621.381'03 — dc21

99-17889

CIP

#### British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library.

The publisher offers special discounts on bulk orders of this book.

For information, please contact:

Manager of Special Sales

Butterworth-Heinemann

225 Wildwood Avenue

Woburn, MA 01801-2041

Tel: 781-904-2500

Fax: 781-904-2620

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

2. To heat and then gradually cool in order to relieve mechanical stresses. Annealing copper makes it softer and less brittle.

**annealed laminations**—Laminations that have been annealed for transformers or choke coils.

**annealed wire**—Wire that has been softened by heating and gradual cooling to remove mechanical stresses.

**annotation**—An added descriptive comment or explanatory note.

**annular**—Ringed; ring-shaped.

**annular conductor**—A conductor consisting of a number of wires stranded in three reversed concentric layers surrounding a saturated hemp core. The core is usually made wholly or mostly of nonconducting material. This construction has the advantage of lower total ac resistance for a given cross-sectional area of conducting material by eliminating the greater skin effect at the center.

**annular transistor**—A mesa transistor in which the semiconductor regions are arranged in concentric circles about the emitter.

**annulling network**—An arrangement of impedance elements connected in parallel with filters to annul or cancel capacitive or inductive impedance at the extremes of the passband of a filter.

**annunciation relay**—1. An electromagnetically operated signaling apparatus that indicates whether a current is flowing or has flowed in one or more circuits. 2. A nonautomatic reset device that gives a number of separate visual indications upon the functioning of protective devices, and which may also be arranged to perform a lockout function.

**annunciator**—1. A visual device consisting of a number of pilot lights or drops. Each light or drop indicates the condition that exists or has existed in an associated circuit and is labeled accordingly. 2. A device for sounding an alarm or attracting attention. The indication is usually aural, but occasionally may be visual or both aural and visual. 3. An alarm-monitoring device that consists of a number of visible signals, such as flags or lamps indicating the status of the detectors in an alarm system or systems. Each circuit in the device is usually labeled to identify the location and condition being monitored. In addition to the visible signal, an audible signal is usually associated with the device. When an alarm condition is reported, a signal is indicated—visible, audible, or both. The visible signal is generally maintained until reset either manually or automatically.

**anode**—1. The positive electrode, such as the plate of a vacuum tube; the element to which the principal stream of electrons flows. 2. In a cathode-ray tube, the electrodes connected to a source of positive potential. These anodes are used to concentrate and accelerate the electron beam for focusing. 3. The less noble and/or higher-potential electrode of an electrolytic cell, at which corrosion occurs. This may be an area on the surface of a metal or alloy, the more active metal in a cell composed of two dissimilar metals, or the positive electrode of an impressed-current system.

**anode-balancing coil**—A set of mutually coupled windings used to maintain approximately equal currents in anodes operating in parallel from the same transformer terminal.

**anode breakdown voltage**—The potential required to cause conduction across the main gap of a gas tube when the starter gap is not conducting and all other tube elements are held at cathode potential.

**anode-bypass capacitor**—Also called plate-bypass capacitor. A capacitor connected between the anode and ground in an electron-tube circuit. Its purpose is to bypass high-frequency currents and keep them out of the load.

**anode characteristic curve**—A graph that shows how the anode current of an electron tube is affected by changes in the anode voltage.

**anode circuit breaker**—A device used in the anode circuits of a power rectifier for the primary purpose of interrupting the rectifier circuit if an arcback should occur.

**anode current**—The electron flow in the element designated as the anode. Usually signifies plate current.

**anode dark space**—In a gas tube, a narrow, dark zone next to the surface of the anode.

**anode dissipation**—The power dissipated as heat in the anode of an electron tube because of the bombardment by electrons and ions.

**anode efficiency**—See plate efficiency.

**anode-load impedance**—See plate-load impedance.

**anode modulation**—See plate modulation.

**anode neutralization**—Also called plate neutralization. A method of neutralization in which a portion of the anode-cathode ac voltage is shifted 180° and applied to the grid-cathode circuit through a neutralizing capacitor.

**anode power input**—See plate power input.

**anode power supply**—The means for supplying power to the plate of an electron tube at a more positive voltage than that of the cathode. Also called plate power supply.

**anode pulse modulation**—See plate pulse modulation.

**anode rays**—Positive ions coming from the anode of an electron tube; these ions are generally due to impurities in the metal of the anode.

**anode saturation**—See plate saturation.

**anode sheath**—A layer of electrons surrounding the anode in mercury-pool arc tubes.

**anode strap**—A metallic connector between selected anode segments of a multicavity magnetron, used principally for mode separation.

**anode supply**—Also called plate supply. The dc voltage source used in an electron-tube circuit to place the anode at a high positive potential with respect to the cathode.

**anode terminal**—1. In a diode (semiconductor or tube), that terminal to which a positive dc voltage must be applied to forward-bias the diode. Compare with *cathode terminal*. 2. In a diode (semiconductor or tube), that terminal at which a negative dc voltage appears when the diode is employed as an ac rectifier (blocking). 3. That terminal which is internally connected to the anodic element of any device.

metals by applying to them a positive (anodic) potential; e.g., aluminum is anodized (oxidized) by a positive charge in a sulfuric acid solution.

**anodic silver**—A precious metal used in plating; fine silver in different configurations, such as shot, cones, bars, etc., is sacrificed during the silver-plating process.

**anodization**—The formation of an insulating oxide over certain elements, usually metals, by electrolytic action. The most commonly anodized materials are tantalum, aluminum, titanium, and niobium. Anodization is particularly useful where protection of a conductor is required. The base metal can form the conductor and the anodized surface layer can form the insulator.

**anodize**—To deposit a protective coating of oxide on a metal by means of an electrolytic process in which it is used as the anode.

**anodizing**—An electrochemical oxidation process used to improve the corrosion resistance or to enhance the appearance of a metal surface. Aluminum and magnesium parts are frequently anodized.

