

GLOSSARY OF TERMS FOR PROCESS CONTROL

Accuracy Conformity of an indicated value to an accepted standard value, or true value.

Accuracy, Reference A number or quantity which defines the limit that errors will not exceed when the device is used under reference operating conditions. Note: Reference accuracy includes the combined conformity, hysteresis and repeatability errors. The units being used are to be stated explicitly. It is preferred that a + and - sign precede the number or quantity. The absence of a sign infers a + and - sign. Reference accuracy can be expressed in a number of forms. The following examples are typical:

1. Reference accuracy expressed in terms of the measured variable. Typical expression: The reference accuracy is + 1%F.
2. Reference accuracy expressed in percent of span. Typical expression: The reference accuracy is + 1/2% of span.
3. Reference accuracy expressed in percent of actual output reading. Typical expression: The reference accuracy is + 1% of actual output reading.

Auctioneering Device A device which automatically selects either the highest or the lowest input signal from among two or more input signals.

Bode Diagram A plot of log amplitude ratio and phase angle values on a log frequency base for a transfer function.

Control Action The nature of the change of the output affected by the input of a controller or a controlling system.

Control Action, Adaptive Control action whereby automatic means are used to change the type or influence (or both) of control parameters in such a way as to improve the performance of the control system.

Control Action, Cascade Control action where the output of one controller is the setpoint for another controller.

Control Action, Derivative (Rate) Control action in which the output is proportional to the rate of change of the input.

Control Action, Direct Digital Control action in which control is performed by a digital device, which establishes the signal to the final controlling element.

Control Action, Feedback Control action in which a

measured variable is compared to its desired value to produce an actuating error signal which is acted upon in such a way as to reduce the magnitude of the error.

Control Action, Feedforward Control action in which information concerning one or more conditions that can disturb the controlled variable is converted into corrective action to minimize deviations of the controlled variable. Note: Feedforward control action can be combined with other types of control to anticipate and minimize deviations of the controlled variable.

Control Action, High Limiting Control action in which the output never exceeds a predetermined high limit value.

Control Action, Integral (Reset) Control action in which the output is proportional to the time integral of the input; i.e., the rate of change of output is proportional to the input.

Control Action, Low Limiting Control action which the output is never less than a predetermined low limit value.

Control Action, Optimizing Control action that automatically seeks and maintains the most advantageous value of a specified variable, rather than maintain it at one set value.

Control Action, Proportional Control action in which there is a continuous linear relation between the output and the input.

Control Action, Proportional Plus Derivative (Rate) Control action in which the output is proportional to a linear combination of the input and the time rate-of-change of input.

Control Action, Proportional Plus Integral (Reset) Control action in which the output is proportional to a linear combination of the input and the time integral of the input.

Control Action, Proportional Plus Integral (Reset) Plus Derivative (Rate) Control action in which the output is proportional to a linear combination of the input, the time integral of input and the time rate-of-change of input.

Control Action, Shared Time Control action in which one controller divides its computation or control time among several control loops rather than acting on all loops simultaneously.

Control Action, Supervisory Control action in which the control loops operate independently subject to intermittent corrective action; e.g., setpoint changes from an external source.

Control Mode A specific type of control action such as proportional, integral or derivative.

Control System A system in which deliberate guidance or manipulation is used to achieve a prescribed value of a variable. Note: It is subdivided into a controlling system and a controlled system.

Control System, Multi-Element (Multi-Variable) A control system utilizing input signals derived from two or more process variables of the purpose of jointly affecting the action of the control system.

Control System, Non-Interacting A multi-element control system designed to avoid disturbances to other controlled variables due to the process-input adjustments, which are made for the purpose of controlling a particular process variable.

Controller A device which operates automatically to regulate a controlled variable.

Controller, Direct-Acting A controller in which the absolute value of the output signal increases, as the absolute value of the input (measured variable) increases.

Controller, Integral (Reset) (I) A controller which produces integral control action only. Note: may also be referred to as controller, proportional speed floating.

Controller, Multi-position A controller having two or more discrete values of output.

Controller, On-off A multi-position controller having two discrete values of output, fully on, or fully off.

Controller, Proportional (P) A controller which produces proportional control action only.

Controller, Proportional Plus Derivative (Rate), (PD) A controller which produces proportional plus derivative (rate) control action.

Controller, Proportional Plus Integral (Reset), (PI) A controller which produces proportional plus integral (reset) control action.

Controller, Proportional Plus Integral (Reset), Plus Derivative (Rate), (PID) A controller which produces proportional plus integral (reset) plus derivative (rate) control action.

Controller, Ration A controller that maintains a predetermined ration between two or more variables.

