

IEEE Standard Definitions of Power Systems Data Transmission and Related Channel Terminology

Sponsor

**Power Systems Communications Committee of the
IEEE Power Engineering Society**

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Foreword

(This Foreword is not a part of IEEE Std 599-1985, IEEE Standard Definitions of Power Systems Data Transmission and Related Channel Terminology.)

This standard includes definitions of those terms deemed necessary for performing measurements ^{or understanding} (or necessary for understanding such measurements) on channels used for data communications. Terms are included which are applicable to audio interfaces of wire line, leased lines, and multi-channel equipments and baseband interfaces of multichannel equipment.

As power systems have evolved in complexity, the increased need for data communication has led electric utilities to utilize many forms of communications paths to carry this information. This has produced a wide variety of application considerations requiring familiarity with many system parameters not previously of concern to the electric utility. In discussions among various groups several literal meanings for a given term have frequently been used. This standard is a summary of many of these terms defined as they relate to data communications in a power environment.

The definitions are organized in alphabetical order and consist of the following categories of terms:

- (1) Terms related to audio circuits (that is, Balanced Wire Circuit, Phantom Circuit)
- (2) Measurable circuit parameters (that is, Bias Distortion, Envelope Delay)
- (3) Circuit elements (that is, Compandor, Bridge)
- (4) Data processing (that is, Dot Cycle, PCM)
- (5) Terms which may be considered common-use expressions in the data communication and leased network field (that is, dBm, CCITT, Central Office).

ANSI/IEEE Std 100-1984, IEEE Standard Dictionary of Electrical and Electronics Terms and other available technical references have served as sources for this material. This project represents an effort that was initiated in 1971. These definitions have been coordinated with the Power Systems Relaying Committee of the Power Engineering Society, Communications Society, IEC — Technical Committee 1, Standards Coordinating Committee 10, and ANSI C37.2. It is hoped that this standard will assist the power communications engineer to coordinate his/her requirements with communications engineers of other regimes.

Former members and past chairmen who have contributed to the completion of this standard include the following individuals: J. R. Elwood (past chairman), D. L. Hedrick (past chairman), J. Haunsperger, R. J. Karazia and C. R. Luther.

The Methods of Measurements Subcommittee of the Power System Communications Committee has been responsible for the generation and approval of this standard. At the time of its completion and review, the committee was composed of the following personnel:

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IEEE Standard Definitions of Power Systems Data Transmission and Related Channel Terminology

absorption loss. The loss of signal energy in a communication circuit that results from coupling to a neighboring circuit or conductor.

adaptive equalization. A system that has a means of monitoring its own frequency response characteristics and a means of varying its own parameters by closed-loop action to obtain the desired overall frequency response.

adjacent channel. The channel whose frequency is adjacent to that of the reference channel.

adjacent channel interference. Interference, in a reference channel, caused by the operation of an adjacent channel.

admittance. The reciprocal of impedance.

alignment. In communication practice, alignment is the process of adjusting a plurality of components of a system for proper interrelationship. The term is applied especially to

- (1) The adjustment of the tuned circuits of an amplifier for desired frequency response
- (2) The synchronization of components of a system.

alternate route. A secondary communications path used to reach a destination if the primary path is unavailable.

amplifier. An unidirectional device which is capable of delivering an enlargement of the wave form of the electric current, voltage, or power supplied to it.

amplitude distortion (nonlinear distortion). Distortion caused by a deviation from a desired linear relationship between specified measures of the output and input of a system.