**anomalous displacement current**—Also called dielectric absorption. The current in addition to the normal leakage current in a circuit containing a capacitor with an imperfect dielectric after the normal charging or discharging current has become negligibly small.

**anomalous photoconductivity**—A spectral phenomenon in which the degree of the photoresponse of an illuminated semiconductor is determined by the wavelength composition of the incident light.

**anomalous propagation**—1. Propagation that is unusual or abnormal. 2. The conduction of UHF signals through atmospheric ducts or layers in a manner similar to that of a waveguide. These atmospheric ducts carry the signals with less than normal attenuation over distances far beyond the optical path taken by UHF signals. Also called superrefraction. 3. In sonar, pronounced and rapid variations in the strength of the echo due to large, rapid focal fluctuations in propagation conditions.

**anonymous FTP (File Transfer Protocol)**—The procedure of connecting to a remote computer as an anonymous or guest user in order to transfer public files back to a local computer. See also FTP; protocol.

**A-N radio range**—A navigational aid that provides four equisignal zones for aircraft guidance. Deviation from the assigned course is indicated aurally by the Morse code letters A (·—) or N (—·). On-course position is indicated by an audible merging of the A and N code signals into a continuous tone.

**ANSI**—American National Standards Institute. The U.S. government organization with responsibility for the development and promulgation of (among others) data processing standards.

**A-N signal**—A radio-range, quadrant-designation signal that indicates to the pilot whether he or she is on course or to the right or left.

**ANSI keyboard**—Abbreviation for American National Standards Institute keyboard. A typewriter standard unit that offers a choice of uppercase characters only or uppercase and lowercase combined.

**ANSI standards**—A series of standards recommended by the American National Standards Institute.

**answerback**—1. The response of a terminal to

tripped by a unique access code, a short predetermined message is broadcast.

**answerback unit**—An electromechanical device used with a teletypewriter set to transmit a predetermined message of not more than 21 characters in response to a request signal. It can transmit either a five-level 7.42 unit code or an eight-level 11.0 unit code at speeds of up to 100 words per minute.

**answering cord**—The cord nearest the face of a telephone switchboard. It is used for answering subscriber's calls and calls on incoming trunks.

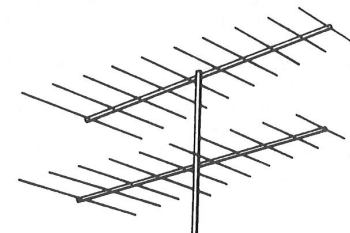
**answering service**—A business that contracts with subscribers to answer incoming telephone calls after a specified delay or when scheduled to do so. It may also provide other services, such as relaying fire or intrusion alarm signals to proper authorities.

**answer lamp**—In a telephone switchboard, a lamp that lights when an answer cord is plugged into a line jack; it extinguishes when the telephone answers and lights when the call is complete.

**answer tone**—Tone signal, with a frequency between 2025 and 2225 Hz and a duration of at least 1.5 s, used by an answering modem to indicate its ready condition to an originating modem.

**antenna**—Also called aerial. 1. That portion, usually wires or rods, of a radio transmitter or receiver station used for radiating waves into or receiving them from space. It changes electrical currents into electromagnetic radio waves, and vice versa. 2. A section of wire or a metallic device designed to intercept radio waves in the air and convert them to an electrical signal for feeding to a receiver. Under relatively difficult reception conditions, such as created by location, terrain, obstructions, etc., an antenna becomes fairly critical and should be one especially designed for its intended purposes. 3. A device for transmitting and receiving radio waves. Depending on their use and operating frequency, antennas can take the form of a single piece of wire, a dipole, a grid such as a yagi array, a horn, a helix, a sophisticated parabolic-shaped dish, or a phase array of active electronic elements of virtually any flat or convoluted surface. 4. A device that collects and focuses electromagnetic energy, i.e., contributes an energy gain. Gain is proportional to surface area for a microwave dish.

**antenna array**—1. A combination of antennas assembled to obtain a desired pickup or rejection pattern. 2. An arrangement of two or more directional antennas, spaced and connected so that they are in phase and their effects are electrically additive.



**navaids**—Navigational aids. The electronic facilities provided on or in the immediate vicinity of an airport so that a pilot using compatible airborne equipment can execute the instrument approach or approaches authorized for the airport.

**navar**—A coordinated series of radar navigation and traffic-control aids utilizing transmissions at wavelengths of 10 and 60 centimeters. In an aircraft, it provides distance and bearing from a given point, display of other aircraft in the vicinity, and commands from the ground. On the ground, it provides a display of all aircraft in the vicinity, as well as their altitudes and identities, plus means for transmitting certain commands.

**navarho**—A continuous-wave, low-frequency navigation system that provides simultaneous bearing and range information over long distances.

**Navascreen**—A system for the display and computation of air-traffic-control data based on information from radar and other sources.

**navigation**—The process of directing an airplane or ship toward its destination by determining its position, direction, etc.

**navigational parameter**—In a navigational aid, a visual or aural output having a specific relationship to navigational coordinates.

**navigation beacon**—A light, radio, or radar beacon that provides navigational aid to ships and aircraft.

**NBFM**—Abbreviation for narrow-band frequency modulation.

**nc**—1. Abbreviation for normally closed. 2. Abbreviation for no connection.

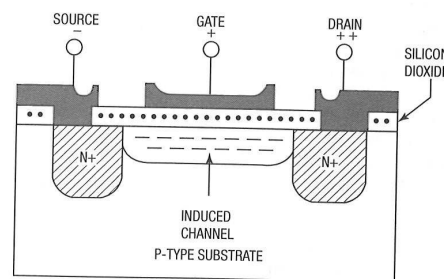
**NC**—Abbreviation for numerical control.

**nc contacts**—Contacts that are normally closed when the control circuit is not energized.

**n-channel**—A device constructed on a p-type silicon substrate whose drain and source components are of n-type silicon.