Controller, Reverse-Acting A controller in which the absolute value of the output signal decreases, as the absolute value of the input (measured variable) increases.

Controller, Sampling A controller using intermittently observed values of a signal such as the setpoint signal, the actuating error signal, or the signal representing the controlled variable, to effect control action.

Controller, Self-Operated (Regulator) A controller in which all the energy to operate the final controlling element is derived from the controlled system, through the sensing element.

Controller, Time Proportioning A controller whose output consists of periodic pulses whose duration is varied to relate, in some prescribed manner, the time average of the output to the actuating error signal.

Controller, Time Schedule A controller in which the setpoint (or reference input signal) automatically adheres to a predetermined time schedule.

Controlling System 1. Of a feedback control system, that portion which compares functions of a directly controlled variable and a setpoint; and adjusts a manipulated variable as a function of the difference. It includes the reference input elements; summing point; forward and final controlling elements; and feedback elements (including sensing element). 2. Of an automatic control system without feedback, that portion of the control system which manipulates the controlled system.

Damping The progressive reduction or suppression of the oscillation of a system. Note: When the time response to an abrupt stimulus is as fast as possible without overshoot the response is said to be "critically damped"; "underdamped" when overshoot occurs; "overdamped" when response is slower than critical.

Damping, Relative For an underdamped system, a number expressing the quotient of the actual damping of a second-order linear system or element by its critical damping. Note: a second order linear system is a system, which is the product of two-second order lags.

Dead Band The range through which an input can be varied without initiating response. Note: Dead Band is usually expressed in percent of span.

Deviation Any departure from a desired or expected value or pattern.

Deviation, System The instantaneous value of the ultimately controlled variable minus the setpoint.

Drift A change in the output-input relationship over a period of time.

Element A component of a device or system.

Element, Final Controlling That forward controlling element which directly changes the value of the manipulated variable.

Element, Sensing The portion of a device directly responsive to the value of the measure quantity.

Elements, Feedback Those elements in the controlling system which change the feedback signal in response to the directly controlled variable.

Elements, Forward Controlling Those elements in the controlling system which change a variable in response to the actuating error signal.

Error The algebraic difference between the indication and the true value of the measured signal. It is the quantity, which algebraically subtracted from the indication gives the true value.

Error, Span The difference between the actual span and the ideal span.

Error, Zero The error of a device operating under the specified conditions of use when the input is at the lower range-value.

Frequency Response Characteristic The frequency dependent relation, in both amplitude and phase, between steady-state sinusoidal inputs and the resulting fundamental sinusoidal outputs.

Gain, Closed Loop The gain of a closed loop system, expressed as the ration of the output change to the input change at a specified frequency.

Gain, Dynamic The magnitude ration of the steady-state amplitude of the output sign from an element or system to the amplitude of the input signal to that element or system, for a sinusoidal signal. Note: It may be expressed as a ratio, or in decibels as 20 times the log of that ratio for a specified frequency.

Gain, Loop The ratio of the change in the return signal to the change in its corresponding error signal at a specified frequency. Note: The gain of the loop elements is frequently measured by opening the loop, with appropriate terminations. The gain so measured is often called the open loop gain.

Gain, Proportional The ratio of the change in output due to proportional control action to the change in input.

Gain, Static The value of the gain approached as a limit as frequency approaches zero.

Hysteresis When used as a performance specification, the maximum difference for the same input between the upscale and downscale output values during a full range traverse in each direction.

Impedance, Input The impedance presented by a device to the source.

Impedance, Load The impedance presented to the output of a device by the load.

Impedance, Output The impedance presented by a device to the load.

Impedance, Source The impedance presented to the input of a device by the source.

Indicator Travel The length of the path described by the indicating means or the tip of the pointer in moving from one end of the scale to the other.

Integral Action Rate (Reset Rate) Of proportional plus integral or proportional plus integral plus derivative control action devices, for a step input, the ratio of the initial rate of change of output due to integral control action to the change in steady-state output due to proportional control action. Note: Integral action rate is often expressed as the number of repeats per minute because it is equal to the number of times per minute that the proportional response to a step input is repeated by the initial integral response.

Interference, Common Mode A form of interference which appears between measuring circuit terminals and ground. Note: May also be referred to as interference, longitudinal, however interference, common mode is the preferred term.

Interference, Differential Mode See interference, normal mode.

Interference, Electrical Any spurious voltage or current arising from external sources and appearing in the circuits of a device.

Interference, Electrostatic Field A form of interference induced in the circuits of a device due to the presence of an electrostatic field. Note: It may appear as common mode or normal mode interference in the measuring circuits.