NOTE: The related measures need not be output and input values of the same quantity; for example, in a linear detector the desired relation is between the output signal voltage and the input modulation envelope; or the modulation of the input carrier and the resultant detected signal.

amplitude modulation. The process by which a continuous high-frequency wave (carrier) is caused to vary in amplitude by the action of another wave containing information. The usual procedure is to key the carrier wave on and off in accordance with the data to be transmitted. For example, a 1170 Hz tone (the carrier) could be off for *space* and on for *mark*. This method has several disadvantages. It does not use bandwidth efficiently, since two sidebands of the carrier are produced and, unlike single sideband voice communication methods, the carrier and one sideband cannot be completely eliminated and still do a satisfactory job. The information carrying characteristics of an am signal is its amplitude.

analog. Used to describe a physical quantity — such as voltage or shaft position — that normally varies in a continuous manner.

analog channel. A channel on which the information transmitted can take any value between the limits defined by the channel. Voice channels are analog channels.

antenna. A means for radiating or receiving radio waves.

aperture (antenna). That portion of a plane surface (for an unidirectional antenna) near the antenna perpendicular to the direction of maximum radiation through which the major part of the radiation passes.

artificial line. An electric network which simulates the electrical characteristics of a line over a desired frequency range.

NOTE: Although the term is basically applied to the case of simulation of an actual line by extension, it is used to refer to all periodic lines which may be used for laboratory purposes in place of actual lines, but which may represent no physically realizable line. For example, an artificial line may be composed of pure resistances.

asynchronous transmission. *See:* nonsynchronous transmission.

attenuation. A general term used to denote a decrease in signal magnitude in transmission from one point to another. Attenuation may be expressed in decibels or as a scalar ratio of the input magnitude to the output magnitude.

attenuation distortion (frequency distortion). Either departure in a circuit or system from uniform amplification or attenuation over the frequency range required for transmission, or the effect of such departure on a transmitted signal.

attenuation equalizer. A corrective network which is designed to make the absolute value of the transfer impedance (with respect to two chosen pairs of terminals) substantially constant for all frequencies within a desired range.

attenuator. An adjustable device for reducing the amplitude of a wave without introducing distortion. An adjustable passive network that reduces the power level of a signal without introducing appreciable distortion.

audio. A term pertaining to frequencies corresponding to a normally audible sound wave.

NOTE: These frequencies range roughly from 15 Hz to 20 000 Hz.

automatic frequency control (afc). An arrangement whereby the frequency of an oscillator of the tuning of a circuit is automatically maintained within specified limits with respect to a reference frequency.

automatic gain control (agc). A method of automatically obtaining a substantially constant output of some amplitude characteristic of the signal over a range of variation of that characteristic at the input. The term is also applied to a device for accomplishing this result.

automatic volume control (avc). A method of automatically obtaining a substantially constant audio output volume over a range of input volume. The term is also applied to a device for accomplishing this result.

back scattering coefficient B (echoing area). The back scattering coefficient B of an object for an incident plane wave is 4π times the ratio of the reflected power per unit solid angle ϕ_r in the direction of the source to the power per unit area W_1 in the incident wave as in the following equation:

$$B = 4\pi \frac{\phi_r}{W_1} = 4\pi r^2 \frac{W_r}{W_1}$$

where

W_r = power per unit area at distance r .

NOTE: For large objects, the back scattering coefficient of an object is approximately the product of its interception area and its scattering gain in the direction of the source, where the interception area is the projected geometrical area and the scattering gain is the reradiated power gain relative to an isotropic radiator.

balanced. In communication practice, balanced signifies (1) That which is electrically alike and symmetrical with respect to ground, or (2) Arranged to provide conjugate conductors between certain sets of terminals.

balanced wire circuit. One whose two sides are electrically alike and symmetrical with respect to ground and other conductors. The term is commonly used to indicate a circuit whose two sides differ only by chance.

band. The range of frequency between two defined limits.

bandpass filter. A wave filter which has a single transmission band, with neither of the cutoff frequencies being zero or infinite.

bandwidth. The range of frequencies within which performance—with respect to some characteristic—falls within specific limits. Bandwidth is commonly defined at the points where the response is 3 dB less than the reference value.

baseband. The band of frequencies occupied by the signal before it modulates the carrier (or subcarrier) frequency to form the transmitted line or radio signal.

