

ELECTRIC HEATER HANDBOOK GLOSSARY OF TERMS

A

- Absolute Zero:** Temperature at which thermal energy is at a minimum. Defined as 0 Kelvin, calculated to be -273.15°C or -459.67°F .
- AC:** Alternating current; an electric current that reverses its direction at regularly recurring intervals.
- Accuracy:** The closeness of an indication or reading of a measurement device to the actual value of the quantity being measured. Usually expressed as \pm percent of full scale output or reading.
- Adapter:** A mechanism or device or attaching non-mating parts.
- Alloy 11:** A compensating alloy used in conjunction with pure copper as the negative leg to form extension wire for platinum—platinum rhodium thermocouples Types R and S.
- Alloy 200/226:** The combination of compensating alloys used with tungsten vs. tungsten 26% rhenium thermocouples as extension cable for applications under 200°C .
- Alloy 203/225:** The combination of compensating alloys used with tungsten 3% rhenium vs. tungsten 25% rhenium thermocouples as extension cable for applications under 200°C .
- Alloy 405/426:** The combination of compensating alloys used with tungsten 5% rhenium vs. tungsten 26% rhenium thermocouples as extension cable for applications under 870°C .
- ALOMEGA®:** An aluminum nickel alloy used in the negative leg of a type K thermocouple (registered trademarks of OMEGA ENGINEERING, INC.).
- Alphanumeric:** A character set that contains both letters and digits.
- Alumel:** An aluminum nickel alloy used in the negative leg of a Type K thermocouple (Trade name of Hoskins Manufacturing Company).
- Ambient Compensation:** The design of an instrument such that changes in ambient temperature do not affect the readings of the instrument.
- Ambient Conditions:** The conditions around the transducer (pressure, temperature, etc.).
- Ambient Temperature:** The average or mean temperature of the surrounding air which comes in contact with the equipment and instruments under test.
- Ammeter:** An instrument used to measure current.
- Ampere (amp):** A unit used to define the rate of flow of electricity (current) in a circuit; units are one coulomb (6.25×10^9 electrons) per second.
- Amplifier:** A device which draws power from a source other than the input signal and which produces as an output an enlarged reproduction of the essential features of its input.
- Amplitude:** A measurement of the distance from the highest to the lowest excursion of motion, as in the case of mechanical body in oscillation or the peak-to-peak swing of an electrical waveform.
- Analog Output:** A voltage or current signal that is a continuous function of the measured parameter.
- Angstrom:** Ten to the minus tenth meters (10–10) or one millimicron, a unit used to define the wave length of light. Designated by the symbol Å.
- ANSI:** American National Standards Institute.
- Anti-reset Windup:** This is a feature in a three-mode PID controller which prevents the integral (auto reset) circuit from functioning when the temperature is outside the proportional band.
- ASCII:** American Standard Code for Information Interchange. A seven or eight bit code used to represent alphanumeric characters. It is the standard code used for communications between data processing systems and associated equipment.
- ASME:** American Society of Mechanical Engineers.
- ASTM:** American Society for Testing and Materials.
- ATC:** Automatic temperature compensation.
- Auto-Zero:** An automatic internal correction for offsets and/or drift at zero voltage input.
- Automatic Reset:** 1. A feature on a limit controller that automatically resets the controller when the controlled temperature returns to within the limit bandwidth set. 2. The integral function on a PID controller which adjusts the proportional bandwidth with respect to the set point to compensate for droop in the circuit, i.e., adjusts the controlled temperature to a set point after the system stabilizes.
- AWG:** American Wire Gage.

