

This article is provided as a reference for use as is. If you have further questions or comments about this article please contact us at <http://www.calservice.net> - [Click Here](#) to go to our Reference Materials.

Breakdown Voltage Rating: The dc or ac voltage which can be applied across insulated portions of a transducer without arcing or conduction above a specific current value.

Bridge Resistance: See Input Impedance and Output Impedance.

BTU: British Thermal Unit. The quantity of thermal energy required to raise the temperature of one pound of water, at its maximum density, by 1 degree F. One BTU is equivalent to .293 watt hours, or 252 calories. One kilowatt hour is equivalent to 3412 BTU.

Buffer: 1) A storage area for data that is used to compensate for speed difference when transferring data from one device to another. Usually refers to an area for I/O operations, into which data is read, or from which data is written. 2) Any substance or combination of substances which, when dissolved in water, produces a solution which resists a change in hydrogen ion concentration upon the addition of an acid or alkali.

Buffer Capacity (B): A measure of the ability of a solution to resist pH change when a strong acid or base is added.

Bulb (Liquid-in-Glass Thermometer): The area at the tip of a liquid-in-glass thermometer containing the liquid reservoir.

Burn-In: A long-term screening test (either vibration, temperature or a combined test) that is effective in weeding out infant mortality because it simulates actual or worst case operation of a device, accelerated through a time, power, and temperature relationship.

Burst Pressure: The maximum pressure that can be applied to a transducer sensing element or case without causing leakage.

Bus: Parallel lines used to transfer signals between devices or components. Computers are often described by their bus structure (*i.e.*, S-100, IBM PC).

Byte: 1) The representation of a character in binary form. 2) Eight bits.

C

Calibration: The process of adjusting an instrument or compiling a deviation chart so that its reading can be correlated to the actual value being measured.

Calorie: The quantity of thermal energy required to raise one gram of water 1°C at 1 atm of pressure.

Cation: A positively charged ion (*e.g.*, Na⁺, H⁺).

Cavitation: The boiling of a liquid caused by a decrease in pressure rather than an increase in temperature.

Celsius: (centigrade) A temperature scale defined by 0°C at the ice point and 100°C at the boiling point of water at sea level.

Center of Gravity (Mass Center): The center of gravity of a body is that point in the body through which passes the resultant of weights of its component particles for all orientations of the body with respect to a uniform gravitational field.

Centripetal Force: The force exerted on an object moving in a circular path which is exerted inward toward the center of rotation.

Ceramic Insulation: A high-temperature composition of metal oxides used to insulate a pair of thermocouple wires. The most common are Alumina (Al₂O₃), Beryllia (BeO), and Magnesia (MgO). Their application depends upon temperature and type of thermocouple. High-purity alumina is required for platinum alloy thermocouples. Ceramic insulators are available as single and multihole tubes or as beads.

CFM: Cubic feet per minute; a measure of the volumetric flow rate of a liquid or gas.

Character: A letter, digit or other symbol that is used to represent data. A connected sequence of characters is called a character string.

Charge Sensitivity: For accelerometers that are rated in terms of charge sensitivity, output voltage (V) is proportional to charge (Q) divided by shunt capacitance (C). This type of accelerometer is characterized by a high output impedance. Sensitivity is given in terms of charge and stated in picocoulombs per unit of acceleration (g).

Chatter: The rapid cycling on and off of a relay in a control process due to insufficient bandwidth in the controller.

CHROMEGA®: A chromium-nickel alloy which makes up the positive leg of Type K and Type E thermocouples (a registered trademark of OMEGA Engineering, Inc.)

Clear: To restore a device to a prescribed initial state, usually the zero state.

Clipping: The phenomenon which occurs when an output signal is limited in some way by the full range of an amplifier, ADC or other device. When this occurs, the signal is flattened at the peak values, the signal approaches the shape of a square wave, and high frequency components are introduced. Clipping may be hard, as when the signal is strictly limited at some level, or it may be soft, in which case the clipping signal continues to follow the input at some reduced gain.

Clock: A device that generates periodic signals for synchronization.

CMR (Common-Mode Rejection): The ability of a panel meter to eliminate the effect of ac or dc noise between signal and ground. Normally expressed in dB at dc to 60 Hz. One type of CMR is specified between SIG LO and PWR GND. In differential meters, a second type of CMR is specified between SIG LO and ANA GND (METER GND).

CMV (Common-Mode Voltage): The ac or dc voltage which is tolerable between signal and ground. One type of CMV is specified between SIG LO and PWR GND. In differential meters, a second type of CMV is specified between SIG LO and ANA GND (METER GND).

Coherence Function: A frequency domain function computed to show the degree of a linear, noise-free relationship between a system's input and output. The value of the coherence function ranges between zero and one, where a value of zero indicates that there is no causal relationship between the input and the output, and a value of one indicates the existence of linear noise-free frequency response between the input and the output.

Color Code: The ANSI established color code for thermocouple wires in the negative lead is always red. The color code for base metal thermocouples is: yellow for Type K, black for Type J, purple for Type E and blue for Type T.

Common Mode: For ac power systems, the term Common Mode may refer to either noise or surge voltage disturbances. Common mode disturbances are those that occur between the power neutral (white wire) and grounding conductor (green wire). Ideally, no common mode disturbances should exist, since the neutral and the grounding wires are always connected at the service distribution panel in most countries. However, unwanted common mode disturbances can arise as a result of noise injection into the neutral or grounding wires, wiring faults, or overloaded power circuits.

Common Mode Rejection Ratio: The measure of an instrument's ability to reject interference from a common voltage at its input terminals with relation to ground. Usually expressed in dB (decibels).

Communication: Transmission and reception of data between processing equipment and related

peripherals.

Compensated Connector: A connector made of thermocouple alloys used to connect thermocouple probes and wires.

Compensating Alloys: Alloys used to connect thermocouples to instrumentation. These alloys are selected so as to have similar thermal electric properties as the thermocouple alloys (however, only over a very limited temperature range).

Compensating Loop: Lead wire resistance compensation for RTD elements. An extra length of wire is run from the instrument to the RTD and back to the instrument, with no connection to the RTD.

