Glossary

Definitions of Commonly Used Terms Used in Heating, Sensing and Controlling

Introduction

The terms contained in this glossary are defined according to their most common use as they apply to heaters, temperature sensors, temperature controllers and power controllers. Also included are terms used in the general discussion of thermodynamic theory, thermal systems and heat energy.

A

A.G.A. See "American Gas Association."

abrasion resistance The ability of a material to resist mechanical wear.

absolute zero The temperature at which substances possess minimal energy. Absolute zero is 0 Kelvin or 0° Rankine and is estimated to be -273.15°C (-459.67°F).

ac (~) See alternating current.

ac line frequency The frequency of the alternating current power line measured in Hertz (Hz), usually 50 or 60Hz.

ac/dc (≈) Both direct and alternating current.

accelerated aging A test that simulates the effects of long-term environmental and operating conditions in a relatively short time period.

accuracy Difference between the value indicated by a measuring instrument and the corresponding true value. Sensor accuracy is based on US NIST (NBS) standards.

action The response of an output when the process variable is changed. See also "direct action," and "reverse action."

active components An electronic device whose properties change with a change in the applied signal. Diodes, transistors and integrated circuits are active components.

actual The present value of the controlled variable.

address An identification, represented by a name, label or number, of a register or location in storage, or any other data source or destination, such as the location of a station in a communication network.

Advance® A thermocouple alloy made of 55 percent copper and 45 percent nickel, used as the negative conductor in ASTM Type E, J, and T thermocouples. Advance® is a registered trademark of Harrison Alloys Company.

alarm A signal that indicates that the process has exceeded or fallen below the set or limit point. For example, an alarm may indicate that a process is too hot or too cold.

alarm dead band An area of no control or alarm change.

alarm delay The lag time before an alarm is activated.

alarm hysteresis A change in the process variable required to re-energize the alarm output.

alarm module 1) A controller hardware and software combination configured to alert an operator or perform another function in response to a problem in the thermal system. 2) A specific behavioral feature in the NAFEM (National Association of Food Equipment Manufacturers) data protocol model that determines if an alarm condition exists. It does this by providing criteria to compare against alarm object attributes.

alarm silence A feature that disables the alarm relay output.

Alloy #11® A compensating alloy made of 99 percent copper and one percent nickel. It is used to make the negative conductor that, in conjunction with pure copper, forms thermocouple extension wire for ASTM Type R and S thermocouples (platinum, platinum/rhodium). Alloy #11® is a registered trademark of Harrison Alloys. See "compensating alloy."

Alloy 188® A cobalt-based austenitic alloy that exhibits high strength and resistance to oxidation and corrosion. It is commonly used in the aerospace, nuclear, chemical and process industries. Alloy 188® is a registered trademark of Haynes International.

Alloy 203/225 Alloys made up of 90 percent nickel and 10 percent chromium (203), and 98 percent nickel and two percent chromium (225). They form thermocouple extension wire conductors for Type D (W3Re/W25Re) thermocouples for applications under 200°C (400°F). Type D is not an ASTM calibration.

Alloy 214® A material that exhibits excellent resistance to oxidation, carburization and chlorine-bearing atmospheres. It is commonly used to make sensor probe sheaths. Alloy 214® is a registered trademark of Haynes International.

Alloy 230® A material that exhibits excellent high temperature strength, oxidation resistance and long-term thermal stability. It works well in nitriding environments, and is commonly used to make sensor probe sheaths. Alloy 230® is a registered trademark of Haynes International.

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Alloy 405/426 Alloys made of 94.5 percent nickel, two percent manganese, one percent silicon and 1.5 percent aluminum (405), and 80 percent nickel and 20 percent copper (426). They form thermocouple extension wire conductors for use with Type C (W5Re/W26Re) thermocouples for applications under 870°C (1600°F). Type C is not an ASTM calibration.

Alloy 556® A multipurpose alloy that exhibits good resistance to sulfidizing, carburizing and chlorine-bearing environments. Alloy 556® is a registered trademark of Haynes International.

Alloy HR160® A material that exhibits superior resistance to sulfides with good resistance in some salt bath applications. It is commonly used to make sensor probe sheaths. Alloy HR160® is a registered trademark of Haynes International.

alpha (A) The temperature coefficient of the change in electrical resistance of a material measured in ohms/ohm/°C. It indicates the basic change in electrical resistance in a material for each °C in temperature. Alpha is a defining parameter for resistance temperature detectors (RTDs). For example, common alphas for platinum RTDs are 0.00385 Ω/Ω/°C (DIN) or 0.003916 Ω/Ω/°C (JIS).

alternating current (~) An electric current that reverses at regular intervals, and alternates positive and negative values.

Alumel® An alloy made of 95 percent nickel, two percent aluminum, two percent manganese and one percent silicon. It forms the negative conductor of ASTM Type K thermocouples. Alumel® is a registered trademark of the Hoskins Manufacturing Company.

ambient compensation See "compensation, ambient."

ambient temperature See "temperature, ambient."

American Gas Association (A.G.A.) Independent testing laboratory that tests gas-related appliances and accessories to ANSI standards, or to A.G.A. standards in the absence of a nationally-recognized standard. Watlow now uses nationally recognized testing laboratories to ANSI standards for gas-related products, rather than A.G.A.

American Wire Gauge (AWG) A standard of the dimensional characteristics of wire used to conduct electrical current or signals. AWG is identical to the Brown and Sharpe (B & S) wire gauge.

ammeter An instrument that measures the magnitude of an electric current.

ampere (amp, A) A unit that defines the rate of flow of electricity (current) in a circuit. Units are one coulomb (6.25 x 1,018 electrons) per second.

analog A method of representing data using the amplitude of a signal.

analog output A continuously variable signal that is used to represent a value, such as the process value or set point value. Typical hardware configurations are 0 to 20mA, 4 to 20mA or 0 to 5V⎓(dc).

anneal To relieve stress in a solid material by heating it to just below its melting point and then gradually cooling it to ambient temperature. Annealing usually lowers the tensile strength while improving flexibility and flex life. Metals and glasses are commonly annealed.

annunciator A visual display that uses indicator lights to display the former or existing condition of several items in a system.

ANSI American National Standards Institute. The United States government agency that defines and maintains technical standards.

anti-reset See "anti-reset windup."

anti-reset windup The feature of a PID temperature controller that prevents the integral (automatic reset) circuit from functioning when the temperature is outside the proportional band. This standard feature helps stabilize a system. Also called "anti-reset."

Application layer (OSI Layer 7) The highest layer of the seven-layer OSI (Open System Interconnection) model where communication begins with a specific application that communicates with another device or system. All application-specific functions occur here, such as user authentication and addressing. An e-mail application or web browser are examples of the application layer for exchanging data over the Internet. The Application Layer resides above the Presentation Layer.

ARP (Address Resolution Protocol) The TCP/IP protocol that converts an IP address into a physical hardware address, such as an address for an address for an Ethernet card.

ASME American Society of Mechanical Engineers.

ASTM American Society for Testing and Materials.

atmosphere The ambient environment.

atmosphere (atm) A standard unit of pressure representing the pressure exerted by a 760 mm (29.92 in.) column of mercury at sea level at 45 degrees latitude and equal to 1,000 g/cm^2 (14.22 psi).

atmospheric pressure Pressure in grams per square centimeter or pounds per square inch exerted by the earth's atmosphere on bodies located within it.

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atmospheric pressure, standard Pressure exerted by the earth's atmosphere on bodies located within it. Standard atmospheric pressure is 14.7 psi (1.013 bar abs.) measured at sea level and 15°C (60°F).

automatic mode A feature that allows the controller to set PID control outputs in response to the process variable (PV) and the set point.

automatic power reset A feature in latching limit controllers that does not recognize power outage as a limit condition. When power is restored, the output is re-energized automatically, as long as the temperature is within limits.

automatic prompts Data entry points where a microprocessor-based controller asks the operator to enter a control value.

automatic reset The integral function of a PI or PID temperature controller that adjusts the process temperature to the set point after the system stabilizes. The inverse of integral.

auto-tune A feature that automatically sets temperature control PID values to match a particular thermal system.

auxiliary output An output that controls external activities that are not directly related to the primary control output. For example, door latches, gas purges, lights and buzzers.

AWG See "American Wire Gauge."

B

B & S Gauge (Brown and Sharp Gauge) A standard of the dimensional characteristics of wire used to conduct electrical current or signals. It is identical to the American Wire Gauge.

B.T.E. thermocouple holes "Behind-the-element" ceramic tubes create electrically isolated thermocouple holes through Watlow ceramic fiber heaters. The holes are built into the heaters to very closely track element temperature for over-temperature protection and to improve heater life.

bandwidth A symmetrical region above and below the set point in which proportional control occurs.

base metal thermocouple Thermocouples with conductors made of base metallic element alloys (iron, copper, and nickel). Base metal thermocouples are ASTM Types E, J, K, N and T. They are usually used in lower temperature applications.

baud rate The rate of information transfer in serial communications, measured in bits per second.

BCC See "Block Check Character."

bend radius (standard) The specified minimum radius to which a sensor (or wire) can be bent without stressing the structure of the metal or damaging its electrical transmitting characteristics. Standard bend radius is a function of sensor (or wire) diameter.

beryllia/beryllium oxide (BeO) A white crystalline powder with a high melting temperature (approximately 2585°C or 4685°F, high thermal conductivity and high dielectric strength. Used in high-temperature ceramic thermocouple insulation. Its dust and particles are toxic. Special precautions are required when handling BeO.

blackbody An ideal surface that absorbs all incident radiation, regardless of wavelength, the direction of incidence and polarization. It radiates the maximum energy possible for given spectral and temperature conditions. A blackbody has an emissivity of 1.00. See "emissivity."

block A set of things, such as words, characters or digits that are handled as a unit.

Block Check Character (BCC) A serial communications error checking method. An acceptable method for most applications, BCC is the default method. See "Cyclic Redundancy Check (CRC)."

blocking voltage The maximum voltage a surge protector can accept without degrading its component current-protective devices.

boiling point The equilibrium temperature between a liquid and a gaseous state. For example, the boiling point of water is 100°C (212°F) at standard atmospheric pressure.

bonding The process of joining two similar or dissimilar materials. In temperature sensors and lead wires, bonding usually establishes a seal against moisture. See "potting."

braid A flexible covering formed from plaited (served) textile or ceramic fibers or metallic filaments. Textile and ceramic fibers are used to produce electrical insulation around electrical conductors. Metallic filaments are used to add abrasion resistance or shielding from electrical noise.

bright annealing The description of stainless steel or aluminum after final surface treatment, produced by passing the metal between rollers with a moderately smooth surface. This surface treatment is used in the processing of aluminum sheets, stainless steel back plates, stainless steel cold rolled sheets and cold rolled strip steels.

browser A software application that finds and displays web pages. Also called "web browser."

BS British Standards. The United Kingdom agency that defines and maintains technical standards.