B

- Background Noise:** The total noise floor from all sources of interference in a measurement system, independent of the presence of a data signal.
- Bandwidth:** A symmetrical region around the setpoint in which proportional control occurs.
- Beryllia:** BeO (Beryllium Oxide) A high-temperature mineral insulation material; toxic when in powder form.
- BIAS Current:** A very low-level DC current generated by the panel meter and superimposed on the signal. This current may introduce a measurable offset across a very high source impedance.
- Binary:** Refers to base 2 numbering system, in which the only allowable digits are 0 and 1. Pertaining to a condition that has only two possible values or states.
- Bipolar:** The ability of a panel meter to display both positive and negative readings.
- Blackbody:** A theoretical object that radiates the maximum amount of energy at a given temperature, and absorbs all the energy incident upon it. A blackbody is not necessarily black. (The name blackbody was chosen because the color black is defined as the total absorption of light energy.)
- BNC:** A quick disconnect electrical connector used to inter-connect and/or terminate coaxial cables.
- Boiling Point:** The temperature at which a substance in the liquid phase transforms to the gaseous phase; commonly refers to the boiling point of water which is 100°C (212°F) at sea level.
- Breakdown Voltage Rating:** The dc or ac voltage which can be applied across insulation portions of a transducer without arcing or conduction above a specific current value.
- BTU:** British thermal units. The quantity of thermal energy required to raise one pound of water at its maximum density, 1 degree F. One BTU is equivalent to .293 watt hours, or 252 calories. One kilowatt hour is equivalent to 3412 BTU.
- 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 combined test) that is effective in weeding out infant mortalities because it simulates actual or worst case operation of the device, accelerated through a time, power, and temperature relationship.
- Burst Proportioning:** A fast-cycling output form on a time proportioning controller (typically adjustable from 2 to 4 seconds) used in conjunction with a solid state relay to prolong the life of heaters by minimizing thermal stress.

C

- Calender-van Dusen Equation:** An equation that defines the resistance-temperature value of any pure metal that takes the form of $RT = R_0(1 + AT + BT^2)$ for values between the ice point (0°C) and the freezing point of antimony (630.7°C) and the form $RT = R_0[1 + AT + BT^2 + C(T-100)T^2]$ between the oxygen point (-183.0°C) and the ice point (0°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 15°C .
- 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 icier point and 100°C at boiling point of water at sea level.
- Ceramic Insulation:** High-temperature compositions of metal oxides used to insulate a pair of thermocouple wires. The most common are Alumina (Al_2O_3), 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.
- Ceramic:** Polycrystalline ferroelectric materials which are used as the sensing units in piezoelectric accelerometers. There are many different grades, all of which can be made in various configurations to satisfy different design requirements.
- Chatter:** The rapid cycling on and off of a relay in a control process due to insufficient bandwidth in the controller.

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CHROMEGA®: A chromium-nickel alloy which makes up the positive leg of type K and type E thermocouples (registered trademarks of OMEGA ENGINEERING, INC.).

Clipping: The term applied to 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 is the case 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.

Closeness of Control: Total temperature variation from a desired set point of system. Expressed as "closeness of control" is $\pm 2^{\circ}\text{C}$ or a system bandwidth with 4°C , also referred to as amplitude of deviation.

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 HI or LO and ANA GND (METER GND).

Color Code: The ANSI established color code for thermocouple wires in the negative lead is always red. 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: The output form or type of control action used by a temperature controller to control temperature, i.e. on/off, time proportioning, PID.

Common-Mode Rejection Ratio: The ability of an instrument to reject interference from a common voltage at its input terminals with relation to ground.

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 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 where 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 of specific materials or devices to counteract a known error.

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.

Conformity Error: For thermocouples and RTDs, 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 can be cast iron, aluminum or plastic within which the electrical connections are made.

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

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.

Cryogenics: Measurement of temperature at extremely low values, i.e., below -200°C .

CSA: Canadian Standards Administration.

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

Current: The rate of flow of electricity. The unit is the ampere (a) defined as 1 ampere = 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 for a controller to complete one on/off cycle.

D

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

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

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

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

Density: Mass per unit of volume of a substance. I.E.: grams/cu.cm. or pounds/cu.ft.

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

Differential Input: 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 the measurement of the voltage difference between two signals tied to the same ground and provides superior common-mode noise rejection.

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

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 $\frac{1}{2}$ -digit will display a 1 and overload at 2, a $\frac{3}{4}$ -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 $3\frac{3}{4}$ digit meter.