Compensation: An addition to specific materials or devices to counteract error.

Compiler: A program that translates a high-level language, such as Basic, into machine language.

Complex Function: Any mathematically defined relationship given by the expression:

$$y(x) = a(x) + ib(x)$$

Where: x = the real variable

$a(x)$ = the real part of $y(x)$

$b(x)$ = the imaginary part of $y(x)$

Complex functions are usually expressed in terms of both their amplitude and phase.

Complex Wave: The resultant form of a number of sinusoidal waves that are summed together to form a periodic wave. Such waves can be analyzed in the frequency domain to readily determine their component parts.

Conductance: The measure of the ability of a solution to carry an electrical current (see Equivalent Conductance).

Conduction: The conveying of electrical energy or heat through or by means of a conductor.

Confidence Level: The range (with a specified value of uncertainty, usually expressed in percent) within which the true value of a measured quantity exists.

Conformity Error: For thermocouples and RTD's, the difference between the actual reading and the temperature shown in published tables for a specific voltage input.

Connection Head: An enclosure attached to the end of a thermocouple which may be cast iron, aluminum or plastic, and within which electrical connections are made.

Constantan: A copper-nickel alloy used as the negative lead in Type E, Type J and Type T thermocouples.

Continuous Spectrum: A frequency spectrum that is characterized by non-periodic data. The spectrum is continuous in the frequency domain and is characterized by an infinite number of frequency components.

Control Character: A character whose occurrence in a particular context starts, modifies or stops an operation that affects the recording, processing, transmission or interpretation of data.

Control Mode: The output form or type of control action used by a temperature controller to control temperature, *i.e.*, on/off, time proportioning, PID.

Control Point: The temperature at which a system is to be maintained.

Convection: 1) The circulatory motion that occurs in a fluid at a non-uniform temperature owing to the variation of its density and the action of gravity. 2) The transfer of heat by this automatic circulation of fluid.

Coriolis Force: A result of centripetal force on a mass moving with a velocity radially outward in a rotating plane.

Correction (Balancing) Plane: A plane perpendicular to the shaft axis of a rotor in which correction for unbalance is made.

Coulomb Sensitivity: Charge/unit acceleration, expressed in Pc/g (also known as "charge sensitivity").

Coulomb: A measurement of the quantity of electrical charge, usually expressed in picocoulombs (10⁻¹² coulombs).

Counts: The number of time intervals counted by a dual-slope A/D converter and displayed as the reading of a panel meter, before addition of the decimal point.

CPS: Cycles per second; the rate or number of periodic events in one second, expressed in Hertz (Hz).

CPU: Central processing unit. The part of the computer that contains the circuits that control and perform the execution of computer instructions.

Critical Damping: Critical damping is the smallest amount of damping at which a given system is able to respond to a step function without overshoot.

Critical Speed: The rotational speed of a rotor or rotating element at which resonance occurs in the system. The shaft speed at which at least one of the "critical" or natural frequencies of a shaft is excited.

Cryogenics: Measurement of temperature at extremely low values, *i.e.*, below -200°C (-328°F).

CSA: Canadian Standards Administration.

Cure Point: The temperature at which a normally magnetic material goes through a magnetic transformation and becomes non-magnetic.

Current Proportioning: An output form of temperature controller which provides a current proportional to the amount of control required; normally a 4 to 20 milliamp current proportioning band.

Current: The rate of flow of electricity. The unit is the ampere (a), defined as = 1 coulomb per second.

Curve Fitting: Curve fitting is the process of computing the coefficients of a function to approximate the values of a given data set within that function. The approximation is called a "fit." A mathematical function, such as a least squares regression, is used to judge the accuracy of the fit.

Cycle Time: The time, usually expressed in seconds, it takes for a controller to complete an on/off cycle.

D

Damping: The reduction of vibratory movement through dissipation of energy. Types include viscous, coulomb, and solid.

Data Base: A large amount of data stored in a well-organized manner. A data base management system (DBMS) is a program that allows access to the information.

dB (Decibel): 20 times the log to the base 10 of the ratio of two voltages. Every 20 dB's corresponds to a voltage ratio of 10, every 10 dB's to a voltage ratio of 3.162. For instance, a CMR of 120 dB provides voltage noise rejection of 1,000,000/1. An NMR of 70 dB provides voltage noise rejection of 3,162/1.

DC: Direct current; an electric current flowing in one direction only and substantially constant in value.

Dead Band: 1) For chart recorders: the minimum change of input signal required to cause a deflection in pen position. 2) For temperature controllers: the temperature band where heat is turned off by a rising temperature and turned on by a falling temperature, expressed as a range of degrees. Thus, the area where no heating or cooling takes place.

This article is provided as a reference for use as is. If you have further questions or comments about this article please contact us at <http://www.calservice.net> - [Click Here](#) to go to our Reference Materials.

Debug: To find and correct mistakes in a program.

Debye-Hückel Equation: Used in relating activity coefficient (f_i) to ion strength (see Activity Coefficient):

where i is the ionic strength,
 A and B the temperature-dependent constants,
 Z_i the valence of the ion (i), and
 a the ion-size parameter in angstroms.

Decimal: A base ten number system using the characters 0 through 9 to represent values.

Default: The value(s) or option(s) that are assumed during operation when not specified.

Degree: An incremental value in the temperature scale, e.g., there are 100 degrees between the ice point and the boiling point of water in the Celsius scale and 180 degrees between the same two points in the Fahrenheit scale.

Density: Mass per unit of volume of a substance, e.g., grams/cu.cm. or pounds/cu.ft.

Deviation: The difference between the value of a controlled variable and the value at which it is being controlled.

Diaphragm: A sensing element consisting of a membrane which is deformed by a pressure differential applied across it.

Dielectric Constant: A measure of the force of attraction between two opposite charges separated by a distance in a uniform medium.

Differential: For an on/off controller, the temperature difference between the temperature at which the controller turns heat off and the temperature at which the heat is turned back on, expressed in degrees.

Differential Input: 1) A signal-input circuit where SIG LO and SIG HI are electrically floating with respect to ANALOG GND (METER GND, which is normally tied to DIG GND). This allows measurement of the voltage difference between two signals tied to the same ground and provides superior common-mode noise rejection. 2) The difference in static pressure between two identical pressure taps at the same elevation located in two different locations in a primary device.

