


Process Control – Understanding the Basics

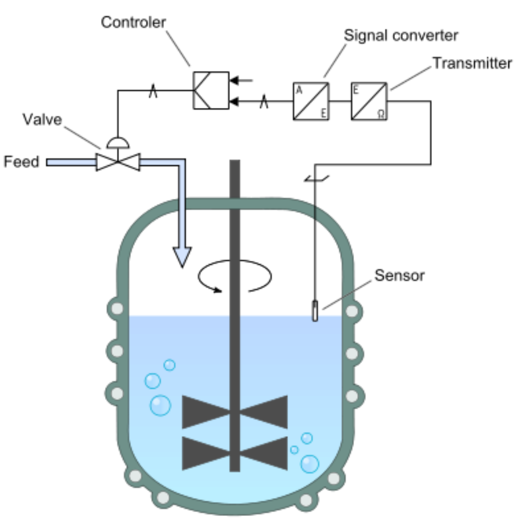
The difference between good control and bad control is the difference between success and failure. Process control begins with understanding your process variables. In manufacturing, a wide number of variables from temperature to flow to pressure can be measured simultaneously. All of these can be interdependent variables in a single process. Controlling each variable manually would be difficult, time-consuming, prone to mistakes and potentially hazardous. Fortunately, process control simplifies complex tasks, reduces variability and ensures the safety of your workers and equipment.

Common process variables include:

Pressure
Flow
Level
Temperature
Density
pH
Mass
Conductivity

All process control loops work in the same way, requiring three tasks to occur:

- **Measure** – measure the right parameters accurately and quickly
- **Decide** – what to adjust and by how much
- **Act** – quickly act on the decision before the process goes further out of control



Let's look at a basic example. A level sensor measures the level in a tank and transmits a signal associated with the level reading to a controller. The controller compares the reading to a pre-determined value. If the level is low, the controller sends a signal to the valve on the feed line. The valve opens to add product to the tank and bring the level back to the correct position.

Many different instruments and devices may be used in control loops (transmitters, sensors, valves, pumps, etc.) but the three basic steps are always used.

Good control decisions are made by applying your process knowledge. The control loop needs to be "tuned" for the best response. Too little correction and you have no impact. Too much correction may result in damage to the controls, the equipment or the product.

Let's define a few other terms commonly used in process control.

Set Point – the value for a process variable that is desired to be maintained. For example, if a process temperature needs to be kept within ±5°C of 100°C, then the set point is 100°C. Set points can also be maximum or minimum values.

Error – the difference between the measured variable and the set point. The error can be either positive or negative. In our example, if the measured temperature is 108°C, then the error is +8°C.

Duration – the length of time that an error condition exists

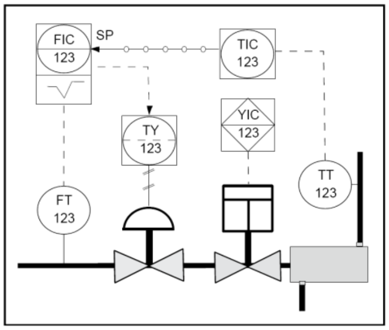
Offset – a sustained deviation of the process variable from the set point. For example, if our control system held the temperature at 100.5°C consistently (even though the set point was 100.0°C), then an offset of 0.5°C exists.

Load Disturbance – an undesired change in one of the factors that can affect the process variable. For example, the addition of cold water to the tank would be a load disturbance because it lowers the temperature of the process fluid.

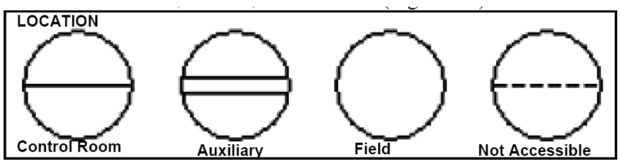
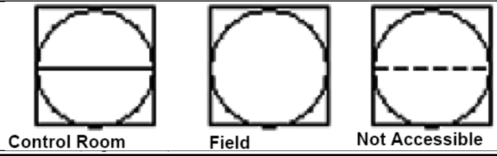
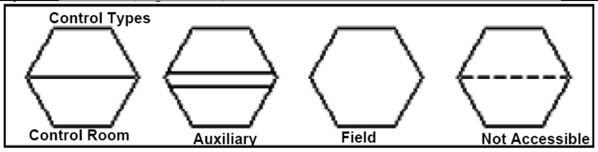
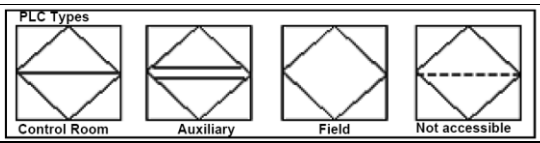
Closed and Open Control Loops – a *closed control loop* exists where a process variable is measured, compared to a set point and action taken to correct any deviation. An *open control loop* exists where action is taken without regard to process variable conditions. For example, a water valve may be opened to add cooling water to a process based on a pre-set time interval, regardless of the actual temperature of the process fluid.

