GLOSSARY

A

AC : Alternating Current; An electric current that reverses its direction at regularly recurring intervals.

Accuracy : The closeness of an indication or reading of a measurement device to the actual value of the quantity being measured. Usually expressed as ± percent of full scale output or reading.

Alumel™ : An Aluminum Nickel alloy used in the negative leg of a Type K Thermocouple. Trademark of Hoskins Manufacturing Co.

Ambient Compensation : Instrument design that guarantees that changes in ambient temperature will not affect the readings of the instrument.

Ambient Conditions : The conditions around the transducer (pressure, temperature, etc.)

Ambient Temperature : The average temperature of the surrounding air which comes in contact with the thermal system. For instruments, it is the temperature inside the control panel.

Ammeter : An instrument used to measure electric current.

Ampere (Amp) : A unit that is used to define the rate of flow of electricity (current) in a circuit.

Amplifier : A device that draws power from a source other than the input signal and produces an enlarged reproduction of the essential features of its input.

Amplitude : A measurement of the distance from the highest to the lowest value, such as the peak-to-peak swing of an electrical waveform.

Analog Output : A voltage or current signal that is a continuous function of the measured parameter.

Annealing : The process of heating a material just below its heat distortion point to relieve stresses

ANSI : American National Standards Institute

Automatic Reset : (1) A feature on a limit controller that automatically resets the controller when the controlled temperature returns to within the limit bandwidth set. (2) The integral function on a PID controller which adjusts the proportional bandwidth with respect to the set-point to compensate for droop in the circuit.

AWG : American Wire Gauge

B

Bandwidth : A symmetrical region around the set-point in which proportional control occurs.

Binary : Refers to Base 2 numbering system, in which the only allowable digits are 0 and 1. A condition that has only two possible values or states.

Bipolar : The ability of a panel meter to display both positive and negative readings.

Blackbody : A theoretical object that radiates the maximum amount of energy at a given temperature, and absorbs all the energy incident upon it.

Boiling Point : The temperature at which a substance in the liquid phase transforms to the gaseous phase.

BTU : British Thermal Units. The quantity of thermal energy required to raise the temperature of one pound of water by 1°F. One kilowatt-hour is equivalent to 3412 BTUs.

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

GLOSSARY

C

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

Celsius : A temperature scale defined by 0°C at the freezing point and 100°C at the boiling point of water at sea level. The formula for conversion to the Fahrenheit scale is:

$$°F = (1.8 \times °C) + 32$$

Ceramic Insulation : High temperature compositions of metal oxides used to insulate wires. Common materials are Alumina (Al_2O_3), Beryllia (BeO), and Magnesia (MgO). Ceramic insulators are available as single or multi-hole tubes or beads.

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

Chromel® : A chromium-nickel alloy which makes up the positive leg of Type K and E thermocouples. Registered Trademark of the Hoskins Manufacturing company.

Clipping : A phenomenon which occurs when an output signal is limited in some way by the full range of an amplifier, ADC or other device. When this occurs, the signal is flattened at the peak values, the sinusoidal waveform becomes similar to a square wave, and high frequency components are introduced.

Common Mode : The output form or type of control action used by temperature controller to control temperature, i.e. ON/OFF, time proportioning, PID.

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

Compensating Alloys : Alloys used to connect thermocouples to instrumentation. These alloys are selected to have similar thermal electric properties as the thermocouple alloys.

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

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

Conductance : The measure of the ability of a solution to carry an electrical current.

Conduction : The mode of heat transfer within a substance or by solids in direct contact with each other when a temperature difference exists.

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

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

Control Mode : Same as **Common Mode**.

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

Cryogenics : Measurement of temperature at extremely low values, for example below –200°C.

C—UL : Underwriter's Laboratory testing certification covering CSA.

CSA : Canadian Standard Association

Current Proportioning : An output form of a temperature controller which provides a current proportional to the amount of control required.

GLOSSARY

Current : The rate of flow of electricity.

Cycle Time : The time usually expressed in seconds for a controller to complete one ON/OFF cycle.

D

DC : Direct Current; An electrical current flowing in one direction.

Dead Band : For temperature controllers; The temperature band where heat is turned off upon rising temperature and turned on upon falling temperature. The area where no heating (or cooling) takes place.