baseband-multiplexer. The frequency band occupied by the aggregate of the transmitted signals applied to the facility interconnecting the multiplexing and line equipment. The multiplex baseband is also defined as the frequency band occupied by the aggregate of the received signals obtained from the facility interconnecting the line and the multiplex equipment.

baud. A unit of signaling speed equal to the number of discrete conditions or signal events per second, or the reciprocal of the time of the shortest signal element in a character.

beating. A phenomenon in which two or more periodic quantities of different frequencies produce a resultant having pulsations of amplitude.

beats. Periodic variations that result from the superposition of waves having different frequencies.

NOTE: The term is applied to both the linear addition of two waves (resulting in a periodic variation of amplitude) and to the nonlinear addition of two waves, resulting in new frequencies, of which the most important usually are the sum and difference of the original frequencies.

bias distortion. A measure of the difference in the pulse width of the positive and negative pulses of a dotting signal. It is usually expressed in a percentage of a full signal.

binary. (1) Pertaining to a characteristic or property involving a selection, choice, or condition in which there are two possibilities.

(2) Pertaining to the numeration system with a radix of two.

binary digit. A character used to represent one of the two digits in the numeration system with a radix of two. Abbreviated **bit**.

bit. (1) An abbreviation of **binary digit**.

(2) A single occurrence of a character in a language employing exactly two kinds of characters.

(3) A unit of storage capacity. The capacity, in bits, of a storage device with **logarithm** to the base two of the number of possible states of the device.

bit error. See: **error rate**.

bit rate. The speed at which bits are transmitted; usually expressed in bits per second.

block. (1) A set of things, such as words, characters, or digits handled as a unit.

(2) A collection of contiguous records recorded as a unit.

(3) In data communications, a group of contiguous characters formed for transmission purposes.

block error. A discrepancy of information in a block, as detected by a checking code or technique.

breakpoint. See: **change in slope**.

bridge. (1) A network with a minimum of two ports or terminal pairs capable of being operated in such a manner that when power is fed into one port — by suitable adjustment of the elements in the network or the element connected to one or more other ports — zero

output can be obtained at another port. Under these conditions the bridge is balanced.

(2) An instrument or intermediate means in a measurement system that embodies all or part of a bridge circuit, and by means of which one or more of the electrical constants of a bridge may be measured.

bridging connection. A parallel connection by means of which some of the signal energy in a circuit may be withdrawn, frequently with imperceptible effect on the normal operation of the circuit.

bridging gain. The ratio of the signal power a transducer delivers to its load Z_B to the signal power dissipated in the main circuit load Z_M across which the input transducer is bridged.

bridging loss. (1) The ratio of the signal power delivered to that part of the system following the bridging point, before the insertion of the bridging element to this signal power delivered to the same part after the bridging.

(2) The ratio of the power dissipated in a load B across which the input of a transducer delivers to its load A.

NOTE: It is the inverse of **bridging gain**. Bridging loss is usually expressed in decibels.

busy hour. The peak 60 min period during a 24 h period when the largest volume of communication traffic is handled.

capacity. (1) The number of digits or characters in a machine word regularly handled in a computer.

(2) The upper and lower limits of the numbers which may be regularly handled in a computer.

(3) The maximum number of binary digits which can be transmitted by a communications channel in one second.

carrier. (1) A wave having at least one characteristic that may be varied from a known reference value by modulation.

(2) That part of the modulated wave that corresponds in a specified manner to the unmodulated wave, having, for example, the carrier-frequency spectral components.

NOTE: Examples of carriers are a sine wave and a recurring series of pulses.

carrier frequency. (1) (periodic carrier). The reciprocal of its period. It is to be noted that

the frequency of a periodic pulse carrier is often called the **pulse repetition frequency** in a signal transmission system.