Digit: A measure of the display span of a panel meter. By convention, a full digit can assume any value from 0 through 9, a 1/2-digit will display a 1 and overload at 2, a 3/4-digit will display digits up to 3 and overload at 4, etc. For example, a meter with a display span of ± 3999 counts is said to be a 3³/₄-digit meter.

Digital Output: An output signal which represents the size of an input in the form of a series of discrete quantities.

Digital-to-Analog (D/A or DAC): A device or circuit that converts a digital value to an analog signal level.

DIN (Deutsche Industrial Norm): A set of German standards recognized throughout the world. The 1/8 DIN standard for panel meters specifies an outer bezel dimension of 96 x 48 mm (3.8 x 1.9") and a panel cutout of 92 x 45 mm (3.6 x 1.8").

Discharge Time Constant: The time required for the output-voltage from a sensor or system to discharge 37% of its original value in response to a zero rise time step function input. This parameter determines a low frequency response.

Disk Operating System (DOS): Program used to control the transfer of information to and from a disk, such as MS DOS.

Displacement: The distance traveled by a point from its position at rest. Peak-to-peak displacement is the total measured movement of a vibrating point between its positive and negative extremes, expressed in inches or millinches.

Dissipation Constant: The ratio for a thermistor which relates a change in internal power dissipation to a resultant change in body temperature.

Dissociation Constant (K): A value which quantitatively expresses the extent to which a substance dissociates in solution. The smaller the value of K, the less dissociation of the species in solution. This value varies with temperature, ionic strength, and nature of the solvent.

DMA: Acronym for direct memory access. A high-speed data storage mode of the IBM PC.

Drift: A change of a reading or a setpoint value over long periods due to several factors including change in ambient temperature, time and line voltage.

Droop: A common occurrence in time-proportional controllers, referring to the difference in temperature between the setpoint and where the system temperature actually stabilizes due to the time-proportioning action of the controller.

Dual Element Sensor: A sensor assembly with two independent sensing elements.

Dual-Slope A/D Converter: An analog-to-digital converter which integrates the signal for a specific time, then counts time intervals for a reference voltage to bring the integrated signal back to zero. Such converters provide high resolution at low cost, excellent normal-mode noise rejection, and minimal dependence on circuit elements.

Duplex Wire: A pair of wires insulated from each other and with an outer jacket of insulation around the inner insulated pair.

Duplex: Pertaining to simultaneous two-way independent data communication transmission in both directions. Same as "full duplex."

Duty Cycle: The total time of one on/off cycle. Usually refers to the on/off cycle time of a temperature controller.

Dynamic (Two-Plane) Balancing Machine: A dynamic balancing machine is a centrifugal balanced machine that furnishes information for performing two-plane balancing.

Dynamic Calibration: Calibration in which the input varies over a specific length of time and the output is recorded vs. time.

Dynamic Pressure: The difference in pressure levels from static pressure to stagnation pressure caused by an increase in velocity. Dynamic pressure increases by the square of velocity.

Dynamic Unbalance: Dynamic unbalance is that condition in which the central principal axis is not coincident with the shaft axis.

E

Echo: To reflect received data back to the sender. For example, keys depressed on a keyboard are usually echoed as characters displayed on the screen.

Electrical Interference: Electrical noise induced upon signal wires that obscures the desired information signal.

Electrode Potential (E): The difference in potential established between an electrode and a solution when the electrode is immersed in the solution.

Electrolyte: Any substance which, when in solution, will conduct an electric current. Acids, bases, and salts are common electrolytes.

Electromotive Force (EMF): The potential difference between the two electrodes in a cell. The cell emf is the cell voltage measured when no current is flowing through the cell. It can be measured by means of a pH meter with high input impedance.

Electronic Industries Association (EIA): A standards organization specializing in the electrical and functional characteristics of interface equipment.

EMF: Electromotive force. Potential (electrical) energy. The principal unit is the volt.

EMI: Electromagnetic interference.

Emissivity: The ratio of energy emitted by an object to the energy emitted by a blackbody at the same temperature. The emissivity of an object depends upon its material and surface texture; a polished metal surface can have an emissivity around 0.2 and a piece of wool can have an emissivity around 0.95.

End Point (Potentiometric): The apparent equivalence point of a titration at which a relatively large potential change is observed.

End Points: The end points of a full scale calibration curve.

Endothermic: Absorbing heat.

Enthalpy: The sum of the internal energy of a body and the product of its volume multiplied by the pressure.

Environmental Conditions: All conditions to which a transducer may be exposed during shipping, storage, handling, and operation.

Eprom: Erasable Programmable Read-Only Memory. The PROM can be erased by ultraviolet light or electricity.

Equilibrium Constant: The product of the concentrations (or activities) of substances produced at equilibrium in a chemical reaction divided by the product of concentrations of the reacting substances, each concentration raised to that power which is the coefficient of the substance in the chemical equation.

Equitransference: Equal diffusion rates of the positively and negatively charged ions of an electrolyte across a liquid junction without charge separation.

Error: The difference between the value indicated by a transducer and the true value of the measurand being sensed, usually expressed in percent of full scale output.

Error Band: The allowable deviations to output from a specific reference norm, usually expressed as a percentage of full scale.

Eutectic Temperature: The lowest possible melting point of a mixture of alloys.

Excitation: The external application of electrical voltage current applied to a transducer for normal operation.

Exothermic: Giving off heat. A process is said to be exothermic when it releases heat.

Expansion Factor: Correction factor for the change in density between two pressure measurement areas in a constricted flow.

Explosion-Proof Enclosure: An enclosure that can withstand an explosion of gases within it and prevent the explosion of gases surrounding it due to sparks, flashes or the explosion of the container itself, and maintain an external temperature which will not ignite the surrounding gases.

Exposed Junction: A form of construction of a thermocouple probe where the hot or measuring junction protrudes beyond the sheath material so as to be fully exposed to the medium being measured. This form of construction usually gives the fastest response time.

