



Industrial Instrumentation

Prasad k Godse








ROSEMOUNT
644
1 2 3 4
METER CONNECTOR
POWER
ON
SIMULATE


ROSEMOUNT

students are suppose to know following

1. ISA symbology & its significance
2. Process variables & their Engineering units with conversion
3. measurement & instrumentation system
types of measurements
4. performance characteristics of instruments
5. Field instrumentation and their identification

   their working principles / function / specifications / applications /

   installation technique

- types of sensors & measurement techniques

  pressure temp flow elements
  level pH humidity conductivity vibrations

- types of industrial switches

- types of transmitters

  DPT Magnetic flow meter Temperature transmitter

- types of converters

- types of actuators

- types of valves

- process instrumentation basics
- functions of instrumentation loop / control system
- control strategies
- FB FF Cascade Ratio split range override / selective

Contents

Industrial Sensors & Measurement Techniques

- What is sensor ? Why sensor is Needed ?
- Classification of Sensors / Measurement Techniques
- Sensor Performance characteristics
- Sensors selection Guidelines
- Applications

What is sensor ? Why Sensor is needed ?

- A sensor is a device that detects and responds to some type of input from the physical environment.
- The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena.
- The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing.
- Here are a few examples of the many different types of sensors:
- In a **mercury-based glass thermometer**, the input is **temperature**. The liquid contained expands and contracts in response, causing the level to be higher or lower on the marked gauge, which is human-readable.
- An **oxygen sensor** in a car's emission control system detects the **gasoline/oxygen ratio**, usually through a chemical reaction that generates a voltage. A computer in the engine reads the voltage and, if the mixture is not optimal, readjusts the balance.
- **Motion sensors** in various systems including home security lights, automatic doors and bathroom fixtures typically send out some type of energy, such as microwaves, ultrasonic waves or light beams and detect when the flow of energy is interrupted by something entering its path.
- A **photosensor** detects the presence of visible light, infrared transmission (IR), and/or ultraviolet (UV) energy.
-

Classification of Sensors / Measurement Techniques

- Active & Passive sensors
- Continuous & Discrete sensors
- Contact & Non contact type
- Mechanical sensors / Conventional sensors (Analog)
- SMART sensors(Digital)

Measurement Techniques

- Human Observations / & OR use of sight Glass meter / Dipstick
- Direct & Indirect Measurement – Level / Pressure / Flow via DP / Level via DP / Temp / Temp via Resistance/ mv change.
- Continuous & Discrete Measurement- Measurement over period of Time / Measurement at certain condition (point)
- Analog & Digital Measurement- Analog output (Gauge)/ Digital output(LED /LCD Display)
- Indication - Gauges / scale / sight glass / Manometer
- Indication + over long Distance Transmission (Transmitter +Display)
- Contact & Non contact type (physical contact of PV/ No contact of PV)

Sensor Performance characteristics

- **Accuracy** is closeness with which instrument reading approaches true value.
- **Resolution** is the smallest amount of a variable that an instrument can resolve, i.e., the smallest change in a variable to which the instrument will respond.
- **Precision** refers to the limits within which a signal can be read and may be somewhat subjective.
- **Reproducibility** is the ability of an instrument to repeatedly read the same signal over time, and give the same output under the same conditions. An instrument may not be accurate but can have good reproducibility, i.e., an instrument could read 20 psi as having a range from17.5 to 17.6 psi over 20 readings.

- **Sensitivity** is a measure of the change in the output of an instrument for a change in the measured variable, and is known as the transfer function, i.e., when the output of a pressure transducer changes by 3.2 mV for a change in pressure of 1 psi, the sensitivity is 3.2 mV/psi. High sensitivity in an instrument is preferred as this gives higher output amplitudes, but this may have to be weighted against linearity, range, and accuracy.
- **Offset** is the reading of an instrument with zero input.
- **Drift** is the change in the reading of an instrument of a fixed variable with time.
- **Hysteresi**s is the difference in readings obtained when an instrument approaches a signal from opposite directions
- **Linearity** is a measure of the proportionality between the actual value of a variable being measured and the output of the instrument over its operating range.
- **Repeatability** is a measure of the closeness of agreement between a number of readings (10 to12) taken consecutively of a variable, before the variable has time to change. The average reading is calculated and the spread in the value of the readings taken.

- **accuracy** describes the **difference between** the measurement and the part's actual value, while **precision** describes the variation you see when you measure the same part repeatedly with the same device
- Precision refers to the closeness of two or more measurements to each other. Using the example above, if you weigh a given substance five times, and get **3.2 kg** each time, then your measurement is very precise. Precision is independent of accuracy. You can be very precise but inaccurate, as described above
- **Sensor calibration** is a method of improving **sensor** performance by removing structural errors in the **sensor** outputs. Structural errors are differences between a**sensors** expected output and its measured output, which show up consistently every time a new measurement is taken.
- **Accuracy** is the capacity of a measuring instrument to give RESULTS close to the TRUE VALUE of the measured quantity
- **Accuracy** is related to the bias of a set of measurements
- (IN)Accuracy is measured by the absolute and relative errors
- ABSOLUTE ERROR = RESULT - TRUE VALUE
- Relative Error=Absolute Error / True Value
- **Discrimination** is the minimal change of the input necessary to produce a detectable change at the output
- **Discrimination** is also known as **RESOLUTION**
- When the increment is from zero, it is called **THRESHOLD**

Sensor selection Guidelines

1. Ruggedness
2. Linearity
3. Repeatability
4. Convenient instrumentation
5. High stability & reliability
6. Good dynamic response
7. Excellent mechanical characteristics
8. Built-in integrated device with noise and other defects minimized

Choosing a Sensor

Environmental Factors	Economic Factors	Sensor Characteristics
Temperature range	Cost	Sensitivity
Humidity effects	Availability	Range
Corrosion	Lifetime	Stability
Size		Repeatability
Overrange protection		Linearity
Susceptibility to EM interferences		Error
Ruggedness		Response time
Power consumption		Frequency response
Self-test capability		

Applications of sensors

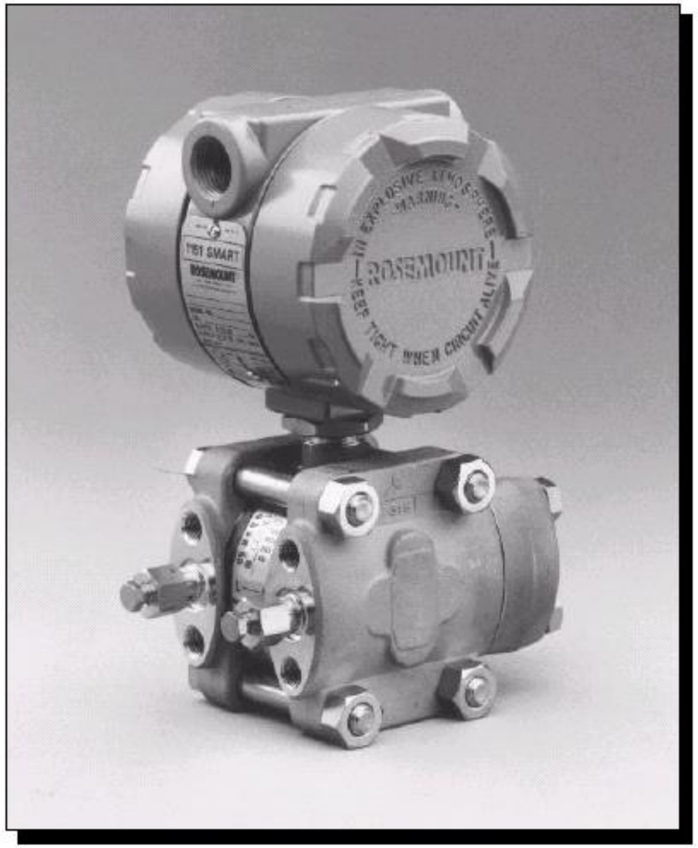
- Light sensors are used in cameras, infrared detectors, and ambient lighting applications
- Automotive: monitor vehicle tilt, roll, skid, impact, vibration, etc., to
- deploy safety devices (stability control, anti-lock breaking system,
- airbags, etc.) and to ensure comfortable ride (active suspension)
- Aerospace: inertial navigation, smart munitions, unmanned vehicles
- Sports/Gaming: monitor athlete performance and injury, joystick, tilt
- Personal electronics: cell phones, digital devices
- Security: motion and vibration detection
- Industrial: machinery health monitoring
- Robotics: self-balancing