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Btu British Thermal Unit. A unit of energy defined as the amount of heat required to raise one pound of water from 32°F to 33°F at standard atmospheric pressure. One Btu is equal to 0.293 watt-hours. One kilowatt-hour is equal to 3,412 Btus.

bumpless transfer A smooth transition from auto (closed loop) to manual (open loop) operation. The control output(s) does (do) not change during the transfer.

burst fire A power control method that repeatedly turns on and off full ac cycles. Also called zero-cross fire, it switches close to the zero-voltage point of the ac sine wave to minimize radio frequency interference (RFI). Variable time-base burst fire selectively holds or transits ac cycles to achieve the desired power level.

bushing The process of adding additional sheath tubing to achieve a larger, non-standard diameter.

C

cabling Gathering insulated electrical conductors into a single cable. Methods include serving (braiding), extruding or wrapping.

Calendar van Dusen equation An interpolation equation that provides resistance values as a function of temperature for RTDs.

calibration The comparison of a measuring device (an unknown) against an equal or better standard.

calibration accuracy Difference between the value indicated by a measuring instrument and a physical constant or known standard.

calibration offset An adjustment to eliminate the difference between the indicated value and the actual process value.

calorie A unit of energy defined as the amount of heat energy required to raise the temperature of one gram of water 1°C at 15°C.

carbon potential control The ability to control the carbon content in steel inside heat treating furnaces.

cascade Control algorithm in which the output of one control loop provides the set point for another loop. The second loop, in turn, determines the control action.

CAT.5 Category 5 wiring or cable manufactured to the TIA/EIA 568-A standard. The standard Ethernet wiring for 10 Mbps or 100 Mbps networks in four twisted pairs; insulated, unshielded and jacketed cable. Terminated with RJ45 connectors in lengths of 100m or less.

CDA Confidential Disclosure Agreement. A legal document that spells out the conditions and circumstances by which confidential information can be shared with another party, and the remedies required for violations. Companies typically use both general CDAs and detailed CDAs that cite specific intellectual property to protect. See “MCDA.”

CE A manufacturer’s mark that demonstrates compliance with European Union (EU) laws governing products sold in Europe.

CE-compliant Compliant with the essential requirements of European directives pertaining to safety and/or electromagnetic compatibility.

Celsius (C) Formerly known as Centigrade. A temperature scale in which water freezes at 0°C and boils at 100°C at standard atmospheric pressure. The formula for conversion to the Fahrenheit scale is:
°F = (1.8 x °C) + 32.

central processing unit (CPU) The unit of a computing system that includes the circuits controlling the interpretation of instructions and their execution.

ceramic fiber An alumina-silica fiber that is lightweight and low density. It is used as a refractory material.

ceramic insulation Materials made of metal oxides that are capable of withstanding high temperatures and providing the desired dielectric strength. They are used to insulate heater elements or thermocouple wires.

CFD Computational Fluid Dynamics. Numerical technique to solve and simulate the behavior of the Navier-Stokes equation that describes fluid flow. Used by Watlow for thermal system simulation.

cfm Cubic feet per minute. The volumetric flow rate of a fluid. When used in gas flow, it is evaluated at a given process temperature and pressure.

channel See “control channel.”

chatter The rapid on-off cycling of an electromechanical relay or mercury displacement relay due to insufficient controller bandwidth. It is commonly caused by excessive gain, little hysteresis and short cycle time.

chemical resistance The ability of a material to resist permeation, erosion or corrosion caused by base, acid or solvent chemicals.

Chromel® An alloy made of approximately 90 percent nickel and 10 percent chromium that is used to make the positive conductors of ASTM Type E and K thermocouples. Chromel® is a registered trademark of the Hoskins Manufacturing Company.

circuit Any closed path for electrical current. A configuration of electrically or electromagnetically-connected components or devices.

client The client half of a client-server system where the client is typically an application (residing on a personal computer) that makes requests to a server, computer with one or more clients networked to it. E-mail is an example of a client-server system.

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closed loop A control system that uses a sensor to measure a process variable and makes decisions based on that input.

CMM 1) Cubic meters per minute, a measure of airflow. 2) Coordinate Measuring Machines, used for dimensional inspection in manufacturing and quality applications. 3) Capability Maturity Model®, a registered trademark software development management model of the Software Engineering Institute (SEI), a research and development center sponsored by the U.S. Department of Defense and operated by Carnegie Mellon University.

CNC Computerized Numerical Control. The programmed instructions used by a class of cutting tool machines (usually driven by design software) for creating machined parts and molds.

coaxial cable A cylindrical transmission cable made of an insulated conductor or conductors centered inside a metallic tube or shield, typically of braided wires. It isolates the signal-carrying conductor from electrical interference or noise.

cold junction Connection point between thermocouple metals and the electronic instrument. See "reference junction."

cold junction compensation Electronic means to compensate for the effective temperature at the cold junction.

color code A system of standard colors used to identify electrical conductors. For example, a color code identifies the thermocouple type in thermocouple circuits. Codes common in the United States have ASTM designations. Color codes vary in different countries.

common-mode line filter A device to filter noise signals on both power lines with respect to ground.

common-mode rejection ratio The ability of an instrument to reject electrical noise, with relation to ground, from a common voltage. Usually expressed in decibels (dB).

communications The use of digital computer messages to link components. See "serial communications" and "baud rate."

compensated connectors A thermocouple connector that uses either actual thermocouple alloy contacts or compensating alloy contacts. Maintaining metallic circuit properties throughout the connection circuit reduces errors due to mismatched materials.

compensating alloy Any alloy that has similar resistance to another thermocouple alloy. Compensating alloys are usually low cost alternatives for extension lead wire types. For example, Alloy #11 is a compensating lead wire for platinum thermocouple sensors.

compensating loop An extra pair of lead wires that have the same resistance as the actual lead wires, but are not connected to the RTD element. A compensating loop corrects lead wire resistance errors when measuring temperature.

compensated, ambient The ability of an instrument to adjust for changes in the temperature of the environment and correct the readings. Sensors are most accurate when maintained at a constant ambient temperature. When temperature changes, output drifts.

computer ground A line for the ground connections to computers or microprocessor-based systems. It is isolated from the safety ground.

conduction The mode of heat transfer within a body or between bodies in contact, caused by the junction between adjacent molecules.

conductivity Electrical conductivity is the ability of a conductor to allow the passage of electrons, measured in the current per unit of voltage applied. It is the reciprocal of resistivity. Thermal conductivity is the quantity of heat conducted through a body per unit area, per unit time, per unit thickness for a temperature difference of 1 kelvin.

connection head A housing on a sensor assembly. It provides a terminal block for electrical connections, and allows the attachment of protection tubes and cables or conduit hook-ups.

connectivity Computer jargon that describes the readiness or capability of a device for communicating with other devices or systems.

Constantan A generic designation for a thermocouple alloy made of 55 percent copper and 45 percent nickel that is used as the negative conductor in ASTM Type E, J and T thermocouples.

continuity check A test of finished assemblies or wire that indicates whether electric current flows continuously throughout the length of the material. It also shows a short circuit between conductors.

control accuracy The ability to maintain a process at the desired setting. This is a function of the entire system, including sensors, controllers, heaters, loads and inefficiencies.

control action The response of the control output relative to the difference between the process variable and the set point. For reverse action (usually heating), as the process decreases below the set point, the output increases. For direct action (usually cooling), as the process increases above the set point, the output increases.

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control channel Often synonymous with “control loop.” In some markets, such as life sciences, its use may indicate the presence of a data communications feature.

control loop A control system with feedback (closed loop) from a single load to the controller, or without feedback (open loop) from the load to the controller.

control mode The type of action that a controller uses. For example, on-off, time proportioning, PID, automatic or manual, and combinations of these.

controllability See “accuracy” and “control.”

convection A mode of heat transfer in a fluid (gas or liquid) in which heat is transferred through movement of masses of the fluid from a region of higher temperature to one of lower temperature.

copper The positive conductor in an ASTM Type T thermocouple. See “OFHC.”

cps Cycles per second. Frequency. Also referred to as Hertz.

CRC See “Cyclic Redundancy Check.”

crosstalk Audio frequency signal interference coupled from one signal-carrying conductor to an adjacent conductor.

cryogenic Related to low temperatures. Generally in the range of 0° to -200°C (32° to -328°F).

CSA Canadian Standards Association. An independent testing laboratory that establishes commercial and industrial standards, tests and certifies products.

C-UL® Canadian recognition of Underwriters Laboratories, Inc. (UL®) approval of a particular product class, such as UL® 508. In some instances, C-UL® approval may stand in lieu of Canadian Standards Association (CSA) approval. All references to C-UL® stem from the original UL® file only, resident at the location of UL® approval. See “CSA and “UL®”.

Cupron® A thermocouple alloy made of 55 percent copper and 45 percent nickel. It is used in the negative conductor of ASTM Type E, J and T thermocouples. Cupron® is a registered trademark of Carpenter Technology.

current The rate of flow of electricity. The unit of measure is the ampere (A). 1 ampere = 1 coulomb per second.

current transformer A transformer designed for measuring electrical current.

cycle time The time required for a controller to complete one on-off-on cycle. It is usually expressed in seconds.

Cyclic Redundancy Check (CRC) An error checking method in communications. It provides a high level of data security, but is more difficult to implement than Block Check Character (BCC). See “Block Check Character.”

D

Data Link Layer (OSI Layer 2) The second layer of the seven-layer OSI (Open System Interconnection) protocol model that handles data packet encoding and decoding to and from bits on a network. The Data Link Layer has two sublayers, Media Access Control (MAC), and Logical Link Control (LLC). The Data Link Layer resides between the Transport Layer and the Physical Layer.

data logging A method of recording a process variable over a period of time. Used to review process performance.

dc (⎓) Direct current. An electrical current that flows in one direction.

dc resistance See “resistance.”

dead band The range through which a variation of the input produces no noticeable change in the output. In the deadband, specific conditions can be placed on control output actions.

decalibration An output shift in the thermocouple so that it no longer conforms to established standards. The shift is caused by the altering of alloys in the thermocouple conductors.

default parameters The programmed values that are permanently stored in the microprocessor software.

degree The increments in a temperature scale, or the increments of rotation of a dial. The location of a reference point in electric or phase in a cycle, in mechanical or electrical cyclic scales. One cycle is equal to 360 degrees.

density Mass per unit volume of a substance expressed in kilograms per cubic meter of pounds per cubic foot

derivative The rate of change in a process variable. Also known as rate. See “PID.”

derivative control (D) The last term in the PID control algorithm. Action that anticipates the rate of change of the process variable and compensates to minimize overshoot and undershoot. Derivative control is an instantaneous change of the control output in the same direction as the proportional error. This is caused by a change in the process variable (PV) that decreases over the time of the derivative (TD). The TD is in units of seconds.

Glossary

Deutsche Industrial Norm (DIN) A set of technical, scientific and dimensional standards developed in Germany. Many DIN standards have worldwide recognition.

deviation Any departure from a desired value or expected value or pattern. Sometimes referred to as delta.

deviation alarm Warns when a process exceeds or falls below a certain range from the set point. Alarms can be referenced at a fixed number of degrees, plus or minus, the set point.