F

Fahrenheit: A temperature scale defined as 32° at the ice point and 212° at the boiling point of water at sea level.

Ferrule: A compressible tubular fitting that is compressed onto a probe inside a compression fitting to form a gas-tight seal.

Field Balancing Equipment: An assembly of measuring instruments for performing balancing operations on assembled machinery which is not mounted in a balancing machine.

Field of View: A volume in space defined by an angular cone extending from the focal plane of an instrument.

File: A set of related records or data treated as a unit.

Filling Solution: A solution of defined composition formulated so as to make contact between an internal element and a membrane or sample. The solution sealed inside a pH glass bulb is called an internal filling solution. The solution normally contains a buffered chloride to provide a stable potential and a designated zero potential point. The solution which surrounds the reference electrode and periodically requires replenishing is called the reference filling solution. It provides contact between the reference electrode and the sample through a permeable junction.

Firmware: Programs stored in PROMS.

Flags: Any of various types of indicators used for identification of a condition or event, for example, a character that signals the termination of a transmission.

Floppy Disk: A small, flexible disk carrying a magnetic medium in which digital data is stored for later retrieval and use.

Flow: Travel of liquids or gases in response to a force (e.g., pressure or gravity).

Flowmeter: A device used for measuring the flow or quantity of a moving liquid.

Flow Rate: Actual speed or velocity of fluid movement.

FM: Factory Mutual Research Corporation. An organization which sets industrial standards.

FM Approved: An instrument that meets a specific set of specifications established by Factory Mutual Research Corporation.

Forced Vibration: Vibration of a system caused by an imposed force. Steady-state vibration is an unchanging condition of periodic or random motion.

FORTRAN: Formula Translation language. A widely used high-level programming language well suited to problems that can be expressed in terms of algebraic formulas. It is generally used in scientific applications.

FPM: Feet Per Minute, a measure of flow velocity.

FPS: Feet Per Second, a measure of flow velocity.

Freezing Point: The temperature at which a substance changes from the liquid phase to the solid phase.

Frequency: The number of cycles over a specified time period in which an event occurs. The reciprocal is called the period.

Frequency Modulated Output: A transducer output which is obtained in the form of a deviation from a center frequency, where the deviation is proportional to the applied stimulus.

This article is provided as a reference for use as is. If you have further questions or comments about this article please contact us at <http://www.calservice.net> - [Click Here](#) to go to our Reference Materials.

Frequency, Natural: The frequency of free (not forced) oscillations of a sensing element of a fully assembled transducer.

Frequency of Vibration: The number of cycles occurring in a given unit of time, e.g., RPM (revolutions per minute), CPM (cycles per minute).

Frequency Output: An output in the form of frequency which varies as a function of the applied input.

Full Bridge: A Wheatstone bridge configuration utilizing four active elements or strain gages.

Full Scale Output: The algebraic difference between minimum output and maximum output.

G

g: The force of acceleration due to gravity, equal to 32.1739 ft/sec² or .386 in./sec².

Gage Pressure: Absolute pressure minus local atmospheric pressure.

Gage Pressure Transducer: A transducer which measures pressure in relation to ambient pressure.

Gain: The amount of amplification used in an electrical circuit.

Galvanometer: An instrument that measures small electrical currents by means of deflecting magnetic coils.

GPH: Gallons Per Hour, a measure of volumetric flow rate.

GPM: Gallons Per Minute, a measure of volumetric flow rate.

Ground: 1) An electrical neutral line having the same potential as the surrounding earth. 2) The negative side of a dc power supply. 3) The reference point for an electrical system.

Grounded Junction: A form of construction of a thermocouple probe where the hot or measuring junction is in electrical contact with the sheath material so that the sheath and thermocouple have the same electrical potential.

H

Half-Duplex: One-way-at-a-time data communication; both devices can transmit and receive data, but only one at a time.

Handshake: An interface procedure based on status/data signals that assures orderly data transfer, as opposed to asynchronous exchange.

Hardcopy: Output in permanent form (usually a printout) rather than in temporary form, as on disk or on a display terminal.

Hardware: The electrical, mechanical and electromechanical equipment and parts associated with a computing system, as opposed to its firmware or software.

Head Loss: The loss of pressure in a flow system as measured by a length parameter (e.g., inches of water or inches of mercury).

Head Pressure: Pressure measured in terms of height of fluid and represented by the equation $P = \rho g h$, where ρ = fluid density, h = fluid column height and g = acceleration due to the force of gravity.

Heat: Thermal energy, expressed in units of calories or BTU's.

Heat Sink: 1) Thermodynamic. A body which can absorb thermal energy. 2) Practical. A finned piece of metal used to dissipate the heat of solid state components mounted on it.

Heat Transfer: Thermal energy flowing from a body of high energy to a body of low energy. The means of transfer are: conduction (the two bodies contact); convection (conduction where the two bodies in contact are in different phases, e.g., solid and gas); and radiation (all bodies emit infrared radiation).

Heat Treating: A process for treating metals whereby heating to a specific temperature and cooling at a specific rate changes the properties of the metal.

Hertz (Hz): Units in which frequency is expressed. Synonymous with cycles per second.

Hexadecimal: A base sixteen number system using the characters 0 through 9 and A through F to represent values. Machine language programs are often written in hexadecimal notation.

Hold: Meter HOLD is an external input which is used to stop the A/D process and freeze the display. BCD HOLD is an external input used to freeze the BCD output while allowing the A/D process to continue.

Hooke's Law: The basis for the measurement of mechanical stresses via strain measurement. The gradient of Hooke's line is defined by the ratio which is equivalent to Modulus of Elasticity E (Young's Modulus).

Host: The primary or controlling computer in a multiple-part system.

Hydrogen Ion Activity (aH⁺): Activity of the hydrogen ion in solution. Related to hydrogen ion concentration (CH⁺) by the activity coefficient for hydrogen (fH⁺).

Hysteresis: The difference in output when the measurand value is approached first with increasing and then with decreasing values. Expressed in percent of full scale during any one calibration cycle. (See also "Deadband.")

Hysteresis (Electrode Memory): When an electrode system is returned to a solution, equilibrium is usually not immediately achieved. This phenomenon is often observed in electrodes that have been exposed to other influences such as temperature, light or polarization.