**n-channel FET**—A field-effect transistor that has an n-type conduction channel.

**n-channel MOS**—1. A metal-oxide semiconductor (unipolar) transistor in which the working current consists of negative (n) electrical charges. 2. A type of metal-oxide silicon field-effect transistor using electrons to conduct current in the semiconductor channel. The channel has a predominantly negative charge.



**n-conductor concentric cable**—A cable composed of an insulated central conducting core with  $n-1$  tubular stranded conductors laid over it concentrically and separated by layers of insulation.

**n-cube**—Also called  $n$ -dimensional cube or  $n$ -variable cube. In switching theory, a term used to indicate two  $n-1$  cubes having corresponding points connected.

**NC value**—See noise-criteria value.

**n-dimensional cube**—See  $n$ -cube.

**N-display**—Also called N-scan or N-scope. A radar display similar to the K-display. The target appears as a pair of vertical deflections (blips) from the horizontal time base. Direction is indicated by the horizontal of the vertical deflections. Target distance is determined by moving a pedestal signal (the control of which is calibrated in distance) along the base line until it coincides with the horizontal position of the vertical deflection.

**near-end crosstalk**—In a disturbed telephone channel, crosstalk propagated in the opposite direction from the current in the disturbing channel. The terminal in which the near-end crosstalk is present is ordinarily near, or coincides with, the energized terminal of the disturbing channel.

**near field**—1. The acoustic radiation field close to the speaker or some other acoustic source. 2. The electromagnetic field within a distance of 1 wavelength from a transmitting antenna.

**near infrared**—1. Name applied to the spectral region primarily comprising wavelengths between 3 and 30 meters. 2. That nonvisible radiant energy with wavelengths nearest the end of the visible spectrum.

**near space**—The space above the earth in which communication satellites travel, beginning at an altitude of about 120 miles (193 km).

**near-ultraviolet**—The longest wavelengths of the ultraviolet region, nominally 300 to 400 nanometers.

**near zone**—The region very close to a radio transmitting antenna in which the induction field predominates. The intensity of the induction field does not reduce in proportion to the square of the distance from the antenna.

**NEC**—Abbreviation for National Electrical Code. A consensus standard published by the National Fire Protection Association (NFPA) and incorporated in OSHA regulations.

**necessary bandwidth**—For a given class of emission, the minimum value of the occupied bandwidth sufficient to ensure the transmission of information at the rate and quality required for the system employed, under specified conditions. Emissions useful for the good functioning of the receiving equipment for example, the emission corresponding to the carrier of reduced carrier systems are included in the necessary bandwidth.

**neck**—The narrow tubular part of the envelope of a cathode-ray tube; it extends from the funnel to the base and houses the electron gun.

**needle**—1. A probe used on stacks of punched cards. 2. See stylus, 1.

**needle chatter**—See needle talk.

**needle drag**—See stylus drag.

**needle electrode**—Small instrument used for simultaneous electrical recording and stimulating.

**negative glow**—The luminous glow between the cathode and Faraday dark spaces in a glow-discharge cold-cathode tube. See also glow discharge.

**negative-grid generator**—A conventional oscillator circuit in which oscillation is produced by feedback from the plate circuit to a grid that is normally negative with respect to the cathode and that is designed to operate without drawing grid current at any time.

**negative ground**—The negative battery terminal of a vehicle is connected to the body and frame.

**negative image**—1. A televised picture in which the whites appear black and vice versa. It is due to the picture signal having a polarity opposite to that of a normal signal. 2. A picture signal having a polarity that is opposite to normal polarity and which results in a picture in which the white and black area are reversed.

**negative impedance**—Also called negative resistance when there is no inductance or capacitance in the circuit. A characteristic of certain electrical devices or circuits—instead of increasing, the voltage decreases when the current is increased, and vice versa.

**negative ion**—An atom with more electrons than the normal number. Thus, it has a negative charge.

**negative-ion generator**—A device that bombards air molecules with electrons so that molecules are ionized negatively.

**negative light modulation**—In television, the process whereby a decrease in initial light intensity causes an increase in the transmitted power.

**negative logic**—A form of logic in which the more positive voltage level represents logical 0 and the more negative level represents logical 1.

**negative modulation**—In an AM television system, that modulation in which an increase in brightness corresponds to a decrease in transmitted power.

**negative modulation factor**—The maximum negative departure of the envelope of an AM wave from its average value, expressed as a ratio. This rating is used whenever the modulation signal wave has unequal positive and negative peaks.

**negative phase-sequence relay**—A relay that functions in conformance with the negative phase-sequence component of the current, voltage, or power of the circuit.

**negative picture phase**—1. For a television signal, the condition in which an increase in brilliance makes the picture-signal voltage swing in a negative direction from the zero level. 2. Positioning the composite video signal so that the maximum level of the sync pulses is at 100% amplitude. The brightest picture signals are in the opposite, negative direction.

**negative picture transmission**—Television transmission system used in North America and other countries in which a decrease in illumination of the original scene causes an increase in percentage of modulation of the picture carrier. When modulated, signals with a higher modulation percentage have more positive voltages.

**negative plate**—The grid and active material connected to the negative terminal of a storage battery. When the battery is discharging, electrons flow from this terminal, through the external circuit, to the positive terminal.

**negative resistance**—1. A resistance that exhibits a characteristic from normal—i.e., when the

**negate**—To invert the value of a function or variable; that is, to change it to 1 if it is 0 or to 0 if it is 1. The symbol for negation is a superscript bar.

**negated-input OR gate**—A gate that has a high output when one or both inputs are low. A negated-input OR gate is identical with a NAND gate in function.

**negation**—The NOT operation in Boolean algebra.

**negative**—Abbreviated neg. 1. Less than zero. 2. The opposite of positive (e.g., negative resistance, transmission, feedback, etc.). 3. A terminal or electrode having an excess of electrons. Electrons flow out of the negative terminal of a voltage source, toward a positive source. 4. An artwork, artwork master, or production master in which the intended conductive pattern is transparent to light, and the areas to be free from conductive material are opaque.

