

TEMPERATURE TERMS

Jargon Buster



An instrumentation user's guide



Temperature Terms Jargon Buster

ABB's *Temperature Terms Jargon Buster* explains the terminology users are likely to encounter in connection with the specification and operation of temperature measurement equipment. If you have a specific temperature-related question, please email ben.pyne@gb.abb.com.

ABB's *Temperature Terms Jargon Buster* uses hyperlinks for quick navigation. A click on any underlined word takes you straight to the relevant entry. Alternatively, use the Quick Navigation Tool below to select a relevant section.

Quick navigation tool

<#> [A](#) [C](#) [D](#) [E](#) [F](#) [G](#) [H](#) [I](#) [J](#) [K](#) [L](#) [M](#) [N](#) [O](#) [P](#) [R](#) [S](#) [T](#) [U](#) [V](#) [W](#) [Z](#)

3 wire RTD

A connection method for Resistance Temperature Detectors designed to minimize errors caused by long lead lengths.

4 wire RTD

A Connection method for Resistance Temperature Detectors designed to minimize errors caused by long lead lengths.

A

Absolute zero

The lowest theoretically possible temperature, usually considered to be -273.15°C

Ambient conditions

The local conditions of the location or installation in which a device is being used. Any data provided for ambient conditions for a temperature device should stipulate the limits for temperature, humidity, pressure and vibration.

Ambient temperature

The average (mean or mode) temperature of the environment surrounding the equipment.

ANSI

American National Standards Institute

Assembly

An arrangement of sensors and measuring equipment designed to measure the changes in temperature of a process or system under test.

ASTME 988

A standard published by the American Society for Testing and Materials for Temperature-Electromotive Force (EMF) Tables for Tungsten-Rhenium Thermocouples

ATEX

A European Directive governing the control of explosive atmospheres and the equipment designed to operate in them.

ATEX / Zone 1

Under the ATEX directive, Zone 1 is classed as a place in which an explosive atmosphere consisting of a mixture of air and an explosive substance in the form of gas, vapour or mist is likely to occur in normal operation.

ATEX EEx ia (Zone 0)

This category of equipment can be used in Zone 0, Zone 1 and Zone 2 hazardous areas.

ATEX EEx n A

Equipment designed to be non-sparking. Can only be used in Zone 2.

Attenuation

The reduction in amplitude, magnitude or intensity of a physical property

Automatic cold junction compensation

A method of relating the temperature across a thermocouple to a universal scale, by the accurate measurement or maintenance of the temperature at the cold junction.

C**Callendar van Dusen coefficients**

The Callendar-Van Dusen equation describes the relationship between resistance (R) and temperature (t) of platinum resistance thermometers. It incorporates coefficients A, B and C, which need to be determined to arrive at a final value.

For the range between -200°C to 0°C, the equation is:

$$R(t) = R(0)[1 + A(t) + B(t)^2 + (t-100)C(t)^3]$$

For the range between 0°C to 661°C, the equation is:

$$R(t) = R(0)(1 + A(t) + B(t)^2)$$

These equations are listed as the basis for the temperature/resistance tables for platinum resistance thermometers and are not intended to be used for the calibration of individual thermometers.

To improve the accuracy of any individual sensors measurement, the coefficients for (A(t) and B(t)) can be obtained by calibration.

Celsius

A temperature scale that places the melting point of water at 0 °C and its boiling point at 100 °C, both at sea level.

Centigrade

A temperature on the Celsius scale

CE Mark

A declaration by the manufacturer that the product meets all relevant European legislation.

Cold junction

The end of the thermocouple that is not exposed to the process

Cold junction compensation

A thermocouple produces an EMF in proportion to the temperature across the conductors, from the hot junction to the cold. To relate this value to a known scale the cold junction temperature must either be known and compensated for or fixed at a known temperature.

Compensation cable

Cable used to link a thermocouple to the measuring equipment at some distance and having the same thermoelectric characteristics as the thermocouple.

Corrosion detection

A type of non-destructive evaluation that primarily uses acoustic methods to detect corrosion in structures. And what has this to do with temperature?

CSA

Canadian Standards Administration

D

Differential measurement

A measurement value which is the result of the difference between two simultaneous readings.

