

A Dictionary of

Electronics and Electrical Engineering

FIFTH EDITION

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displacement (electric displacement; dielectric strain; electric flux density) (symbol: D ; unit: coulombs per metre squared) A vector quantity defined as

$$\mathbf{D} = \epsilon_0 \mathbf{E} + \mathbf{P}$$

where $\mathbf{E}$ is the electric field strength, $\mathbf{P}$ the *dielectric polarization, and ϵ_0 the permittivity of free space. In a dielectric medium the total charge within any given closed surface consists of any free charges, ρ_e , in the surface together with the apparent charge density, $-\text{div} \mathbf{P}$, due to the polarization. The volume charge density becomes $(\rho_e - \text{div} \mathbf{P})$ and *Gauss's theorem relating to a dielectric is written as

$$\text{div} \mathbf{E} \cdot d\tau = \left(\frac{1}{\epsilon_0} \right) \int (\rho_e - \text{div} \mathbf{P}) d\tau$$

where $d\tau$ is a small volume element. It can therefore be shown that the displacement $\mathbf{D}$ is given by

$$\text{div} \mathbf{D} = \rho_e$$

In a vacuum $\mathbf{P}$ is zero and Gauss's theorem is written as

$$\text{div} \mathbf{E} = \frac{\rho_e}{\epsilon_0}$$

displacement current The rate of change of electric *displacement in a dielectric with respect to time ($\partial \mathbf{D} / \partial t$) when the applied electric field changes. No motion of charge carriers is involved apart from the setting up of electric dipoles (see DIELECTRIC POLARIZATION). A displacement current gives rise to magnetic effects similar to those of a conduction current and these effects form the basis of Maxwell's electromagnetic theory of light.

display A device for the visual presentation of information, as on the screen of a *cathode-ray tube, flat-screen television, or computer display, or by using *scaling alphanumeric displays in cascade, as in a *digital voltmeter.

display resolution The number of *pixels that make up a display, expressed as the product of its width and its height. There are a large number of standards for different display resolutions, most of which are determined by the *Consumer Technology Association. See also 4K HD; STANDARD-DEFINITION; ULTRA EXTENDED GRAPHICS ARRAY; WIDESCREEN ULTRA EXTENDED GRAPHICS ARRAY.

dissipation (loss) A loss of power due to the tendency of electronic circuits and components to resist the flow of current. In a resistive circuit the power dissipated is equal to $I^2 R$, where I is the current and R the resistance. This is $I^2 R$ loss. In an inductor or capacitor the dissipation factor is the cotangent of the *phase angle, α , or the tangent of the loss angle, δ . In low-loss components it is almost equal to the power factor, $\cos \alpha$, and can be given approximately by $\sigma / 2\pi f \epsilon$, where σ is the conductivity, ϵ is the permittivity of the medium, and f the frequency.

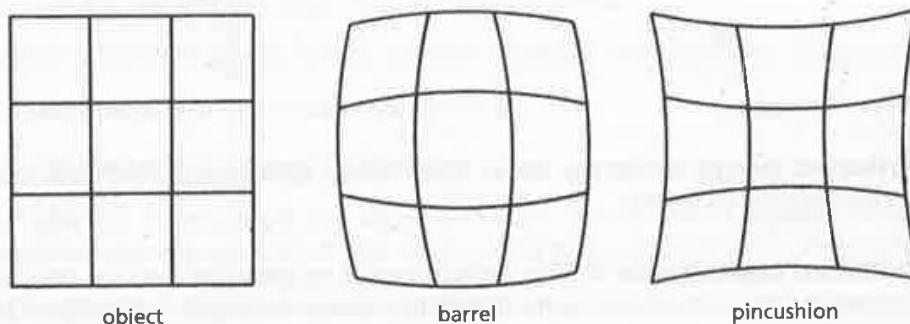
Dissipation causes free oscillations to be *damped and removes the sharpness of cut-off in *filters. High-frequency industrial heating is made possible because of dissipation of eddy-current energy in conductors (see INDUCTION HEATING) and displacement-polarization energy in dielectrics (see DIELECTRIC HEATING).