(2) **(modulated amplifier)**. The frequency that is used to modulate the input signal for amplification.

carrier group (base group). The frequency band, 60 kHz–108 kHz, containing twelve voice channels which serves as the basic building block of a larger system.

carrier modulation. A process whereby a high-frequency carrier wave is altered by a signal containing the information to be transmitted.

carrier shift (frequency shift). The difference between the steady state, mark, and space frequencies in a system utilizing frequency shift modulation.

carrier system. A communication system using frequency multiplexing to a number of channels over a single path by modulating each channel upon a different carrier frequency and demodulating at the receiving point to restore the signals to their original form.

carrier-to-noise ratio. The ratio of the magnitude of the carrier to that of the noise after selection and before any nonlinear process, such as amplitude limiting and detection. The bandwidth used for measurement of the noise should be specified when using this ratio.

CCITT (International Consultative Committee for Telephone and Telegraph). An advisory committee established under the United Nations in accordance with International Telecommunications Convention (Geneva 1959), Article 13, to study and recommend solutions for questions on technical operation and tariffs. The organization is attempting to establish standards for intercountry operation on a worldwide basis.

central office. The place where communications common carriers terminate customer lines and locate the equipment which interconnects those lines. It is usually the junction point between metallic pair and carrier system.

central-office exchange. The place where a communication common carrier locates the equipment which interconnects incoming subscribers and circuits.

channel (electric communication). (1) A single

path for transmitting electric signals, usually distinct from other parallel paths, or

(2) A band of frequencies.

NOTE: The word *path* is to be interpreted in a broad sense to include separation by frequency division or time division. The term *channel* may signify either a one-way path, providing transmission in one direction only, or a two-way path, providing transmission in two directions.

channel capacity (information theory). The maximum possible information rate through a channel subject to the constraints of that channel.

NOTE: Channel capacity may be either per second or per symbol.

channel group (group). A number of channels regarded as a unit.

NOTE: The term is especially used to designate part of a larger number of channels.

channel supergroup (supergroup). A number of channel groups regarded as a unit.

NOTE: The term is especially used to designate part of a larger number of channels.

character. One of a set of elementary symbols which normally include both alpha and numeric codes, plus punctuation marks and any other symbol which may be read, stored, or written and is used for organization, control, or representation of data.

character distortion. The normal and predictable distortion of data bit produced by characteristics of a given circuit at a particular transmission speed.

character interval. In start-stop operation, the duration of a character expressed as the total number of unit intervals (including information, error checking and control bits, and the start and stop elements) required to transmit any given character in any given communication system.

characteristic impedance. (1) (two conductor transmission line for a traveling transverse electromagnetic wave). The ratio of the complex voltage between the conductors to the complex current on the conductors in the same transverse plane with the sign so chosen that the real part is positive.

(2) (coaxial transmission line). The driving impedance of the forward traveling transverse electromagnetic wave.

check before operate (checkbox). A message

and control technique providing for confirmation of control request before operation.

check summation (checksum). A redundant check is which groups of digits are summed usually without regard for overflow, and that sum checked against a previously computed sum to verify accuracy.

CIGRE (Conference Internationale Des Grands Reseaux Electriques). An international organization concerned with large high-voltage electric power systems.

circuit. (1) A conductor or system of conductors through which an electric current is intended to flow.

(2) A network providing one or more closed paths.

circuit switch. A communications switching system which completes a circuit from sender to receiver at the time of transmission (as opposed to a message switch).

clamper. When used in broadband transmissions, it reinserts low-frequency signal components that were not faithfully transmitted.

clipper. A device that automatically limits the instantaneous value of the output to a predetermined maximum value.