Delta : An electrical network where loads are connected directly between three phases.

Density : Mass per unit of volume, usually expressed in lbs/ft^3. Density remains nearly constant for solids and most liquids under ordinary conditions of temperature and pressure.

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

Dielectric : A material with low electrical conductivity, commonly called an electrical insulator.

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

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

DIN : Deutsche Industrial Norms. A set of technical/scientific and dimensional standards developed a German agency. Many DIN standards have worldwide recognition.

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

Droop : A common occurrence in time-proportional controllers. It refers to the difference in temperature between the set point and where the system temperature actually stabilizes due to the time-proportioning action of the controller.

Duplex : Pertaining to simultaneous two-way independent data communication transmission in both directions.

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

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

E

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

Electromotive Force (emf) : The potential difference between two electrodes in a cell. The cell emf is the voltage measured when no current is flowing through the cell.

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

EMI : Electromagnetic Interference.

Emissivity : The ratio of energy emitted by an object to the energy emitted by a blackbody at the same temperature. The emissivity of an object depends on its material and surface texture.

Energy : Power per unit of time (BTU & kWh)

Endothermic : A process is said to be endothermic when it absorbs heat.

GLOSSARY

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

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

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

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

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

F

.**Fahrenheit :** A temperature scale defined by 32° at the freezing point and 212° as the boiling point of water at sea level. The formula for conversion to Celsius:

°C = 5/9 (°F—32)

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

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

Frequency : The number of cycles over a specified time period. The inverse of Frequency is called the Period.

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

G

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

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

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

H

Heat Sink : A finned piece of metal (usually aluminum) used to dissipate heat generated by electrical components.

Heat Transfer : The process of thermal energy (heat) flowing from a body of high energy to a body of low energy. Means of transfer are conduction (two bodies touching), convection (bodies of different states touching), and radiation (bodies emit infrared radiation).

Hertz : A unit of measure for frequency expressed in cycles per second.

Hysteresis : Same as **Dead Band**.

I

ID : Abbreviation for inside diameter.

Impedance : The sum of oppositions to electrical flow (resistive plus reactive).

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

Insulated Junction : See **Ungrounded Junction**

GLOSSARY

Integral : A form of temperature control. See **Automatic Reset**.

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

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

ISA : Instrument Society of America.

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

J

Joule : A basic unit of thermal energy.

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

K

Kelvin (K) : The unit of absolute or thermodynamic temperature scale based on the Celsius scale. The formula for converting to Kelvin is:

$$K = °C + 273.15$$

Kilowatt (KW) : Electrical unit of power equal to 1000 Watts or 3412 BTUs per hour.

Kilowatt Hour (KWH) : Electrical unit of energy or work expended by one kilowatt in one hour.

L

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

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

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

Loop Resistance : The total resistance of a thermocouple circuit caused by the resistance of the thermocouple wire.

M

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

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

Mass Flow Rate : The amount of a substance flowing per unit of time past a given cross-section are within a conduit.

Maximum Operating Temperature : The highest temperature at which an instrument or device can operate safely, or with expected normal service life.

Maximum Power Rating : The highest power in watts that a device can handle safely or without a shortened operating life.

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

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

MgO : The chemical symbol for Magnesium Oxide, a good heat conductor and electrical insulator.

Mineral-insulated Thermocouple : A type of thermocouple which has an outer metal sheath and MgO insulation inside separating a par of thermocouple wires and from the outer sheath.

GLOSSARY

N

N/C (No Connection) : A connector point, like in a temperature controller, that has no internal connection.

NBS : National Bureau of Standards.

NEC : National Electrical Code.

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

NEMA : National Electrical Manufacturers Association.

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

Noise : An unwanted electrical interference on signal wires.

NPT : National Pipe Thread standard.

O

OD : Abbreviation for Outside Diameter.

Offset : The difference in temperature between the set point and the actual process temperature. See **Droop**.

Ohmmeter : An instrument used to measure electrical resistance.

ON/OFF Controller : A controller that switches from fully on to fully off to control temperature.

Open Circuit : The lack of electrical contact, usually characterized by rapid large jumps in displayed potential, followed by an off-scale reading.

Overshoot : The number of degrees that a process exceeds the set point temperature while attempting to reach and stabilize at the set point temperature.