**negative acceleration**—A relative term often used to indicate that, referenced to zero acceleration, a negative electrical output will be obtained from a linear accelerometer when its sensitive axis is oriented normal to the surface of the earth and a given minus reference point along the center of the seismic mass.

**negative acknowledgement character**—Abbreviated NAK. A communication control character transmitted from a receiving point as a negative response to a sender. It may also be used as an accuracy control character.

**negative bias**—In a vacuum tube, the voltage that makes the control grid more negative than the cathode.

**negative booster**—A booster used with a ground-return system to reduce the difference of potential between two points to the grounded return. It is connected in series with a supplementary insulated feeder extending from the negative bus of the generating station or substation to a distant point on the grounded return.

**negative charge**—A condition in a circuit when the element in question retains more than its normal quantity of electrons.

**negative conductor**—A conductor connected to the negative terminal of a source of supply. Such a conductor is frequently used as an auxiliary return circuit in a system of electric traction.

**negative differential conductance region**—That part of the characteristic of a tunnel diode between the peak and valley points.

**negative-effective-mass amplifiers and generators**—A class of solid-state devices for broadband amplification and generation of microwave energy. Operation of these devices is based on the phenomenon by which the effective masses of charge carriers in semiconductors become negative when their kinetic energies are sufficiently high.

**negative electricity**—The type of electricity possessed by a body that has an excess of electrons.

**negative electrode**—The electrode from which the forward current flows.

**negative electron**—Also called negatron. An electron, distinguished from a positive electron or positron.

**negative feedback**—Also called degeneration, inverse feedback, or stabilized feedback. A process by which a part of the output signal of an amplifying circuit is fed back to the input, in phase with the input, to reduce the gain and stabilize the output.

**radiant intensity**—1. The energy emitted within a certain length of time per unit solid angle about the direction considered. 2. The radiant power per unit solid angle in the direction considered, i.e., the time rate of transfer of radiant energy per unit solid angle, or the flux radiated per unit solid angle about the specified direction. The unit of measure is watts per steradian or joules per steradian-second.

**radiant power**—1. The rate of transfer of radiant energy. 2. The time rate of flow of electromagnetic energy. The unit is watts or joules per second.

**radiant reflectance**—The ratio of reflected radiant power to incident radiant power.

**radiant sensitivity**—The output current of a phototube or camera tube divided by the incident radiant flux of a given wavelength at constant electrode voltages. The term "output current" as here used does not include the dark current.

**radiant transmittance**—The ratio of transmitted radiant power to incident radiant power.

**radiate**—To emit rays from a center source; e.g., electromagnetic waves emanating from an antenna.

**radiated**—Energy transfer by propagation of electromagnetic fields.

**radiated interference**—1. Interference that is transmitted through the atmosphere according to the laws of electromagnetic wave propagation. (The term radiated interference is generally considered to include the transfer of interfering energy by inductive or capacitive coupling.) 2. Any unwanted electrical signal that is radiated from the equipment under test or from any lines connected to that equipment under test.

**radiated output noise**—Electrical interference signals radiated by switching the ac/dc converters and by the transformer in line-operated power supplies. These signals can cause malfunctioning of analog and digital circuits within their fields.

**radiated power**—The total energy, in the form of Hertzian waves, radiated from an antenna.

**radiated spurious transmitter output**—A spurious output radiated from a radio transmitter. (The associated antenna and transmission lines are not considered part of the transmitter.)

**radiating curtain**—An array of dipoles in a vertical plane, positioned to reinforce each other. Usually placed one-quarter wavelength ahead of a reflecting curtain of corresponding half-wave reflecting antennas.

**radiating element**—Also called radiator. A basic subdivision of an antenna. It, by itself, is capable of radiating or receiving radio-frequency energy.

**radiating guide**—A waveguide designed to radiate energy into free space. The waves may emerge through slots or gaps in the guide, or through horns inserted into its wall.

**radiation**—1. The emission and propagation of energy through space or a material medium. The energy may be in the form of electromagnetic waves (Y-rays and X-rays) or particles (beta particles, alpha particles, and neutrons). 2. A general term for energy emitted from a substance and traveling across space in straight lines. (Originally used only for electromagnetic waves, it now

6. Act of giving off electromagnetic energy, particularly by an antenna when excited by a transmitter.

**radiation angle**—The vertical angle at which maximum energy is radiated by an antenna with respect to the earth. Low-angle radiation delivers more energy in the local area. High-angle radiation augments skip transmission and is wasteful of power.

**radiation belt**—See Van Allen radiation belts.

**radiation characteristic**—An identifying feature, such as frequency or pulse width, of a radiated signal.

**radiation counter**—1. A device for counting radiation particles (alpha, beta, gamma, neutrons, etc.) or photons of energy (X-rays, etc.), usually using either scintillation or ionization resulting from the presence of the particle or photon to be measured. 2. An instrument used to recognize and identify incident radiation by the ionizing or stimulating properties of the radiation.

**radiation counter tube**—See counter tube.

**radiation damage**—A loss in certain physical properties of organic substances, such as elastomers, caused principally by ionization of the long-chain molecule. This ionization process (i.e., loss of electrons) is believed to result in redundant cross-linking and possible scission of the molecule. The effect is cumulative.

**radiation detection (fluorescence)**—Radiation detection using fluorescence produced in an efficient screen.

**radiation detector**—Any of the many devices used to detect the presence of radiation from a specific region of the electromagnetic spectrum.

**radiation detector tube**—A tube in which current passes between its electrodes whenever the tube is exposed to penetrating radiation. The amount of this current corresponds to the intensity of radiation.

**radiation dosage**—The total radiation energy absorbed by a substance, usually expressed in ergs per gram. See also rad; roentgen; roentgen equivalent man; roentgen equivalent physical.

**radiation dosimetry**—The detection and measurement of the presence of nuclear and X-ray radiation.

**radiation efficiency**—In an antenna, the ratio of the radiated power to the total power supplied to the antenna at a given frequency.