NOTE: The term is usually applied to devices that transmit only portions of an input wave lying on one side of an amplitude boundary.

closed-circuit signaling. That type of signaling in which current flows in the idle condition, and a signal is initiated by increasing or decreasing the current.

common battery signaling. A method of actuating a line or supervisory signal at the distant end of a telephone line by the closure of a dc circuit with the exchange providing the feeding current.

communication. The transmission of information from one point to another by means of electromagnetic waves.

communication facility. Anything used or available for use in the furnishing of communication service.

communication theory. The mathematical theory underlying the communication of messages from one point to another.

communications common carrier. A company recognized by an appropriate regulatory agency as having a vested interest in furnishing communications services to the public at large.

companding. A process in which compression is followed by expansion.

NOTE: Companding is often used for noise reduction, in which case the compression is applied before the noise exposure and the expansion after the exposure.

compandor. A combination of a compressor at one point in a communication path for reducing the amplitude range of signals followed by an expander at another point for a complementary increase in the amplitude range.

NOTE: The purpose of a compandor is to improve the ratio of the signal to the interference entering in the path between the compressor and expander.

compression. A process in which the effective gain applied to a signal is varied as a function of the signal magnitude, the effective gain being greater for small rather than for large signals.

compressor. A transducer, which for a given amplitude range of input voltages, produces a smaller range of output voltages. One important type of compressor employs the envelope of speech signals to reduce their volume range by amplifying weak signals and attenuating strong signals.

contention. A condition on a multipoint communication channel when two or more locations try to transmit at the same time.

concentrator. A communication technique wherein several subscribers or data terminals simultaneously share a single communication circuit by using time division or other techniques.

converter. A device for changing one form of information language to another, so as to render the language acceptable to a different machine (that is, card to tape conversion).

coupling. The association of two or more circuits or systems in such a way that power or signal information may be transferred from one to another.

critical frequency. In radio propagation (by way of the ionosphere) the limiting frequency below which a wave component is reflected by, and above which it penetrates through, an ionospheric layer of vertical incidence.

NOTE: The existence of the critical frequency is the result of electronic limitation, that is, the inadequacy of the existing number of free electrons to support reflection at higher frequencies.

cross fire. An interfering current in one telegraph or signaling channel resulting from telegraph or signaling current in another channel.

cross modulation. A type of intermodulation due to the modulation of the carrier of the desired signal by an undesired signal wave.

cross talk. (1) Undesired energy appearing in one signal path as a result of coupling from other signal paths.

NOTE: Path implies wires, waveguides, or other localized or constrained transmission systems.

(2) **(electroacoustics).** The unwanted sound reproduced by an electroacoustic receiver associated with a given transmission channel resulting from cross coupling to another transmission channel carrying sound-controlled electric waves or, by extension, the electric waves in the disturbed channel that result in such sound.

NOTE: In practice, cross talk may be measured either by the volume of the overheard sounds or by the magnitude of the coupling between the disturbed and disturbing channels. In the latter case, to specify the volume of the overhead sounds, the volume in the disturbing channel shall also be given.

cycle. (1) An interval of space or time in which one set of events or phenomena is completed. Any set of operations that is related regularly in the same sequence. The operations may be subject to variations on each repetition.

(2) The complete series of values of a periodic quantity that occurs during a period.

NOTE: It is one complete set of positive and negative values of an alternating current.

data communications. The movement of encoded information by means of communication techniques.

data set. A modem serving as a conversion element and interface between a data machine and communication facilities. *See:* **modem.**

data sink. The equipment which accepts data signals after transmission.

data source. The equipment which supplies data signals that enter into a data link.

data terminal. A device which modulates or demodulates data between one input-output device and a data transmission link, or both.

data transmission (data link). The sending of data from one place to another or from one part of a system to another.

dBm. A unit for expression of power level in decibels with reference to a power of 1 mW.

decibel (dB). One tenth of a bel, the number of decibels denoting the ratio of the two amounts of power being ten times the logarithm to the base 10 of this ratio.

