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ELECTRONICS ENGINEERING
DICTIONARY**

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WILEY ELECTRICAL AND ELECTRONICS ENGINEERING DICTIONARY

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Lexicographer



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PREFACE AND NOTES ON THE USE OF THIS DICTIONARY

This dictionary has over 35,000 entries, each of which occupies a place in one or more of the many areas of expertise encompassed by electrical and electronics engineering. All available sources were consulted, seeking to ascertain the exact manners in which each term is currently utilized. Textbooks, handbooks, treatises, instruction manuals, theses, articles, reports, Usenet postings, and so on, were researched during the process of selecting the terms and writing their definitions, with a good number of entries having multiple provided connotations.

The Internet was used extensively throughout this project, and if one or more persons or entities used a given technical term in the areas covered by this dictionary, there is a decent chance it was taken into consideration. If any given words or phrases were used frequently by multiple people, in varied settings, and when referring to serious endeavors, there is a pretty good chance it can be found in this dictionary. Even so, some terms that continue to appear may not be found here. If a user feels that a given word or phrase not found in this dictionary should be added to a future edition, or wishes to otherwise comment on this book, an email may be sent to the author at: wileyiee@yahoo.com.

There are no special rules for the use of this dictionary. The user simply looks up the desired term to find its definition, plus other practical information when appropriate. When a word or phrase is the same as another, this is clearly stated so as to easily find the definition.

This dictionary could not have been prepared without the contributions of George J. Telecki, Associate Publisher at John Wiley & Sons. He had the idea for this dictionary, suggested the approach and format, and throughout the project provided inestimable support and guidance.

This dictionary has been prepared within the exquisite nature settings of Northwestern Austria. Mr. Wolfgang Gießler is the person who determined that I should be allowed to perform my work as an author in this wonderful country. I am tremendously grateful to him for kindly providing me with the opportunity to live here.

Steven M. Kaplan

*Austria, Europe
October, 2003*

accessibility 1. The degree to which computer hardware and software caters to the particular needs of users with reduced sensory function or mobility. 2. The ease with which a component or device can be reached.

accessibility aids Tools and features, such as head-mounted devices, sticky keys, mouse trails, and text-to-speech conversion, which enhance **accessibility** (1).

accessory 1. A device which is not essential for the proper operation of another, but that adds functionality to it. 2. A device that adds functionality to a computer. Usually synonymous with **peripheral** (1).

accessory board Same as **adapter card**.

accessory card Same as **adapter card**.

aCcm Abbreviation of **abcoumb centimeter**.

accompanying audio Also called **accompanying sound**.

1. The sound channels that accompany the image seen on a TV. 2. Specialized audio channels that are available from certain sources such as a DVD. An example of this specialized audio is surround sound.

accompanying sound Same as **accompanying audio**.

accumulation In semiconductors, the buildup of charge carriers.

accumulator 1. In a computer, a register that stores partial or complete results of arithmetic and/or logical operations. 2. Same as **accumulator battery**.

accumulator battery A battery composed of rechargeable cells. Examples include lithium polymer batteries, and gel-cell batteries. Also called **accumulator** (2), **rechargeable battery**, **storage battery**, or **secondary battery**.

accuracy The extent to which a measured or calculated value approximates the real value. May be expressed as a percentage, as in accurate within 2%.

accuracy rating The maximum error of an instrument when operated under specified conditions. Usually expressed as a percentage of the full-scale value.

ACD Abbreviation of **automatic call distributor**, or **automated call distributor**.

acetate film A non-deforming film which is durable, transparent, hygienic, air-proof, dust-proof, and oil-proof. It is made from cellulose acetate, and is used in the preparation of magnetic tapes and photographic films, among others. Also called **cellulose acetate film**.

acetate tape Recording tape that has a magnetic oxide layer over an **acetate film**. Also called **cellulose acetate tape**.