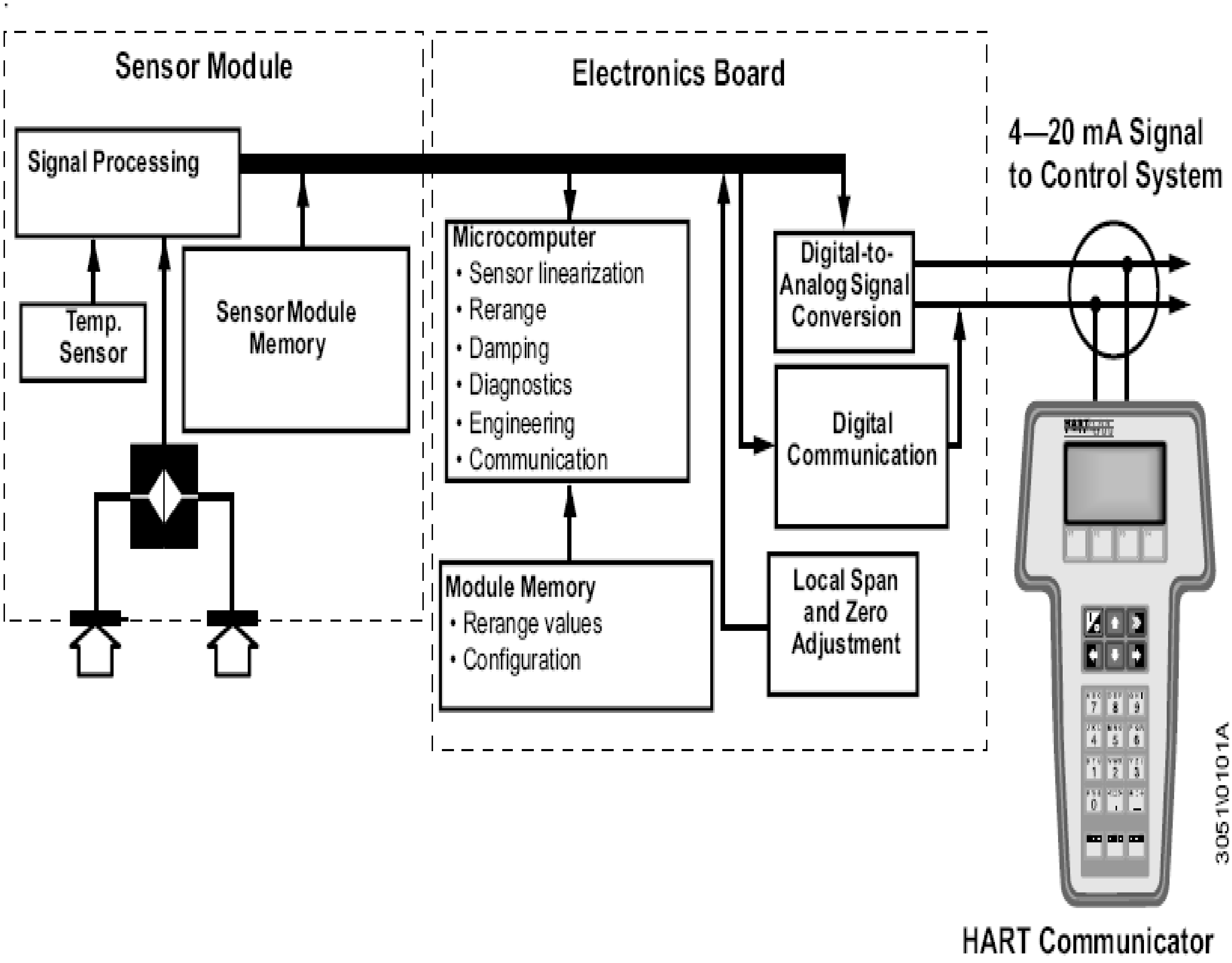
- Magnetic Field sensors are used for power steering, security, and current measurements on transmission lines
- Ultrasonic sensors are used for position measurements
- Oxygen sensor, used to monitor the amount of oxygen in the exhaust
- Parking sensors, used to alert the driver of unseen obstacles during parking maneuvers
- Radar gun, used to detect the speed of other objects
- Speedometer, used measure the instantaneous speed of a land vehicle
- Speed sensor, used to detect the speed of an object

- some examples of the industrial equipment where sensors are used for various purpose:
- Transport and Case Refrigeration Systems
  - Temperature Sensors are used to measure the supply air to control compartments.
  - Pressure Sensors measure refrigerant pressure to improve system efficiency.
- Wind Farm
  - Inclinometers are used to level windmill during construction and operation.
  - Vibration Sensors (Accelerometers) monitor the gearbox and provide early warning for maintenance.
- Oil and Gas
  - Rugged, hermetically sealed Rotary Magnetic Encoders, which are coupled to the fuel flow meter of a gas pump, are used to convert rotational pulses into gallons or liters purchased.
  - LVDT Sensors are used to provide positive feedback regarding valve position for flow controls.
- Process Control
  - Fluid Property Analyzers installed in refrigeration and cooling systems monitor lubricant refrigerant ratios and fluid condition.
  - LVDT Sensors provide positive feedback of pneumatic cylinder position.
- Traffic/Smart Highway
  - Our specially designed Traffic Sensors are used to monitor traffic patterns and collect data on highways.

What is Transmitters ?

- **Transmitter** is a **secondary transducer**
- **It converts physical signal** directly OR signal **generated by primary sensor**
- **Responds to a measurement variable OR Measurand)** into **suitable signal level OR standardized Transmission signal** which can be used for further processing OR can be displayed on indication system.
- It is an **instrument** used to transmit the information in a **standard format** over a long distance.
- Standard format signal levels for Electronic Transmitter is **4 – 20 mA DC @24 VDC**;
- Standard signal levels for Pneumatic Transmitter is 0.2 – 1 Kg / sq. CM (g) OR 3 – 15 psig




Sensor Module
Electronics Board
4—20 mA Signal to Control System
Signal Processing
Temp. Sensor
Sensor Module Memory
Microcomputer
• Sensor linearization
• Rerange
• Damping
• Diagnostics
• Engineering
• Communication
Module Memory
• Rerange values
• Configuration
Digital-to-Analog Signal Conversion
Digital Communication
Local Span and Zero Adjustment
HART Communicator
3051\0101A

Transmitters

- Need & Classification of Transmitters
- Transmitter Features & specifications
- Transmitter selection Guidelines
- Applications

Need & Classification of Transmitters

- Signals generated by sensors / Transducers are very weak and unable to inform to indication / control system.
- Output of a sensors affected by interferences.
- Receiving systems/ instruments accepts standard signals only.
- Sensors data is required to send over long distance.