NOTE: The abbreviation dB is commonly used for the term decibel. With P_1 and P_2 designating two amounts of power and n the number of decibels denoting their ratio.

$$n = 10 \log_{10} (P_1/P_2) \text{ dB}$$

When the conditions are such that ratios of current or ratios of voltages (or analogous quantities in other fields) are the square roots of the corresponding power ratios, the number of decibels by which the corresponding powers differ is expressed by the following equations:

$$n = 20 \log_{10} (I_1/I_2) \text{ dB}$$

$$n = 20 \log_{10} (V_1/V_2) \text{ dB}$$

where

I_1/I_2 = given current

V_1/V_2 = voltage ratios

By extension, these relations between numbers of decibels and ratios of current or voltages are sometimes applied where these ratios are not the square roots of the corresponding power ratios; to avoid confusion, such usage should be accompanied by a specific statement of this application. Such extensions of the term described should preferably be avoided.

decilog. A division of the logarithmic scale used for measuring the logarithm of the ratio of two values of any quantity. Its value is such that the number of decilog is equal to 10 times the logarithm to the base 10 of the ratio. One decilog, therefore, corresponds to a ratio of $10^{0.1}$ (that is, 1.25892 +).

de-emphasis. The use of an amplitude-frequency characteristic complementary to that used for pre-emphasis earlier in the system.

degree of distortion. At the digital interface for binary signals, a measure of the time displacement of the transitions between signal states from their ideal instants. The degree of

distortion is generally expressed as a percentage of the unit interval.

degree of individual distortion (of a particular signal transition). The ratio to the unit interval of the displacement, expressed algebraically, of this transition from its ideal instant. This displacement is considered positive when the transition occurs after its ideal instant (late).

degree of isochronous distortion. (1) The ratio to the unit interval of the maximum measured difference, irrespective of sign, between the actual and the theoretical intervals separating any two transitions of modulation (or of restitution), these transitions not being necessarily consecutive.

(2) The algebraical difference between the highest and lowest value of individual distortion affecting the transitions of an isochronous modulation. (This difference is independent of the choice of the reference ideal instant.) The degree of distortion (of an isochronous modulation of restitution) is usually expressed as a percentage.

degree of gross start-stop distortion. The degree of start-stop distortion determined using the unit interval which corresponds to the actual mean modulation rate of the signal involved.

degree of start-stop distortion. The ratio to the unit interval of the maximum measured difference (irrespective of sign) between the actual interval and the theoretical interval (the appropriate integral multiple of unit intervals) separating any transition from the start transition preceding it.

delay (phase). The time interval by which a pulse is time retarded with respect to a reference time.

delay (time delay) (general). The time interval between the manifestation of a signal at one point and the manifestation or detection of the same signal at another point.

NOTES: (1) Generally, the term **time delay** is used to describe a process whereby an output signal has the same form as an input signal causing it, but is delayed in time; that is, the amplification of all frequency components of the output are related by a single constant to those of corresponding input frequency components but each output component lags behind the corresponding input component by a phase angle proportional to the frequency of the component.

(2) Transport delay is synonymous with time delay but usually is reserved for applications that involve the flow of material.

delay distortion. (1) Phase delay distortion (also called phase distortion) which is either a departure from flatness in the phase delay of a circuit, or a system over the frequency range required for transmission or the effect of such departure on a transmitted signal, or

(2) Envelope delay distortion, which is either a departure from flatness in the envelope delay of a circuit or system over the frequency range required for transmission, or the effect of such departure on a transmitted signal.

delay equalizer. A corrective network which is designed to make the phase delay or envelope delay of a circuit, or system, substantially constant over a desired frequency range.

delay line. (1) Originally a device utilizing wave propagation for producing a time delay of a signal.

(2) Commonly, any real or artificial transmission line or equivalent device designed to introduce delay.