Achilles' heel In computer and communications security, an area of vulnerability which represents the weakest link within the protective safeguards taken.

achromatic 1. Without color. 2. Transmitting white light without breaking it up into its constituent colored rays.

achromatic color A color that possesses brightness, but not hue. These include white, black, and shades of gray.

achromatic locus Within a chromaticity diagram, a region that includes all points necessary for use as a reference standard of illumination. Also called **achromatic region**.

achromatic region Same as **achromatic locus**.

acicular In the shape of a needle. In magnetic storage, the shape of the magnetizable particles on the surface of the tape or disk are usually acicular.

acid A chemical which has any of the following characteristics: increases the proportion of hydrogen ions in a solution, gives up a proton in solution, has at least one hydrogen that can be replaced by metals or basic radicals, that can react with a base to form a salt, or that accepts two electrons. According to the pH scale, an acid has a reading of less than 7.0, while a **base** (6) has a value above 7.0. The lower the reading, the stronger the acid.

acidity The degree to which a solution or chemical is an **acid**.

ACK Abbreviation of **acknowledge**, or **acknowledgement**.

acknowledge Same as **acknowledgement**. Its abbreviation is **ACK**.

acknowledge character Same as **acknowledgement**.

acknowledgement In communications, a message indicating readiness to receive a transmission, or that a transmission has been received successfully. This message is sent from the receiving unit or station to the sending unit or station as a means of verification. Its abbreviation is **ACK**. Also called **acknowledgement code**, **acknowledge**, or **acknowledge character**.

acknowledgement code Same as **acknowledgement**.

ACL Abbreviation of **access-control list**.

aclinic line A great line along the surface of the earth that connects all points at which the magnetic dip is 0°. This contrasts with the **geomagnetic equator**, which is a great circle which at each point is 90° from the geomagnetic poles. Also called **magnetic equator**, or **dip equator**.

ACN Abbreviation of **Automatic Crash Notification**.

acoustic Pertaining to the detection, production, transmission, reception, control, processing, and study of sound, in addition to all phenomena arising from the effects of sound. This contrasts with **acoustical**, which is all that is related to sound, but not having its physical properties or characteristics. Thus, terms with acoustical should pertain to units, measurement, materials, and devices. Nonetheless, even in technical usage acoustic and acoustical are mostly used synonymously.

acoustic absorber A material, surface, or medium which absorbs a proportion of the acoustic (sound) energy that strikes it. Also called **sound absorber**.

acoustic absorption Sound energy which is retained or dissipated by a medium which has had acoustic (sound) waves pass through or strike it. Also called **sound absorption**.

acoustic absorption coefficient The proportion of the incident acoustic (sound) energy which is absorbed by a surface or medium. Also called **acoustic absorption factor**, **acoustic absorptivity**, or **sound absorption coefficient**.

acoustic absorption factor Same as **acoustic absorption coefficient**.

acoustic absorption loss The loss of acoustic (sound) energy due to its retention or dissipation by a medium or surface. This loss in incident acoustic energy may be due, for example, to conversion into heat. Also called **sound absorption loss**.

acoustic absorptivity Same as **acoustic absorption coefficient**.

acoustic amplifier Same as **audio amplifier**.

acoustic capacitance Same as **acoustic compliance**.

acoustic chamber A room or other enclosure, such as an anechoic chamber, utilized to perform sound tests, measurements, and experiments. Also called **sound chamber**.

acoustic compliance The measure of the volume displacement of an acoustic medium when subjected to acoustic (sound) waves. It is the reciprocal of **acoustic stiffness**. Also known as **acoustic capacitance**.

acoustic coupler An apparatus utilized to connect a modem to a telephone line via an ordinary telephone handset. The handset is cradled in the device in a manner that a speaker and microphone are used to exchange the electrical signals between the computer and the remote site. Rarely used nowadays, as most modems connect directly to the phone line, thus avoiding many of the drawbacks, such as signal degradation.

acoustic coupling Communication using an **acoustic coupler**.

acoustic damping The reduction of the magnitude of vibration or resonance of a surface or material, in order to reduce

drive circuit A circuit which provides **drive** (1), especially to a motor.

drive control 1. A device which controls **drive** (1). 2. In a TV receiver, a potentiometer which adjusts the output of the horizontal oscillator. Also called **horizontal drive control**.

drive current A current which causes the function of a component, circuit, device, piece of equipment, system, process, or mechanism.

drive signal Same as **drive** (1).

drive tray A tray upon which a storage medium, such as an optical disc, is laid for insertion into its drive.

drive voltage A voltage which causes the function of a component, circuit, device, piece of equipment, system, process, or mechanism.

driven antenna An antenna which receives energy directly from the transmission line. This contrasts with a **parasitic antenna**, which is driven indirectly, that is, through radiation from a driven antenna. Also called **primary radiator**.

