

Process Instrumentation Terminology

International Society of Automation, ISA

ANSI/ISA-5.1-2009 ANSI/ISA-5.1-2009, Instrumentation Symbols and Identification

Accuracy - Degree of *conformity* of an indicated value to a recognized accepted standard value, or ideal value.

Accuracy, measured - The maximum positive and negative *deviation* observed in testing a *device* under specified conditions and by a specified procedure.

Note 1: It is usually measured as an inaccuracy and expressed as accuracy.

Note 2: It is typically expressed in terms of the measured variable, percent of span, percent of upper range- value, percent of scale length or percent of actual output reading.

Accuracy rating - A number or quantity that defines a limit that *errors* will not exceed when a *device* is used under specified *operating conditions*. See Figure 1.

Note 1: When operating conditions are not specified, *reference operating conditions* shall be assumed.

Note 2: As a performance specification, *accuracy* (or reference accuracy) shall be assumed to mean accuracy rating of the *device*, when used at *reference operating conditions*.

Note 3: Accuracy rating includes the combined effects of *conformity*, *hysteresis*, *dead band* and *repeatability* errors. The units being used are to be stated explicitly. It is preferred that a \pm sign precede the number or quantity. The absence of a sign indicates a + and a - sign.

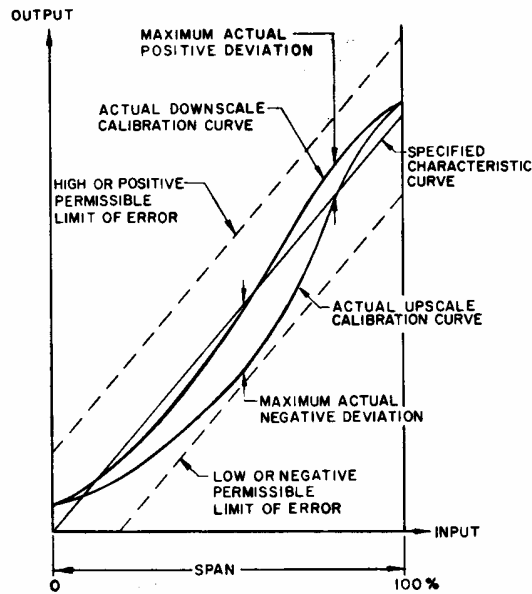
Accuracy rating can be expressed in a number of forms. The following five examples are typical:

- a. Accuracy rating expressed in terms of the *measured variable*. Typical expression: The accuracy rating is $\pm 1^\circ\text{C}$, or $\pm 20\text{ F}$.
- b. Accuracy rating expressed in percent of *span*. Typical expression: The accuracy rating is $\pm 0.5\%$ of span. (This percentage is calculated using scale units such as degrees F, psig, etc.)
- c. Accuracy rating expressed in percent of the upper range- value. Typical expression: The accuracy rating is $\pm 0.5\%$ of upper-range value. (This percentage is calculated using scale units such as kPa, degrees F, etc.)
- d. Accuracy rating expressed in percent of scale length. Typical expression: The accuracy rating is $\pm 0.5\%$ of scale length.
- e. Accuracy rating expressed in percent of actual output reading. Typical expression: The accuracy rating is $\pm 1\%$ of actual output reading.

Accuracy, reference - *see accuracy, rating*.

Actuating error signal - *see signal, actuating error*. adaptive control - *see control, adaptive*.

Adjustment, span - Means provided in an instrument to change the slope of the input-output curve. See *span shift*.



Accuracy Rating

Dead band – The range through which an input can be varied without initiating observable response.

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

Hysteresis – That property of an element evidenced by the dependence of the value of the output, for a given excursion of the input, upon the history of prior excursions and the direction of the current traverse.

Precision – (of measurement) the extent to which repeated measurements of a standard with a given instrument yields the same result.