DHCP Dynamic Host Configuration Protocol. A protocol that assigns a network device, a unique IP address each time it logs onto a network.

di/dt The time rate of change in current. Excessive di/dt can damage a phase-fired silicon controlled rectifier (SCR) power controller when it is used for large resistive loads. In this case, an inductor may be necessary to protect the SCR.

dielectric An insulating material with very low electrical conductivity.

dielectric breakdown The point at which a dielectric substance becomes conductive. Usually a catastrophic insulation failure caused by excessive voltage.

dielectric strength The potential gradient at which electric failure or breakdown occurs. Also known as breakdown potential.

differential control A control algorithm where the set point represents a desired difference between two processes. The controller then manipulates the second process to hold it at a set value relative to the first controller.

differential mode line filter A device to filter electrical noise between two power lines.

diffusion A gradual mixing of molecules of two or more substances through random thermal motion.

digital adaptive filter A filter that rejects high frequency input signal noise (noise spikes).

digital filter (DF) A filter that slows the response of a system when inputs change unrealistically or too fast. Equivalent to a standard resistor-capacitor (RC) filter.

DIN See “Deutsche Industrial Norm.”

direct action An output control action in which an increase in the process variable causes an increase in the output. Cooling applications usually use direct action.

direct current (⎓) An electric current that flows in one direction.

display capability In an instrument with digital display, the entire possible span of a particular parameter or value.

dissipation constant The ratio of the change in internal power dissipation to the resulting change in the body temperature of a thermistor.

distributed zero crossing (DZC) A form of digital output control used by Watlow Anafaze in which the output on-off state is calculated for every cycle of the ac line cycle. Power is switched at the zero crossing point, reducing electrical noise. See “zero cross.”

distributed zero crossing (DZC) A form of digital output control. Similar to burst fire.

DNS Domain Name Server. A computer that translates alphabetic internet domain names into IP (Internet protocol) addresses.

drain wire An uninsulated wire that is used as a ground conductor in wire and cable construction.

draw A manufacturing process action that pulls a material through a die to compact the material.

drift A change in reading or value that occurs over long periods. Changes in ambient temperature, component aging, contamination, humidity and line voltage may contribute to drift.

droop In proportional controllers, the difference between set point and actual value after the system stabilizes. The integral (reset) component of PID control corrects droop.

dual element sensor A sensor with two independent sensing elements. Usually used to measure temperature gradients or provide redundancy in a single point sensor assembly.

duplex control With enhanced software, duplex control splits a single process output into two individual outputs. For example, a 4 to 20mA output is split into a 4 to12mA direct action (cooling) output and a 12 to 20mA reverse action (heating) output, thus allowing one control output to function as two.

duplex wire A cable or wire with two insulated conductors that are parallel or twisted together. Duplex constructions may also include a drain-wire conductor.

duty cycle The percentage of a cycle time in which the output is on.

dv/dt Time rate of change in voltage. Excess dv/dt can cause false turn on and destroy a silicon controlled rectifier (SCR) power controller. Loose wiring connections may arc and produce this voltage change.

E

earth ground A metal rod, usually copper, that provides an electrical path to the earth, to prevent or reduce the risk of electric shock.

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efficiency The ratio of useful output energy (work) to input energy.

EIA See “Electronics Industries of America.”

EIA/TIA -232, -422, -423 and -485 Data communications standards set by the Electronic Industries of America and Telecommunications Industry Association. Formerly referred to as RS (Recognized Standard).

EIA/TIA-232 (formerly RS-232) An Electronics Industries of America (EIA)/Telecommunication Industry Association (TIA) standard for interface between data terminal equipment and data communications equipment for serial binary data interchange. This is usually for communications over a short distance (50 feet or less) and to a single device.

EIA/TIA-485 (formerly RS-485) An Electronics Industries of America (EIA)/Telecommunication Industry Association (TIA) standard for electrical characteristics of generators and receivers for use in balanced digital multipoint systems. This is usually used to communicate with multiple devices over a common cable or where distances over 50 feet are required.

elastomer Any material that returns to its original shape or dimensions after being stretched or distorted.

electrical interference Electrical noise that can obscure desired information.

electrical noise See “noise.”

electrical-mechanical relay See “relay” and “electromechanical relay.”

electromagnetic compatibility (EMC) The ability of equipment or a system to function as designed in its electromagnetic environment without introducing intolerable electro-magnetic disturbances to that environment, or being affected by electromagnetic disturbances in it.

electromagnetic interference (EMI) Electrical and magnetic noise imposed on a system. There are many possible causes, such as switching ac power on inside the sine wave. EMI can interfere with the operation of controls and other devices.

electromechanical relay A power switching device that completes or interrupts a circuit by physically opening or closing electrical contacts. Not recommended for PID control.

electromotive force (EMF) A difference in electrical potential energy, measured in volts.

Electronics Industries of America (EIA) An association in the US that establishes standards for electronics and data communications.

electropolishing Creating a bright, smooth metal surface by depositing a thin layer of another metal on it via electrolysis. Also, “electroplating.”

electrostatic discharge (ESD) An electrical discharge, usually of high voltage and low current. For example, the shock that occurs when walking across a carpet.

EMC See “electromagnetic compatibility.”

EMF See “electromotive force.”

EMI See “electromagnetic interference.”

emissivity The ratio of radiation emitted from a surface compared to radiation emitted from a blackbody at the same temperature.

endothermic A process that absorbs heat.

engineering units Selectable units of measure, such as degrees Celsius and Fahrenheit, pounds per square inch, newtons per meter, gallons per minute, liters per minute, cubic feet per minute or cubic meters per minute.

enthalpy A property expressing the relative energy state of a gas or vapor at a given temperature, pressure and volume. Expressed in units of Btu/lb or Joules/gram. It is used to evaluate the energy change that occurs when a vapor or gas is heated. Steam heating problems are readily solved using this property.

EPROM Erasable, programmable, read-only memory inside the controller.

error The difference between the correct or desired value and the actual measured value.

ESD See “electrostatic discharge.”

e-Solutions A system that allows Watlow's Authorized Distributors to complete business transactions with Watlow via the Internet. ***e-Solutions*** allows Watlow's Distributors to order products, to build products to meet specifications, to check order status and stock availability, and to access a variety of other features.

ETFE Ethylene tetrafluoroethylene, or Tefzel®, the DuPont brand. See “Tefzel.”

Ethernet A local area network (LAN) protocol that supports a bus or star-configured network with speeds up to 1,000 Mbps (megabits per second).

event An input or output signal representing an on or off state. Events can control peripheral equipment or processes, or act as an input for another control or control loop.

exothermic A process that releases heat.

explosion-proof enclosure An enclosure designed to withstand an explosion of gases inside, to isolate sparks inside from explosive or flammable substance outside, and to maintain an external temperature that will not ignite surrounding flammable gases or liquids.

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exposed junction A type of thermocouple probe in which the hot, or measuring, junction protrudes beyond the sheath material and is fully exposed to the substance being measured. It usually gives the fastest response time. No electrical isolation is provided.

extension wire See "thermocouple extension wire."

external transmitter power supply A dc voltage source that powers external devices.

extrusion A process by which a material is melted and pushed or pulled through a die to create a desired shape.

F

Fahrenheit The temperature scale that sets the freezing point of water at 32°F and its boiling point at 212°F at standard atmospheric pressure. The formula for conversion to Celsius is: °C = ⅝ (°F - 32°F).

failed sensor alarm Warns that an input sensor no longer produces a valid signal. For example, when there are thermocouple breaks, infrared problems, or resistance temperature detector (RTD) open or short failures.

FEA Finite Element Analysis. A Watlow Research and Development method of using a computer simulation to create a thermal model of a heater or heated part, saving the time and expense of multiple prototype builds. FEA optimizes the heater design with an accurate prediction of the expected temperature uniformity.

FEM Finite Element Method. A numerical technique to solve and simulate the behavior of differential equations, used for thermal system simulation.

FEP Fluorinated ethylene propylene. A fluorocarbon copolymer of tetrafluoroethylene and hexafluoropropulene. See "Teflon®."

ferrule A tubular compression component used to mount a temperature sensing probe. It creates a gas-tight seal.

fiber, insulation Any nonmetallic, nonconductive textile that is used to insulate conductors. Fibers may be braided or wrapped.

field of view The target size or distance necessary for an infrared sensor to receive 90 percent of the power radiated by a surface.

FIREROD® A registered tradename for Watlow's patented cartridge heater.

firmware A combination of software and hardware, where the software is written (embedded) into a ROM (read only memory) chip, such as PROM (programmable read only memory) or EPROM (erasable programmable read only memory).

fixed point A reproducible temperature at the equilibrium point between the phase changes in a material. For example, the triple point of water at standard atmospheric pressure is 0.01°C (32.02°F).

flexibility The relative ease with which a conductor can bend. See "bend radius."

flow area The unobstructed area in the cross section of a conduit that is available for fluid flow.

flow rate The actual volume of a fluid passing through a section of a conduit. Flow rate may be measured in cubic feet per minute, cubic meters per second or other units.

FM See "Factory Mutual Research Corporation."

FNPT informal; Female (internal) National Pipe Thread.

Form A — A single-pole, single-throw relay that uses only the normally open (NO) and common contacts. These contacts close when the relay coil is energized. They open when power is removed from the coil.

Form A or C — An electromechanical relay capable of Form A or Form C function, selected with a jumper wire.

Form B — A single-pole, single-throw relay that uses only the normally closed (NC) and common contacts. These contacts open when the relay coil is energized. They close when power is removed from the coil.

Form C — A single-pole, double-throw relay that uses the normally open (NO), normally closed (NC) and common contacts. The operator can choose to wire for a Form A or Form B contact.

fpm Feet per minute. A measure of flow velocity. When used in gas flow, it is evaluated at a specific process temperature and pressure.

fps Feet per second. A measure of flow velocity. When used in gas flow, it is evaluated at a specific process temperature and pressure.

freezing point The fixed temperature point at which a material changes from a liquid to a solid state. This is the same as the melting point for pure materials. For example, the freezing point of water is 0°C or 32°F.

frequency The number of cycles over a specified period of time, usually measured in cycles per second. Also referred to as Hertz (Hz). The reciprocal is called the period.

fuse A device that protects electric circuits by interrupting power in a circuit when an overload occurs. Silicon controlled rectifiers (SCRs) require special, fast acting fuses, sometimes referred to as I^2t ($amps^2$-seconds) fuses.

Teflon® is a registered trademark of E.I. duPont de Nemours & Company.

Glossary

fuzzy logic A type of artificial intelligence logic that uses a percentage match to represent variable or inexact data, rather than the exactly true (1) or false (0) of binary logic.

G

gain The amount of amplification used in an electrical circuit. Gain can also refer to the proportional (P) mode of PID.