driven array An antenna incorporating multiple driven elements, all fed by a common source.

driven element An antenna element which is driven directly by the transmission line. This contrasts with a **parasitic element**, which is driven indirectly, that is, through radiation from a driven element. Also called **active element** (3).

driver 1. A circuit or device which provides and/or controls **drive** (1). 2. Same as **device driver**. 3. In an amplifier, the stage that precedes the output stage. Also called **driver stage**. 4. A transducer which converts electrical energy into sound energy, which is then radiated outward to the surrounding medium. Also called **speaker**, or **loudspeaker**. 5. Within a speaker system, a specialized speaker unit, such as a woofer or tweeter.

driver element Within an antenna incorporating multiple elements, a **driven element**.

driver stage Same as **driver** (3).

driver transformer A transformer which provides **drive** (1). Utilized, for instance, between stages of an amplifier.

driving-point admittance The reciprocal of **driving-point impedance**.

driving-point impedance The complex ratio, measured at the input terminals of a network or transducer, of the applied alternating voltage, to the resulting AC between said terminals.

driving signal 1. Same as **drive** (1). 2. In a TV transmitting system, a timing signal utilized to synchronize the horizontal or vertical scanning of an image.

DRO 1. Abbreviation of **dielectric resonator oscillator**. 2. Abbreviation of **digital readout**. 3. Abbreviation of **destructive readout**.

drone cone A cone speaker which is not driven. It vibrates in response to a driven speaker in the same enclosure. Utilized to reinforce bass frequencies. Also called **passive radiator**.

droop In a pulse train, a decrease in mean pulse amplitude, after maximum amplitude has been attained. Usually expressed as a percentage of maximum amplitude. Also called **pulse droop** (2).

drop 1. Same as **drop-out** (1). 2. Same as **drop cable**. 3. The voltage difference between any two points of a circuit or conductor, due to the flow of current. Also called **voltage drop** (1), or **potential drop** (2). 4. The voltage difference between the terminals of a circuit element, due to the flow of current. Also called **voltage drop** (2), or **potential drop** (3).

drop bar A safety device which grounds a high-voltage capacitor upon opening the door of a protective enclosure.

drop cable An aboveground or underground line which connects a terminal of a distribution cable to a subscriber's

premises. Such a line may carry telephone service, cable TV, a link to a network, electric power, and so on. It may consist, for example, of a telephone wire extending from a pole to the home of a subscriber. Also called **drop** (2), **drop wire**, or **service wire**.

drop-down menu In a GUI, a menu which is always available in the active window, but whose contents are revealed only when a user selects said menu with a mouse or keyboard command. Once selected, the menu choices are presented in a vertical array below the menu title. Also spelled **drop-down menu**. Also called **pull-down menu**, or **pop-down menu**.

drop-in The erroneous gaining of bits during a read/write operation.

drop-out Same as **dropout**.

drop repeater In a multichannel communications system, a repeater which incorporates the necessary equipment for the local termination of multiple channels.

drop wire Same as **drop cable**.

dropdown menu Same as **drop-down menu**.

dropout Also spelled **drop-out**. 1. To lose or delete part of a transmitted signal, whether this occurs intentionally or not. Also called **drop** (1). 2. The erroneous loss of bits during a read/write operation. 3. A deterioration or loss of signal when a magnetic tape is dirty or has lost sections of its magnetic coating. In a video tape, for instance, this is manifested as streaks appearing on the screen during playback.

dropout current The maximum current at which a device, such as a relay or circuit-breaker, will release to its deenergized position. Also called **release current**.

dropout value The maximum actuating quantity, such as a current or voltage, at which a device, such as a relay or circuit-breaker, will release to its deenergized position. Also called **release value**.

dropout voltage The maximum voltage at which a device, such as a relay or circuit-breaker, will release to its deenergized position. Also called **release voltage**.

dropping resistor A resistor used in series with a load, which reduces the voltage applied to said load. The voltage reduction is equal to the voltage drop across the terminals of the resistor. Also called **series dropping resistor**.

dross Contaminants, usually oxides, which form on the surface of molten metals or alloys, especially solders.