Classification of Transmitters

- **Based on the type of medium.**
  - **Electronic Output(Typical 4-20 mA DC)**
  - **Pneumatic Output (3-15 Psig)**
- **Based on the signal Transmission.**
  - Conventional (Analog)
  - SMART or INTELLIGENT (Analog + HART)
  - FF compatible(Digital)
- **Based on the Parameter measurement.**
- Transmitters are broadly classified based on the parameters to be measured .
- **Based on Mounting Arrangement.**

Transmitter Classification based on Signal Transmission

- **Conventional (Analog)**
  - DPT / GPT /APT
  - TT / FT / LT
- **SMART or INTELLIGENT (ANALOG + HART)**
  - DPT
  - Capacitance Type LT
  - Radar LT
  - Ultrasonic LT
- FF compatible (Digital)
  - DPT
  - Magnetic Flow meter
  - Vortex Flow meter
  - Mass Flow meter

Transmitter Classification based on parameter measurement

- Pressure
  - DPT
  - GPT
  - APT
- Level
  - DPT
  - Capacitance Type LT
  - Radar LT
  - Ultrasonic LT
- Flow
  - DPT
  - Magnetic Flow meter
  - Vortex Flow meter
  - Mass Flow meter
- Temperature
  - Head Mounted
  - Remote
- Miscellaneous
  - pH Transmitter
  - Conductivity
  - Consistency

Transmitter Classification based on Type of Mounting Arrangement

- 2 inch stanchion Mounting
  - DPT
  - GPT
  - APT
  - TT
  - Magnetic flow Transmitter
- Tank Mounting
  - DPT
  - Capacitance Type LT
  - Radar LT
  - Ultrasonic LT
- DIN Rail Mounting
  - TT
  - Power transmitters
- Flanged Mounting
  - Integral Magnetic Flow meter
  - Vortex Flow meter
  - Mass Flow meter

- Intelligent Instrument in the field of industrial automation has applications due to its wide range of outstanding technical advantages and features, such as its high stability, high reliability, high accuracy, easy maintenance.
- The smart transmitter, for example, smart meters have the following advantages
- high precision smart transmitter with high accuracy. Using built-in microprocessor, real-time measure static pressure and temperature change on the impact of detection devices, data processing, the nonlinear correction, and the reproducibility of the hysteresis to compensate, making the output signal more accurate.
- In general, accuracy of 0.1% of the maximum range, the digital signal of up to 0.075%
- strong function smart transmitter with a variety of complex computing functions, dependent on the internal microprocessor and memory, can perform the evolution, temperature and pressure compensation and a variety of complex operations.
- wide range of common transmitter measurement range than the maximum of 10:1, and 40:1 or 100:1 intelligent transmitter up to the migration of up to 1900% and -200%, reduce the transmitter specifications, enhanced versatility and interchangeability, a lot of convenience to the user.
- communication can be achieved strong intelligent transmitter to operate the terminal, either at the scene to the terminal into the corresponding jack on the transmitter, you can also hand in the control room will be connected to the transmitter terminal the signal line, the zero and span adjustments and changes. Some transmitters have both analog and digital output (such as the HART protocol) for the realization of the foundation fieldbus communication.
- improve the self-diagnostic function transmitter through the communication device can detect the fault self-diagnosis result information

Transmitter Features & specifications

- Contribution of microprocessor is to calibrate unit over a wide range than actual span needed for particular application.
- Zero / Span settings can be changed electronically through Keyboard.
- High Turndown ; i.e. Ability to adjust span setting (Sensing Range) of a Transmitters.
- Allow for 2 way Communication with control Room.
- Standby sensor OR Multiple sensors facility allows to switch from an RTD to a TC sensor while using the same Transmitter.
- It can also memorize and recall tag Numbers & Failure modes, provide Damping & Temperature Compensation.

Advantages of smart Transmitters

- Compact Design
- Higher reliability
- Lower cost
- Ease of use
- electronic data storage
- self diagnosis and remote calibration
- self correction
- auto display

Transmitter specifications

- General Specifications
- Physical Specifications
- Performance specifications
- Functional specifications

General specifications

- Tag Name / No
- Line / Equipment No
- Supplier Details
- Model No / serial No
- Type of Design

Physical specifications

- **(STANDARD CONFIGURATION)**
- **Wetted Materials**
- **Isolating Diaphragms**
- 316L SST, Hastelloy C-276, Monel, gold-plated Monel, or Tantalum.
- **Drain/Vent Valves**
- 316 SST, Hastelloy C, or Monel.
- **Process Flanges and Adaptors**
- Plated carbon steel, 316 SST, Hastelloy C, or Monel.
- **Wetted O-rings**
- Viton With gold-plated Monel diaphragms,
- special fluorocarbon O-rings are supplied.

Non wetted Material

- **Fill Fluid**
- Silicone oil or inert fill.
- **Bolts and Bolting Flange (GP and AP only)**
- Plated carbon steel.
- **Electronics Housing**
- Low-copper aluminium. NEMA 4X. IP 65, IP 66.
- **Cover O-rings -** Buna-N.
- **Paint -** Polyurethane.
- **Process Connections -** ¼–18 NPTF
- **Electrical Connections-** ½–14 NPTF conduit entry
- **Weight -** 12 lb (5.4 kg)

Performance specifications

- **Accuracy**
- ±0.2% of calibrated span for Model 1151DP & All other ranges and transmitters, ±0.25% of calibrated span.
- **Stability**
- ±0.2% of URL for six months & ±0.25 for all
- other ranges. ±0.25% of URL for six months.
- **Short Circuit Condition** No damage to the transmitter will result when the output is shorted to

common or to power supply positive (limit 12 V).

- **Mounting Position Effect**
- Zero shift of up to 1 inH2O (0.24 kPa) that can be calibrated out.
- **EMI/RFI Effect**
- Output shift of less than 0.1% of span when tested to IEC 801-3 from 20 to 1000 MHz and for field strengths up to 30 V/m.

Functional Specifications

- **Service-** Liquid, gas, and vapor applications.
- **Ranges-** Minimum span equals the upper range limit (URL) divided by rangedown. Rangedown varies with the output code.
- **Outputs**
- **Analog -** 4–20 mA dc, linear with process pressure.
- **Analog-** 10–50 mA dc, linear with process pressure.
- **Analog-** 4–20 mA dc, square root of differential input pressure between 4 and 100% of input. Linear with differential input pressure between 0 and 4% of input.