**radiation field**—The electromagnetic field that breaks away from a transmitting antenna and radiates outward into space as electromagnetic waves.

**radiation filter**—A transparent body that transmits only selected wavelengths.

**radiation flux density (irradiance)**—The total incident radiation energy measured in power per unit area (e.g., milliwatts per square centimeter).

**radiation hard**—The characteristic of a material that is insensitive to nuclear or X-ray radiation.

**radiation-hardened circuit**—Integrated circuit manufactured with special devices and isolation techniques such that when it is exposed to heavy radiation it remains operational. Conventional circuits will short out under such conditions because the radiation generates electrical currents inside the semiconductor material.

**radiation hardening**—1. Manufacturing techniques applied to a device so that its performance is not degraded by radiation.

615 encountered in space. The principle involved in applying this hardening to the device is to change the characteristics of the component by the preapplication of gamma or neutron rays, so as to permanently fix its electrical characteristics. Entering the hostile space environment, the preconditioned or hardened components will no longer be affected by additional gamma and neutron ray exposure.

**radiation hazard**—1. The health hazard caused by exposure to ionizing radiation. 2. The possible harmful effect of powerful electromagnetic radiation on the human body or on electrical components.

**radiation intensity**—In a given direction, the power radiated from an antenna per unit solid angle in that direction.

**radiation lobe**—See lobe.

**radiation loss**—In a transmission system, the portion of the transmission loss due to radiation of the radio frequency power.

**radiation monitor**—A device for determining amount of exposure to radioactivity. May be periodic or continuous, may monitor an area or an individual's breath, clothing, etc.

**radiation pattern**—1. See directional pattern. 2. For a fiber or bundle, a curve of the output radiation intensity plotted against the exit angle. 3. For an optical fiber or fiber bundle, the curve of the output radiation intensity plotted as a function of the angle between the optical axis of the fiber or bundle and a normal to the surface on which the radiation intensity is being measured, i.e., the output radiation versus direction of measurement relative to the optical axis.

**radiation potential**—The voltage required to excite an atom or molecule and cause the emission of one of its characteristic radiation frequencies.

**radiation pyrometer**—Also called a radiation thermometer. 1. A pyrometer that uses the radiant power from the object or source whose temperature is being measured. Within wide- or narrow-wavelength bands filling a definite solid angle, the radiant power impinges on a suitable detector—usually a thermocouple, thermopile, or a bolometer responsive to the heating effect of the radiant power, or a photosensitive device connected to a sensitive electric instrument. 2. A temperature-measuring device that uses an optical system to focus radiant energy from an object onto a detector. The detector converts this energy into an electrical signal that varies with the temperature of the object.

**radiation report**—A formal report of radiation measurements made by an engineer skilled in interference control techniques. Usually required by the FCC prior to certification of industrial heating equipment.

**radiation resistance**—1. The power radiated by an antenna, divided by the square of the effective antenna current referred to a specified point. 2. The resistance that, if inserted in place of the antenna, would consume the

same amount of power radiated by the antenna. 3. The characteristic of a material that enables it to retain useful properties during or after exposure to nuclear radiation.

**radiation sensitivity**—The ratio of photoinduced current to incident radiant energy, the latter measured at the plane of the lens of a photodevice.

**radiation sickness**—An illness resulting from exposure to radiation.

**radiation survey meter**—An instrument that measures instantaneous radiation.

**radiation temperature**—1. The temperature to which an ideal blackbody must be heated so it will have the same emissive power as a given source of thermal radiation. 2. The temperature of a complete radiator that has a total radiant emittance identical with that of an unknown source.

**radiation thermocouple**—A thermocouple that is used in infrared spectroscopy to detect a sample's infrared emittance. See thermocouple.

**radiation thermometer**—See radiation pyrometer.

**radiation transfer index**—Abbreviated RTI. A parameter that describes the transmission performance of optical fiber cables. It measures cable performance and includes both coupling and propagation losses.

**radiation trapping**—That process whereby radiation spontaneously emitted by a volume of optical material is resonantly reabsorbed within the same volume before it escapes. This effect is manifested in a reduction in the observed rate of spontaneous emission from the material relative to the rate for single atoms or ions.

**radiative equilibrium**—The constant-temperature condition that exists in a material when the radiant energies absorbed and emitted are equal.

**radiative recombination**—In an electroluminescent diode in which electrons and holes are injected into the p-type and n-type regions by application of a forward bias, the recombining of injected minority carriers with the majority carriers in such a manner that the energy released on recombination results in the emission of photons of energy  $h\nu$ , which is approximately equal to the bandgap energy. Radiative recombination produces the light in a LED, which can be modulated for signaling purposes using optical fibers for transmission or integrated optical circuits for switching.

**radiator**—1. Any device that emits radiation. See also radiating element. 2. Any of the parts of an antenna that radiate electromagnetic waves, either directly into space or against a reflector.

**radio**—1. Communication by electromagnetic waves transmitted through space. 2. A general term, principally an adjective, applied to the use of electromagnetic waves between 10 kHz and 3000 GHz. 3. Electronic equipment for the wireless transmission or reception, or both, of electromagnetic waves, especially when used to transmit and receive sounds, activate a remote-control mechanism, etc.;



Radio spectrum

| Band number | Frequency range*      | Metric subdivision    | Band designation |
|-------------|-----------------------|-----------------------|------------------|
| 4           | 3–30 kHz              | Myriametric waves     | VLF              |
| 5           | 30–300 kHz            | Kilometric waves      | LF               |
| 6           | 300–3000 kHz          | Hectometric waves     | MF               |
| 7           | 3–30 MHz              | Decametric waves      | HF               |
| 8           | 30–300 MHz            | Metric waves          | VHF              |
| 9           | 300–3000 MHz          | Decimetric waves      | UHF              |
| 10          | 3–30 GHz              | Centimetric waves     | SHF              |
| 11          | 30–300 GHz            | Millimetric waves     | EHF              |
| 12          | 300–3000 GHz or 3 THz | Decimillimetric waves | —                |

\*Lower limit is exclusive, upper limit inclusive.