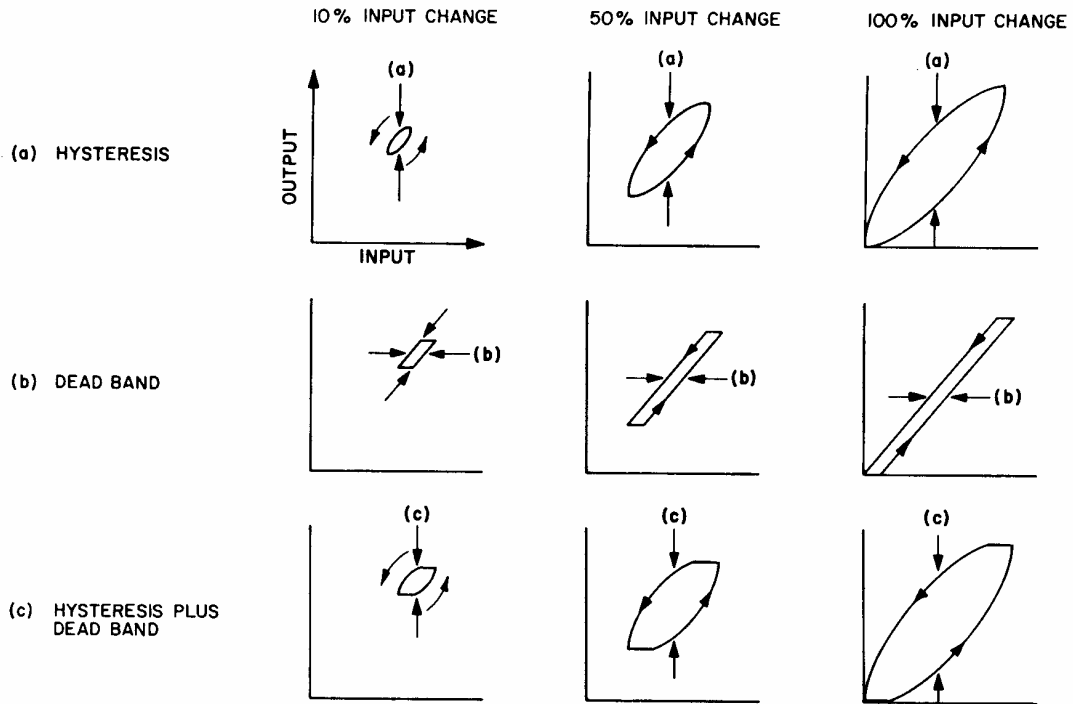
Range – The region between the limits within which a quantity is measured, received or transmitted, expressed as lower and upper values

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.

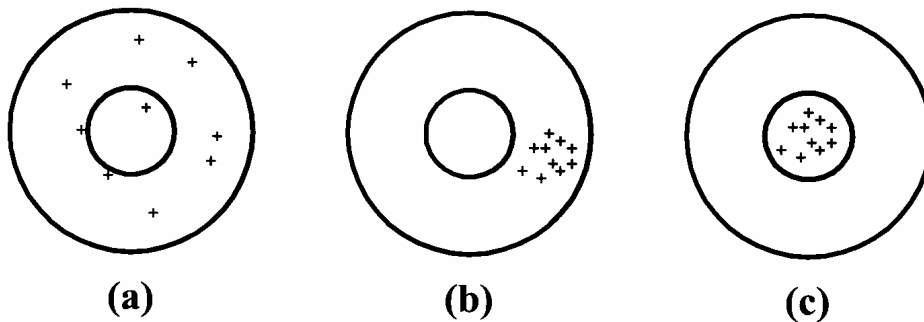
Transducer - An element or device that receives information in the form of one quantity and converts it to information in the form of the same or another quantity.

Note: This is a general term and definition and as used here applies to specific classes of devices such as primary element, signal transducer, and transmitter.

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 measured variable.



Hysteresis and Dead band



Targets which demonstrate the difference between accuracy and repeatability. (a) Neither accurate nor repeatable. (b) Repeatable but not accurate. (c) Accurate and repeatable.

Accuracy and Repeatability

Sources of Error in Measurement

A measurement error is the difference between the measured value and the true value. This difference from the true value can be a problem of precision or accuracy.

Several sources of error exist in most instruments - non-linearity, hysteresis (e.g., gear back-lash), and sensitivity to environmental factors such as temperature, magnetic or electrical fields are a few examples. Instrument error is often magnified by the fixturing required in the measuring process. Poor electrical connection, improper fastening of mechanical linkages, and loose clamps are examples of fixturing problems. Temperature induced error, in addition to its effects on measuring instruments, affects the specimen being measured. As temperature changes, the length (L) of a specimen changes. The observed s or standard deviation is a function of the causes contributing to the variation. The equation is:

$$\sigma_{obs} = \sqrt{\sigma_{cause(a)}^2 + \sigma_{cause(b)}^2 + \dots + \sigma_{cause(n)}^2}$$