I

Icon: A graphic functional symbol display. A graphic representation of a function or functions to be performed by the computer.

ICP: Integrated Circuit Piezoelectric, a term sometimes used to describe an accelerometer with built-in electronics.

Impedance: The total opposition to electrical flow (resistive plus reactive).

Infrared: An area in the electromagnetic spectrum extending beyond red light from 760 nanometers to 1000 microns (106 nm). It is the form of radiation used for making non-contact temperature measurement.

Input Impedance: 1) Resistance measured across the excitation terminals of a transducer. 2) The resistance of a panel meter as seen from the source. In the case of a voltmeter, this resistance has to be taken into account when the source impedance is high; in the case of an ammeter, when the source impedance is low.

Input Resistance (Impedance): The input resistance of a pH meter is the resistance between the glass electrode terminal and the reference electrode terminal. The potential of a pH-measuring electrode chain is always subject to a voltage division between the total electrode resistance and the input resistance.

Insulated Junction: See Ungrounded Junction.

Insulation Resistance: The resistance between two insulated points on a transducer when a specific dc voltage is applied at room temperature.

Integral: A form of temperature control. See Automatic Reset, definition 2).

Interchangeability Error: A measurement error that can occur if two or more probes are used to make the same measurement. It is caused by a slight variation in the characteristics of different probes.

Interface: The means by which two systems or devices are connected and interact with each other.

Internal Reference Electrode (Element): The reference electrode placed internally in a glass electrode.

Interpreter: A system program that converts and executes each instruction of a high-level language program into machine code as it runs, before going on to the next instruction.

Interrupt: To stop a process in such a way that it can be resumed.

Intrinsically Safe: An instrument which will not produce any spark or thermal effects under normal or abnormal conditions that will ignite a specified gas mixture is deemed intrinsically safe.

Ionic Mobility: Similar to mobility of nonelectrolytic particles; defined as the speed the ion obtains in a given solvent when influenced by a unit of power.

Ionic Strength: The weight concentration of ions in solution, computed by multiplying the concentration of each ion in solution (C) by the corresponding square of the charge on the ion (Z) summing this product for all ions in solution and dividing by 2: ionic strength = $1/2 \sum Z^2 C$.

IPTS-48: International Practical Temperature Scale of 1948. Fixed points in thermometry as specified by the Ninth General Conference on Weights and Measures, which was held in 1948.

IPTS-68: International Practical Temperature Scale of 1968. Fixed points in thermometry set by the 1968 General Conference on Weights and Measures.

ISA: Instrument Society of America.

Isolation: The reduction of the capacity of a system to respond to an external force by use of resilient isolating materials.

Isopotential Point: A potential which is not affected by temperature changes. It is the pH value at which dE/dT for a given electrode pair is zero. Normally, for a glass electrode and SCE reference, this potential is approximately obtained when the instrument is immersed in pH 7 buffer.

Isothermal: A process or area that has a constant temperature.

J

Joule: The basic unit of thermal energy.

Junction: The point in a thermocouple where the two dissimilar metals are joined.

K

K: When referring to memory capacity, two to the tenth power (1024 in decimal notation).

Kelvin: Symbol K. The unit of absolute or thermodynamic temperature based upon the Celsius scale with 100 units between the ice point and boiling point of water but starting at absolute zero. 0°C = 273.15K (there is no degree (°) symbol used with the Kelvin scale).

Kilowatt (kw): 1000 watts.

Kilowatt hour (kwh): 1000 watthours. Kilovolt amperes (kva): 1000 volt amps.

Kinetic Energy: Energy (E) associated with mass in motion, $= 1/2 m V^2$, where m is the mass of the particle or body and V is its velocity.

KVA: Kilovolt amperes (1000 volt amps).

L

Lag: 1) The time delay between the output of a signal and the response of the instrument to which the signal is sent. 2) The time relationship between two waveforms where a fixed reference point on one wave occurs after the same point of the reference wave.

Laminar Flow: Streamlined flow of a fluid where viscous forces are more significant than inertial forces, generally below a Reynolds number of 2000.

Large Scale Integration (LSI): The combining of about 1,000 to 10,000 circuits on a single chip. Typical examples of LSI circuits are memory chips and microprocessors.

Latent Heat: The amount of heat needed (absorbed) to convert a pound of boiling water to a pound of steam, expressed in BTU per pound.

Leakage Rate: The maximum rate at which a fluid is permitted or determined to leak through a seal. The type of fluid, the differential pressure across the seal, the direction of leakage, and the location of the seal must be specified.

Least-Squares Line: The straight line for which the sum of the squares of the residuals (deviations) is minimized.

Life Cycle: The minimum number or pressure cycles a transducer can endure and still remain within a specified tolerance.

Limits of Error: A tolerance band for the thermal electric response of thermocouple wire expressed in degrees or percentage defined by ANSI specification MC-96.1 (1975).

Linearity: The closeness of a calibration curve to a specified straight line. Linearity is expressed as the maximum deviation of any calibration point on a specified straight line during any one calibration cycle.

Liquid Junction Potential: The difference in potential at a liquid-liquid boundary. The sign and size of this potential depends on the composition of the liquids and the type of junction used.

Load: The electrical demand of a process expressed as power (watts), current (amps) or resistance (ohms).

Load Impedance: The impedance presented to the output terminals of a transducer by the associated external circuitry.

Logarithmic Scale: A method of displaying data (in powers of ten) to yield maximum range while keeping resolution at the low end of the scale.

Loop Resistance: The total resistance of a thermocouple circuit caused by the resistance of the thermocouple wire. Usually used in reference to analog pyrometers which have typical loop resistance requirements of 10 ohms.

LS-TTL Compatible: For digital input circuits, a logic 1 is obtained for inputs of 2.0 to 5.5 V which can source 20 mA, and a logic 0 is obtained for inputs of 0 to 0.8 V which can sink 400 mA. For digital output signals, a logic 1 is represented by 2.4 to 5.5 V with a current source capability of at least 400 mA, and a logic 0 is represented by 0 to 0.6 V with a current sink capability of at least 16 mA. "LS" stands for Low-power Schottky.