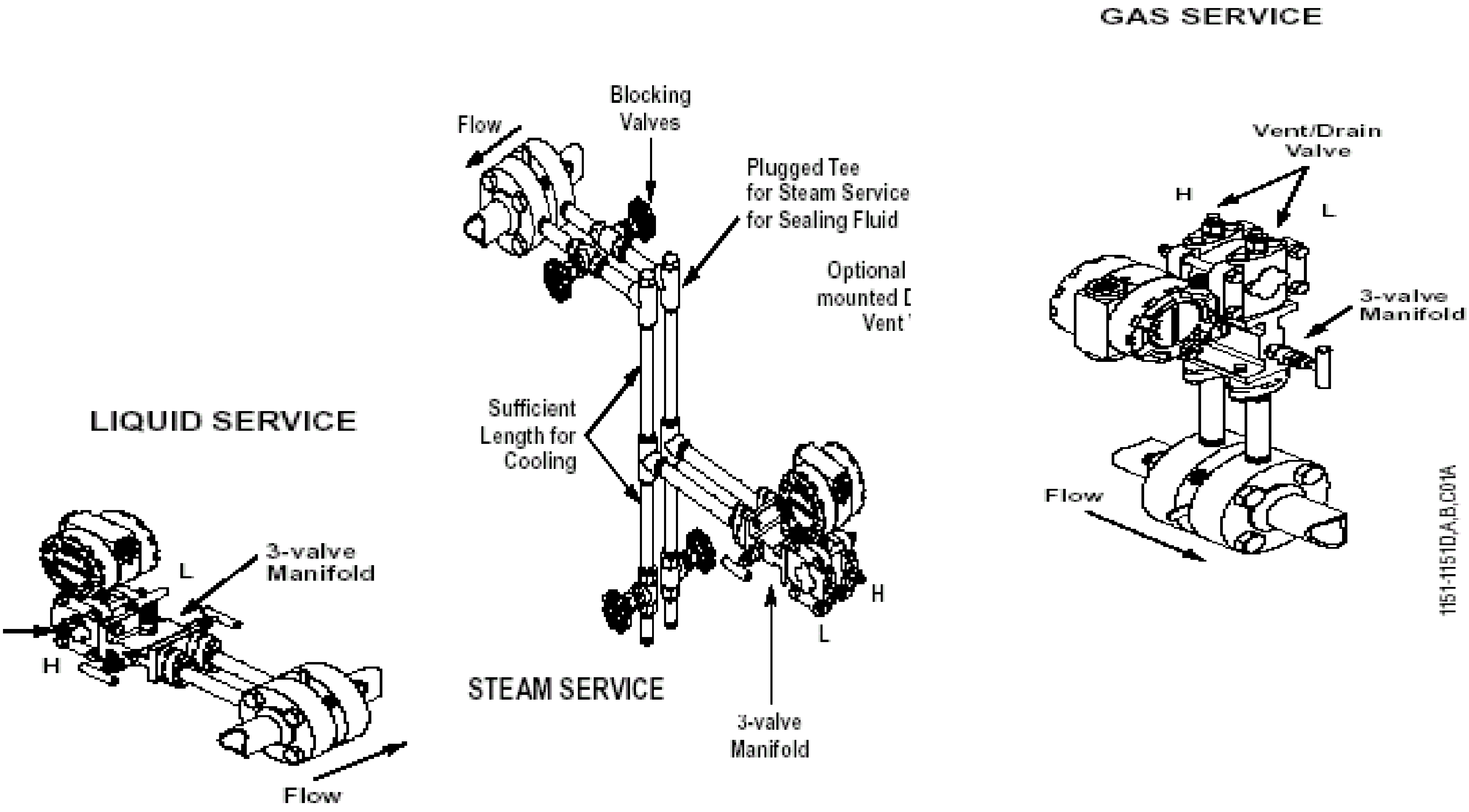
- **Power Supply -** External power supply required. Transmitter operates on:
- 12 to 45 V dc with no load
- 30 to 85 V dc with no load
- 5 to 12 V dc for Output
- 8 to 14 V dc for Output

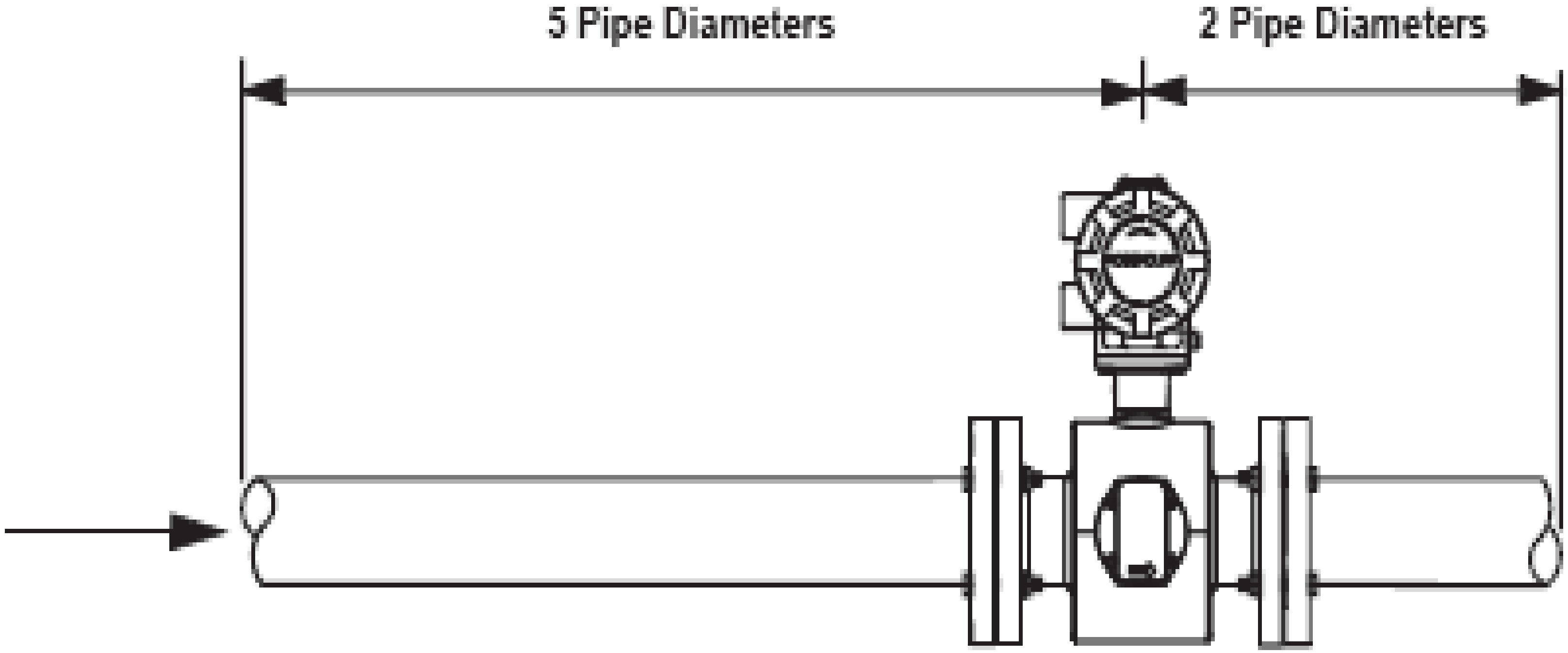
- **Current Consumption (Low Power Only)**
- **Under Normal Operating Conditions**
- 1.5 mA dc.& 2.0 mA dc.
- **Span and Zero**
- Span and zero are continuously adjustable.
- **Hazardous Locations Certifications**
- Stainless steel certification tag is provided.
- **Temperature Limits-Electronics Operating**
- –40 to 200 °F (–40 to 93 °C).
- –20 to 200 °F (–29 to 93 °C).
- –20 to 150 °F (–29 to 66 °C).
- **Sensing element operating**
- Silicone fill: –40 to 220 °F (–40 to 104 °C).
- Inert fill: 0 to 160 °F (–18 to 71 °C).
- **Static Pressure Limits**