GGS Glass Glass Silicone. An optional heater lead wire covering, for Watlow cartridge or multicoil tubular heaters, made with two layers of fiberglass and a silicone binder.

giga (G) A prefix that means 10^9 (one billion in the US). Note: The word billion refers to different numbers in Europe and the US. In the US a billion is one thousand million (1,000,000,000). In Germany, England, France and other countries, a billion is one million million (100,000,000,000). That is a trillion in the US.

global alarm Alarm associated with a global digital output that is cleared directly from a controller or through a user interface.

gph Gallons per hour. A measure of the volumetric flow rate of a fluid.

gpm Gallons per minute. A measure of the volumetric flow rate of a fluid.

green rot See "preferential oxidation."

ground An electrical line with the same electrical potential as the surrounding earth. Electrical systems are usually grounded to protect people and equipment from shocks due to malfunctions. Also called "safety ground."

ground loop A condition created when two or more paths for electricity are created in a ground line, or when one or more paths are created in a shield. Ground loops can create undesirable noise.

grounded potential The electrical potential of the earth. A circuit, terminal or chassis is said to be at ground potential when it is used as a reference point for other potentials in the system.

grounded junction Type of thermocouple probe in which the hot, or measuring junction, is an integral part of the sheath material. No electrical isolation is provided.

GUI Graphic User Interface. A representation, on a computer screen, of a system or process that allows the computer user to interact with the system or process.

H

HAI-KN® A thermocouple alloy made of 95 percent nickel, two percent aluminum, two percent manganese and one percent silicon that is used as the negative conductor of ASTM Type K thermocouples. HAI-KN® is a registered trademark of the Harrison Alloys Company.

HAI-KP® A thermocouple alloy made of 90 percent nickel and 10 percent chromium used in the positive conductor of ASTM Type K and E thermocouples. HAI-KP® is a registered trademark of the Harrison Alloys Company.

Hastelloy® A family of related alloys (X, Alloy B2 and C276). Hastelloy® is a registered trademark of Haynes International.

HDPE Chemical abbreviation representing high-density polyethylene plastics.

heat Energy transferred between material bodies as a result of a temperature difference between them. See "Btu," "calorie" and "Joule."

heat transfer The flow of heat energy from one body of higher temperature to one of lower temperature.

heat treating thermocouple See "thermocouple" and "heat treating."

heat/cool output filter A filter that slows the change in the response of the heat or cool output. The output responds to a step change by going to approximately ⅔ its final value within the number of scans that are set.

heated insulation concept A description of one of the major features of the ceramic fiber heater product line from Watlow Columbia, that the insulation and heater element exist in one package.

heat sink Any object that conducts and dissipates heat away from an object in contact with it. Also a finned piece of metal, usually aluminum, that is used to dissipate heat generated by electrical and electronic devices.

Hertz (Hz) Frequency, measured in cycles per second.

high deviation alarm Warns that the process exceeds the set point by the high deviation value or more. It can be used as either an alarm or control function.

high process alarm Warns that the process exceeds a set value. It can be used as either an alarm or control function.

high process variable See "process variable."

high reading An input level that corresponds to the high process value. For linear inputs, the high reading is a percentage of the full scale input range. For pulse inputs, the high reading is expressed in cycles per second (Hertz, Hz).

hi-pot test A test that applies a high voltage to a conductor to assure the integrity of the surrounding insulation. See "dielectric breakdown."

hole fit The gap between the cartridge heater sheath and the part it fits into. The smaller this gap, the better the heater transfer to the part.

Glossary

hot change A feature of ceramic fiber and band heaters that allows individual heater replacement without total system shutdown or disassembly.

HTML Hypertext Markup Language. HTML uses tags and attributes to format documents displayed on a web browser.

HTTP Hypertext Transfer Protocol. The protocol used by the worldwide web that defines messages and transmissions between servers and clients.

hub connecting point in a star-configured LAN (local area network). A hub gathers individual network nodes together.

hunting Oscillation of a process value near the set point.

Hypalon® A synthetic rubber, chlorosulfonated polyethylene. Hypalon® is a registered trademark of the E.I. duPont de Nemours & Company.

hysteresis A change in the process variable required to re-energize the control or alarm output. Sometimes called switching differential.

I

I.D. Inside diameter.

ice point The temperature at which pure water changes from a liquid to a solid (freezes). 0°C (32°F).

idle set point Desired control value after a timing period.

IETF Internet Engineering Task Force A collection of expert volunteers who by consensus set the engineering standards for Internet technology. The IETF is overseen by the Internet Society, an international, non-profit, membership organization focused on the expansion of the Internet.

IFC heated part Interference Fit Construction. A manufactured part with a specially designed groove milled into it with an IFC heater element permanently formed into the groove, creating intimate contact between the element and the part. IFC heated parts offer an alternative to milled groove heaters and brazed heater assemblies for application with temperatures too high for aluminum "cast-in" heated parts, or for environments where cast aluminum cannot be used.

i-key A toggle-action information key on controllers that provides context sensitive help in a display. Typically colored as "highway information sign blue," i.e., Pantone 293C or equivalent.

impedance (Z) The total opposition of a circuit to the flow of alternating current. It includes resistance and reactance, and is measured in ohms.

Incoloy® A family of related alloys (800, 800X and 825). A registered trademark of the Special Metals Corporation (formally Inco).

Incoloy® 800 The standard heater protective sheath material, a nickel-iron-chromium alloy, and registered tradename of Special Metals Corporation, used for the Watlow FIREROD® heater. Incoloy® 800 is very corrosion- and temperature-resistant, and a key to the long-lived FIREROD® in high-temperature applications.

Inconel® A family of related alloys (600, 601, 625, X750). A registered trademark of the Special Metals Corporation (formerly Inco).

indication accuracy Closeness between the displayed value and a measured value. Usually expressed as a + or -, a percent of span or number of digits.

infrared A region of the electromagnetic spectrum with wavelengths ranging from one to 1,000 microns. These wavelengths are most suited for radiant heating and infrared (non-contact) temperature sensing.

initial calibration tolerance The allowable deviation from the theoretical EMF value generated by any particular thermocouple type at a given temperature. See "limit of error."

input Process variable information that is supplied to the instrument.

input scaling The ability to scale input readings (readings in percent of full scale) to the engineering units of the process variable.

input type The signal type that is connected to an input, such as thermocouple, RTD, linear or process.

installed power Amount of power used for an application or process. It is the same as the kilowatt (kW) rating of installed heaters.

Instrument Society of America (ISA) An engineering society that defines and maintains standards for scientific and technical measuring devices.

insulation A material that electrically isolates a conductor from its surroundings, or thermally isolates an object from its surroundings.

insulation resistance The capacity of an insulation material to resist the flow of electricity. Expressed in ohms. See "dielectric strength."

integral Control action that automatically eliminates offset, or droop, between set point and actual process temperature. See "reset" and "automatic reset."

integral control (I) A form of temperature control. The I of PID. See "integral."

interchangeability The ability to interchange system components with minimum effect on system accuracy.

Glossary

IP One of two primary protocols that internet hosts use. IP describes the message packet (datagrams or segment of messages) format. IP is network layer protocol defined by the IETF. See "TCP" and "TCP/IP."

IPTS48, 68 International Practical Temperature Scales of 1948 and 1968. These have been superseded by ITS90. See "ITS90."

iron The positive conductor in ASTM Type J thermocouples.

ISA See "Instrument Society of America."

isolation junction A form of thermocouple probe construction in which the measuring junction is fully enclosed in a protective sheath and electrically isolated from it. Commonly called an ungrounded junction.

isolation Electrical separation of sensor from high-voltage circuitry. Allows use of grounded or ungrounded sensing element.

isothermal A process, volume or area that maintains a constant temperature.

ITS90 International Temperature Scale of 1990. The standard scale made of fixed points that closely approximate thermodynamic temperatures. All temperatures between the fixed points are derived by interpolation using the assigned interpolation instrument. Adopted in late 1993, this scale replaces both IPTS48 and 68.

J

jacket The outer covering on a wire or cable. It may provide electrical insulation and/or resistance to chemicals, abrasion and moisture.

JDA Joint Development Agreement. Specifies what role each party agrees to when developing a new product.

JIS See "Joint Industrial Standards."

job A set of operating conditions for a process that can be stored and recalled in a controller's memory. Also called a recipe.

Joint Industrial Standards (JIS) A Japanese agency that establishes and maintains standards for equipment and components. Also known as JISC (Japanese Industrial Standards Committee), its function is similar to Germany's Deutsche Industrial Norm (DIN).

Joule A basic unit of heat energy, equal to the work done when a current of one ampere is passed through a resistance of one ohm for one second.

junction The point where two dissimilar metal conductors join to form a thermocouple.

K

Kapton® A lightweight organic polymer film that is a versatile dielectric material because of its tensile strength, dimensional stability and low emission of gas in vacuums. A registered trademark of the E.I. duPont de Nemours & Company.

Kelvin (k) An absolute temperature scale. Zero Kelvin is absolute zero. No degree symbol (°) is used with the Kelvin scale. (0°C = 273.15K, 100°C = 373.15K).

kilo (k) A prefix meaning thousand.

kilowatt (kW) Unit of electrical power equal to 1,000 watts or 3,412 Btus per hour when the power factor equals 1.0.

kilowatt hour (kWh) Unit of electrical energy, or work, expended by one kilowatt in one hour. Also expressed as 1,000 watt hours.

Nial® and Tophel® are registered trademarks of Carpenter Technology (Car Tech).

Chromel® and Alumel® are registered trademarks of Hoskins Manufacturing Company.

KN A thermocouple alloy made of 95 percent nickel, two percent aluminum, two percent manganese and one percent silicon that is used in the negative conductor of ASTM Type K thermocouples. Manufacturer trademarks for KN include Alumel®, Nial® and HAI-KN®.

KP A thermocouple alloy made of 90 percent nickel and 10 percent chromium that is used in the positive conductors of ASTM Type E and K thermocouples. Manufacturer trademarks for KP include Chromel®, Tophel® and HAI-KP®.

kVA Kilovoltampere or 1,000 voltamperes (VA). One unit of apparent power equals 1VA.

k-value The measure of a material's thermal conductivity coefficient or its ability to conduct heat. Copper conducts better than plastic; copper has a higher k value. The k-value is expressed in W/cmK (watt per centimeter Kelvin) or in Btu/hft.F (Btu per hour per ft. degree Fahrenheit). The k-value is the reciprocal of the R-value, thermal resistance.

L

LA Lead Adaptor. Watlow's patented method for adding a variety of options for leads and lead protection to stock heaters.

ladder logic An electrical circuit diagram schematic style that arranges the positive and negative sides of the power input as the two main beams of a vertical ladder, and arranges the connections between them as the rungs of the ladder.

lag The amount of time delay between two related parts of a process or system.

HAI-KN® and HAI-KP® are registered trademarks of Harrison Alloys Company.