LS-TTL Unit Load: A load with LS-TTL voltage levels, which will draw 20 mA for a logic 1 and -400 mA for a logic 0.

LSD (Least Significant Digit): The rightmost active (non-dummy) digit of a display.

This article is provided as a reference for use as is. If you have further questions or comments about this article please contact us at <http://www.calservice.net> - [Click Here](#) to go to our Reference Materials.

M

M: Mega; one million. When referring to memory capacity, two to the twentieth power (1,048,576 in decimal notation).

Machine Language: Instructions written in binary form that a computer can execute directly. Also called "object code" and "object language."

Mandrel (Balancing Arbor): An accurately machined shaft on which work is mounted for balancing.

Manual Reset (Adjustment): The adjustment on a proportioning controller which shifts the proportioning band in relation to the setpoint to eliminate droop or offset errors.

Manual Reset (Switch): The switch in a limit controller that manually resets the controller after the limit has been exceeded.

Mass Flow Rate: Volumetric flowrate multiplied by density, *e.g.*, pounds per hour or kilograms per minute.

Mass Storage: A device like a disk or magtape that can store large amounts of data and keep it readily accessible to a central processing unit.

Maximum Excitation: The maximum value of excitation voltage or current that can be applied to a transducer at room conditions without causing damage or performance degradation beyond specified tolerances.

Maximum Operating Temperature: The maximum temperature at which an instrument or sensor can be safely operated.

Maximum Power Rating: The maximum power in watts that a device can safely handle.

Mean Ionic Activity Coefficient: See Activity Coefficient.

Mean Temperature: The average of the maximum and minimum temperatures of a process equilibrium.

Measuring Junction: The thermocouple junction (referred to as the "hot junction") that is used to measure an unknown temperature.

Mechanical Hysteresis: The difference in an indication depending on whether it is measuring increasing or decreasing strain, even though the measurements were taken at identical strain values of the specimen.

Medium Effect (f m): For solvents other than water, the medium effect is the activity coefficient related to the standard scale in water at zero concentration. It reflects differences in the electrostatic and chemical interactions of the ions with the molecules of various solvents. Solvation is the most significant interaction.

Melting Point: The temperature at which a substance transforms from a solid phase to a liquid phase.

Membrane: A pH-sensitive glass bulb is the membrane across which the potential difference due to the formation of double layers with ion-exchange properties on two swollen glass surfaces is developed. The membrane makes contact with and separates the internal element and filling solution from the sample solution.

Method of Correction: A procedure whereby the mass distribution of a rotor is adjusted to reduce unbalance, or vibration due to unbalance, to an acceptable value. Corrections are usually made by adding material to, or removing it from, the rotor.

Mica: A transparent mineral used as window material in high-temperature ovens.

Microamp: One millionth of an ampere, 10^{-6} amps.

Microcomputer: A computer which is physically small. It can fit on top of or under a desk; based on LSI circuitry, computers of this type are now available with much of the power currently associated with minicomputer systems.

Micron: One millionth of a meter, 10^{-6} meters.

Microvolt: One millionth of a volt, 10^{-6} volts.

Mil: One thousandth of an inch ($.001^{\circ}$).

Milliamp: One thousandth of an amp, 10^{-3} amps, symbol mA.

Millimeter: One thousandth of meter, symbol mm.

Millivolt: Unit of electromotive force. It is the difference in potential required to make a current of 1 milliamper flow through a resistance of 1 ohm; one thousandth of a volt, symbol mV.

Mineral-Insulated Thermocouple: A type of thermocouple cable which has an outer metal sheath and mineral (magnesium oxide) insulation inside separating a pair of thermocouple wires from themselves and from the outer sheath. This cable is usually drawn down to compact the mineral insulation and is available in diameters from .010 to .375 inches. It is ideally suited for high-temperature and severe-duty applications.

Minor Scale Division: On an analog scale, the smallest indicated division of units on the scale.

Modem: Modulator/Demodulator. A device that transforms digital signals into audio tones for transmission over telephone lines, and does the reverse for reception.

Molality: A measure of concentration expressed in moles per kilogram of solvent.

Molarity: A measure of concentration expressed in moles per liter of solution.

Monovalent Ion: An ion with a single positive or negative charge (*e.g.*, H⁺, Cl⁻).

Motherboard: The pc board of a computer that contains the bus lines and edge connectors to accommodate other boards in the system. In a microcomputer, the motherboard contains the microprocessor and connectors for expansion boards.

Mounting Error: The error produced when installing the transducer, both electrical and mechanical.

MSD (Most Significant Digit): The leftmost digit of a display.

Mueller Bridge: A high-accuracy bridge configuration used to measure three-wire RTD thermometers.

Multiplex: A technique which allows different input (or output) signals to use the same lines at different times, controlled by an external signal. Multiplexing is used to save on wiring and I/O ports.

N

N/C (No Connection): A connector point for which there is no internal connection.

NBS: National Bureau of Standards; renamed National Institute of Standards and Technology (NIST).

NEC: National Electrical Code.

Negative Temperature Coefficient: A decrease in resistance with an increase in temperature.

NEMA-12: A standard from the National Electrical Manufacturers Association which defines enclosures with protection against dirt, splashes by non-corrosive liquids, and salt sprays.

NEMA-4: A standard from the National Electrical Manufacturers Association which defines enclosures intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose-directed water.

NEMA-7: A standard from the National Electrical Manufacturers Association which defines explosion-proof enclosures for use in locations classified as Class I, Groups A, B, C, or D, as specified in the National Electrical Code.

NEMA-Size Case: An older U.S. case standard for panel meters, which requires a panel cutout of 100 x 43 mm (3.93 x 1.69 inches).

Nernst Equation: A mathematical description of electrode behavior, in which E is the total potential, in millivolts, developed between the sensing and reference electrodes; Ex varies with the choice of electrodes, temperature, and pressure; $2.3RT/nF$ is the Nernst factor (R and F are constants, n is the charge on the ion, including sign, T is the temperature in degrees Kelvin), and ai is the activity of the ion to which the electrode is responding.