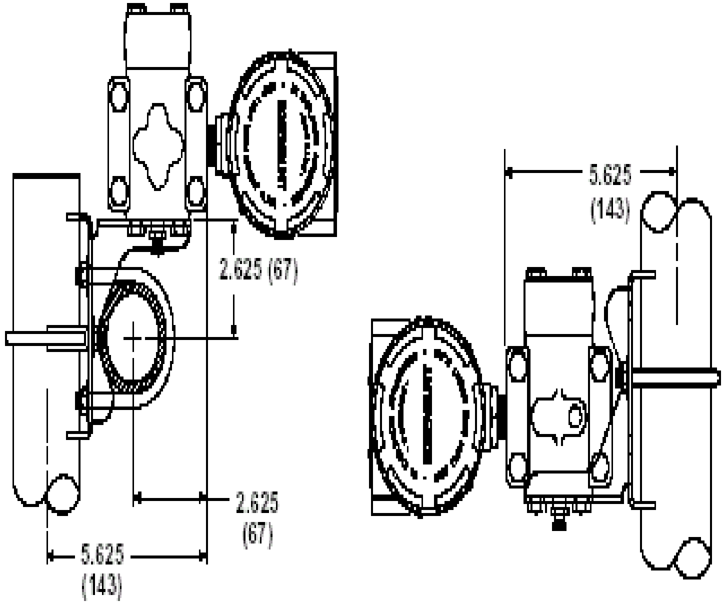
- **Overpressure Limits**
- Transmitters withstand the following limits without damage:
- **Model 1151DP**
- 0 psia to 2,000 psig (0 to 13790 kPa).
- **Model 1151HP**
- 0 psia to 4,500 psig (0 to 31027 kPa).
- **Burst Pressure Limit**
- All models: 10,000 psig (68.95 MPa) burst pressure on the flanges.
- **Humidity Limits**
- 0 to 100% relative humidity.
- **Volumetric Displacement**
- Less than 0.01 in3 (0.16 cm3).
- **Damping**
- Numbers given are for silicone fill fluid at room temperature. The minimum time constant is 0.2 seconds (0.4 seconds for Range 3). Inert filled sensor values would be slightly higher.
- **Turn-on Time**
- Maximum of 2.0 seconds with minimum damping. Low power output is within 0.2% of steady state value within 200 ms after application of power.

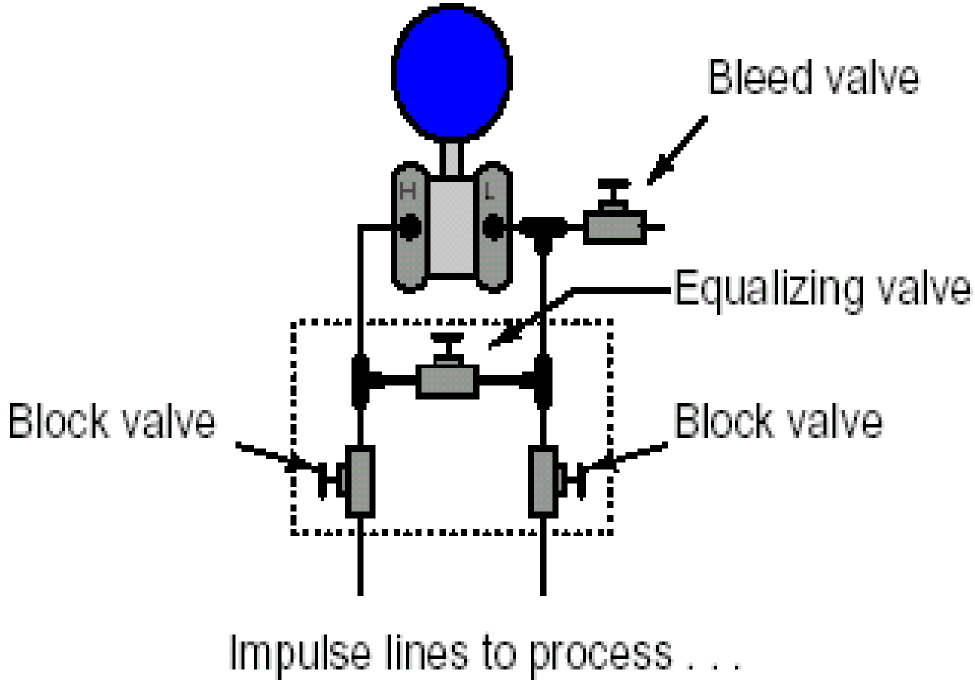
Transmitter Installation Guidelines

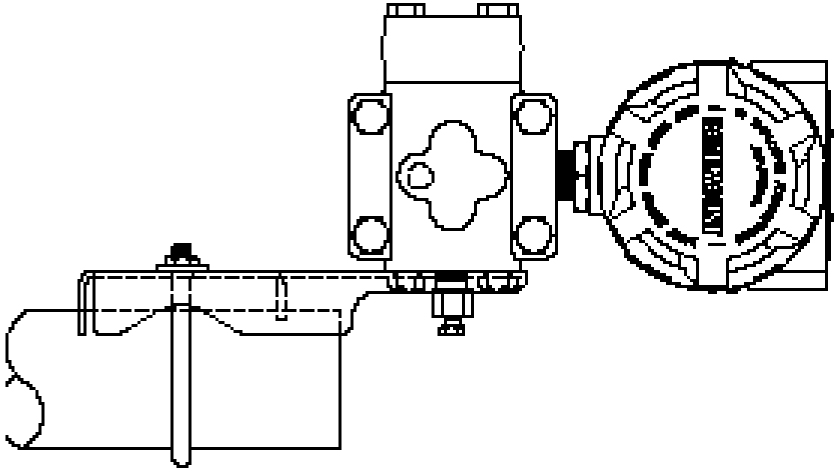
- General Considerations
- Mechanical Considerations
- Environmental Requirements
- Access Requirements .
- Process Flange Orientation
- Housing Rotation
- Terminal Side of Electronics Housing
- Circuit Side of Electronics Housing
- Exterior of Electronics Housing
- Mounting Effects.
- Process Connections
- Mounting Brackets


GAS SERVICE
Vent/Drain Valve
H
L
3-valve Manifold
Flow
1151-1151D A,B,C01A
Blocking Valves
Flow
Plugged Tee for Steam Service for Sealing Fluid
Optional
mounted
Vent
Sufficient Length for Cooling
H
L
3-valve Manifold
STEAM SERVICE
LIQUID SERVICE
L
3-valve Manifold
H
Flow


5 Pipe Diameters
2 Pipe Diameters


5.625
(143)
2.625 (67)
2.625
(67)
5.625
(143)


Bleed valve
Equalizing valve
Block valve
Block valve
Impulse lines to process . . .



Transmitter Terminology

- **Calibration** Operations that adjust for minor effects such as span shift and zero shift. These effects are usually caused by outside influences such as rotating a transmitter, or mounting a transmitter on its side.
- **Damping** Output function that increases the response time of the transmitter to smooth the output when there are rapid input variations.
- **Lower Range Limit (LRL)** Lowest value of the measured variable that the transmitter can be configured to measure.
- **Lower Range Value (LRV)** Lowest value of the measured variable that the analog output of the transmitter is currently configured to measure.
- In flow measurement, the turndown ratio indicates the range of flow that a flow meter is able to measure with acceptable accuracy. It is also known as rangeability.
- **Turndown ratio** refers to the width of the operational range of a device, and is defined as the ratio of the maximum capacity to minimum capacity.