Glossary

LAN Local Area Network. A computer network in a single physical location. LANs can be connected together in a Wide Area Network (WAN).

latent heat of fusion (H_F) The amount of heat energy, expressed in Btu/lb or Joule/gram, required to change a solid to a liquid without an increase in temperature.

latent heat of vaporization (H_V) The amount of heat energy, expressed in Btu/lb or Joule/gram, required to change a liquid to a vapor without an increase in temperature.

lava cone Low temperature silicate-based insulator used between electrically conductive and non-conductive casings or tubes.

LCP Liquid Crystal Polymer. A high-temperature thermoplastic with good impact strength.

LED See "light emitting diode."

leg One connection in an electric circuit.

light emitting diode (LED) A solid-state electronic device that glows when electric current passes through it.

limit of error A tolerance band of the thermal electric response of thermocouple wire, expressed as a percentage or a specific degree value in defined temperature ranges, defined by the ASTM specification MC96.1 (1982).

limit or limit controller A highly reliable, discrete safety device (redundant to the primary controller) that monitors and limits the temperature of the process, or a point in the process. When temperature exceeds or falls below the limit set point, the limit controller interrupts power through the load circuit. A limit controller can protect equipment and people when it is correctly installed with its own power supply, power lines, switch and sensor.

linear input A process input that represents a straight line function.

linearity The deviation in response from an expected or theoretical straight line value for instruments and transducers. Also called linearity error.

linearization, input See "linearization" and "square root."

linearization, square root The extraction of a linear signal from a nonlinear signal corresponding to the measured flow from a flow transmitter. Also called square root extraction.

liquid crystal display (LCD) A type of digital display made of a material that changes reflectance or transmittance when an electrical field is applied to it.

load The electrical demand of a process, expressed in power (watts), current (amps) or resistance (ohms). The item or substance that is to be heated or cooled.

local set point The primary set point.

loop See "control loop."

loop alarm Any alarm system that includes high and low process, deviation band, dead band, digital outputs, and auxiliary control outputs.

loop resistance The total resistance of the conducting materials in a thermocouple circuit.

low deviation alarm Warns that the process is below the set point by the low deviation value or move process variable. It can be used as either an alarm or control function.

low process alarm Warns that the process is below a set value. It can be used as either an alarm or control function.

low process variable See "process variable."

low reading An input level corresponding to the low process value. For linear inputs, the low reading is a percentage of the full scale input range. For pulse inputs, the low reading is expressed in cycles per second, Hertz (Hz).

M

manual mode A selectable mode without automatic control. The operator sets output levels. Same as open loop control.

manual reset 1) A feature on a limit control that requires human intervention to return the limit to normal operation after a limit condition has occurred. 2) The adjustment of a proportional control to raise the proportional band to compensate for droop.

mass flow rate The amount of a substance that flows past a given cross-section area of a conduit in a given unit of time.

master A device that transmits a set point signal to other controlling devices, called remotes.

maximum load impedance The largest load that the output device can operate. Usually specified in ohms.

maximum operating temperature The highest temperature at which a device can operate safely, or with expected normal service life.

maximum power rating The maximum operating power at which a device can operate safely or with expected normal operating life.

MCDA Mutual Confidential Disclosure Agreement. A legal document that spells out mutual provisions for both parties, and the conditions and circumstances in which confidential information can be shared by both parties, and the remedies required for violations.

Glossary

MDR See "relay, mercury displacement."

measuring junction See "junction."

measuring junction The thermocouple junction that is affixed to or inserted into the material being measured. Also called hot junction.

mega (M) A prefix that means one 10^6 (one million in the US).

megawatt (MW) $1x10^6$ watts or 1,000,000 (one million) watts.

melting point The temperature at which a substance changes from a solid to liquid state. This is the same as the freezing point of pure materials.

menu A list of options from which the operator can select the tasks to be done.

mercury displacement relay (MDR) A power switching device in which mercury, displaced by a plunger, completes the electric circuit across contacts.

metal fatigue A breakdown in metal strength caused by mechanical action. For example, when sheath and conductor materials have different linear expansion coefficients, heating and cooling cause mechanical movement that induces strain. Metal fatigue shortens the life of the heater and the thermocouple.

MGT Mica Glass Teflon®. An optional heater lead wire covering, used with several Watlow heater lines, made with mica, fiberglass and a Teflon® binder.

MI leads Mineral Insulated leads. A Watlow LA (Lead Adaptor) termination option for cartridge heaters that handles both high temperatures up to 815°C (1,500°F) and contamination, such as moisture, gases, oils, plastic drool, solvents and water.

MIB Management Information Base A database of defined properties of objects that can be monitored or manipulated by a network administrator via an SNMP agent.

mica A silicate material used primarily as an electrical and heat insulator.

micron A unit of length. One micron is equivalent to 10^{-6} meters.

microvolt (µV) One 10^{-6} of a volt (one millionth in the US).

mil One thousandth of an inch, or 0.001 inches in decimal form.

milled groove A machined groove milled into a part to accept a heater shaped to fit the groove.

milliampere (mA) One 10^{-3} (thousandth) of an ampere.

millivolt (mV) One 10^{-3} (thousandth) of a volt.

mineral insulated thermocouple A thermocouple probe constructed by loading a metal sheath with thermocouple conductors and a mineral-based dielectric material, then compacting the entire assembly.

minimum load current The smallest load current required to ensure proper operation of an output switching device.

minimum output impedance See "offstate impedance."

MNPT informal; Male (external) National Pipe Thread.

MO Magnesium Oxide. The powdered chemical compound used in heater manufacturing to insulate the resistance wire from the metal sheath. This high grade material also contributes to the long life of Watlow heaters.

MODBUS™ protocol driver A software program subroutine that converts programming language- or operating system-specific instructions to the MODBUS™ protocol for a MODBUS™ device.

moisture resistance The relative ability to resist permeation by water.

Monel® An alloy made of nickel and copper sensor sheath that is used to make sensor sheaths. It exhibits excellent resistance to sea water; to hydrofluoric, sulfuric and hydrochloric acids; and to most alkalis. Monel® is a registered trademark of the Special Metals Corporation (formally Inco).

multilayer hybrid A hybrid circuit constructed of alternating conductive and insulating layers. The multilayer structure combines very dense packaging of electronics with good ability to remove generated heat. Multilayers are typically built through repeated firings as layers are added and are typically constructed with gold, silver-palladium or copper conductors.

Mylar® Terephtalate (polyester) film. A registered trademark of the E.I. duPont de Nemours & Company.

N

National Bureau of Standards (NBS) Now called the National Institute of Standards Technology (NIST).

National Electrical Code (NEC) A set of specifications devised for the safe application and use of electric power and devices in the United States.

National Electrical Manufacturers Association (NEMA) A United States association that establishes specifications and ratings for electrical components and apparatuses. Conformance by manufacturers is voluntary.

National Institute of Standards and Technology (NIST) A United States government agency responsible for establishing scientific and technical standards. Formerly the National Bureau of Standards.

National Pipe Thread (NPT) The taper pipe thread standard used in North America.

Glossary

NBS See “National Bureau of Standards.”

NEC See “National Electrical Code.”

negative temperature coefficient A decrease in electrical resistance that occurs with a temperature increase. See “thermistor.”

NEMA See “National Electrical Manufacturers Association.”

NEMA 4X A NEMA specification for determining resistance to moisture infiltration and corrosion resistance. This rating certifies the controller as washable and corrosion resistant.

neoprene A synthetic rubber, also referred to as polychloroprene, that exhibits good resistance to oil, chemicals and flame.

NetBios Network Basic Input Output System. An application programming interface (API) that adds special network functions to a computer’s basic operating system.

Network Layer (OSI Layer 3) The third layer of the seven-layer OSI (Open System Interconnection) protocol model that handles switching, routing, and packet sequencing between nodes on a network. The Network Layer resides between the Transport Layer and the Data Link Layer.

Nial® A thermocouple alloy made of 95 percent nickel, two percent aluminum, two percent manganese and one percent silicon that is used in the negative conductor of ASTM Type K thermocouples. Nial® is a registered trademark of Carpenter Technology.

nicrosil A thermocouple alloy that is made of 84.6 percent nickel, 14.0 percent chromium and 1.4 percent silicon. It is used in the positive conductor of an ASTM Type N thermocouple.

nisil A thermocouple alloy that is made of 95.6 percent nickel and 4.4 percent silicon. It is used in the negative conductor of an ASTM Type N thermocouple.

NIST See “National Institute of Standards and Technology.”

no key reset A method for resetting the controller's memory (for instance, after an EPROM change).

noble metal thermocouple The general designation for thermocouples with conductors made of platinum and/or platinum alloys (ASTM Types B, R and S). They are used in high-temperature or corrosive applications.

node A connection point on a computer network for one computer or other addressable device, such as a printer.

no-heat The part of a Watlow heater intentionally designed as unheated, or as an unheated extension, outside the resistance wire (heater coil) area. The no-heat area has a lower temperature due to heat losses of various types: radiation; conduction; or convection.

noise Unwanted electrical signals that usually produce signal interference in sensors and sensor circuits. See “electromagnetic interference (EMI).”

noise suppression The use of components to reduce electrical interference that is caused by making or breaking electrical contact, or by inductors.

Nomex® A temperature-resistant, flame retardant nylon compound that is used as a wire insulation. A registered trademark of E.I. duPont de Nemours & Company.

NPT See “National Pipe Thread.”

NPT American National Standard Taper Pipe Thread as defined by ANSI B1.20.1.

NSF 1) National Sanitation Foundation; 2) National Science Foundation.

NUWARMTH® A Watlow wholly-owned subsidiary that produces and markets consumer-focused thermopolymer products primarily for the home and automotive industries.

nylon A thermoplastic that is commonly used as an insulation because it exhibits excellent abrasion and good chemical resistance.

O

O.D. Outside diameter.

offset Synonym for “droop.” In a stable thermal system, the difference between the process set point and the process actual temperature. An offset variable can be introduced intentionally into the system by some controllers to compensate for sensor placement. In PID control, integral (reset) will eliminate droop.

offstate impedance The minimum electrical resistance of the output device in the off, or de-energized, state. It is based on the frequency of the load supply current plus internal and/or external noise suppression devices.

OFHC Oxygen-free, high conductivity copper. The pure copper used in the positive conductor of a an ASTM Type T thermocouple.

ohm (Ω) The unit of electric resistance. The resistance value through which one volt will maintain a current of one ampere. See “Ohm’s Law.”

Ohm’s Law Current in a circuit is directly proportional to the voltage, and inversely proportional to resistance; stated as: E = IR, I = E/R, R = E/I, P = EI where 1 = current in amperes, E = EMF in volts, R = resistance in ohlms and P = power in watts.