DIN 43760

DIN 43760 specifies the characteristics of a 100 ohm platinum RTD. On the resistance vs. temperature curve, A has the value of 0.00385 ohms per degree centigrade.

DIN EN 60654-1

The German standard governing the climatic conditions of Industrial-process measurement and control equipment

DIN IEC 60751

The German standard governing Industrial platinum resistance thermometer sensors

Drift

When a reading or a set point value changes over time due to factors such as ambient temperature, time and line voltage.

DTM

Dynamic Temperature Monitoring – simultaneously monitoring the temperature at more than four locations

DTM

Device Type Manager. The DTM (Device Type Manager) provides a Fieldbus-specific interface to enable access to all the information available in even the most complex of intelligent field devices.

Dust-ignition proof: ATEX / Zone 20

Dust Ignition Proof devices are used in atmospheres where explosive dust surrounds a device, or where dust settles under its own weight on the device. These devices are designed to prevent ingress of dust and so avoid the risk of causing explosion.

Dynamic range

The ratio of a specified maximum level of a parameter to its minimum detectable value.

E**Electrical conductivity**

The electrical conductivity of a metal is dictated by the movement of electrons through its crystal lattice. The electrical resistance of a conductor varies according to its temperature (see [Thermocouple](#)). This effect is most commonly exhibited as an increase in resistance with increasing temperature (see [Positive Temperature Coefficient](#)).

Electromagnetic Compatibility

The ability of an electronic device to work in conjunction with or in proximity to, another such device without causing or being effected by interference in the form of induced electromagnetic phenomena.

EMC

See [Electromagnetic Compatibility](#)

EMF

Abbreviation of 'Electromagnetic field'. An electromagnetic field is the combination of an electric field and a magnetic field and is produced by electrically charged objects. The electric field is produced by stationary charges, and the magnetic field by moving charges (currents).

Emitted interference

Electrical interference that radiates from an item of electronic equipment.

EN1473

The standard governing the installation and equipment for liquefied natural gas.

EN60584

A standard defining the tolerances and temperature ranges for thermocouples. All examples given in this guide for thermocouples are in accordance with EN60584.

ENCL 4X

A NEMA designation for enclosures. 4X is watertight, dust tight and corrosion resist and meant for indoor use.

Ex mark

The Ex mark is a specific marking for equipment designed to be used in potentially explosive atmospheres, showing that the equipment complies with the European ATEX directive.

Extended diagnostics (NE 107)

NAMUR recommendations NE 107, "Self-monitoring and diagnosis. of field devices," calls for the classification of diagnostic events into their status signals.

External "hot" junction

Junction within a thermocouple that is exposed to the process

F

Fahrenheit

A temperature scale that places the freezing point of water at 32° and the boiling point at 212°, both at sea level.

FDT / DTM

FDT (Field Device Tool) technology standardizes the communication interface between field devices and systems. Independent of the communication protocol and the software environment of either the device or the host system, FDT allows any device to be accessed from any host through any protocol.

The DTM (Device Type Manager) provides a Fieldbus-specific interface to enable access to all the information available in even the most complex of intelligent field devices.

Fieldbus

A fully digital and duplex data transmission system, Fieldbus connects intelligent field devices and automation systems to an industrial plant's network. Unlike point-to-point connections, which allow only two circuits to exchange data, Fieldbus usually joins a larger number of circuits, each of which take an active role in the exchange.

FM

A mark used to show that a product conforms to the Factory Mutual (FM) approvals standard. A US approvals standard, the FM mark is used worldwide to show that products are certified to a stipulated level of quality for a particular application.

Functional safety

The ability of a safety instrumented system to carry out the actions needed to achieve or maintain a safe state.

G**Gaussian distribution**

Also called the normal distribution or bell curve, the Gaussian distribution is the standard distribution of probabilities and is applicable to many engineering, statistical and scientific data sets.

GOST

GOST standards were originally developed by the government of the Soviet Union as part of its national standardization strategy. The GOST standard refers to a set of technical standards maintained by the Euro-Asian Council for Standardization, Metrology and Certification (EASC), a regional standards organisation operating under the Commonwealth of Independent States (CIS).