**radiosonde recorder**—An instrument that is located at the surface observing station and is used to record the data presented by a radiosonde aloft. The mechanism of the recorder depends upon the type of radiosonde system used.

**radiosonde transmitter**—The component of the radiosonde that includes the modulating blocking oscillator and the radio-frequency carrier oscillator.

**radiosonobuoy**—See sonobuoy.

**radio spectrum**—The range of frequencies of electromagnetic radiation usable for radiocommunication. The radio spectrum may range from 3 kHz to over 300 GHz. Corresponding wavelengths are 100 km to 1 mm.

**radio station**—An assemblage of equipment for radio transmission, reception, or both.

**radio-station interference**—Interference caused by reception of radio waves from other than the desired station.

**Radio Technical Commission for Aeronautics**—A cooperative, nonprofit association of all telecommunications agencies of the U.S. government and industry. Its purpose is to advance the art and science of aeronautics through investigation of all available or potential applications of the telecommunications art, coordination of these applications with allied arts, and the adaptation of them to recognized operational requirements.

**radiotelegraph transmitter**—A radio transmitter capable of handling code signals.

**radiotelegraphy**—Radiocommunication by means of the International Morse code or some other, similarly coded, signal.

**radiotelephone**—Also called radiophone. The complete radio transmitter, receiver, and associated equipment required at one station for radiotelephony.

**radiotelephone distress signal**—The spoken word MAYDAY (phonetic spelling of the French expression *m'aidez*, or "help me"). It corresponds to SOS in radiotelegraphy and is used by aircraft, ships, etc., needing help.

**radiotelephone transmitter**—A radio transmitter capable of handling audio-frequency modulation (e.g., voice and music).

**radiotelephony**—

within the radio-frequency range of the spectrum in amounts sufficient to be measured.

**radioteletype**—See RTTY.

**radiotherapy**—The treatment of disease with radiation, especially ultraviolet, infrared, X-rays, and gamma rays.

**radiothermics**—The application of heat generated by radio waves (e.g., in diathermy or electronic heating).

**radio transmission**—Transmission of signals by electromagnetic waves other than light or heat waves.

**radio transmitter**—A device capable of producing radio-frequency power and used for radio transmission.

**radiotransparent**—Permitting the passage of X-rays or similar radiation.

**radio tube**—A general term for any type of electron tube used in electronic equipment.

**radiovision**—An early name for television.

**radio warning**—See radio detection.

**radio watch**—Also called watch. The vigil maintained by an operator when on duty in the radio room of a vessel and listening for signals—especially on the international distress frequencies.

**radio wave**—1. Electromagnetic wave at a frequency lower than 3000 GHz and propagated through space without an artificial guide. 2. Combination of electric and magnetic fields varying at a radio-frequency rate and capable of travelling through space at the speed of light. It is produced by feeding the output of a radio transmitter into a transmitting antenna.

**radio wavefront distortion**—A change in the direction of advance of a radio wave.

**radio-wave propagation**—The transfer of energy by electromagnetic radiation at frequencies below approximately  $3 \times 10^{12}$  hertz.

**radist**—The radionavigation system in which the position of a vehicle is determined by comparing the arrival times of transmitted pulses at three or more ground stations.

**radix**—Also called the base. 1. The total number of distinct marks or symbols used in a numbering system. For example, since the decimal numbering system uses ten symbols (0, 1, 2, 3, 4, 5, 6, 7, 8, 9), the radix is 10. In the binary numbering system, the radix is 2.

**radix complement**—Also called true complement. A number obtained by subtracting each digit of the given number from one less than the radix, then adding to the least significant digit, executing all required carries. Examples are the tens complement in decimal notation and the two's complement in binary notation.

**radix-minus-one complement**—Also called diminished-radix complement. A number obtained by subtracting each digit of the given number from one less than the radix. Examples are the nines complement in decimal notation and the ones complement in binary notation.

**radix notation**—A positional representation in which any two adjacent digit positions have significances in an integral ratio called the radix of the least significant of the two positions; the digit in any position may have a value from zero to one less than the radix of that position.

**radix point**—Also called base point, and binary point, decimal point, etc., depending on the numbering system. The index that separates the integral and fractional digits of the numbering system in which the quantity is represented.

**radome**—Also called radar dome. The housing that protects a radar antenna from the elements, but does not block radio frequencies.

**radux**—A long-distance, low-frequency navigational system that provides hyperbolic lines of position. It is of the continuous-wave, phase-comparison type.

**railing**—Radar pulse jamming at high recurrence rates (50 to 150 kHz). On a radar indicator, it results in an image resembling fence railing.

**railings**—The pattern produced on an A-scope by continuous waves modulated with a high-frequency signal. It appears as a series of vertical lines resembling target echoes along the baseline.

**rain-barrel effect**—The characteristic sound noted on an equalized line that is overcompensated.

**rainbow**—The technique that applies pulse-to-pulse frequency changing to identify and discriminate against decoys and chaff.

**rainbow generator**—A signal generator with which the entire color spectrum can be produced on the screen of a color television receiver. The colors merge together as in a rainbow. See also keyed rainbow generator.

**rake angle**—The angle that a stylus makes with a phonograph record when viewed from the side.

**RAM**—Abbreviation for random-access memory.

**ram**—The moving part of the head of a crimping tool.

**remark**—Also called a radar marker. A fixed radar transmitter that emits a continuous signal that is used as a bearing indication on a radar display.

**ramp**—A voltage or current that varies at a constant rate; for example, that portion of the output waveform of a time/linear sweep generator used as a time base for scope display.

**ramping**—Control method used to vary the pulse rate from one value to another, to produce either acceleration or deceleration of a stepper motor.