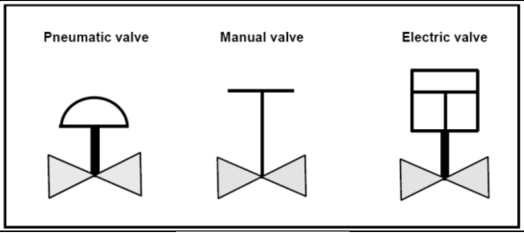
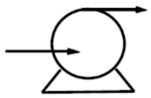
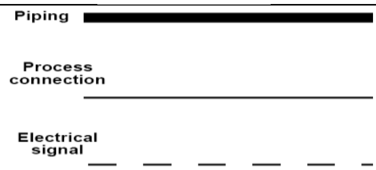
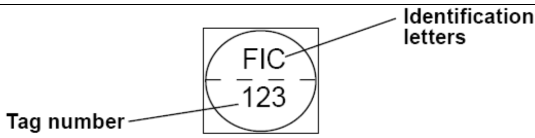
ISA Symbols

The Instrumentation, Systems and Automation Society (ISA) is one of the leading process control standards organizations. They have developed a series of symbols for use in engineered drawings and design of control loops. Drawings using these symbols are known as Piping and Instrumentation Drawings (P&ID).

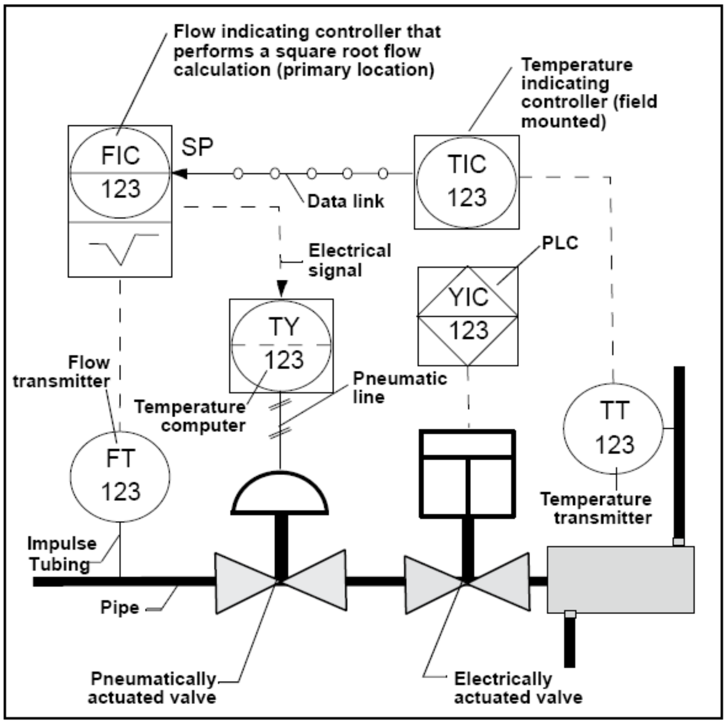


In P&ID drawings, these symbols represent measurement instrumentation, controls, piping, equipment and the process variable being measured. Below is a quick reference guide for commonly used symbols:

	A circle represents individual measurement instruments, such as transmitters, sensors and detectors. A single horizontal line indicates that the instrument is located in a primary location (i.e. control room). A double line indicates an auxiliary location. No line indicates that it is field-mounted and a dotted line indicates that the instrument is inaccessible (i.e. behind a panel board).
	A square with a circle inside represents instruments that both display readings and perform some control function.
	A hexagon represents computer functions, such as those carried out by a controller.
	A square with a diamond inside represents PLC's.

	A ‘bow tie’ shape represents a valve in the piping. An actuator is always drawn above the valve to indicate whether it is pneumatic, manual or electric.
	Pumps are represented with this symbol. Directional arrows show the flow direction.
	Piping and connections are represented with several symbols: a heavy line for piping; a thin solid line for process connections to instruments, etc. A full list of piping listings can be found on the ISA site.
	Identification letters indicate the variable being measure (flow, temperature, etc) and the device function (transmitter, sensor, valve, etc). The tag number references the specific control loop.

The figure below is an example of several elements of these symbols being used in a P&ID.



For a complete listing of ISA symbols and identification letters, visit www.isa.org.