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

DIN (Deutsche Industrial Norm): A set of German standards recognized throughout the world. The $\frac{1}{2}$ DIN standard for panel meters specifies an outer bezel dimension of 96×48 mm and a panel cutout of 92×45 mm.

DIN 43760: The standard that defines the characteristics of a 100 ohm platinum RTD having a resistance vs. temperature curve specified by a $= 0.00385$ ohms per degree.

DIN: Deutsche Industrial Norms. A German agency that sets engineering and dimensional standards that now has worldwide recognition.

Displacement: The measured 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. Measurement units expressed as inches or millinches.

Drift: A change of a reading or a set point 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. It refers to the difference in temperature between the set point 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.

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

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

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

E

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

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. A rise in (electrical) potential energy. The principal unit is the volt.

EMI: Electromagnetic interference.

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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 wood can have an emissivity around 0.95.

Endothermic: Absorbs heat. A process is said to be endothermic when it absorbs 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 in which a transducer may be exposed during shipping, storage, handling, and operation.

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

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

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

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

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

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

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

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

G

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

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

Ground: 1. The electrical neutral line having the same potential as the surrounding earth. 2. The negative side of DC power supply. 3. 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 will have the same electrical potential.

H

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: The process of thermal energy flowing from a body of high energy to a body of low energy. Means of transfer are: conduction; the two bodies contact. Convection; a form of conduction where the two bodies in contact are of different phases, i.e. solid and gas. Radiation: all bodies emit infrared radiation.

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

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

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

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 operation.

Hysteresis: See *Deadband*

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

I

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 measurements.

Input Impedance: 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.

Insulated Junction: See *Ungrounded Junction*

Insulation Resistance: The resistance measured 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, #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 characteristics of different probes.

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

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.

IPTS-48: International Practical Temperature Scale of 1948. Fixed points in thermometry as specified by the Ninth General Conference of 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 of 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.

Isothermal: A process or area that is 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 scale based upon the Celsius scale with 100 units between the ice point and boiling point of water. 0°C = 273.15K (there is no degree (°) symbol used with the Kelvin scale).

Kilowatt (kw): Equivalent to 1000 watts.

Kilowatt Hour (kwh): 1000 watt-hours. Kilovolt amperes (kva): 1000 volt amps.

KVA: Kilovolt amperes (1000-volt amps).

L

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

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

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.

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

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

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.

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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.

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

M

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

Manual Reset (Adjustment): The adjustment on a proportioning controller which shifts the proportioning band in relationship to the set point 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.

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

Measurand: A physical quantity, property, or condition which is measured.

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

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

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

Microamp: One millionth of an ampere, 10–6 amps.

Micron: One millionth of a meter, 10–6 volts.

Microvolt: One millionth of a volt, 10–6 volts.

Mil: One thousandth of an inch (.001").

Milliamp: One thousandth of an amp, 10–3 amps, symbol mA.

Millimeter: One thousandth of a meter, symbol mm.

Millivolt: Unit of electromotive force. It is the difference in potential required to make a current of 1 millampere 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 .375 to .010 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.

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

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

N

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

NBS: National Bureau of Standards.

NEC: National Electric Codes.

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, dust, splashes by non-corrosive liquids, and salt spray.

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.

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

MMR (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: An unwanted electrical interference on the signal wires.

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 set point and the actual process temperature. Also, referred to as droop.

Ohmmeter: An instrument used to measure electrical resistance.

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

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

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

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

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

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

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

P

Peltier Effect: When a current flows through a thermocouple junction, heat will either be absorbed or evolved depending on the direction of current flow. This effect is independent of joule I²R heating.

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.

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.

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

Platinel: A non-standard, high temperature platinum thermocouple alloy whose thermoelectric voltage nearly matches a Type K thermocouple (Trademark of Englehard Industries).

Platinum 6% Rhodium: The platinum-rhodium alloy used as the negative wire in conjunction with platinum-30% rhodium to form a Type B thermocouple.

Platinum 10% Rhodium: The platinum-rhodium alloy used as the positive wire in conjunction with pure platinum to form a Type S thermocouple.