drum 1. Something whose shape resembles that of a drum. 2. An early type of data-storage device, which consisted of a cylinder coated with a magnetic material, and whose tracks each had their own read/write head. Also called **drum storage**, or **magnetic drum**. 3. A rotating drum used in electrostatic printing, such as that employed by a laser printer to retain a charge.

drum recorder A recorder whose reproduced information is printed on a sheet which is wrapped around a rotating drum. Used, for instance, in some fax devices.

drum scanner A scanner in which the original to be scanned is mounted within a drum which is spun very rapidly during scanning, and which incorporates devices such as microscope lenses and photomultiplier tubes. The resolution attained when utilizing drum scanners is particularly high.

drum storage Same as **drum** (2).

drum switch A switch whose contacts, pins, surfaces, or the like, are placed on the periphery of a revolving drum. Used, for instance, as a motor controller.

drum winding 1. A winding in which the coils are on the outside of a cylindrical surface. 2. A winding in which the coils are on the inside of a cylindrical surface.

dry battery A battery composed of **dry cells**.

dry cell 1. A primary cell in which the positive electrode is carbon, the negative electrode is zinc, and the electrolyte is

wire. 2. For a conducting wire moving through a magnetic field, a rule stating that if the middle finger, index finger, and thumb of a left hand are extended at right angles to each other, that the middle finger will indicate the current flow, the index finger the direction of the magnetic field, and the thumb will indicate the direction of the movement of the wire. This rule also applies if the conducting wire is substituted by an electron beam.

hand set Same as **handset**.

hand shake Same as **handshake**.

hand shaking Same as **handshaking**.

hand wiring The wiring of a circuit by hand, as opposed, for instance, to that accomplished via a printed circuit.

handheld computer A computer which is small enough to hold in a hand or place in a pocket. Such computers generally have a specialized operating system, and provide an interface to communicate with other computers, such as desktop systems. There are many types, including models which are industry-specific, such as those utilized by transport companies to keep track of shipments, those that provide only email functions, or PDAs. Also spelled **hand-held computer**. Also called **palmtop**, or **pocket computer**.

handheld device A device, such as a PDA or handheld PC, which is small enough to hold in a hand or place in a pocket.

Handheld Device Markup Language Same as **HDML**.

handheld PC A **handheld computer** whose functionality more closely approximates that of larger computer, such as a notebook or a desktop system. It is an abbreviation of **handheld personal computer**. Also spelled **hand-held PC**. Its own abbreviation is **HPC**.

handheld personal computer Same as **handheld PC**. Its abbreviation is **HPC**.

handheld scanner An optical scanner which is guided, by hand, across the surface that is being scanned. This contrasts, for instance, with a **flatbed scanner**, which provides a flat surface for scanning. Also spelled **hand-held scanner**.

handle 1. In computers, one of several small squares surrounding a graphic, and which serves to size it. 2. A temporary designation which identifies a given memory block, file, object, or the like.

handler A programming routine which conducts a specific task, such as error handling.

handoff Same as **hand-off**.

hands-free A device, especially that utilized for voice communications, which can be operated with little or no use of the hands. An example is a hands-free phone.

hands-free computer A computer whose components are all worn by a user. For example, a head-mounted device which incorporates a head-mounted display, a microphone and earphones for the input and output of data, and all other needed components such as the CPU, RAM, and disk drive. A wearable computer is well-suited, for instance, for the real-time analysis of data by scientists working under field conditions, rural doctors, people conducting business on the go, or to assist those with special needs, such as individuals with reduced vision or motor function. Also called **wearable computer**.

hands-free computing The use of **hands-free computers**.

hands-free phone A phone, such as a speakerphone, which can be operated with little or no use of the hands. Also called **hands-free telephone**.

hands-free telephone Same as **hands-free phone**.

handset A part of a telephone incorporating a microphone and an earphone, and which is designed to be held by the hand while talking and listening. A handset frequently has a dial for placing calls. Also spelled **hand set**. Also called **telephone handset**.

handset cord The cord running from the base of a telephone to the handset.

handshake The coordination signals exchanged in **handshaking**. Also spelled **hand shake**. Also called **hardware handshake**.

handshaking The exchange of signals between communications devices, such as modems, so as to establish contact, agree on a communications protocol, and establish and maintain synchronization while sending and receiving. Also spelled **hand shaking**.

handwriting recognition The technology utilized, or the ability for a computer to recognize hand written characters, words, symbols, signatures, and the like. It may accept direct input, as is the case with PDAs, or that which is scanned after being written on paper or another suitable medium. Also, specific instances of the use of this technology.

hang To have a **hangup**.

hang-up Same as **hangup**.

hangover 1. An unwanted prolongation in the vibration in a low-frequency speaker after the driving signal has stopped. May be due, for instance, to insufficient damping. Also called **ringing** (3). 2. An unwanted prolongation in the decay of a signal. In fax, for example, this may manifest itself as a tail that forms on the lines in the recorded copy. Also called **tailing**.

hangup Also spelled **hang-up**. Also called **unexpected halt**.