- The **definition for turndown** is the "ratio of maximum plant design for flow rate to the minimum plant design flow rate"
- Range ability is usually defined as the ratio of maximum to minimum flow.
- range ability as "the ratio of the maximum flow to the minimum flow of a meter.
- **Reranging** Configuration function that changes the transmitter 4 and 20 mA settings.
- **Span** Algebraic difference between the upper and lower range values.
- **Upper Range Limit (URL)** Highest value of the measured variable that the transmitter can be

  configured to measure.
- **Upper Range Value (URV)** Highest value of the measured variable that the analog output of the transmitter is currently configured to measure.
- **Zero Trim** A zero-based, one-point adjustment used in differential pressure applications to compensate for mounting position effects or zero shifts caused by static pressure.

Transmitter selection Guidelines

- Select Transmitter based on User Requirements like- Process Parameter to be measured / Direct OR Indirect measurement Method / Type of Output desired / mounting Ease / Type of signal Transmission / Field calibration Requirement / based on Receiving facility.

- considerations that should be viewed in selecting a transmitter include
  - Process Fluid / Service / Operating Range
  - functional considerations
  - performance considerations
  - material selection
  - desirable features
  - Operating Environment (Hazardous Area /Non Hazardous Area)
  - Service nature
  - Type preference
  - Installation and Mounting consideration / Limitations
  - Type of output
  - Maintenance Requirements
  - Special requirements

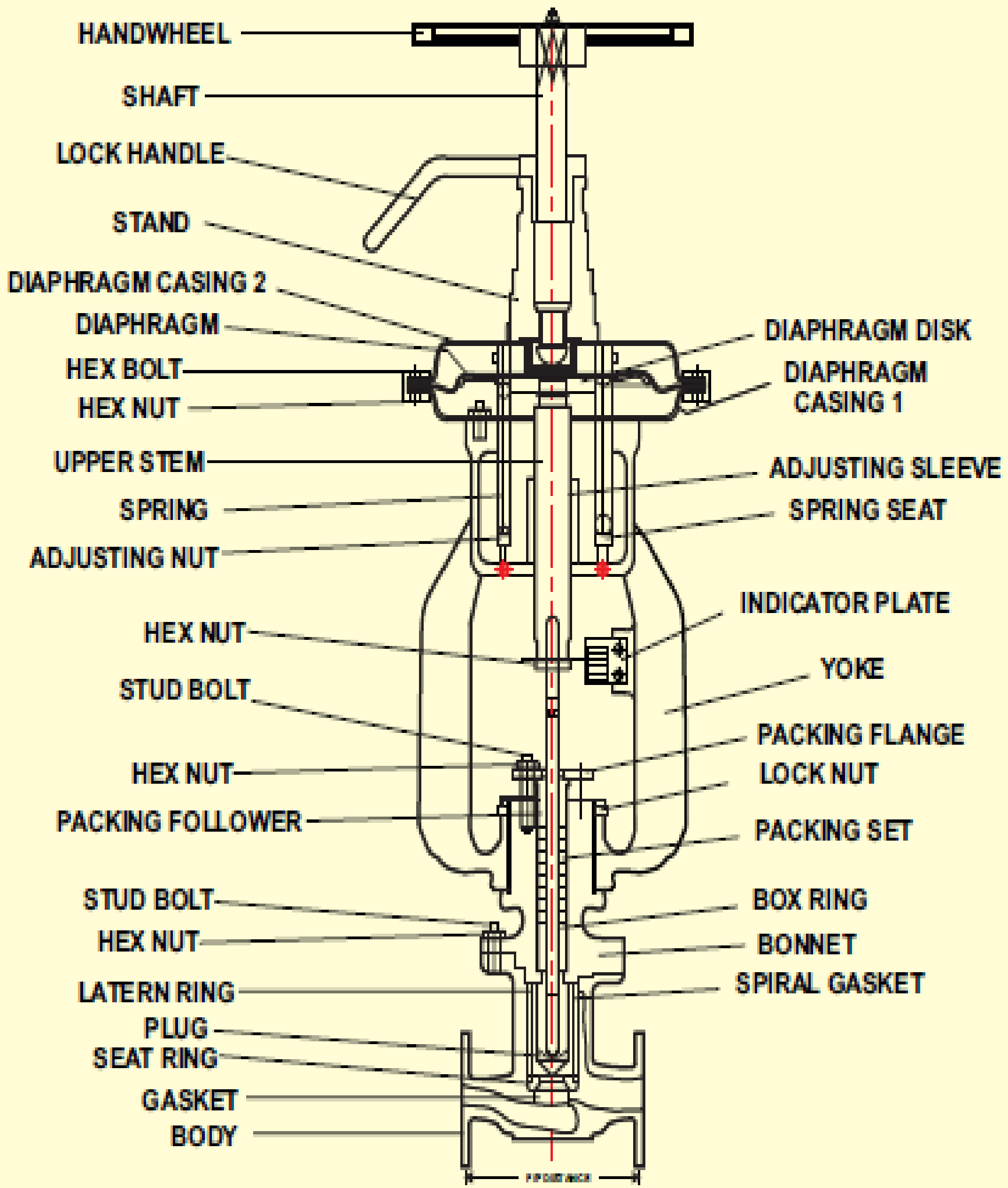
Applications

- Petrochemical industry
- Fertilizer industry
- Pulp & paper industry
- Sugar factory
- Rubber chemicals
- And many more.

Control Valves

- Need & Classification of Control Valves
- Control Valve specifications & characteristics
- Control valve selection Guidelines
- Applications

SINGLE SEATED GLOBE VALVE



Need & Classification of Control Valves

- A valve is a mechanical device that controls the flow of fluid and pressure within a system or process.
- A valve controls system or process fluid flow and pressure by performing any of the
- following functions:
- Stopping and starting fluid flow
- Varying (throttling) the amount of fluid flow
- Controlling the direction of fluid flow
- Regulating downstream system or process pressure
- Relieving component or piping over pressure
- There are many valve designs and types that satisfy one or more of the functions identified
- above. A multitude of valve types and designs safely accommodate a wide variety of industrial
- applications.

- Process plants consist of hundreds, or networked together to produce a product to be offered for sale.
- Each of these control loops is designed to keep some important process variable such as pressure, flow, level, temperature,etc. within a required operating range to ensure the quality of the end product.
- Each of these loops receives and internally creates disturbances that detrimentally affect the process
- variable, and interaction from other loops in the network provides disturbances that influence the process variable.

- To reduce the effect of these load disturbances, sensors and transmitters collect information about the process variable and its relationship to some desired set point.

- A controller then processes this information and decides should be after a load disturbance occurs.

- When all the measuring, comparing, and calculating are done, some type of **final control element** must implement the strategy selected by the controller.

- **The most common final control element in the process control industries is the control valve**.