Platinum 13% Rhodium: The platinum-rhodium alloy used as the positive wire in conjunction with pure platinum to form a Type R thermocouple.

Platinum 30% Rhodium: The platinum-rhodium alloy used as the positive wire in conjunction with platinum 6% rhodium to form a Type B thermocouple.

Platinum 67: To develop thermal emf tables for thermocouples, the National Bureau of Standards paired each thermocouple alloy against a pure platinum wire (designated Platinum 2 prior to 1973, and currently Platinum 67). The thermal emf's of any alloy combination can be determined by summing the "vs. Pt-67" emf's of the alloys, i.e., the emf table for a Type K thermocouple is derived from the Chromel vs. Pt-67 and the Alumel vs. Pt-67 values.

Platinum: A noble metal which in its pure form is the negative wire of Type R and Type S thermocouples.

Polarity: In electricity, the quality of having to oppositely charged poles, one positive one negative.

Positive Temperature Coefficient: An increase in resistance due to an increase in temperature.

Potential Energy: Energy related to the position or height above a place to which fluid could possibly flow.

Potentiometer: 1. A variable resistor often used to control a circuit. 2. A balancing bridge used to measure voltage.

Power Supply: A separate unit or part of a circuit that supplies power to the rest of the circuit or to a system.

Primary Standard (NBS): The standard reference units and physical constants maintained by the National Bureau of Standards upon which all measurement units in the United States are based.

Probe: A generic term that is used to describe many types of temperature sensors.

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Process Meter: A panel meter with sizeable zero and span adjustment capabilities, which can be scaled for readout in engineering units for signals such as 4–20 mA, 10–50 mA and 1–5 V.

Proportioning Band: A temperature band expressed in degrees within which a temperature controller's time proportioning function is active.

Proportioning Control Mode: A time proportioning controller where the amount of time that the relay is energized is dependent upon the system's temperature.

Proportioning Control plus Derivative Function: A time proportioning controller with a derivative function. The derivative function senses the rate at which a system's temperature is either increasing or decreasing and adjusts the cycle time of the controller to minimize overshoot or undershoot.

Proportioning Control plus Integral: A two-mode controller with time proportioning and integral (auto reset) action. The integral function automatically adjusts the temperature at which a system has stabilized back to the setpoint temperature, thereby eliminating droop in the system.

Proportioning Control with Integral and Derivative

Functions: Three mode PID controller. A timeproportioning controller with integral and derivative functions. The integral function automatically adjusts the system temperature to the set point temperature to eliminate droop due to the time proportioning function. The derivative function senses the rate of rise or fall of the system temperature and automatically adjusts the cycle time of the controller to minimize overshoot or undershoot.

Protection Head: An enclosure usually made out of metal at the end of a heater or probe where connections are made.

Protection Tube: A metal or ceramic tube, closed at one end into which a temperature sensor is inserted. The tube protects the sensor from the medium into which it is inserted.

PSIA: Pounds per square inch absolute. Pressure referenced to a vacuum.

PSID: Pounds per square inch differential. Pressure difference between two points.

PSIG: Pound per square inch gage. Pressure referenced to ambient air pressure.

PSIS: Pounds per square inch standard. Pressure referenced to a standard atmosphere.

R

Radiation: See *Infrared*

Range: Those values over which a transducer is intended to measure, specified by its upper and lower limits.

Rangeability: The ratio of the maximum flowrate to the minimum flowrate of a meter.

Rankine (°R): An absolute temperature scale based upon the Fahrenheit scale with 180° between the ice point and boiling point of water. $459.67^{\circ}\text{R} = 0^{\circ}\text{F}$.

Rate Action: The derivative function of a temperature controller. Rate time: the time interval over which the system temperature is sampled for the derivative function.

Rate Time: The time interval over which the system temperature is sampled for the derivative function.

Record: A collection of unrelated information that is treated as a single unit.

Reference Junction: The cold junction in a thermocouple circuit which is held at a stable known temperature. The standard reference temperature is 0°C (32°F). However, other temperatures can be used.