A network that is designed to absorb power is a **dissipative network**, as compared to a network that attenuates by impedance reflection. All networks provide some dissipation since entirely loss-free components cannot be made.

distortion The extent to which a system or component fails to reproduce accurately at its output the characteristics of the input. The modification of a waveform by a transmission system or network involves the introduction of features not present in the original input or the suppression or modification of features that are present. Distortion is a significant problem in telecommunication systems. There are several different types of distortion.

- **Amplitude distortion** occurs when the ratio of the root-mean-square value of the output to the r.m.s. value of the input varies with the amplitude of the input, both waveforms being sinusoidal. If harmonics are present in the output waveform only the fundamental frequency is considered.
- **Crossover distortion** occurs in *push-pull operation when the transistors are not operating in the correct phase with each other.
- **Delay distortion** is a change in the waveform because of the variation of the delay with frequency.
- **Deviation distortion** occurs in frequency-modulated receivers that have an inadequate bandwidth or nonlinear discriminator.
- **Harmonic distortion** is due to harmonics not present in the original waveform.
- **Intermodulation distortion** results from spurious combination-frequency components in the output of a nonlinear transmission system when two or more sinusoidal voltages, applied simultaneously, form the input. Intermodulation distortion of a complex waveform arises from *intermodulation within the waveform.
- **Nonlinear distortion** is produced in a system when the instantaneous transmission properties depend on the magnitude of the input. Amplitude, harmonic, and intermodulation distortion are all results of nonlinear distortion.
- **Phase distortion** occurs when the phase change introduced is not a linear function of frequency.

Optical distortion of an image is seen in electronic systems due to errors in the electron-lens focusing systems.



Optical distortion

- **Aperture distortion** of an image occurs in a scanning system when the scanning spot has finite dimensions rather than infinitely small dimensions.
- **Barrel and pincushion distortion** are seen when the lateral magnification is not constant but depends on image size (see diagram). Barrel distortion occurs when the magnification decreases with object size, pincushion distortion when it increases with object size.

input impedance The *impedance of a circuit or device presented at its input.

input/output (I/O) The passing of information into or out of the processing unit of a *computer. Input devices include keyboards, pointing devices such as the mouse, document scanners, magnetic-card readers, and speech-recognition units. The most common output devices are printers and visual displays. *Magnetic disks and *magnetic tape are examples of media used for the recording and reading of data. An important function of most I/O equipment is the translation between the processor's signals and the symbols, actions, or sounds understood or generated by people.

insertion loss The loss of power in a load that occurs when a network is inserted between the load and the generator supplying the load. **Insertion gain** occurs when a gain rather than a loss of power results. The loss or gain is usually expressed as the ratio of the power delivered to the load after insertion of the network, to the power delivered to the load before insertion; it is measured in *nepers or *decibels. The value usually depends not only on the network parameters but also on the load and generator impedances.

instantaneous automatic gain control A fast-acting automatic gain control in *radar systems that reduces the *clutter by responding very rapidly to variations in the mean clutter level.

instantaneous carrying-current The peak value of current that may be carried instantaneously by a switch, circuit-breaker, or similar device at rated voltage under specific conditions.

instantaneous frequency The rate of change of phase of any oscillating electric variable, measured in radians per second divided by 2π . Particular applications are in *frequency and *phase modulation.

instantaneous power The value, at the output terminals of a circuit, of the rate at which power is transmitted from that circuit to the next portion of the system.

instantaneous sampling See SAMPLING.

instantaneous value The value at a particular moment of any quantity, such as current or potential difference, that varies with time.