Nernst Factor (S, Slope): The term $2.3RT/nF$ is the Nernst equation, which is equal (at T = 25°C/77°F) to 59.16 mV when n = 1 and equal to 29.58 mV when n = 2, and which includes the sign of the charge on the ion in the term n. The Nernst Factor varies with temperature.

Network: A group of computers connected to each other by communications lines to share information and resources.

Nibble: One half of a byte.

Nicrosil/Nisil: A nickel-chrome/nickel-silicon thermal alloy used to measure high temperatures. Inconsistencies in thermoelectric voltages exist in these alloys with respect to the wire gage.

NIST: National Institute of Standards and Technology; formerly, National Bureau of Standards (NBS).

NMR (Normal-Mode Rejection): The ability of a panel meter to filter out noise superimposed on the signal and applied across the SIG HI to SIG LO input terminals. Normally expressed in dB at 50/60 Hz.

Noise: Unwanted electrical interference on signal wires.

Normal (Axial) Stress: The force per unit area on a given plane within a body; $\sigma = F/A$.

Normal Hydrogen Electrode: A reversible hydrogen electrode (Pt) in contact with hydrogen gas at 1 atmosphere partial pressure and immersed in a solution containing hydrogen ions at unit activity.

Normal-Mode Rejection Ratio: The ability of an instrument to reject interference, usually of line frequency (50-60 Hz) across its input terminals.

NPT: National Pipe Thread.

Null: A condition, such as balance, which results in a minimum absolute value of output.

O

O.D.: Outside diameter.

Octal: Pertaining to a base 8 number system.

Offset: The difference in temperature between the setpoint and the actual process temperature. Also referred to as "droop".

ofhc: Oxygen-free high-conductivity copper. The industrial designation of the pure copper used in a Type T thermocouple.

On/off Controller: A controller whose action is fully on or fully off.

Open Circuit: The lack of electrical contact in any part of a measuring circuit. An open circuit is usually characterized by large, rapid jumps in displayed potential, followed by an off-scale reading.

Operating System: A collection of programs that controls the overall operation of a computer and performs such tasks as assigning places in memory to programs and data, processing interrupts, scheduling jobs and controlling the overall input/output of the system.

Operational pH: The determination of sample pH by relating to pH measurements in a primary standard solution. This relationship assumes that electrode errors such as sensitivity and changes in asymmetry potential can be disregarded or compensated for, provided the liquid junction potential remains constant between standard and sample.

Optical Isolation: Two networks which are connected only through an LED transmitter and photoelectric receiver with no electrical continuity between the two networks.

Outboard Rotor: A two-journal rotor which has its center of gravity between the journals.

Output Impedance: Resistance as measured on the output terminals of a pressure transducer.

Output: The electrical signal which is produced by an applied input to a transducer.

Output Noise: The RMS, peak-to-peak (as specified) ac component of a transducer's dc output in the absence of a measured variation.

Overshoot: The number of degrees that a process exceeds the setpoint temperature when coming up to the setpoint temperature.

P

Parallax: An optical illusion which occurs in analog meters and causes reading errors. It occurs when the viewing eye is not in the same plane, perpendicular to the meter face, as the indicating needle.

Parallel Transmission: Sending all data bits simultaneously. Commonly used for communications between computers and printers.

Parity: A technique for testing transmitting data. Typically, a binary digit is added to the data to make the sum of all the digits of the binary data either always even (even parity) or always odd (odd parity).

Peltier Effect: When a current flows through any bimetallic junction, such as a thermocouple junction, heat will either be absorbed or evolved, depending on the direction of current flow. This effect is independent of self heating.

Perfectly Balanced Rotor: A rotor is perfectly balanced when its mass distribution is such that it transmits no vibratory force or motion to its bearings as a result of centrifugal forces.

Peripheral: A device that is external to the CPU and main memory (*e.g.*, a printer, modem or terminal), but that is connected by appropriate electrical connections.

pH Junctions: The junction of a reference electrode or combination electrode is a permeable membrane through which the filling solution seeps (called the liquid junction).

pH(S) (Standard pH Scale): The conventional standard pH scale established on the basis that an individual ionic activity coefficient can be calculated from the Debye-Hückel law for primary buffers.

Phase: A time-based relationship between a periodic function and a reference. In electricity, it is expressed in angular degrees to describe the voltage or current relationship of two alternating waveforms.

Phase Difference: The time, expressed in degrees, between the same reference point on two periodic waveforms.

Phase Proportioning: A form of temperature control where the power supplied to the process is controlled by limiting the phase angle of the line voltage.

PID: Proportional, integral, derivative. A three-mode control action whereby the controller has time proportioning, integral (auto reset) and derivative rate action.

This article is provided as a reference for use as is. If you have further questions or comments about this article please contact us at <http://www.calservice.net> - [Click Here](#) to go to our Reference Materials.

Thermocouple Types (ANSI Symbol)	Materials
J	Iron/Constantan
K	Chromel/Alumel
T	Copper/Constantan
E	Chromel/Constantan
R	Platinum/Platinum 13% Rhodium
S	Platinum/Platinum 10% Rhodium
B	Platinum 6% Rhodium/Platinum 30% Rhodium
G*	Tungsten/Tungsten 26% Rhenium
C*	Tungsten 5% Rhenium/Tungsten 26% Rhenium
D*	Tungsten 3% Rhenium/Tungsten 25% Rhenium

*Not ANSI symbols

Thermopile: An arrangement of thermocouples in series such that alternate junctions are at the measuring temperature and the reference temperature. This arrangement amplifies the thermoelectric voltage. Thermopiles are usually used as infrared detectors in radiation pyrometry.

Thermowell: A closed-end tube designed to protect temperature sensors from harsh environments, high pressure, and flows. A thermowell can be installed into a system by pipe thread or welded flange and is usually made of corrosion-resistant metal or ceramic material, depending upon the application.

Thomson Effect: When current flows through a conductor within a thermal gradient, a reversible absorption or evolution of heat will occur in the conductor at the gradient boundaries.

Transducer: A device (or medium) that converts energy from one form to another. The term is generally applied to devices that take a physical phenomenon (pressure, temperature, humidity, flow, etc.) and convert it to an electrical signal.