Refractory Metal Thermocouple: A class of thermocouples with melting points above 3600°F. The most common are made from tungsten and tungsten/rhenium alloys Types G and C. They can be used for measuring high temperatures up to 4000°F (2200°C) in non-oxidizing, inert, or vacuum environments.

Relay (Mechanical): An electromechanical device that completes or interrupts a circuit by physically moving electrical contacts into contact with each other.

Relay (Solid State): A solid state switching device which completes or interrupts a circuit electrically with no moving parts.

Repeatability: The ability of a transducer to reproduce output readings when the same measurand value is applied to it consecutively, under the same conditions, and in the same direction. Repeatability is expressed as the maximum difference between output readings.

Resistance Ratio Characteristic: For thermistors, the ratio of the resistance of the thermistor at 25°C to the resistance at 125°C.

Resistance Temperature Characteristic: A relationship between a thermistor's resistance and the temperature.

Resistance: The resistance to the flow of electric current measured in ohms (Ω) for a conductor resistance is function of diameter, resistivity (an intrinsic property of the material) and length.

Response Time (time constant): The time required by a sensor to reach 63.2% of a step change in temperature under a specified set of conditions. Five time constants are required for the sensor to stabilize at 100% of the step change value.

Response Time: The length of time required for the output of a transducer to rise to a specified percentage of its final value as a result of a step change of input.

RFI: Radio frequency interference.

Rheostat: A variable resistor.

Rise Time: The time required for a sensor or system to respond to an instantaneous step function, measured from the 10% to 90% points on the response waveforms.

Room Conditions: Ambient environmental conditions under which transducers must commonly operate.

Root Mean Square (RMS): Square root of the mean of the square of the signal taken during one full cycle.

RTD: Resistance temperature detector.

S

SAMA: Scientific Apparatus Makers Association. An association that has issued standards covering platinum, nickel, and copper resistance elements (RTD's).

SCR: Silicon controlled rectifier.

Scroll: To move all or part of the screen material up to down, left or right, to allow new information to appear.

Seebeck Coefficient: The derivative (rate of change) of thermal EMF with respect to temperature normally expressed as millivolts per degree.

Seebeck Effect: When a circuit is formed by a junction of two dissimilar metals and the junctions are held at different temperatures, a current will flow in the circuit caused by the difference in temperature between the two junctions.

Seebeck EMF: The open circuit voltage caused by the difference in temperature between the hot and cold junctions of a circuit made from two dissimilar metals.

Self Heating: Internal heating of a transducer as a result of power dissipation.

Sensing Element: That part of the transducer which reacts directly in response to the input.

Sensitivity Shift: A change in slope of the calibration curve due to a change in sensitivity.

Sensitivity: The minimum change in input signal to which an instrument can respond.

Setpoint: The temperature at which a controller is set to control a system.

Settling Time: The time taken for the display to settle within one digit final value when a step is applied to the meter input.

SI: System Internationale. The name given to the standard metric system of units.

Signal Conditioner: A circuit module which offsets, attenuates, amplifies, linearizes and/or filters the signal for input to the A/D converter. The typical output signal conditioner is +2 V dc.

Signal Conditioning: To process the form or mode of a signal so as to make it intelligible to, or compatible with, a given device, including such manipulation as pulse shaping, pulse clipping, compensating, digitizing, and linearizing.

Signal: An electrical transmittance (either input or output) that conveys information.

Single Precision: The degree of numeric accuracy that requires the use of one computer word. In single precision, seven digits are stored, and up to seven digits are printed. Contrast with double precision.

Single-ended Input: A signal-input circuit where SIG LO (or sometimes SIG HI) is tied to METER GND. Ground loops are normally not a problem in AC-powered meters, since METER GND is transformer-isolated from AC GND.

Software: Generally, programs loaded into a computer from external mass storage but also extended to include operating systems and documentation.

Span Adjustment: The ability to adjust the gain of a process or strain meter so that a specified display span in engineering units corresponds to a specified signal span. For instance, a display span of 200°F may correspond to the 16 mA span of a 4–20 mA transmitter signal.