Interference, Longitudinal See interference, common mode.

Interference, Magnetic Field A form of interference induced in the circuits of a device due to the presence of

a magnetic field. Note: I may appear as common mode or normal mode interference in measuring circuits.

Interference, Normal Mode A form of interference which appears between measuring circuit terminals. Note: May also be referred to as interference, differential mode or interference, transverse, however interference, normal mode is the preferred term.

Interference, Transverse See interference, normal mode.

Linearity The closeness to which a curve approximates a straight line. Note: It is usually measured as a nonlinearity and expressed a linearity; e.g. a maximum deviation between an average curve and a straight line. The average curve is determined after making two or more full range traverses in each direction. The value of linearity is referred to the output unless otherwise stated.

Load, Regulation The change in output (usually speed or voltage) from no-load to full-load (or other specified limits).

Longitudinal Interference See Interference, common mode.

Loop, Closed (Feedback Loop) A signal path which includes a forward path, a feedback path and a summing point, and forms a closed circuit.

Loop, Open A signal path without feedback

Modulation The process, or result of the process, whereby some characteristic of one wave is varied in accordance with some characteristic of another wave.

Mounting Position The position of a device relative to physical surroundings.

Noise An unwanted component of a signal or variable which obscures the information content. Note: It may be expressed in units of the output or in percent of output span.

Offset The steady-state deviation when the setpoint is fixed. See also deviation, steady-state.

Operating Conditions Conditions (such as ambient temperature, ambient pressure, vibration, etc.) to which a device is subject, but not including the variable measured by the device.

Operating Conditions, Normal The range of operating conditions within which a device is designed to operate, and under which operating influences are usually stated.

Operative Limits The range of operating conditions to which a device may be subjected without permanent impairment of operating characteristics.

Overrange Of a system or element, any excess value of the input signal above its upper range-value or below its lower range-value.

Parameter A controllable or variable characteristic of a system or device, temporarily regarded as a constant, the respective values of which serve to distinguish the various specific states of a (the) system or device.

Power Consumption The maximum wattage used by a device within its operating range during steady-state signal condition.

Pressure, Ambient The pressure of the medium surrounding a device.

Pressure, Process The pressure of the process medium at the sensing element.

Pressure Supply The pressure at the supply port of the device.

Primary Element The system element that quantitatively converts measured variable energy into a form suitable for measurement.

Process The collective functions performed in and by the equipment in which the variable(s) is (are) to be controlled.

Proportional Band The change in input required to produce a full range change in output, due to proportional control action.

Range The region between the limits within which a quantity is measured, received, or transmitted, expressed by stating the lower and upper range values.

Range, Elevated-Zero A range where the zero value of the measured variable, measured signal, etc., is greater than the lower range-value. Note: The zero may be between the lower and upper range values, at the upper range value, or above the upper range value. Note 2: Terms suppression, suppressed range or suppressed span is frequently used to express the condition in which the zero of the measured variable is greater than the lower range value. The term range, elevated zero is preferred.

Range, Suppressed-Zero A range where the zero value of the measured variable is less than the lower range value. Zero does not appear on the scale.

Range-Limit, Lower The lowest quantity that a device can be adjusted to measure.

Range-Limit, Upper The highest quantity that a device can be adjusted to measure.

Reference Performance Performance attained under reference operating conditions. Note: Performance includes such things as accuracy, dead band, repeatability, hysteresis, linearity, etc.

Repeatability The closeness of agreement among a number of consecutive measurements of the output for the same value of the input under the same operating conditions, approaching from the same direction, for full range traverses. Note: It is usually measured as a non-repeatability and expressed as repeatability in percent of span. It does not include hysteresis.

Reproducibility The closeness of agreement among repeated measurements of the output for the same value of input, made under the same operating conditions over a period of time, approaching from both directions. Note 1: It is usually measured as a non-reproducibility and expressed as reproducibility in percent of span for a specified time period. Normally, this implies a long period of time, but under certain conditions, the period may be a short time during which drift may not be included. Note 2: Reproducibility includes hysteresis, drift and repeatability.

Resolution The degree to which equal values of a quantity can be discriminated by the device.

Response, Dynamic The behavior of the output of a device as a function of the input, both with respect to time.

Response, Ramp The total (transient plus steady-state) time response resulting from a sudden increase in the rate of change in the input from zero to some finite value.

Response, Step The time response of an instrument when subjected to an instantaneous change in input from one steady-state value to another.

Response, Time The time response of an instrument when subjected to an instantaneous change in input from one steady-state value to another.

Sampling Period The time interval between observations in a periodic sampling control system.