P

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

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

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

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

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

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

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

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

Polarity : The quality of having oppositely charged poles, one positive and one negative.

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

GLOSSARY

Potentiometer : A variable resister often used to control a circuit.

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

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

Process Meter : A panel meter that can be scaled for readout in engineering units for signals such as 4-20mA, 10-50mA and 1-5 V.

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

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

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

Proportioning Control Plus Integral : A time proportioning controller with integral (reset) action. The integral function automatically adjusts the temperature at which a system has stabilized back to the set point temperature, thereby eliminating droop in the system.

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

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

R

Radiation : The process of emitting radiant energy in the form of waves or particles (see **Emissivity** and **Infrared**).

Rate Action : The derivative function of a temperature controller.

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

Reference Junction : The cold junction in a thermocouple circuit which is held at a stable known temperature.

Relay, Electromechanical : A power switching device that completes or interrupts a circuit by physically moving electrical contacts into contact with each other.

Relay, Solid State : A power switching device that completes or interrupts an electric circuit with no moving parts (see **SSR**).

Resistance : Opposition to the flow of electric current measured in Ohms. For a conductor, resistance is a function of diameter, resistivity, and length.

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

Root Mean Square (RMS) : Square root of the mean of the square of the signal taken during one full cycle. The RMS value of a sinusoidal waveform is 0.707 multiplied by the peak value.

RTD : Resistance temperature Detector. A temperature sensor whose resistance increases with increasing temperature in a known manner. The most commonly used RTD material is Platinum.

GLOSSARY

S

SCR : Silicone Controlled Rectifier. A solid state device, or thyristor, having no moving parts, that when used in pairs, controls AC voltages within one cycle. SCRs control voltage from a power source to the load by Burst (zero-cross) or Phase Angle Firing.

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

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

Sensor : A device which detects the temperature, pressure or other physical property of a controlled media, and provides an output signal to an automatic controller or switching mechanism.

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

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

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

Signal Conditioning : To process the form or mode of a signal to make it readable to a given device. Some of the modulations include pulse shaping, compensation, amplification, filtering and linearizing.

Soft Start : A method of using phase angle control to gradually increase the output power over a period of several seconds. Used for heaters with low electrical resistance when cold or for limiting in-rush current for inductive loads.

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

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

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

SSR : Solid State Relay. A solid state switching device that switches current on and off without moving parts.

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

Surge Current : A current of short duration that occurs when power is first applied to capacitive loads or temperature dependent resistive loads that usually lasts no more than several cycles.

Swaging : A sheathed electrical element manufacturing process when the element sheath is hammered in a die to reduce its diameter and compact its insulation.

T

Teflon™ : A fluorocarbon polymer used for insulation of electrical wires and heating elements. Trademark of DuPont company.

Temperature : The hotness or coldness of a body measured on a definitive scale.

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

Thermal Conductivity : A property which indicates a material's ability to transfer heat.

Thermal Expansion : An increase in size due to an increase in temperature expressed in units of an increase in size per degree.

GLOSSARY

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

Thermocouple : A temperature-sensing element composed of two dissimilar metals joined to produce a voltage output proportional to the difference between the hot junction and the lead wires.

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

Thermoplastic : Used to describe materials that become soft and moldable when heated and change back to solids when allowed to cool.

Thermostat : An electromechanical device which opens or closes a contact at a specified temperature. The most common forms are bulb and capillary and bi-metal strip.

Thermowell : A closed-end tube designed to protect temperature sensors from harsh environments, high pressure and flows. They can be installed into a system by pipe thread or flange and are made of corrosion-resistant metal or ceramic material.

Transducer : A device that converts energy from one form to another. It is generally used for devices that take a physical phenomenon (pressure, temperature, humidity, etc) and converts it to an electrical signal.

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

U

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

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

Ungrounded Junction : A form of thermocouple construction where the measuring junction is fully enclosed in a protective sheath, and is electrically isolated from the sheath.

V

Viscosity : The fluid property which determines the amount of resistance to flow.

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

Voltmeter : An instrument used to measure voltage.

W

Watt : A measurement of real power.

Watt Density : The power produced in watts per square unit surface area of a heater.

Wye : An electrical connection when one end of three loads is connected together and the other end to one each of the three phases of the power supply.

Z

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