1. A unexpected stoppage in the operation of a computer program or system. It may be due to most any cause, such as a crash, an error condition, or the awaiting of an input that does not arrive. 2. An unexpected halt or delay in the operation of a device, piece of equipment, or system.

haptic Pertaining to, or based on the sense of touch. Also called **tactile**.

haptic device A device, such as a mouse or a data glove, which utilizes the sense of touch to provide input.

haptic interface An interface, such as a keyboard, mouse, or light pen, which communicates information through touching and some sort of feedback. For instance, a mouse is moved laterally, and this movement is seen by the user on the display, or a keyboard key is pressed and there is an opposing force felt. Haptic interfaces are also employed in robotics and in virtual reality applications.

hard 1. Resistant to scratching, denting, bending, penetration, stretching, and/or wear. 2. Having high energy, such as gamma rays or X-rays. 3. Having the characteristic of readily penetrating matter. Said of radiation, such as that of gamma rays or X-rays. 4. That which has a permanent or fixed character to it, such as a hard drive or a hard error.

hard boot The starting of a computer by turning on its power. Many program failures are resolved through turning off a computer then turning it back on again. Also called **cold boot**, or **startup** (2).

hard card An expansion card, incorporating a hard disk drive and its controller, which is plugged into an expansion slot.

hard-coded Hardware or software tasks or features which are incorporated in a manner which cannot be changed. Hard-coded operations are faster, but less flexible, than those that are not hard-coded.

hard copy A printed, or otherwise permanent output of a device such as a printer, or that which incorporates a printing function, such as a fax or oscillograph. When used in the context of computers, this contrasts with **soft copy**, which is data displayed on a screen, or stored. Also spelled **hardcopy**. Also called **printout**.

hard disk A magnetic storage medium used in computers, which consists of one or more rigid platters which rotate at very high speeds. Each of these platters, which are usually made of aluminum, is coated with a material which enables

impedance state. Used, for instance, as a harmonic generator. Its abbreviation is **SRD**.

step relay Same as **stepping relay**.

step switch Same as **stepping switch**.

step-through execution Same as **single-step operation**.

step-through operation Same as **single-step operation**.

step-up 1. To increase in precise steps. Also, pertaining to that which increases in precise steps. 2. To increase a voltage. Also, pertaining to that which increases a voltage, such as a step-up transformer.

step-up ratio For transformer, a turns ratio of less than one. A step-up transformer has such a ratio.

step-up transformer A transformer whose output voltage is higher than its input voltage. A secondary winding of such a transformer has more turns than the primary. Such a transformer may have multiple secondary windings. Used, for instance, to increase the voltage of electricity as it leaves the power generating station and enters the transmission system. The output voltage of a **step-down transformer** is lower than its input voltage. Also spelled **stepup transformer**.

stepdown transformer Same as **step-down transformer**.

stepped leader In lightning, an initial streamer which sets the path for subsequent streamers.

stepper motor A motor whose rotation occurs in discrete steps, as opposed to a continuous motion. Used, for instance, to move an access arm in a disk drive. Also called **stepping motor**.

stepper relay Same as **stepping relay**.

stepper switch Same as **stepping switch**.

stepping motor Same as **stepper motor**.

stepping relay A relay which turns around an axis when opening or closing contacts. Also called **stepper relay**, **step relay**, or **rotary relay**.

stepping switch A switch that turns around an axis when opening or closing contacts. Such a switch is usually adjusted by a knob, and may have detents to hold in a given position. Used, for instance, to select from multiple settings. Also called **stepper switch**, **step switch**, or **rotary switch**.

stepup transformer Same as **step-up transformer**.