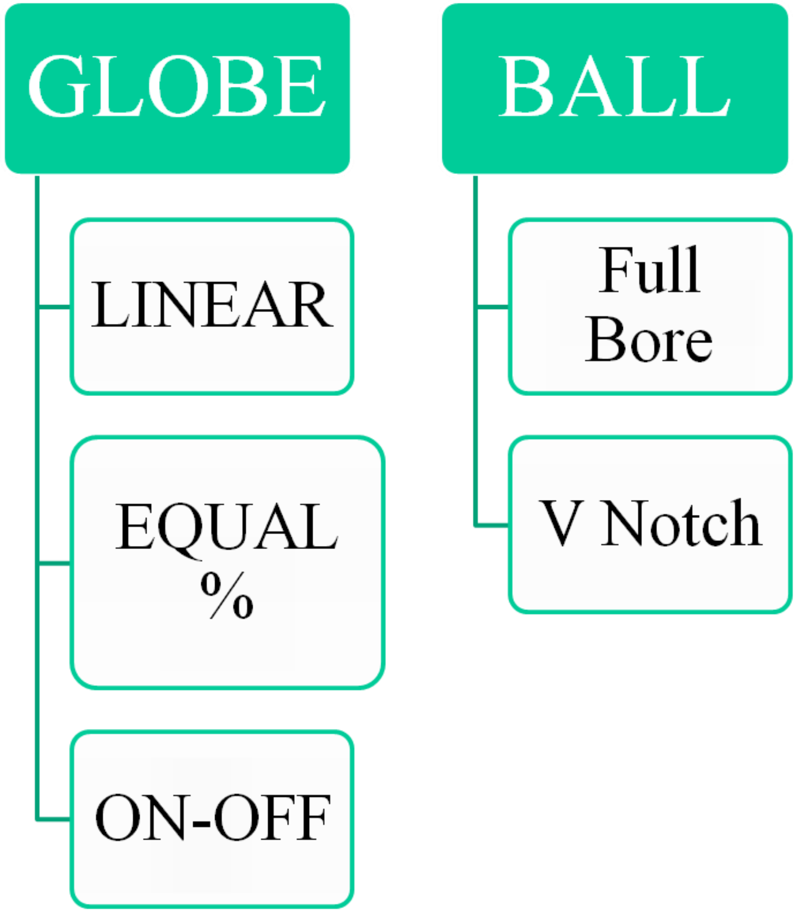
Control Valves Classification based on Sliding Method

- Linear sliding stem
  - GLOBE
  - GATE
  - DIAPHRAGM
  - PINCH
- Rotary stem
  - BUTTERFLY
  - BALL
  - ECCENTRIC PLUG

Control Valves Classification based on Operation

- THROTTLING
  - GLOBE
  - GATE
  - BALL
  - BUTTERFLY
- ON-OFF
  - BUTTERFLY
  - BALL
  - ECCENTRIC PLUG

Control Valves Classification based on Plug / Trim style



Control Valve specifications & characteristics

ISA S20.50, Rev. 1 — **CONTROL VALVE DATA SHEET** — **Second Printing**

ISA®	PROJECT ______ UNIT ______ P.O. ______ ITEM ______ CONTRACT ______ *MFR. SERIAL	DATA SHEET ______ of ______ SPEC ______ TAG ______ DWG ______ SERVICE ______

			Units	Max Flow	Norm Flow	Min Flow	Shut-Off	
1	Fluid					Crit Press PC		
2	SERVICE CONDITIONS	Flow Rate					—	
3		Inlet Pressure						
4		Outlet Pressure						
5		Inlet Temperature						
6		Spec Wt/Spec Grav/Mol Wt					—	
7		Viscosity/Spec Heats Ratio					—	
8		Vapor Pressure P_V					—	
9		*Required C_V					—	
10		*Travel	%				O	
11		Allowable/*Predicted SPL	dBA	/	/	/	—	
12								

13	LINE	Pipe Line Size In ______	53	ACTUATOR	*Type ______
14		& Schedule Out ______	54		*Mfr & Model ______
15		Pipe Line Insulation	55		*Size ______ Eff Area ______
16	VALVE BODY/BONNET	*Type ______	56		On/Off ______ Modulating ______
17		*Size ______ ANSI Class ______	57		Spring Action Open/Close ______
18		Max Press/Temp ______	58		*Max Allowable Pressure ______
19		*Mfr & Model ______	59		*Min Required Pressure ______
20		*Body/Bonnet Matl ______	60		Available Air Supply Pressure:
21		*Liner Material/ID ______	61		Max ______ Min ______
22		End In ______	62		*Bench Range ______ / ______
23		Connection Out ______	63		Actuator Orientation ______
24		Flg Face Finish ______	64		Handwheel Type ______
25		End Ext/Matl ______	65		Air Failure Valve ______ Set at ______
26		*Flow Direction ______	66		
27		*Type of Bonnet ______	67	POSITIONER	Input Signal
28		Lub & Iso Valve ______ Lube ______	68		*Type ______
29		*Packing Material ______	69		*Mfr & Model ______
30		*Packing Type ______	70		*On Incr Signal Output Incr/Decr ______
31			71		Gauges ______ By-pass ______
32		*Type ______	72		*Cam Characteristic ______
33		*Size ______ Rated Travel ______	73		

34	TRIM	*Characteristic
35		*Balanced/Unbalanced
36		*Rated C_V ____ F_L ____ X_T ____
37		*Plug/Ball/Disk Material
38		*Seat Material
39		*Cage/Guide Material
40		*Stem Material
41		
42		
43	SPECIALS/ACCESSORIES	NEC Class ____ Group ____ Div ____
44		
45		
46		
47		
48		
49		
50		
51		
52		

74	SWITCHES	Type ____ Quantity ____
75		*Mfr & Model
76		Contacts/Rating
77		Actuation Points
78		
79	AIR SET	*Mfr & Model
80		*Set Pressure
81		Filter ____ Gauge ____
82		
83	TESTS	*Hydro Pressure
84		ANSI/FCI Leakage Class
85		
86		

Rev	Date	Revision	Orig	App

*Information supplied by manufacturer unless already specified

- Type of Process Fluid / service – simple / slurry / Toxic / Precipitating
- Type of Process – critical / Non critical
- Line size
- Type of control action Required
- Expected Response Time
- Type of actuation required
- Duty- ON OFF OR Throttling
- End connection
- Permissible Leakage

Control valve selection Guidelines

- **Selection Procedure**
- • Estimate the size of the valve by taking one size smaller than the line. If there is no line size available calculate using a velocity of 5m/s for liquids and 40m/s for gases or vapours.
- • Use the chart to determine the valve type which best satisfies the requirements of the
- application.
- Generally for larger sizes of l00mm or greater the order of preference assuming cost to be of a high priority would be as follows:
- • Butterfly
- • Disk
- • Rotary plug
- • Ball