Transient Vibration: A temporary vibration or movement of a mechanical system.

Transitional Flow: Flow between laminar and turbulent flow, usually between pipe Reynolds numbers of 2000 and 4000.

Transmitter: A device which translates the low level output of a sensor or transducer to a high level signal suitable for transmission to a site where it can be further processed.

Transmitter (Two-Wire): A device which is used to transmit temperature data from either a thermocouple or RTD via a two-wire current loop. The loop has an external power supply and the transmitter acts as a variable resistor with respect to its input signal.

Triac: A solid state switching device used to switch alternating current wave forms.

Triboelectric Noise: The generation of electrical charges caused by layers of cable insulation. This is especially troublesome in high impedance accelerometers.

Triple Point: The temperature and pressure at which solid, liquid, and gas phases of a given substance are all present simultaneously in varying amounts.

Triple Point (Water): The thermodynamic state where all three phases, solid, liquid, and gas, may all be present in equilibrium. The triple point of water is .01°C.

True RMS: The true root-mean-square value of an ac or ac-plus-dc signal, often used to determine the power of a signal. For a perfect sine wave, the RMS value is 1.11072 times the rectified average value, which is utilized for low-cost metering. For significantly non-sinusoidal signals, a true RMS converter is required.

TTL: Transistor-to-transistor logic. A form of solid state logic which uses only transistors to form the logic gates.

TTL-Compatible: For digital input circuits, a logic 1 is obtained for inputs of 2.0 to 5.5 V which can source 40 mA, and a logic 0 is obtained for inputs of 0 to 0.8 V which can sink 1.6 mA. For digital output signals, a logic 1 is represented by 2.4 to 5.5 V with a current source capability of at least 400 mA; and a logic 0 is represented by 0 to 0.6 V with a current sink capability of at least 16 mA.

TTL Unit Load: A load with TTL voltage levels, which will draw 40 mA for a logic 1 and -1.6 mA for a logic 0.

Turbulent Flow: The type of flow that occurs when forces due to inertia are more significant than forces due to viscosity. This typically occurs with a Reynolds number in excess of 4000.

Typical Error: Error within plus or minus one standard deviation ($\pm 1\%$) of the nominal specified value, as computed from the total population.

U

UL: Underwriters Laboratories, Inc. An independent laboratory that establishes standards for commercial and industrial products.

Ultraviolet: That portion of the electromagnetic spectrum below blue light (380 nanometers).

Unbalance: That condition which exists in a rotor when vibratory force or motion is imparted to its bearings as a result of centrifugal forces.

Unbalance Tolerance: The unbalance tolerance with respect to a radial plane (measuring plane or correction plane) is that amount of unbalance which is specified as the maximum below which the state of unbalance is considered acceptable.

Undershoot: The difference in temperature between the temperature a process goes to below the setpoint after the cooling cycle is turned off, and the setpoint temperature.

Ungrounded Junction: A thermocouple probe in which the hot or measuring junction is fully enclosed by and insulated from the sheath material.

Union: A pipe fitting where two extension pipes are joined at a separable coupling.

V

Vacuum: Any pressure less than atmospheric pressure.

Velocity: The time rate of change of displacement: dx/dt .

Vibration Error: The maximum change in the output of a transducer when a specified amplitude and range of frequencies are applied to a specific axis at room temperature.

Vibration Error Band: The error recorded in the output of a transducer when subjected to a given set of amplitudes and frequencies.

Vibration Transducer: Generally, any device which converts movement, either shock or steady state vibration, into an electrical signal proportional to the movement; a sensor.

Viscosity: The inherent resistance of a substance to flow.

Volt: The (electrical) potential difference between two points in a circuit. The fundamental unit is defined as work per unit charge ($V=W/Q$). One volt is the potential difference required to move one coulomb of charge between two points in a circuit while using one joule of energy.

Voltage: An electrical potential which can be measured in volts.

Voltmeter: An instrument used to measure voltage.

Volumetric Flow Rate: Calculated using the area of the full closed conduit and the average fluid velocity in the form, $Q = \bar{v}A$, to arrive at the total volume quantity of flow. Q = volumetric flowrate, \bar{v} = average fluid velocity, and A = cross-sectional area of the pipe.

W

Watt Density: The watts emanating from each square inch of the heated surface area of a heater. Expressed in units of watts per square inch.

Wheatstone Bridge: A network of four resistances, an emf source, and a galvanometer connected such that, when the four resistances are matched, the galvanometer will show a zero deflection or "null" reading.

Window: In computer graphics, a defined area in a system not bounded by any limits; unlimited "space" in graphics.

Word: Number of bits treated as a single unit by a CPU. In an 8-bit machine, the word length is 8 bits; in a sixteen-bit machine, it is 16 bits.

Working Standard: A standard of unit measurement calibrated from either a primary or secondary standard which is used to calibrate other devices or make comparison measurements.

Write: To record data in a storage device or on a data medium.

Y

Young's Modulus: Also known as Modulus of Elasticity; equivalent to the ratio of normal stress to strain.

Z

Zero Adjustment: The ability to adjust the display of a process or strain meter so that zero on the display corresponds to a non-zero signal, such as 4 mA, 10 mA, or 1 Vdc. The adjustment range is normally expressed in counts.

Zero Offset: 1) The difference, expressed in degrees, between true zero and an indication given by a measuring instrument. 2) See "Zero Suppression."

Zero Point pH Meters: The electrical zero point where zero millivolts would be displayed. Used in conjunction with the slope control to provide a narrower range calibration.

Zero Point Electrode: See "Isopotential Point."

Zero Power Resistance: The resistance of a thermistor or RTD element with no power being dissipated.

Zero Suppression: The span of an indicator or chart recorder may be offset from zero (zero suppressed) such that neither limit of the span will be zero. For example, a temperature recorder which records a 100° span from 400° to 500° is said to have 400° zero suppression.

Zero Voltage Switching: The making or breaking of a circuit timed such that the transition occurs when the voltage wave form crosses zero voltage; typically found only in solid state switching devices.

Zooming: In computer graphics, causing an object to appear smaller or larger by moving the window and specifying various window sizes.