H

HART signal

HART stands for Highway Addressable Remote Transducer and is a popular digital communication protocol for industrial process measurement applications. HART uses a low-level modulation superimposed on the standard 4-to-20 mA current loop. The HART signal is small, and does not affect the accuracy of the analogue current signal.

Hot junction

The end of the thermocouple that is exposed to the process. It is formed when two dissimilar metals are joined together – (the Seebeck effect)

Humidity

The degree of moisture present in the atmosphere

Hysteresis

The maximum difference between readings for the same input when approached from opposite directions - i.e. when increasing and decreasing the input – expressed as a percentage of full scale.

I

IEC 61326 (2002)

Electrical equipment for measurement, control and laboratory use – EMC requirements

IEC 68-2-6

A method of test providing a standard procedure for determining the ability of components, equipment and other articles to withstand specified severities of sinusoidal vibration. Has the status of a basic safety publication in accordance with IEC Guide 104.

IEC 68-2-11

This standard compares resistance to deterioration from salt mist between specimens of similar construction. It may be used to evaluate the quality and the uniformity of protective coatings.

Immersion depth

The ideal depth at which the measuring element is inserted into the process fluid. This is usually a minimum of four times the outside diameter of the sheath. The correct immersion depth can be found by moving the probe into or out of the process medium incrementally - at the correct depth, there will result in no change in the indicated temperature.

For maximum accuracy and speed of response, the ideal position of the element within a pipe or duct should be 5-10 millimetres below the centre line of the pipe to allow fluid/gas to flow past the centre of the element.

Incendive

Capable of causing a fire or explosion.

Input

Signals or data entering a temperature measurement system, usually from thermocouples or other temperature measurement devices.

Input functionality

The ability of the device to accept more than one type of input device – such as voltages or thermocouples or resistance in ohms.

Insulation resistance

The insulation resistance depends on the purity of the insulation ceramics used as well as the manufacturing processes and the humidity content of the insulation. The insulation resistance also depends on the length of the sensor.

Internal “hot” junction

Junction within a thermocouple that is not exposed to the process

Interference immunity

The degree to which a temperature measurement system is unaffected by external signals produced by electromagnetic noise.

Internal reference junction

A thermocouple junction connected in series with, but opposite in polarity to, the measurement junction. A change in temperature of the measurement junction causes a difference in voltage between the two junctions, of around 40 microvolts per degree Celsius for the type K thermocouple.

Intrinsically safe

Electrical equipment is said to be intrinsically safe where its circuits are designed to limit the energy in any spark or thermal effect which can cause ignition in any of the explosive atmospheres of subgroup IIA, IIB or IIC (of the ATEX regulations)

IPxx

Ingress Protection. The first number indicates the level of protection against contact and foreign bodies. The second indicates the protection against the penetration of water.

IP66

Dust proof, protected from strong water jets

IP67

Dust proof, protected from temporary immersion in water 1 meter deep for 30 minutes

J

J type thermocouple

Iron-constantan thermocouple with a temperature range of -40°C to 750°C .

JIS

Japanese Standards Association

K

Kelvin

A thermodynamic temperature scale where absolute zero is defined as zero Kelvin (0 K), equal to -273.15°C .

K type thermocouple

Chromel-Alumel thermocouple with a temperature range of -40°C to $1,000^{\circ}\text{C}$.

L

L type thermocouple

An Iron, Copper/Nickel thermocouple with a temperature range of 0 to 900°C . Similar to the J type, but regarded as obsolete.

Linear resistance

A device is said to exhibit linear resistance when its temperature/resistivity curve approximates a straight line, making its resistance at particular temperatures more predictable and thus temperature readings more accurate.

Linear temperature

A temperature variation increasing or decreasing in a straight line.

Linear voltage

A voltage variation increasing or decreasing in a straight line.

Linearity deviation

When plotted data deviates from a predetermined line.

Long-term drift

A phenomenon where the output or data value will drift from its nominal or calibrated value over a long period of time, commonly months or years.

Loop resistance

The total resistance of a thermocouple or RTD circuit. In order to assess measuring errors, the loop resistance is an important parameter in addition to the

insulation resistance. The lower the loop resistance, the lower its influence on the measuring accuracy.