**ramp input**—A change, in an input signal, that varies at a constant rate.

**Ramsauer effect**—The absorption of slow-moving electrons by intervening matter.

by its address. 4. The ability to gain access to any location of a memory unit in a time that is independent of the location itself. 5. A term used to describe computer files that do not have to be searched sequentially to find a particular record but can be addressed directly. 6. The ability of a computer to directly access random bits of memory without going through a predefined sequence of locations.

**random-access device**—Also called direct-access device. A data-storage device in which the access time is effectively independent of the location of the stored data.

**random-access memory**—Abbreviated RAM.

1. A storage arrangement from which information can be retrieved with a speed that is independent of the location of the information in the storage. For example, a core memory is a random-access memory, but a magnetic tape memory is not. 2. A device that permits individual interrogation of any memory cell in a completely random sequence. Any point in the total memory system can be accessed without looking at any other bit. 3. A memory that may be written to, or read from, any address location in any order. May refer specifically to the integrated circuit method of implementation. 4. A read/write memory, usually a permanent memory, that stores information in such a way that each bit of information may be retrieved within the same amount of time as any other bit. As opposed to serial memory. 5. A type of memory that offers access to storage location within it by means of X and Y coordinates. 6. The main memory of a computer. Instructions can be written into and read out of RAM, and its contents can be changed at any time. But its contents are wiped clean when power is shut off. See ROM. 7. A type of memory that is used to store and retrieve digital data that is constantly being changed, updated, or modified in some way. 8. A memory in which the central processor can access all locations with equal facility. Sometimes called read/write memory because data can be added to or removed from such memory as an ordinary procedure. RAM is used for both storage of a computer operation program and for data. 9. A memory that permits access to any of its address locations in any desired sequence with similar access time to each location. The term has come to mean only a read/write memory, not a ROM or EPROM, which, strictly speaking, are also random-access memories.

**random-access programming**—Programming a problem for a computer without regard to the access time to the information in the registers called for in the program.

**random-access storage**—A form of storage in which information can be recovered immediately, regardless of where it was stored. For example, magnetic-core memory devices will usually yield any bit of information with almost no time penalty regardless of where it is located, while magnetic tape must be run until the required information can be found.

**random bundle**—A fiber-optics bundle that scrambles an image but can convey light from a source to a relatively inaccessible point, and then again from that location to a photocell.

**random error**—The inherent imprecision of a given process of measurement; the unpredictable component of repeated independent measurements on the same object

**transaction processing**—A processing method in which transactions are executed immediately after they are received by the computer. The largest single application for fault-tolerant computers, which involves repetitive, typically financial, tasks in banking, stock trading, and the like.

**transadmittance**—From one electrode to another, the alternating components of the current of the second electrode divided by the alternating component of the voltage of the first electrode, all other electrode voltages being maintained constant. As most precisely used, the term refers to infinitesimal amplitudes.

**transceiver**—The combination of radio transmitting and receiving equipment in a common housing, usually for portable or mobile use and employing some common circuit components for both transmitting and receiving.

**transceiving data link**—Integrated data processing by means of punched cards, using transceivers as terminal equipment. The transmission path can be wire or radio.

**transconductance**—Symbolized  $g_m$ . Also called mutual conductance. An electron-tube rating equal to the change in anode current divided by the change in grid voltage causing the anode-current change. The unit of transconductance is the siemens; a more commonly used unit is the microsiemens ( $10^{-6}$  siemens).

**transconductance amplifier**—An amplifier that supplies an output current proportional to its input voltage. From its output terminals the amplifier appears to be a current source with a high output impedance  $Z_o$ . Its input impedance  $Z_{in} \gg Z_g$ , and the output impedance  $Z_o \gg Z_L$ , where  $Z_g$  and  $Z_L$  are the source and load impedances.

**transconductance meter**—Also called a mutual-conductance meter. An instrument for indicating the transconductance of a grid-controlled electron tube.

**transconductance tube tester**—Also called a mutual-conductance or dynamic mutual-conductance tube tester. A tube tester with circuits set up in such a manner that the test is made by applying an ac signal of known voltage to the control grid, and the tube amplification factor or mutual conductance is measured under dynamic operating conditions.

**transconductor**—An active or passive network whose short-circuit output current is a specific, accurately known, linear or nonlinear function of the input voltage, thereby establishing a predetermined relationship between input voltage and output current.

**transcribe**—1. To copy, with or without translating, from one external storage medium of a computer to another. 2. To copy from a computer into a storage medium or vice versa.

**transcriber**—Equipment associated with a computing machine for the purpose of transferring input or output data from a record of information in a given language to the medium and language used by a digital computing machine, or from a computing machine to a record of information.

**transcription**—1. An electrical recording (e.g., a high-fidelity, 33 1/3-rpm record) containing part or all of a (radio) program. It may be either an instantaneous recording disc or a pressing. 2. A phonograph record, especially the 33 1/3-rpm 16-inch (40.6-cm) record, used to record broadcast programs.

2. A device, component, machine, system, or combination of these that converts energy from one form to another. The energy may be in any form, such as electrical, mechanical, acoustical, etc. The term transducer is often restricted to a device in which the magnitude of an applied stimulus is converted into an electrical signal proportional to the quantity of the stimulus. 3. A device used to convert physical parameters, such as temperature, pressure, or weight, into electrical signals. 4. A device that converts information from one physical form to another. Examples include the phono cartridge (mechanical to electrical), speaker (electrical to acoustical), and microphone (acoustical to electrical). 5. A force-measuring device. It has the characteristics of providing an output, usually electrical, that serves as the measurement of load, force, compression, pressure, etc., when placed along the sensitive axis of the force cell. 6. An electromechanical device for translating a physical quantity such as pressure, temperature, displacement, acceleration, etc., into a proportional electrical quantity, such as voltage or current. 7. A device that converts something measurable into another form; often, a physical property such as temperature or flow into an electrical signal. Frequently used interchangeably with *sensor*.

**transducer-coupling system efficiency**—The power output at the point of application, divided by the electrical power input into the transducer.