steradian A unit of measure of solid angles. There are 4 π steradians in a sphere, thus one steradian equals about 0.079577 sphere. Its symbol is **sr**.

stereo 1. Abbreviation of **stereophonic**. 1. Abbreviation of **stereo sound**, or **stereophonic sound**. 3. Abbreviation of **stereo system**, or **stereophonic system**. 4. Abbreviation of **stereoscope**.

stereo AM Also called **AM stereo**. 1. The broadcasting of AM signals with two or more tracks. 2. The transmission and reception of **stereo AM** (1) broadcasts.

stereo amplifier An audio amplifier utilized for delivering **stereo sound**.

stereo audio system Same as **stereo system**.

stereo broadcast A broadcast utilizing two or more channels or tracks, as in stereo FM or stereo TV.

stereo broadcasting Broadcasting utilizing two or more channels or tracks, as in stereo FM or stereo TV.

stereo effect The reproduction of sound in which there is a slight delay between channels, so as to create a listening experience where sounds appear to arrive from two or more locations. In **monaural sound** the audio seems to come from a single point, while **ambisonics** strives to provide a faithful three-dimensional sound image.

stereo FM Also called **FM stereo**. 1. The broadcasting of FM signals with two or more tracks. 2. The transmission and reception of **stereo FM** (1) broadcasts.

stereo receiver An audio receiver utilized for delivering **stereo sound**.

stereo reception The reception of **stereo sound**, as in stereo FM.

stereo recording A recording utilizing two or more channels or tracks. Also called **stereophonic recording**.

stereo separation Same as **separation** (4).

stereo signal A signal having two or more channels or tracks. For example, that of a stereo broadcast. Also called **stereo sound** (3).

stereo sound Its abbreviation is **stereo** (2). Also called **stereophonic sound**. 1. Sound reproduction in which two channels are utilized. Stereo sound, as opposed to monophonic sound, provides a more natural, three-dimensional sound experience. 2. Sound reproduction in which two or more channels are utilized. 3. Same as **stereo signal**.

stereo sound system Same as **stereo system**.

stereo system A sound-reproduction system providing **stereo sound**. Such a system incorporates an amplifier or receiver, two or more speakers, and one or more signal sources such as tuners, DVD players, CD players, TVs, or cable TV or satellite signals. Its abbreviation is **stereo** (3). Also called **stereo sound system**, **stereo audio system**, **stereophonic sound system**, or **stereophonic system**.

stereo television Same as **stereo TV**.

stereo transmission The transmission of **stereo sound**, as in stereo TV.

stereo tuner A tuner that can receive **stereo signals**, such as those of stereo FM or stereo TV.

stereo TV Abbreviation of **stereo television**. 1. A standard for the transmission and reception of TV signals in which two or more audio channels are utilized. 2. A device, such as a TV receiver, which is compatible with **stereo TV** (1).

stereolithography A manufacturing technique or technology in which a photosensitive material, usually a polymer resin, is formed into the desired shape through the use of a laser which cures said material layer by layer. Used, for instance, to create a solid model directly from CAD data in rapid prototyping. Its abbreviation is **SL**.

stereophonic Its abbreviation is **stereo** (1). 1. Pertaining to two or more channels, as in stereo sound. 2. Pertaining to the recording, transmission, and reproduction of sound utilizing two or more channels.

stereophonic recording Same as **stereo recording**.

stereophonic sound Same as **stereo sound**. Its abbreviation is **stereo** (2).

stereophonic sound system Same as **stereo system**.

stereophonic system Same as **stereo system**. Its abbreviation is **stereo** (3).

stereoscope An instrument which is utilized to view two overlapped two-dimensional images, so as to create the impression of depth. Each pair of images, such as photographs, is taken at slightly different angles. Its abbreviation is **stereo** (4).

stereoscopic Pertaining to a **stereoscope**, or to **stereoscopy**.

stereoscopic machine vision In robotics, a method of vision which allows for interpretation of three-dimensional surfaces, by combining the input from each of the two optical sensors. Used, for instance, in obstacle-detection systems in mobile robots. Also called **binocular machine vision**.

stereoscopic television Same as **stereoscopic TV**.

stereoscopic TV Abbreviation of **stereoscopic television**. TV in which two-dimensional images are presented so as to create the impression of depth. One such system uses multiple cameras, with the positions, angles, and the like computed taking into account the manner in which the brain processes