(3) A sequential logic element or device with one input channel in which the output channel state at a given instant t is the same as the input channel state at the instant $t-n$, that is, the input sequence undergoes a delay of n units. There may be additional taps yielding output channels with smaller values of n .

demarcation strip. The terminals at which the telephone company's service ends and the customer's equipment is connected.

demodulation. A modulation process wherein a wave resulting from previous modulation is employed to derive a wave substantial to the characteristics of the original modulating wave.

NOTE: The term is sometimes used to describe the action of a frequency converter or mixer, but this practice is deprecated.

deviation distortion. Distortion in an fm receiver due to inadequate bandwidth and inadequate amplitude modulation rejection, or inadequate discriminator linearity.

deviation ratio (frequency-modulation system). The ratio of the maximum frequency deviation to the maximum modulating frequency of the system.

dibit. Two bits; two binary digits.

digital data. Pertaining to data in the form of digits or interval quantities. Contrast with analog data.

diplex operation. The simultaneous transmission or reception of two signals using a specified common feature, such as a single antenna or a single carrier.

dipole antenna. Any one of a class of antennas producing the radiation pattern approximating that of an elementary electric dipole.

NOTE: Common usage considers a dipole antenna to be a metal radiating structure which supports a line current distribution similar to that of a thin straight wire $\frac{1}{2}$ wavelength long so energized that the current has two nodes, one at each of the far ends.

director element. A parasitic element located forward of the driven element of an antenna, intended to increase the directive gain of the antenna in the forward direction.

dish (radio practice). A reflector, the surface of which is concave, as, for example, a part of a sphere or of a paraboloid of revolution.

distortion. An undesired change in waveform. The principal sources of distortion are:

- (1) A nonlinear relation between input and output at a given frequency
- (2) Nonuniform transmission at different frequencies
- (3) Phase shift not proportional to frequency.

Doppler effect. The phenomenon changing the observed frequency of a wave in a transmission system caused by a time rate of change in the effective length of the path of travel between the source and the point of observation.

dot cycle. One cycle of a periodic alternation between two signaling conditions, with each condition having unit duration.

NOTE: Thus, in two-condition signaling, it consists of a dot, or marking element followed by a spacing element.

dot signal. A series of binary digits having equal and opposite states, such as a series of alternate 1 and 0 states.

double sideband transmitter. A transmitter that transmits the carrier frequency and both sidebands resulting from the modulation of the carrier by the modulating signal.

drop. A connection made between a through transmission circuit and a local terminal unit.

dropouts. A loss of discrete data signals due to noise or attenuation hits.

drop wire (drop). A wire suitable for extending an open wire or cable pair from a pole or cable terminal to a building.

dual alternate routing (when applied to the routing of two circuits). The transmission facility assigned to one circuit is geographically separated from the transmission facility assigned to the other circuit throughout their entire length.

To meet the aforementioned criteria, dual alternate routes shall be constructed in such a manner that an interruption on one route will not result in an interruption on the other.

dual diversity. The term applied to the simultaneous combining of four signals and their detection through the use of space, frequency, or polarization characteristics.

duplex. Pertaining to a simultaneous two-way independent transmission in both directions.

duplex channel. See: duplex operation.

duplex operation. (1) (general). The operation of transmitting and receiving apparatus at one location in conjunction with associated transmitting and receiving equipment at another location; the processes of transmission and reception being concurrent.

(2) (radio communication) (two-way radio communication circuit). The operation utilizing two radio-frequency channels, one for each direction of transmission, in such a manner that intelligence may be transmitted concurrently in both directions.

echo. A wave which has been reflected or otherwise returned with sufficient magnitude and delay to be perceived in some manner as a wave distinct from that directly transmitted.

NOTE: Echoes are frequently measured in decibels relative to the directly transmitted wave.

echo attenuation. In a 4-wire or 2-wire circuit in which the two directions of transmission can be separated from each other, the attenuation of the echo current (which return to the input of the circuit under consideration) is determined by the ratio of the transmitted power to the echo power received expressed in decibels.

echo suppressor. A voice-operated device for