M

Mean measurement

The average value calculated from the sum of the measurements divided by the number of measurements taken.

Measurement accuracy

A measure of how close the system's readings are to the known or calibrated value - the closer a system's measurements to a known or calibrated value, the more accurate the system is considered to be.

Measurement current

The output a device uses, e.g. an RTD uses resistance in ohms and thermocouples use millivolts. Each can be converted to a 4-20mA output current via a temperature transmitter.

Measurement error

A measurement which is deviated from a known standard or calibrated range. It is composed of both random errors and systematic errors.

Measurement interval

The sampling rate or the distance between measurements of a process.

Measuring range

For a sensor, the range the instrument can operate over. For a transmitter, the span over which the transmitter can operate or be set to – i.e. 4-20mA is equal to 20°C to 100°C.

Measuring junction (or internal “hot” junction)

The junction in a thermocouple exposed to the measured temperature.

MIL

The US military standard.

Millivolt transmitter

Typically a transmitter operates with a voltage output of 4-20mA. This is normally linear to the type of sensor which is connected to the transmitter.

Mineral insulation

Mineral insulated cables have an outer sheath of metal with 2 to 8 inner conductors. The insulation material is usually made from a highly compressed metal oxide powder (preferably MgO or Al₂O₃)

Minimum span

The lowest span/range a device can be set to

N**N type thermocouple**

Nicrosil-Nisil thermocouple with a temperature range of -40°C to 1,000°C.

NAMUR

Standardisation authority for measurement and control in chemical industries.

NAMUR NE21 (02/2004)

A NAMUR recommendation addressing the electromagnetic compatibility (EMC) of industrial process and laboratory control equipment.

NE 53

A NAMUR recommendation addressing Software of Field Devices and Signal Processing Devices with Digital Electronics

NE 79

A NAMUR recommendation addressing Microprocessor Equipped Devices for Safety Instrumented Systems

NE 89

A NAMUR recommendation addressing measuring temperature with a digital transmitter.

Negative temperature coefficient (NTC) thermistors

Thermistors exhibiting decreasing electrical resistance with increases in environmental temperature and increasing electrical resistance with decreases in temperature

NEMA

National Electrical Manufacturers' Association.

NEMA 4X

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

Ni

Chemical symbol for nickel.

Non-incendive

Incapable of causing a fire or explosion. One of the recognised protection standards for devices that may be used in hazardous areas.

O**Offset adjustment**

A means of adjusting the output of a temperature measuring device to a desired value.

Output

Electrical signals or data received from a temperature measuring device

P**Positive Temperature Coefficient (PTC) thermistors**

Thermistors exhibiting increasing electrical resistance with increases in environmental temperature and decreasing electrical resistance with decreasing environmental temperature

Process connection

A way of connecting a sensor assembly or a sensor to the process – e.g. pipe or vessel, flanged, threaded or welded

Protection tube

A means of protecting the temperature sensor from the process. Also known as a [thermowell](#).

Protection type

A device's protection characteristic – e.g. ingress protection of the housing (denoted by its IP rating) or hazardous area protection, e.g. ATEX Zone 0 or FM or CSA.

PRT

Platinum Resistance Thermometers. The PRT works on the principle of changing resistance through a fine platinum wire varying with temperature. Advantages include higher accuracy over lower temperature ranges (typically -50°C to +450°C).

Pt100

The most common type of PRT (Platinum Resistance Thermometer), with a resistance of 100 ohms at 0°C and 138.4 ohms at 100 °C.

PTC

Positive Temperature Coefficient (of resistance). The higher the coefficient, the greater an increase in electrical resistance for a given temperature increase.

R

R type thermocouple

A precious metal thermocouple with an operating range of 0 to 1,600°C. This type is easily contaminated and needs to be housed in a protective sheath.

Rankine

Rankine temperature scale. This is a temperature scale with an absolute zero, below which temperatures do not exist. It uses a degree of the same size as that used by the Fahrenheit temperature scale, with absolute zero or 0°R, corresponding to a temperature of -459.67°F. This is the temperature at which molecular energy is at a minimum.

Redundancy

The provision of one or more duplicate components to provide a back up to the main system in the event of a failure.