Glossary

OID ("oh-eye-dee") Object IDentifier. In the NAFEM (National Association of Food Equipment Manufacturers) context, Object Identifiers form an index of attributes of a supplier's programmable objects in a data protocol model. Object identifiers derive from the SNMP standard.

on-off A method of control that turns the output full on until set point is reached, and then off until the process error exceeds the hysteresis.

on-off controller A temperature controller that operates in either full-on or full-off state.

open loop A control system with no sensory feedback. See "manual mode."

operator menus The menus accessible from the front panel of a controller. These menus allow operators to set or change various control actions or features.

optical isolation Two electronic networks that are connected through an LED (light emitting diode) and a photoelectric receiver. There is no electrical continuity between the two networks.

OSHA Occupational Safety and Health Act. Also the Occupational Safety and Health Agency, the United States governmental agency that establishes and enforces safety standards in the workplace.

OSI Reference Model (Open System Interconnection, ISO/IEC 7498-1) A seven-layered model for developing and implementing communication among systems. Control passes from one layer to the next and back again, beginning at the application layer in the system that initiates the communication. The reference model provides a common basis for the coordination of standards development for the purpose of systems interconnection from ISO/IEC 7498-1.

output The control signal that affects the and process value.

output type The form of PID control output, such as time proportioning, distributed zero crossing, serial digital-to-analog converter or analog. Also the description of the electrical hardware that makes up the output.

overshoot The amount by which a process variable exceeds the set point before it stabilizes.

P

P control Proportioning control.

panel lock A feature that prevents operation of the front panel.

parallel circuit A circuit configuration in which the same voltage is applied to all components, with current divided among the components according to their respective resistances or impedances.

parameter 1. A variable that is given a constant value for a specific application or process. 2. A value that determines the response of an electronic controller to given inputs.

passivation A process for treating stainless steel surfaces, usually with dilute nitric acid to remove contaminants, and to apply a passive film protecting the fresh metal surface.

passive component A component whose properties do not change with changes in the applied signal. Resistors, capacitors and inductors are passive components.

PC See "polycarbonate."

PD control Proportioning control with derivative (rate) action.

PDR control Proportional derivative control with manual reset, used in fast responding systems where the reset causes instabilities. With PDR control, an operator can enter a manual reset value that eliminates droop in the system.

PEI See "polyetherimide."

Peltier Effect Inverse of Seebeck effect, used in thermoelectric applications. See "Seebeck" effect.

percent power control Open-loop control with output power set at a particular level.

percent power limit Restriction of output power to a predetermined level.

PET Chemical abbreviation for polyethylene terephthalate.

PFA Chemical abbreviation representing a perfluoroalkyl group. See "Teflon®."

phase The time-based relationship between alternating current cycles and a fixed reference point. In electricity, it is usually expressed in angular degrees, with a complete cycle equal to 360˚. It describes the relationships of voltage and current of two or more alternating waveforms.

phase-angle firing A mode of power control in silicon controlled rectifiers (SCRs). Phase-angle firing varies the point at which the SCR switches voltage inside the AC sine wave.

Physical Layer (OSI Layer 1) The first and lowest layer of the seven-layer OSI (Open System Interconnection) protocol model where bits of information move through the physical medium or space. The Physical Layer includes the hardware means of moving the information. The Physical Layer resides below the Data Link Layer.

PI control Proportioning control with integral (automatic reset) action.

PID Proportional, Integral, Derivative. A control mode with three functions: proportional action dampens the system response, integral corrects for droop, and derivative prevents overshoot and undershoot.

Glossary

ping Packet Internet groper. A computer utility used to troubleshoot Internet connections. Ping verifies that a specific IP address is available.

plastic Natural and synthetic polymeric substances, excluding rubbers, that flow under heat and/or pressure. See http://www.plasticstechnology.com/materials/index.html for an extensive materials database, including abbreviations, properties, features, etc.

Platinel® A nonstandard platinum alloy with thermoelectric characteristics that closely match ASTM Type K thermocouples at temperatures above 800°C (1440°F). Platinel® is a registered trademark of Englehard Industries.

platinum (Pt 2) A noble metal that is more ductile than silver, gold or copper, and has excellent chemical and heat resistant characteristics. It is used in the negative conductor in ASTM Types R and S thermocouples.

platinum 10 percent rhodium The platinum-rhodium thermocouple alloy that forms the positive conductor on ASTM Type S thermocouples.

platinum 13 percent rhodium The platinum-rhodium thermocouple alloy that forms the positive conductor on ASTM Type R thermocouples.

platinum 30 percent rhodium The platinum-rhodium thermocouple alloy that forms the positive conductor on ASTM Type B thermocouples.

platinum 6 percent rhodium The platinum-rhodium thermocouple alloy that forms the negative conductor on ASTM Type B thermocouples.

platinum 67 An NIST platinum standard. Platinum 67 is used to interpolate the temperature scale between 630.74 and 1064.43°C (1167.33 and 1947.97°F). Replacing platinum 27, platinum 67 (IPTS68) is nine microvolts negative to platinum 27.

polarity The electrical quality of having two opposite poles, one positive and one negative. Polarity determines the direction in which a current tends to flow.

poll engine A software application dedicated to continuously requesting data from connected devices on a network.

polycarbonate (PC) A thermoplastic that offers high strength and toughness.

polyester A broad class of polymers possessing good moisture resistance and electrical properties.

polyetherimide (PEI) A high-temperature thermoplastic with excellent strength and chemical resistance.

polyethylene (PE) A thermoplastic that exhibits excellent dielectric characteristics.

polymer Any substance made of many repeating chemical molecules. Often used in place of plastic, rubber or elastomer.

polyphenylene sulfide (PPS) A high-temperature thermoplastic with good solvent resistance and flame retardation.

polypropylene A thermoplastic that is similar to polyethylene, but has a higher softening point (temperature).

polysulfone (PSU) A thermoplastic with excellent water and similar fluid resistance.

polyurethane (PUR) A broad class of polymers that has good abrasion and chemical resistance.

polyvinyl chloride (PVC) A thermoplastic with excellent dielectric strength and flexibility.

positive temperature coefficient (PTC) An increase in resistance that occurs with an increase in temperature. See "resistance temperature detector" and "thermistor."

potting The sealing of components and associated conductors with a compound to exclude moisture and contaminants.

power factor (PF) The ratio of real power (P_R) to apparent power (P_A).

power loss alarm Associated with latching limit controls, the limit control recognizes a power outage as a limit condition. Manual reset is required to re-energize the output after power is restored.

PPS See "polyphenylene sulfide."

pre-aging A process by which a thermocouple is subjected to application conditions that cause most of any electromagnetic force shift (decalibration). When it is installed and calibrated to an instrument, a pre-aged thermocouple will produce reliable readings.

preferential oxidation Commonly called green rot. A phenomenon peculiar to nickel-based thermocouples, most often ASTM Type K, when oxygen is limited. The limited oxygen reacts with the more active chromium in the conductor alloy, which changes to chromium oxide and creates a green scale. An increasing nickel skin is left behind, causing decalibration. Decalibration is caused when the negative thermoelement is paired against a nickel skin and not the original homogeneous nickel-chromium alloy. Preferential oxidation will not occur when there is an abundant supply or a total absence of oxygen.

presentation layer (OSI Layer 6) The sixth layer of the seven-layer OSI (Open System Interconnection) protocol model where syntax, compatibility, and encryption issues are resolved. The Presentation Layer resides between the Application Layer and the Session Layer.

Glossary

primary standard An instrument that meets conditions required by the International Temperature Scale (ITS90).

probe A temperature sensor. A probe may contain a thermocouple, RTD, thermistor or integrated circuit (IC) sensor.

process alarm Warns that process values are outside the process alarm range. A fixed value independent of the set point.

process error The difference between the set point and the actual process value.

process variable The parameter that is controlled or measured. Typical examples are temperature, relative humidity, pressure, flow, fluid level, events, etc. The high process variable is the highest value of the process range, expressed in engineering units. The low process variable is the lowest value of the process range.

programmed display data Displayed information that gives the operator the intended process information, such as intended set point, intended alarm limit, etc., corresponding to temperature or other engineering units.

prompt A symbol or message displayed by the computer or controller that requests input from the user.

proportional Output effort proportional to the error from set point. For example, if the proportional band is 20° and the process is 10° below set point, the heat proportioned effort is 50 percent. The lower the PB value, the higher the gain.

proportional band (PB) A range in which the proportioning function of the control is active. Expressed in units, degrees or percent of span. See "PID."

proportional control A control using only the P (proportional) value of PID control.

protection head An enclosure that protects the electrical connections of heaters or sensor probes.

protection tube A tube that protects a sensor (thermocouple, RTD or thermistor) from harsh environmental or process conditions.

psia Pounds per square inch absolute. Pressure expressed in terms of its actual or absolute value with reference to a perfect vacuum. psia = psig + 14.7 psi (1 atmosphere). See "psig."

psig Pounds per square inch gauge. Pressure expressed in terms of a value read directly from installed gauges. psig = psia -14.7 psi (1 atmosphere). See "psia."

PSU See "polysulfone."

PTFE Chemical abbreviation for polytetrafluoroethylene. See "Teflon®" and "TFE."

pulse input Digital pulse signals from devices, such as optical encoders.

PVC See "polyvinyl chloride."

Q

quality Thermodynamic term that indicates the relative amount of liquid present in saturated steam as a percent of the total weight. The quality of steam is 100 percent minus the percent of liquid. Dry saturated steam has a quality of 100 percent.

R

radiation Radiant energy emitted in the form of waves or particles. See "emissivity" and "infrared."

radio frequency interference (RFI) Electromagnetic waves between the frequencies of 10kHz and 300gHz that can affect susceptible systems by conduction through sensor or power input lines, and by radiation through space.

ramp A programmed increase in the temperature of a set point system.

range The area between two limits in which a quantity or value is measured. It is usually described in terms of lower and upper limits.

rate Anticipatory action that is based on the rate of temperature change, and compensates to minimize overshoot and undershoot. See "derivative."

rate band A range in which the rate function of a controller is active. Expressed in multiples of the proportional band. See "PID."

ratio A method by which the controller measures the flow of an uncontrolled variable and uses a portion of it to control the flow of a second variable.

recipe See "job."

reference junction The known temperature point at which a thermocouple or its extension wire connects to a temperature measurement instrument or controller. To prevent an error from introducing itself at this point, some instruments will add a compensation value to the signal. Also called the "cold junction."

reflection compensation mode A control feature that automatically corrects the reading from a sensor.

reflective energy Energy from the background that causes an error when an infrared sensor measures the radiant energy of a specific object.

refractory metal thermocouple A thermocouple made from materials such as tungsten and rhenium, which melt above 1935°C (3515°F). These are non-ASTM types C, D and G.

relative thermal index (RTI) A long-term heat aging test used by Underwriter's Laboratories (UL®) to determine the maximum application temperature for plastics.

relay A switching device.