Institute of Electrical and Electronics Engineers, Inc. (IEEE) See STANDARDIZATION.

instruction fetch The part of a machine cycle during which the *central processing unit fetches an instruction from memory and decodes it prior to execution.

instruction register A *register in the control unit of a CPU that holds an instruction while the circuitry decodes and executes it. It is not generally part of the computer's instruction-set architecture.

instruction set The repertoire of arithmetic and logical operations of a computer. All programs exist in a computer as sequences of instructions drawn from the instruction set.

instrumentation amplifier A type of amplifier used in measurement and control to amplify the voltage difference between two *nodes of a circuit, but

loopback address An address used to send messages directly back to the transmitter, which can be useful in testing communications systems.

loop direction finding (frame direction finding) See DIRECTION FINDING.

loop error See FEEDBACK CONTROL LOOP.

loop gain The product of the gains, in an amplifier with feedback, as the loop is traversed from the amplifier input, through the amplifier, and through the network creating the feedback path (with the summing junction, completing the loop, open).

loop signals See FEEDBACK CONTROL LOOP.

loose coupling (undercoupling) See COUPLING.

loosely coupled multiprocessor See MULTIPROCESSOR.

Lorentz force The force experienced by an electron or other charged particle moving in a region of electric field, E , and magnetic flux density, B . The force due to the magnetic flux acts in a direction that is perpendicular both to the direction of particle motion and of the flux density and is given by the vector product $qv \times B$, where v is the particle velocity and q the charge. The total force due to both fields is given by $F = qE + qv \times B$.

loss See DISSIPATION.

loss angle The angle by which the angle of *lead of the current is less than 90° when a capacitor or dielectric is subjected to sinusoidal alternating electric stress. It is mainly due to *electric hysteresis loss.

loss factor 1. The ratio of the average power dissipation in a line, circuit, or device to the power dissipated at peak load. **2.** The product of the *power factor and the relative *permittivity of a *dielectric. For a given alternating field the power factor is proportional to the heat generated in the material.

lossless compression A technique of reducing the bit rate required for the transmission and/or storage of digital data by exploiting the redundancy in the original information content, such that the output after decoding is identical to the original input before coding.

lossless line A hypothetical transmission line in which no attenuation occurs.

lossy Denoting an insulator that dissipates more energy than is considered normal for that class of material.

lossy compression A technique of reducing the bit rate required for the transmission and/or storage of digital data by exploiting the redundancy in the original information content, such that the output after decoding is not identical to the original input before coding.

lossy line A type of *transmission line that is designed to produce a high degree of attenuation.

loudness The perceived position of a sound on a scale from soft to loud. Loudness varies primarily as the intensity of a sound is altered, but it also varies to a lesser extent when, for example, the spectral content or duration is changed.

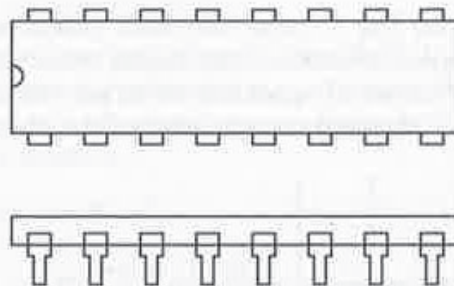


PABX (private automatic branch exchange) See TELEPHONY.

package The protective shell of material in which an *integrated circuit and its electrical contacts are encapsulated. There are a range of different package shapes and sizes, and different numbers and patterns of connecting pins. Some common types include:

- *ball grid array (BGA)
- *dual-flat no-leads package (DFN)
- *dual in-line package (DIP)
- *leadless chip carrier (LCC)
- *pin grid array (PGA)
- *plastic leaded chip carrier (PLCC)
- *quad-flat no-leads package (QFN)

The very common DIP type is here illustrated for a chip with 16 pins. This DIP16 chip has a notch at one end and the convention for numbering the pins is anti-clockwise, starting from the notch.



Package

packet A segment of a *digital signal - i.e. a group of *bits - that travels through a communications network as an information unit. Each packet has a fixed maximum size, and includes information about its source and destination. See also PACKET SWITCHING; DIGITAL COMMUNICATIONS.

packet switching In *digital communications, a technique that provides point to point transmission of *packets through a switching network. When a packet is received by a digital switching point such as a digital exchange, the packet is stored, has its destination read, and is then directed towards the destination in the most effective way: the exchange can choose from a number of channels, the selection depending on how busy each channel is.

packing density 1. (functional packing density) The number of devices or logic gates per unit area of an *integrated circuit. **2.** The amount of information that is