Reference junction

The thermocouple junction that must be known in order to infer the temperature of the other thermocouple measurement junction.

Reference oven

An oven specially designed with a calibrated sensor to which other sensors can be calibrated against.

Reproducibility

The ability of a temperature device to reproduce output readings when the same value is applied to it repeatedly and under the same conditions.

Resistance thermometer (2-, 3-, 4-wire circuit)

Another name for Resistance Temperature Detector/Resistance Thermometer Device or RTD.

Resistance-type transmitter (0 ... 5000 Ω)

Another name for Resistance Thermometer Device/Resistance Temperature Detector or RTD

RTD

Resistance Thermometer Devices/Resistance Temperature Detectors or RTDs for short, are constructed from wire wound or thin film devices that measure temperature through the positive temperature coefficient of electrical resistance of metals. The hotter they become, the higher the value of their electrical resistance.

There are three types of RTDs – [Wire Wound Ceramic](#), [Wire Wound Glass](#) and [Thin Film](#).

S

S type thermocouple

A thermocouple with an operating temperature range of 0°C to 1,600°C. This type is easily contaminated and needs to be housed in a protective sheath.

Seebeck effect

A thermoelectric effect theory developed in 1822 by Thomas Seebeck. The Seebeck effect states that a difference of potential will occur if a homogenous material having mobile charges has a different temperature at each measurement. When two dissimilar metals or alloys are joined together to form a thermocouple and the ends are at different temperatures, an electromagnetic field will be developed causing a current to flow around the circuit. The size of the field varies according to the temperature difference between the two junctions and on the materials used.

Sensor break monitoring

See [Sensor wire break](#)

Sensing resistor

The sensing element of a resistance thermometer. Usually a platinum or wirewound thin film element – see [RTD](#).

Sensor backup

See [Sensor redundancy](#)

Sensor matching

A pair of sensors which are matched to a known standard or calibration curve (see also [Callendar van Dusen](#))

Sensor redundancy

Using more than one sensor to measure a value to guard against failure in the primary sensor. Back-up will be activated if the primary sensor fails

Sensor short-circuit

A short-circuit of two or more wires of the measuring circuit

Sensor wire break

A break in one of the wires of the sensor measuring circuit which, if connected to a transmitter, would trigger an alarm

Sheath

A strong, chemically resistant barrier between the process and the temperature sensor. This is designed to protect the sensor from the process medium which may cause corrosion or deterioration, potentially leading to sensor failure in extreme conditions

SIL

Safety Integrity Level, a measure of performance for a safety system

Simple device

An installation consisting of a temperature sensor only giving an output of ohms or millivolts.

Single piece forging

A thermowell formed from a single piece of material

Solid drilled forging

A thermowell which is drilled from a single piece forging

Specific linearization

Linearising a signal from a transmitter against a known standard. See also [Callendar van Dusen coefficients](#)

Supply voltage monitoring

Monitoring of the supply voltage to a device to ensure it is not damaged by voltage spikes

T**T type thermocouple**

A copper nickel (constantan) thermocouple with an operating temperature range of -40°C to 350°C.

Thermal conductivity

The ability of a material to conduct heat

Thermal gradient

The distribution of different temperatures both within and across an object

Thermistor

A type of resistance thermometer, usually a negative temperature coefficient (NTC) type (see also [Negative Temperature Coefficient/Positive Temperature Coefficient](#))

Thermocouple types

A recognised standard for categorising thermocouples according to their minimum and maximum temperature operating ranges and suitability for certain applications. The commonly recognised standard types are B, C, E, J, K, L, R, S, T and U with K being the most commonly used.

Thermocouples

A closed loop circuit formed by joining the ends of two strips of dissimilar metals and exposing them to different temperatures. As the temperature of the metals rises, so does the voltage. This voltage is proportional to the temperature difference between the junctions.

Thermocouple response times

The time taken for the thermal voltage (output) to reach 63% of maximum for the step change temperature in question.