Glossary

remote A controller that receives its set point signal from another device called the master.

remote set point A signal from another device that indicates the set point for the process.

repeatability The ability to provide the same output or reading under repeated, identical conditions. See "stability."

reset Control action that automatically eliminates offset, or droop, between set point and actual process temperature. Also see "integral."

reset windup inhibit See "anti-reset wind-up."

resistance Opposition to the flow of electric current, measured in ohms. See "ohms."

resistance temperature characteristic The characteristic change in a sensor's resistance when exposed to a change in temperature. See "positive temperature coefficient" and "negative temperature coefficient."

resistance temperature detector (RTD) A sensor that uses the resistance temperature characteristic to measure temperature. There are two basic types of RTDs: the wire RTD, which is usually made of platinum, and the thermistor, which is made of a semiconductor material. The wire RTD is a positive temperature coefficient sensor only, while the thermistor can have either a negative or positive temperature coefficient.

resistive loads All loads that limit the flow of electric current. With pure resistive loads, voltage and current are in phase.

resolution An expression of the smallest input change unit detectable at a system output.

response time (time constant) 1) The time required by a sensor to reach 63.2 percent of a temperature step change under a specified set of conditions. Five time constants are required for the sensor to stabilize at 100 percent of the step change value. 2) With infrared temperature sensing, the time required for a sensor to reach 95 percent of a step change. This is known as the time constant times three. The overall system response time is the sum of the time constants of each component.

retransmit output An analog output signal that may be scaled to represent the process value or set point value.

reverse action An output control action in which an increase in the process variable causes a decrease in the output. Heating applications usually use reverse action.

RFI See "radio frequency interference."

rhenium (Re) A metallic element that, when added to tungsten, forms an alloy with better ductility and higher temperature strength than tungsten alone.

rhodium (Rh) A metallic element inside the platinum group that, when added to pure platinum, forms an alloy with reduced ductility and better high temperature strength than platinum alone.

router A device that connects one computer local area network (LAN) to another using ICMP (Internet Control Message Protocol), part of IP (Internet Protocol), to communicate with other routers, and to determine optimum data paths.

RTD See "resistance temperature detector."

RTI See "relative thermal index."

rubber insulation A general designation for thermosetting elastomers, such as natural and synthetic rubbers, neoprene, Hypalon®, and butyl rubber. They are used to insulate wire conductors. Hypalon® is a registered trademark of the E.I. duPont de Nemours & Company.

S

SAE See "Society of Automotive Engineers."

safety limit An automatic limit intended for use in applications where an over-temperature fault may cause a fire or pose other safety concerns.

SAMA See "Scientific Apparatus Makers Association."

saturation pressure The pressure on a liquid when it boils at a given temperature. Both the saturated liquid and saturated vapor phases can exist at this time.

saturation temperature The boiling temperature of a liquid at its existing pressure.

scfm Standard volumetric flow rate in cubic feet per minute. A measure of the flow rate of gases and vapors under standard conditions of 15°C (60°F) and standard atmospheric pressure.

Scientific Apparatus Makers Association (SAMA) An association that sets standards for platinum, nickel and copper resistance elements (RTDs).

SCR See "silicon controlled rectifier."

Glossary

screen printing A printing method that uses a photographic process to create an image on a fine screen, and then transfers that image to another surface with a squeegee forcing ink or other viscous material through the mesh of the screen. Watlow uses screen printing in both traditional product labeling and in thick film manufacturing.

secondary standard A measurement device that refers to a primary standard.

Seebeck coefficient The rate of change (derivative) of thermal EMF (voltage) with respect to temperature. Expressed as millivolts per degree.

Seebeck effect When a circuit is formed with a junction of two dissimilar metals and the junctions at each end are held at different temperatures, a current will flow in the circuit.

Seebeck EMF The net thermal electromotive force (EMF) in a thermocouple under conditions of zero current.

semiconductor Any material that exhibits a degree of electrical conductivity that falls between that of conductors and dielectrics.

serial communications A method of transmitting information between devices by sending all bits serially over a single communication channel.

series circuit A circuit configuration in which a single current path is arranged among all components.

server A device or computer on a network that serves or delivers network resources, such as a file server, database server, print server or web server.

serving The process by which metallic or nonmetallic filaments or fibers are woven around a wire conductor to produce electrical insulation, shielding or improved abrasion resistance. See “braid.”

Session Layer (OSI Layer 5) The fifth layer of the seven-layer OSI (Open System Interconnection) protocol model that starts, stops and manages connections between applications. The Session Layer resides between the Presentation Layer and the Transport Layer.

set point The desired value programmed into a controller. For example, the temperature at which a system is to be maintained.

setpot A potentiometer used to adjust controller set point temperature.

setting accuracy Closeness between the value established by an input device, such as a dial, and the desired value. Usually expressed as a percent of span or number of digits.

SFPM Standard flow velocity in feet per minute. For gas flow, it is evaluated using the SCFM (standard cubic feet per minute) divided by the flow area.

sfpm Standard flow velocity in feet per minute. Gas flow is calculated using scfm divided by the flow area.

shape factor The amount of energy a target object receives, relative to the size of the heater and its distance from the object.

sheath thermocouple A mineral-insulated thermocouple that has an outer metal sheath. It is usually made from mineral-insulated thermocouple cable.

shield A metallic foil or braided wire layer surrounding conductors that is designed to prevent electrostatic or electromagnetic interference from external sources.

shield coverage See “shield percentage.”

shield effectiveness The relative ability of a shield material to screen interference. Shield effectiveness is often confused with shield percentage.

shield percentage The area of a circuit or cable that is covered by a shielding material, expressed as a percentage.

shunt In an electrical circuit, a low resistance connection between two points that forms an alternate path for some of the current. Dielectric materials lose resistance at temperatures above their operating range. This condition can cause shunting of the sensor’s signal, causing an error in the reading.

SI Systems Internationale. The system of standard metric units.

signal Any electrical transmittance that conveys information.

silicon A tetravalend nonmetallic element.

silicon controlled rectifier (SCR) A solid-state device, or thyristor, with no moving parts, that is used in pairs to control ac voltages within one cycle. SCRs control voltage from a power source to the load by burst firing (also called zero-cross firing) or phase angle firing. See “burst fire.”

silicone A thermosetting elastomer that is made of silicone and oxygen, and noted for high heat resistance.

silicone rubber Rubber that is made from silicone elastomers and noted for its retention of flexibility, resilience and tensile strength.

slidewire feedback A method of controlling the position of a valve. using a potentiometer. The resistance indicates the valve position.

SMTP Simple Mail Transfer Protocol. A protocol that enables e-mail servers and clients to send e-mail.

Glossary

SNMP Simple Network Management Protocol. Protocols for managing complex networks. SNMP exists at the Presentation (Layer 6) and Application (Layer 7) layers of the seven-layer Open System Interconnection (OSI) model, from standard ISO/IEC (International Organization for Standardization/International Electrotechnical Commission) 7498-1.

SNMP agent A means for a network administrator to communicate with an object within a specific device on a network.

SNMP manager A network administrator's interface for performing network management tasks on a network's Simple Network Management Protocol layers.

soaking In heat treating, the practice of immersing an object in a heated environment so it can complete a desired metallurgical change at a specific temperature.

Society of Automotive Engineers (SAE) A society that establishes standards for the transportation industries (automotive, marine and aviation), including the system of English units (pounds, feet, gallons, etc.).

soft start A method of using phase-angle SCR control to gradually increase the output power over a period of several seconds. Soft starts are used for heaters that have a low electrical resistance when they are cold, or for limiting in-rush current to inductive loads.

software Instructions that enable a computing device 1) to function, as in an operating system , or 2) to perform specific tasks, as in applications. These instructions are typically stored in some type of memory media.

solid-state relay (SSR) A switching device with no moving parts that completes or interrupts a circuit electrically.

span The difference between the lower and upper limits of a range expressed in the same units as the range. See "range."

spark test A high voltage, low amperage test that detects insulation defects in wire and cable.

specific gravity (sp. gr.) Density relative to the density of water, which is given the arbitrary value of one at 0°C. See "density."

specific heat capacity The quantity of heat (in joules or Btus) necessary to raise the temperature of one kilogram (or pound) of substance through 1 Kelvin. In most materials, specific heat capacity varies with changes in temperature and material state.

specific volume The inverse of density, expressed in units of cubic feet per pound or cubic meters per kilogram.

spectral filter A filter that restricts the electromagnetic spectrum to a specific bandwidth, such as four to eight microns infrared radiation.

spectral response band The region of the infrared portion of the electromagnetic spectrum over which an infrared sensor processes a signal. Infrared sensors that operate at shorter wavelengths are designed for higher temperatures.

spot size See "field of view."

spread In heat/cool applications, the difference between heat and cool. Also known as process dead band. See "dead band."

SSR See "solid state relay."

stability The ability of a device to maintain a constant output with the application of a constant input.

standard A set value or reference point from which measurements or calibrations are made.

standard wire error The level of deviation from established standards. Usually expressed in terms of ±°C or percent. Also known as standard tolerances.

subnet Part of a TCP/IP network that shares the same IP address prefix. Networks are divided into subnets to increase performance and security.

superheat Heating of a gas or vapor to a temperature well above its dry saturation temperature. This term will be encountered frequently when working with steam. These temperatures, coupled with the tabulated enthalpy values, provide a simple means of calculating the power needed for superheating.

surge current A short duration rush of current that occurs when power is first applied to capacitive, inductive or temperature dependent resistive loads, such as tungsten or silicon carbide heating elements. It also occurs when inductive loads are de-energized. Surge currents usually last no more than several cycles.

swage Uniform compaction process that decreases the diameter and increases the length of a cylinder. This compaction process used in cartridge heater and sensor manufacturing, creates higher thermal conductivity (better heat transfer) and greater dielectric strength (longer life). The unit can be swaged multiple times, known as double swaging.

switch 1) A device, either electrical or mechanical, used to open or close an electrical circuit. 2) A computer programming technique that will change a selection from one state to another. 3) A telephone interface that connects callers. 4) A network routing device that provides numbered nodes, one for each connected device.

switching differential See "hysteresis."

Glossary

switching sensitivity In on-off control, the temperature change necessary to change the output from full on to full off. See “hysteresis.”

Systems Internationale (SI) The system of standard metric units.

T

TCP Transmission Control Protocol. One of two primary protocols that distinct Internet hosts use to establish a connection and exchange data while ensuring that data packets are received in the same order as they were sent. TCP is a session-based transport layer protocol defined by the IETF. See “IP” and “TCP/IP.”

TCP/IP Transmission Control Protocol/Internet Protocol. The two primary protocols used to connect hosts and exchange data on the Internet.

TD Timed derivative. The derivative function.

Teflon® A registered trademark of E.I. duPont de Nemours & Company, covering a family of fluorocarbon materials that includes FEP, PFA and PTFE.

Tefzel® (ETFE) Fluoropolymer material, ethylene tetrafluoroethylene, with excellent mechanical properties, particularly important in wire and cable applications. Tefzel® is a registered trademark of the E.I. duPont de Nemours & Company.

Telecommunication Industry Association (TIA) A trade group that sets standards for the telecommunications industries.

temperature calibration point A temperature at which the output of a sensor is compared against a standard.

temperature limit switch Factory Mutual (FM) Standard 3545. See “limit control.”

temperature, ambient The temperature of the air or other medium that surrounds the components of a thermal system.

tera (T) A prefix meaning 10^{12} (one trillion in the US).