**transducer efficiency**—Ratio of the power output to the electrical power input at the rated power.

**transducer equivalent noise pressure (of an electroacoustic transducer or system used for sound reception)**—Also called equivalent noise pressure. For a sinusoidal plane-progressive wave, the rms sound pressure that, if propagated parallel to the principal axis of the transducer, would produce an open-circuit signal voltage equal to the rms of the inherent open-circuit noise voltage of the transducer in a transmission band having a bandwidth of 1 hertz and centered on the frequency of the plane sound wave.

**transducer gain**—Ratio of the power that the transducer delivers to the load under specified operating conditions to the available power of the source.

**transducer insertion loss**—See insertion loss.

**transducer loss**—Ratio of the available power of the source to the power that the transducer delivers to the load under specified operating conditions.

**transducer pulse delay**—The interval of time between a specified point on the input pulse and on its related output pulse.

**transfer**—1. To transmit, or copy, information from one device to another. 2. To jump. 3. The act of transferring. 4. In electrostatography, the act of moving a developed image, or a portion thereof, from one surface to another without altering its geometrical configuration (e.g., by electrostatic forces or by contact with an adhesive-coated surface). 5. In a computer, to terminate one sequence of instructions and start another.

**transfer accuracy**—The input-to-output error as a percentage of the input. Transfer accuracy depends on the source impedance, switch resistance, load impedance if the multiplexer is not buffered, and the signal frequency.

**transfer admittance**—1. The complex ratio of the current at the second pair of terminals of an electrical transducer to the electromotive force applied between the

792

multiplied by an input magnitude will give a resulting output magnitude. 4. Relation between the illumination on a camera tube and the corresponding output-signal current, under specified conditions of illumination.

**transfer charge**—The net electric charge moved from one terminal of a capacitor to another through an external circuit.

**transfer check**—In a computer, verification of transmitted data by temporarily storing, retransmitting, and comparing. Also a check to see if the transfer or jump instruction was properly performed.

**transfer circuit**—A circuit that connects communication centers of two or more separate networks in order to transfer the traffic between the networks.

**transfer constant**—Also called the image-transfer constant. One-half the natural logarithm of the complex ratio of the voltage times current entering a transducer to that leaving the transducer when it is terminated in its image impedance.

**transfer contact**—See break-make contact.

**transfer control**—See jump.

**transfer current**—The starter-gap current required to cause conduction across the main gap of a glow-discharge cold-cathode tube.

**transfer efficiency**—The percentage of total charge that is transferred in a charge-coupled device from one position to another during readout.

**transfer factor**—Number relating the input and output currents of a transducer. See propagation constant, 2.

**transfer function**—1. A characterization of a system (for example, mechanical structure of filter) by determining how the system responds to input energy at different frequencies. It may be measured by one of three methods: (a) applying a single sine wave and measuring the response to that sine wave, then varying the frequency of the sine wave and noting the change in the system's response, (b) applying specially shaped random noise (many frequencies simultaneously) and observing the system response, or (c) applying an impulse (also containing a broad range of frequencies). The transfer function can be derived by dividing the cross-spectral density by the power spectral density of the input or driven signal. 2. A mathematical expression that describes the relationship between the values of a set of conditions at two different times, typically at the beginning and end of a process. 3. The mathematical expression that relates the output and input of any characteristics of a filter as a function of frequency. The function usually is complex and therefore usually contains components corresponding to both attenuation and phase. 4. The mathematical expression of the relationship between a simple scale factor, representing the effects of any linear transmitting or recording medium when a waveform is evaluated as frequency components, and the frequency.

**transfer-function analyzer**—An instrument that measures the amplitude and phase response of the output of a circuit relative to the input over a range of frequencies.

**transfer impedance**—Ratio of the potential difference applied at one pair of terminals of a network to the resultant current at another pair of terminals (all terminals

to another. Transfer is sometimes taken to refer specifically to movement between different media; storage to movement within the same medium. 2. In a computer, transferring information from an accumulator to memory, or from memory to an accumulator; pushing into or popping out of the stack; or moving information to the program counter, stack pointer, etc.

**transfer rate**—The rate at which a transfer of data between the computer registers and storage, input, or output devices may be performed. It is usually expressed as a number of characters per second.

**transfer ratio**—From one point to another in a transducer at a specified frequency, the complex ratio of the generalized force or velocity at the second point to that applied at the first point.

**transferred charge**—The net electric charge moved from one terminal of a capacitor to another through an external circuit.

**transferred charge characteristic**—The mathematical function that relates transferred charge to capacitor voltage.

**transfer switch**—A form of air switch arranged so that a conductor connection can be transferred from one circuit to another without interrupting the current.

**transfer time**—1. The time required for a transfer to be made in a digital computer. 2. In a relay, the total time—after contact bounce has ceased—between the breaking of one set of contacts and the making of another.

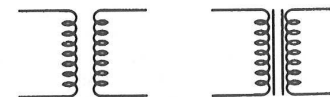
**Transfluxor**—A trade name (RCA) for a binary magnetic core having two or more openings. Control of the transfer of magnetic flux between the three or more legs of the magnetic circuits provides ways to store information, gate electrical signals, etc.

**transform**—1. To convert a current or voltage from one magnitude to another, or from one type to another. 2. In digital-computer programming, to change information in structure or composition without significantly altering the meaning or value. 3. To pass through a transformer. 4. To change data or equations from rectangular to polar coordinates, or vice versa.

**transformation point**—The temperature at which an alloy or metal changes from one crystal state to another as it heats or cools.

**transformation ratio**—The ratio between electrical output and input under certain specified conditions.

**transformer**—1. An electrical device that, by electromagnetic induction, transforms electric energy from one or more circuits to one or more other circuits at the same frequency, but usually at a different voltage and current value. 2. An electrical device that changes voltage in direct proportion to the ratio of the number of turns of its primary and secondary windings.



Air core.

Iron core.