Span: The difference between the upper and lower limits of a range expressed in the same units as the range.

Spare: A connector point reserved for options, specials, or other configurations. The point is identified by an (E#) for location on the electrical schematic.

Specific Gravity: The ratio of mass of any material to the mass of the same volume of pure water at 4°C.

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Specific Heat: The ratio of thermal energy required to raise the temperature of a body 1° to the thermal energy required to raise an equal mass of water 1°.

Spot Size: The diameter of the circle formed by the cross section of the field of view of an optical instrument at a given distance.

Spurious Error: Random or erratic malfunction.

SSR: Solid state relay See *Relay, Solid State*

Stability: The quality of an instrument or sensor to maintain a consistent output when a constant input is applied.

Super Cooling: The cooling of a liquid below its freezing temperature without the formation of the solid phase.

Super Heating: 1. The heating of a liquid above its boiling temperature without the formation of the gaseous phase. 2. The heating of the gaseous phase considerably above the boiling-point temperature to improve the thermodynamic efficiency of a system.

Surge Current: A current of short duration that occurs when power is first applied to capacitive loads or temperature dependent resistive loads such as tungsten or molybdenum heaters—usually lasting no more than several cycles.

T

Teflon: A fluorocarbon polymer used for insulation of electrical wires (trademark of DuPont Company).

TEMPCO: Abbreviation for "temperature coefficient": the error introduced by a change in temperature. Normally expressed in %/°C or ppm/°C.

Temperature Error: The maximum change in output, at any measurand value within the specified range, when the transducer temperature is changed from room temperature to specified temperature extremes.

Temperature Range, Compensated: The range of ambient temperatures within which all tolerances specified for Thermal Zero Shift and Thermal Sensitivity Shift are applicable (temperature error).

Temperature Range, Operable: The range of ambient temperatures, given by their extremes, within which the transducer may be operated. Exceeding compensated range may require recalibration.

Thermal Coefficient of Resistance: The change in resistance of a semiconductor per unit change in temperature over a specific range of temperature.

Thermal Conductivity: The property of a material to conduct heat in the form of thermal energy.

Thermal emf: See *Seebeck emf*

Thermal Expansion: An increase in size due to an increase in temperature expressed in units of an increase in length or increase in size per degree, i.e. inches/inch/degree C.

Thermal Gradient: The distribution of a differential temperature through a body or across a surface.

Thermal Sensitivity Shift: The sensitivity shift due to changes of the ambient temperature from room temperature to the specified limits of the compensated temperature range.

Thermal Zero Shift: An error due to changes in ambient temperature in which the zero pressure output shifts. Thus, the entire calibration curve moves in a parallel displacement.

Thermistor: A temperature-sensing element composed of sintered semiconductor material which exhibits a large change in resistance proportional to a small change in temperature. Thermistors usually have negative temperature coefficients.

Thermocouple Type (ANSI Symbol)	Material
J	Iron/Constantan
K	CHROMEGA®/ALOMEGA®
T	Copper/Constantan
E	CHROMEGA/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

Thermocouple: The junction of two dissimilar metals which has a voltage output proportional to the difference in temperature between the hot junction and the lead wires (cold junction) (refer to *Seebeck emf*).

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. They can be installed into a system by pipe thread or welded flange and are 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 form one from to another. The term is generally applied to devices that take physical phenomenon (pressure, temperature, humidity, flow, etc.) and convert it to an electrical signal.

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.

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.

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

True RMS: The true root-mean-square value of an AC or AC-plus-DC signal, often used to determine 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.

Typical: Error is within plus or minus one standard deviation (±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.

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

Ungrounded Junction: A form of construction of a thermocouple probe where the hot or measuring junction is fully enclosed by and insulated from the sheath material.

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

V

Vacuum: A pressure less than atmospheric pressure.

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

Volt: The (electrical) potential difference between two points in a circuit. The fundamental unit is derived 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.

W

Watt Density: The watts emanating from each square inch of 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.

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.

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

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