where σ_{obs} = observed variation

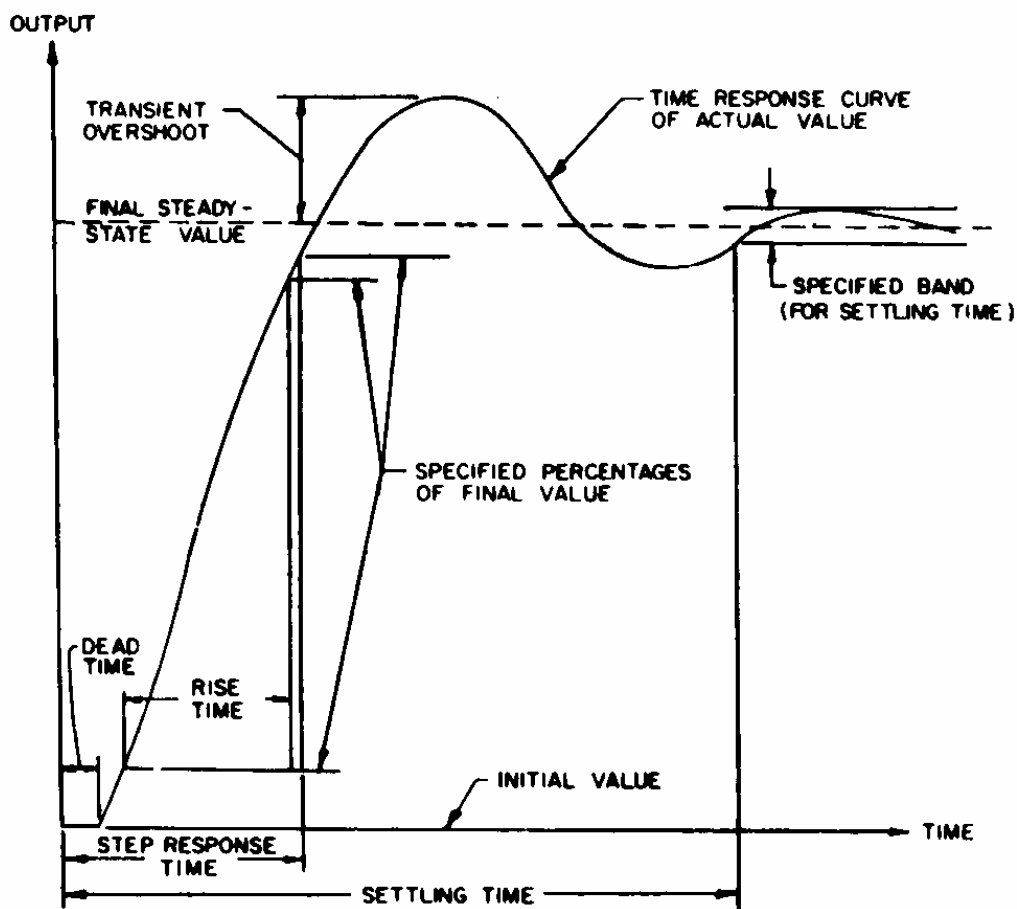
$\sigma_{cause(n)}^2$ = variance of a cause

Response Times

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

Time Constant – The value T in an exponential response term $A \exp(-t/T)$ or of the transform factors $1 / (Ts + 1)$.

Rise Time – The time required for the output of a system (other than first order) to change from a small-specified percentage of steady state to a large specified percentage of steady state.

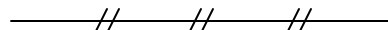


TYPICAL TIME RESPONSE OF A SYSTEM TO A STEP INCREASE OF INPUT

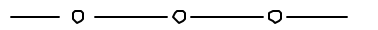
Drawings and Symbols

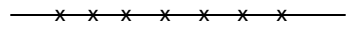
EFD, Engineering Flow Diagram – A drawing showing all the major engineering details of a plant or facility. This included the piping details; pipe size and specifications, insulation, vessel sizes and ratings, pump sizes and instruments. There is little to no information about the flow rates and energy transfers.

PFD, Process Flow Diagram – A drawing of a plant or facility that shows process flows, instrumentation, controls. Missing are the piping details, sizes etc. The PFD frequently has, in table form, the process and energy flows, capacity, etc. This document is used frequently used to define control strategy or basis.


Pneumatic Signal Line


Electronic Signal Line


System Link software link or manuf.
system connection between functions.


Filled System Capillary Signal Line

Common Signal Line Connection Symbols

Hysteresis and Dead band – Did your valve move, how much?