Sensitivity The ratio of a change in output magnitude to the change of input which causes it after the steady-state has been reached. Note 1: It is expressed as a

ration with the units of measurement of the two quantities stated. (The ratio is constant over the range of a linear device. For a nonlinear device the applicable input level must be stated). Note 2: Sensitivity has frequently been used to denote the deadband. However its usage in this sense is deprecated since it is not in accord with accepted standard definitions of the term.

Setpoint (Command) An input variable which sets the desired value of the controlled variable.

Signal Information about a variable that can be transmitted.

Signal, Error In a closed loop, the signal resulting from subtracting a particular return signal from its corresponding input signal.

Signal, Feedback That return signal which results from a measurement of the directly controlled variable.

Signal, Input A signal applied to a device, element or system.

Signal, Measured The electrical, mechanical, pneumatic, or other variable applied to the input of a device. It is the analog of the measured variable produced by a transducer (when such is used).

Signal Output A signal delivered by a device, element or system.

Signal, Reference-Input One external to a control loop which serves as the standard of comparison for the directly controlled variable.

Signal, Return In a closed loop, the signal resulting from a particular input signal, and transmitted by the loop and to be subtracted from the input signal.

Signal to Noise Ratio Ratio of signal amplitude to noise amplitude.

Signal Transducer (Signal Converter) A transducer, which converts one standardized transmission signal to another.

Span The algebraic difference between the upper and lower range-values.

Summing Point Any point at which signals is added algebraically.

System, Directly-Controlled The body, process, or machine directly guided or restrained by the final controlling element to achieve a prescribed value of the directly-controlled variable.

System, Indirectly-Controlled That portion of the controlled system in which the indirectly controlled variable is changed in response to changes in the controlled variable.

Temperature, Ambient The temperature of the medium surrounding a device. Note: allowable ambient temperature limits are based on the assumption that the device in question is not exposed to significant radiant energy sources.

Temperature, Process The temperature of the process medium at the sensing element.

Thermal Shock An abrupt temperature change applied to a device.

Time, Dead The interval of time between initiation of an input change or stimulus and the start of the resulting response.

Time, Ramp Response The time interval by which an output lags an input, when both are varying at a constant rate.

Time, Rise The time required for the output of a system (other than first order) to make the change from a small specified percentage (often 5 or 10) of the steady-state increment to a large specified percentage (often 90 to 95), either before or in the absence of overshoot.

Time, Settling The time required, following the initiation of a specified stimulus to a system, for the output to enter and remain within a specified narrow band centered on its steady-state value.

Time, Step Response Of a system or an element, the time required for an output to make the change from an initial value to a large specified percentage of the final steady-state value either before or in the absence of overshoot, as a result of a step change to the input.

Time Constant The value **T** in an exponential response term $A \exp(-t/T)$ or in one of the transform factors $1 + sT$, $1 + jwT$, $1/(1 + sT)$, $1/(1 + jwT)$.

Where:

s = complex variable

t = time, seconds

T = time constant

J = $\sqrt{-1}$

w = frequency, rad/sec

Note: For the output of a first-order (lag or lead) system forced by a step or an impulse, **T** is the time required to complete 63.2 percent of the total rise or decay; at any instant during the proceed, **T** is the quotient of the instantaneous rate of change divided into the change to be completed. In higher order systems, there is a time constant for each of the first-order components of the process. In a Bode diagram, breakpoints occur at $w = 1/T$.

Transducer An element or device which receives information in the form of one physical quantity and converts it to information in the form of the same or other physical quantity.

Transmitter A transducer which responds to a measured variable by means of a sensing element, and converts it to a standardized transmission signal which is a function only of the measurement.

Variable, Directly Controlled In a control loop that variable whose value is sensed to originate a feedback signal.

Variable, Indirectly-Controlled A variable which does not originate a feedback signal, but which is related to and influenced by the directly controlled variable.

Variable, Manipulated A quantity or condition which is varied as a function of the actuating error signal so as to change the value of the directly controlled variable.

Warm-Up Period The time required after energizing a device before its rated performance characteristics apply.

Zero Elevation For an elevated-zero range, the amount the measured variable zero is above the lower range-value. It may be expressed either in units of the measured variable or in percent of span.

Zero Shift Any parallel shift of the input-output curve.

Zero Suppression For a suppressed-zero range, the amount the measured variable zero is below the lower range-value. It may be expressed either in units of the measured variable or in percent of span.

Zone, Dead A zone in which no value of the output exists.

CREDIT: Extracted from SAMA Standard PMC20-2-1970. Process Measurement and Control Terminology, with the permission of the publisher, Process Measurement & Control Section, SAMA, 370 Lexington Ave., New York, NY 10017

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