TFE A common short hand abbreviation for **PTFE**, polytetrafluoroethylene, or Teflon®.

thermal conductivity The quantity of heat transmitted by conduction through a body per unit area, per unit time, per unit thickness for a temperature difference of 1 Kelvin. This value changes with temperature in most materials and must be evaluated for conditions given. Expressed in Btu/hr-ft-°F or Watts/meter-°C.

thermal EMF The ability of a thermocouple to produce a voltage that increases or decreases in proportion to its change in temperature.

thermal expansion An increase in the size of a material that is caused by an increase in temperature. Expressed as the number of inches/inch/°F or cm/cm/°C per reference length.

thermal gradient The distribution of differential temperatures through a body or across a surface.

thermal lag The delay in the distribution of heat energy throughout a system. Thermal lag can cause process temperature instability.

thermal shunt A condition in which the mass of the sensor absorbs a portion of the heat being measured, which results in an erroneous reading.

thermal system A regulated environment that consists of a heat source, heat transfer medium or load, sensing device and a control instrument.

thermistor A temperature sensing device made of a semiconductor material that exhibits a large change in resistance for a small change in temperature. Thermistors usually have negative temperature coefficients, although they are also available with positive temperature coefficients.

thermocouple (T/C) A temperature sensing device made by joining two dissimilar metals. This junction produces an electrical voltage in proportion to the difference in temperature between the hot junction (sensing junction) and the lead wire connection to the instrument (cold junction).

thermocouple aging or aging range A positive shift in electromotive force (EMF) in nickel-based thermocouple alloys that is caused by a temperature gradient along the thermocouple elements. Factors that cause EMF shift are the measured temperature, the previous thermal history of the element, the amount of time spent at the aging temperature and the amount of the element subjected to the aging temperature. Different thermocouple types age differently under different application conditions.

thermocouple break protection The ability of a control to detect a break in the thermocouple circuit and take a predetermined action.

thermocouple extension wire A pair of wires connecting a thermocouple sensor to its reference junction or instrumentation. The electromotive force (EMF) characteristics of the extension wire must be similar to the EMF characteristics of the thermocouple.

Glossary

thermocouple junction The point where the two dissimilar metal conductors join. In a typical thermocouple circuit, there is a measuring junction and a reference junction. See "junction," "measuring junction" and "reference junction."

thermocouple pre-aging See "pre-aging."

thermocouple type A particular combination of metallic elements and/or alloys that make up the conductors of a thermocouple, and defines their EMF output relative to absolute temperature. ASTM designated types include: B, E, J, K, N, R, S and T. Non-ASTM types include: C, D and G (tungsten based thermocouples) and Pt 2.

thermocouple, heat treating A thermocouple that is appropriate for the temperature range and atmospheres used in heat treating. Heat treating is a process that alters the physical properties of a metal by heating and cooling at specific rate changes, and by introducing chemical atmospheres.

thermopile An arrangement of thermocouples in a series with alternate junctions at the measuring temperature and the reference temperature. This arrangement amplifies the thermoelectric voltage. Thermopiles are usually used in infrared detectors in radiation pyrometry.

thermopolymer technology The technology that applies heated plastics to applications.

thermoset A material that undergoes a chemical reaction and is cured or set when subjected to heat. An example is bakelite. Thermosetting also applies to vulcanizing, as with rubber and neoprene.

thermowell A tube with a closed end that is designed to protect temperature sensors from hostile environments. See "protection tube."

Thompson Effect When a current flows through a conductor within a thermal gradient, a reversible absorption or evolution of heat occurs in the conductor at the gradient boundaries.

three-mode control Proportioning control with integral (reset) and derivative (rate). Also see "PID."

TI Integral term.

TIA See "Telecommunications Industry Association."

time proportioning control A method of controlling power by varying the on-off duty cycle of an output. This variance is proportional to the difference between the set point and the actual process temperature.

Tophel® A thermocouple alloy that is made of 90 percent nickel and 10 percent chromium. It is used in the positive conductors of ASTM Type E and K thermocouples. Tophel® is a registered trademark of Carpenter Technology.

transducer A device that receives energy in one form and retransmits it in another form. For example, a thermocouple transforms heat energy input into a voltage output.

transient A surge in electrical current, usually of short duration. Transients can damage or interfere with the proper operation of electronic temperature and power controllers.

transmitter A device that transmits temperature data from either a thermocouple or a resistance temperature detector (RTD) by way of a two-wire loop. The loop has an external power supply. The transmitter acts as a variable resistor with respect to its input signal. Transmitters are desirable when long lead or extension wires produce unacceptable signal degradation.

Transport Layer (OSI Layer 4) The fourth layer of the seven-layer OSI (Open System Interconnection) protocol model that handles data transfer, flow control and error recovery between communicating hosts. The Transport Layer resides between the Session Layer and the Network Layer.

triac A solid-state device that switches alternating current.

tribology The science or study of surface friction.

triple point A thermodynamic state in which the gas, liquid and solid phases all occur in equilibrium. For water, the triple point is 0.01°C at standard atmospheric pressure.

tungsten (W) An element that is used as the positive conductor in a Type G thermocouple, which is made of tungsten/tungsten 26 percent rhenium (W/W26Re). Type G is not an ASTM symbol.

tungsten 25 percent rhenium The thermocouple alloy that is used as the negative conductor in a Type D thermocouple, which is made of tungsten 3 percent rhenium/tungsten 25 percent rhenium thermocouple (W3Re/W25Re). Type D is not an ASTM symbol.

tungsten 26 percent rhenium The thermocouple alloy that is used as the negative conductor in both the Type G thermocouple, which is made of tungsten/tungsten 26 percent rhenium (W/W26Re), and the Type C thermocouple, which is made of tungsten 5 percent/tungsten 26 percent rhenium (W5Re/W26Re). Types G and C are not ASTM symbols.

tungsten 3 percent rhenium The thermocouple alloy that is used as the positive conductor in a Type D thermocouple, which is made of tungsten 3 percent rhenium/tungsten 25 percent rhenium (W3Re/W25Re). Type D is not an ASTM symbol.

Glossary

tungsten 5 percent rhenium The thermocouple alloy that is used as the positive conductor in a Type C thermocouple, which is made of tungsten percent rhenium/tungsten 26 percent rhenium (W5Re/W26Re). Type C is not an ASTM symbol.

tungsten lamp The technology used by the standard incandescent light bulb, in place since 1911, with a tungsten metal filament surrounded by an inert gas or a vacuum. Tungsten has a 16:1 hot to cold resistance ratio, that is, the filament has 16 time higher resistance at its hot operating temperature than at cooler ambient.

turnkey A selling feature describing a complete and ready to use system, one similar to simply turning the door key of a ready-to-live-in home. Watlow offers turnkey solutions with cast-in and thick film heaters.

twisted pair Two insulated conductors that are twisted together. An effective method of duplexing and reducing electromagnetic interference (EMI).

U

UDP User Datagram Protocol. A connectionless protocol that runs on top of IP networks as UDP/IP. Hosts can broadcast messages via UDP/IP without establishing connections with the receivers. Datagrams are packets, pieces of messages. UDP is a sessionless transport layer protocol defined by the IETF.

UL® The registered trademark and abbreviation for the Underwriter's Laboratories, Inc. An independent testing laboratory that establishes commercial and industrial standards, and tests and certifies products in the United States.

ultraviolet The portion of the electromagnetic spectrum that is just beyond the violet in the visible spectrum. Ultraviolet light can degrade many insulation materials.

undershoot The amount by which a process variable falls below the set point before it stabilizes.

ungrounded junction See "isolated junction."

uninsulated Without thermal insulation; without electrical insulation (bare wire).

union A pipe fitting that joins extension pipes, without regard to their thread orientation.

upscale break protection A form of break detection for burned-out thermocouples. It signals the operator that the thermocouple has burned out.

USB Universal Serial Bus. An external bus standard for connecting as many as 127 peripheral devices to computers with data transfer rates of up to 12 Mbps (million bits per second). USB is likely to supercede serial and parallel ports because of its speed and "hot swappable" (unplug and plug in with power on) feature.

V

vacuum braze A process to join metals or alloys with heat in the absence of atmosphere, in a vacuum chamber or furnace, for example.

value The quantitative measure of a signal or variable.

VDE Abbreviation for Verband Deutscher Elektrotechniler, an independent German testing and certification institute concerned with the safety of electrical products. Authorizes use of the VDE Mark.

viscosity The resistance of fluid to sheering forces (flow). High viscosity indicates a tendency for a fluid to flow or move slowly. The viscosity of fluids decreases as their temperatures increase. Heating gases will increase their absolute viscosity.

VOC 1) Volatile Organic Compound(s). Carbon-based organic compounds that evaporate quickly. Watlow's thick film heaters do not contain harmful volatile organic compounds, such as hydrocarbons, ammonia fluorine, hydrogen sulfide or sulfur dioxide. 2) Voice of the Customer; APICS (The Educational Society for Resource Management).

volt (V) The unit of measure for electrical potential, voltage or electromotive force (EMF). See "voltage."

volt amperes (VA) A measurement of apparent power. The product of voltage and current in a reactive circuit. V I = VA, where V is volts and I is current in amperes. The term watt is used for real power.

voltage (V) The difference in electrical potential between two points in a circuit. It's the push or pressure behind current flow through a circuit. One volt (V) is the difference in potential required to move one coulomb of charge between two points in a circuit, consuming one joule of energy. In other words, one volt (V) is equal to one ampere of current (I) flowing through one ohm of resistance (R), or V = IR.

Glossary

W - X

watt (W) A measurement of real power. The product of voltage and current in a resistive circuit. VI = P, where V is volts, I is current in amperes and P is power in watts.

watt density The watts of power produced per unit of surface area of a heater. Watt density indicates the potential for a surface to transmit heat energy and is expressed in W/in^2 or W/cm^2. This value is used to express heating element ratings and surface heat loss factors.

WCAD™ A computer-based version of a power calculations tool published by Watlow Polymer Technologies.

web server A device with an IP address and running server software to make it capable of serving web pages to a network or to the Internet. A web server may also have a domain name.

wire size The specification and use of proper wire gauge for the load size and its distance from the control. Wire sizing is of prime importance to output wiring. Refer to the National Electrical Code (NEC) and local codes for wire sizing guidelines. See “American Wire Gauge” and “B & S Gauge.”

working standard A measurement device that refers to a secondary standard.

WPT Watlow Polymer Technologies. A Watlow division that manufactures heated plastics.

XML eXtensible Markup Language. A document markup language defined by the Worldwide Web Consortium (WC3) as a subset of SGML (Standard Generalized Markup Language), and a web-friendly document description tool. XML provides for customized tags that enable data sharing between systems, applications and organizations.

Z

zero cross Action that provides output switching only at or near the zero-voltage crossing points of the AC sine wave. See “burst fire.”

zero switching See “zero cross.”