Thermocouple wire

The conductor wire which is used to construct a thermocouple. The wire must have a temperature/EMF relationship to the appropriate standard over the complete temperature range

Thermocouple junction

The junction formed between the dissimilar conductors of a thermocouple. Another name for the measuring junction or hot junction

Thermoelectric effect

If a closed loop is formed by joining the ends of two strips of dissimilar metals and the two junctions of the metals are at different temperatures, an electromotive force, or voltage, arises that is proportional to the temperature difference between the junctions. This is known as the thermoelectric effect.

Thermopile

A number of thermocouples connected in series

Thermowell

Components used to protect the primary measuring sensor/element of a temperature device when in contact with the process medium

Thin Film RTD

One of the three main types of RTD. The device is based on a ceramic former coated with a thin film of platinum. Advantages of this type of device are their relatively low cost and fast response.

Total or combined accuracy

The combination of the accuracy of the sensor and the measurement system to which it is attached

Total or combined error

The combination of the error of the sensor and the measurement system to which it is attached

Triple point calibration

The most fundamental of the thermometric fixed points. The ideal state to do a calibration at where a calibration to a perfect zero is required. At this point, the water exists in its three possible phases – i.e. liquid, solid and under its own vapour.

Twisted pair

Two insulated conductors twisted together, employed in thermocouple circuits to minimise noise pick-up

Type (or degree) of protection

Describes the suitability of a device for use in various hazardous areas. Types of protection include non-incendive, non-sparking and flame proof.

U**U type thermocouple**

A thermocouple similar to the popular standard J type. Operating temperature range is -200°C to +600°C.

V**van Dusen coefficient**

See [Callendar van Dusen coefficients](#).

Variant pairs

A pair of signals or user defined linear calibration curves which are specific to a customer or deviant from a standard. See also [Callendar van Dusen coefficients](#)

Vibration resistance

The degree to which a temperature measuring device will continue to operate accurately following vibration at a specified acceleration.

Voltages

The difference of electrical potential between two points of an electrical or electronic circuit. Voltage can be used as an output measurement signal.

W

Wake frequency calculation

The method of calculating the frequency of shedding of the vortices which form at both sides of a thermowell inserted into a pipe or duct. These vortices are important because as the vortex shedding frequency approaches the natural frequency of the thermowell, the thermowell will oscillate and, in the worse case, could snap off.

Wheatstone Bridge

An electrical circuit for the precise comparison of resistances. The Wheatstone bridge, was originally invented by Samuel Hunter Christie and put into popular use by Charles Wheatstone. It is constructed from four resistors connected as the sides of a square. Of these resistors, one has an unknown value, one has a variable value and two have fixed and equal values.

The two opposite corners of the square are connected to an electrical power source, with a galvanometer connected across the other two opposite corners. The variable resistor is adjusted so that the galvanometer reads zero. This provides a known ratio between the variable resistor and its neighbour which is equal to the ratio between the unknown resistor and its neighbour, which then allows the value of the unknown resistor to be calculated.

Wire Wound Ceramic

One of the three main types of RTD. The device is based on a ceramic former around which wire is coiled. These types of devices are suitable for most general temperature measurement duties

Wire Wound Glass

One of the three main types of RTD. These devices feature a wire solidly embedded into a glass former. These types of devices are suited to extreme operating conditions.

Z

Zero point

The point at which the reading on an instrument reads zero. This can be adjusted so that the zero reading corresponds to a non-zero signal, such as 4mA or 1V DC.

Zone 0

A place in which an explosive atmosphere consisting of a mixture of air and flammable substances in the form of gas, vapour or mist is present continuously or for long periods or on a frequent basis. A Zone 0 application is typically one where an explosive atmosphere exists for more than 1,000 hours per year.

Zone 1

A place in which an explosive atmosphere consisting of a mixture of air and flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally. In a zone 1 application, an explosive atmosphere typically exists for between 10 and 1,000 hours per year.

Zone 2

An atmosphere where a mixture of air and flammable substances in the form of gas, vapor or mist is not likely to occur in normal operation but, if it does occur, will persist for only a short period.

Zone 20

An atmosphere where a cloud of combustible dust in the air is present frequently, continuously or for long periods.

Zone 21

An atmosphere where a cloud of combustible dust in the air is likely to occur in normal operation occasionally.

Zone 22

An atmosphere where a cloud of combustible dust in the air is not likely to occur in normal operation but, if it does occur, will persist for only a short period.