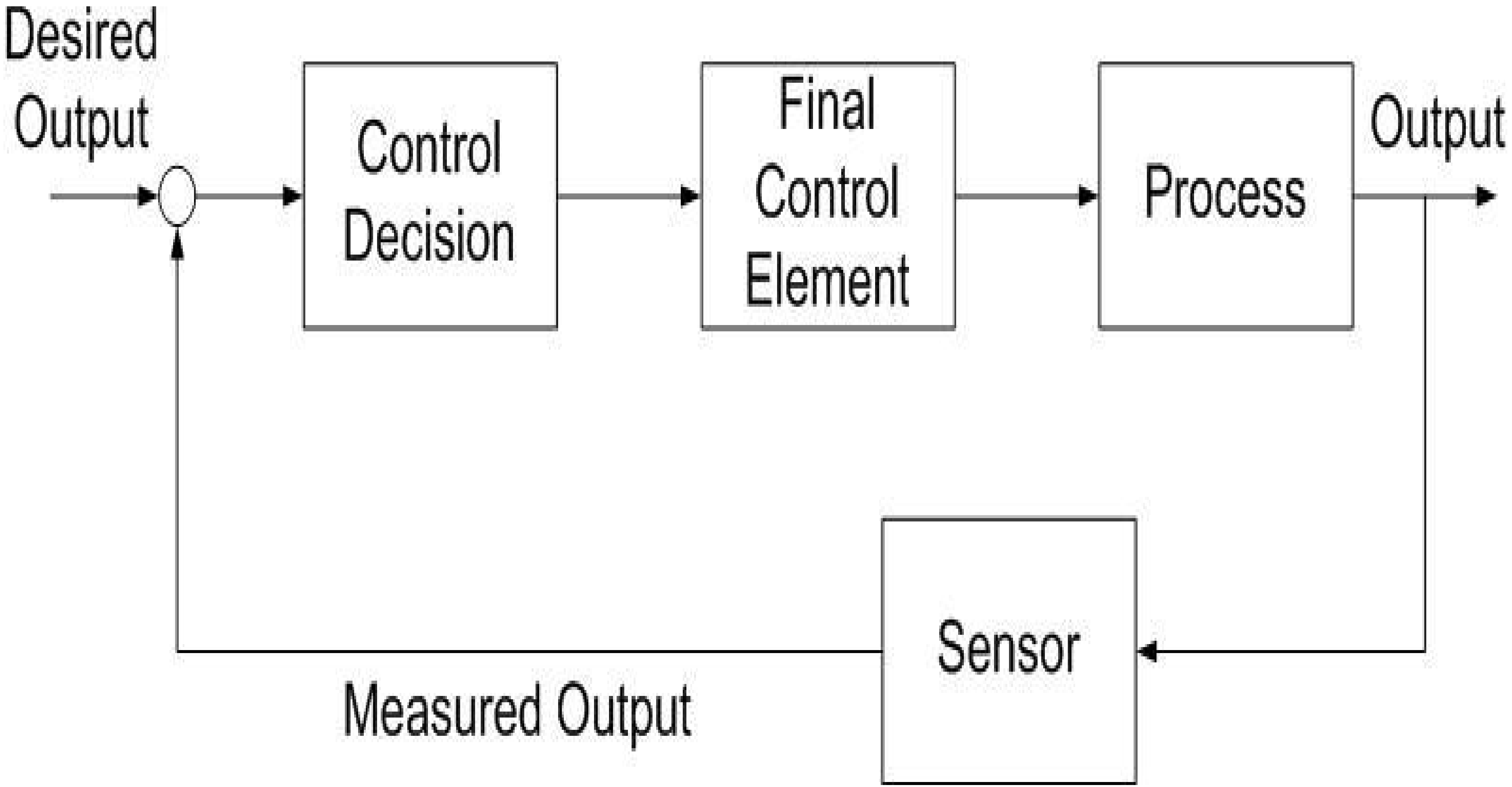
- but using globe if the pressure drop is high and using pinch/diaphragm valves for slurries.
- small valves of less than l00mm the order of preference would be:
- • Globe
- • Rotary plug
- • Ball
- • Pinch/Diaphragm
- **Conclusion**
- There is nothing definitive about selecting a type of valve and there is seldom a choice that can be considered to be 'right'; some selections will just be better than others - and of course it is easy to chose the wrong one!

Process control Techniques

- Manual Control
- ON-OFF Control
- Continuous Control
- Sequential control
- Safety control
- Centralized control
- Distributed Control
- Remote control (SCADA)
- Hybrid Control

Types of control systems

- Feedback Control system
- Feed Forward Control system
- Cascade Control system
- Ratio Control system
- Split Range control system
- Selective Control / Over ride control system
- Auctioneering Control system
- Adaptive control system
- Advanced control system


Desired Output
Control Decision
Final Control Element
Process
Output
Sensor
Measured Output

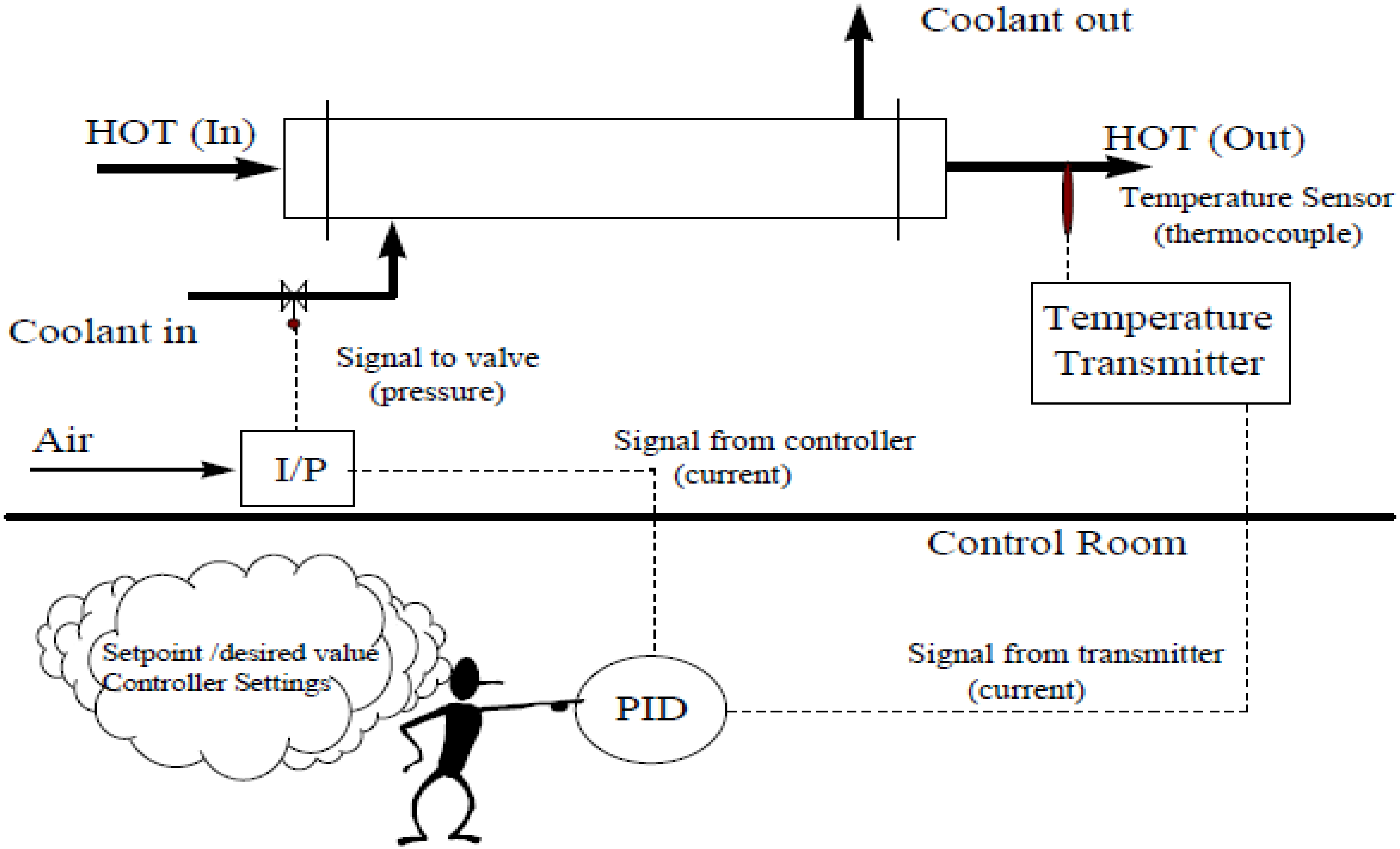
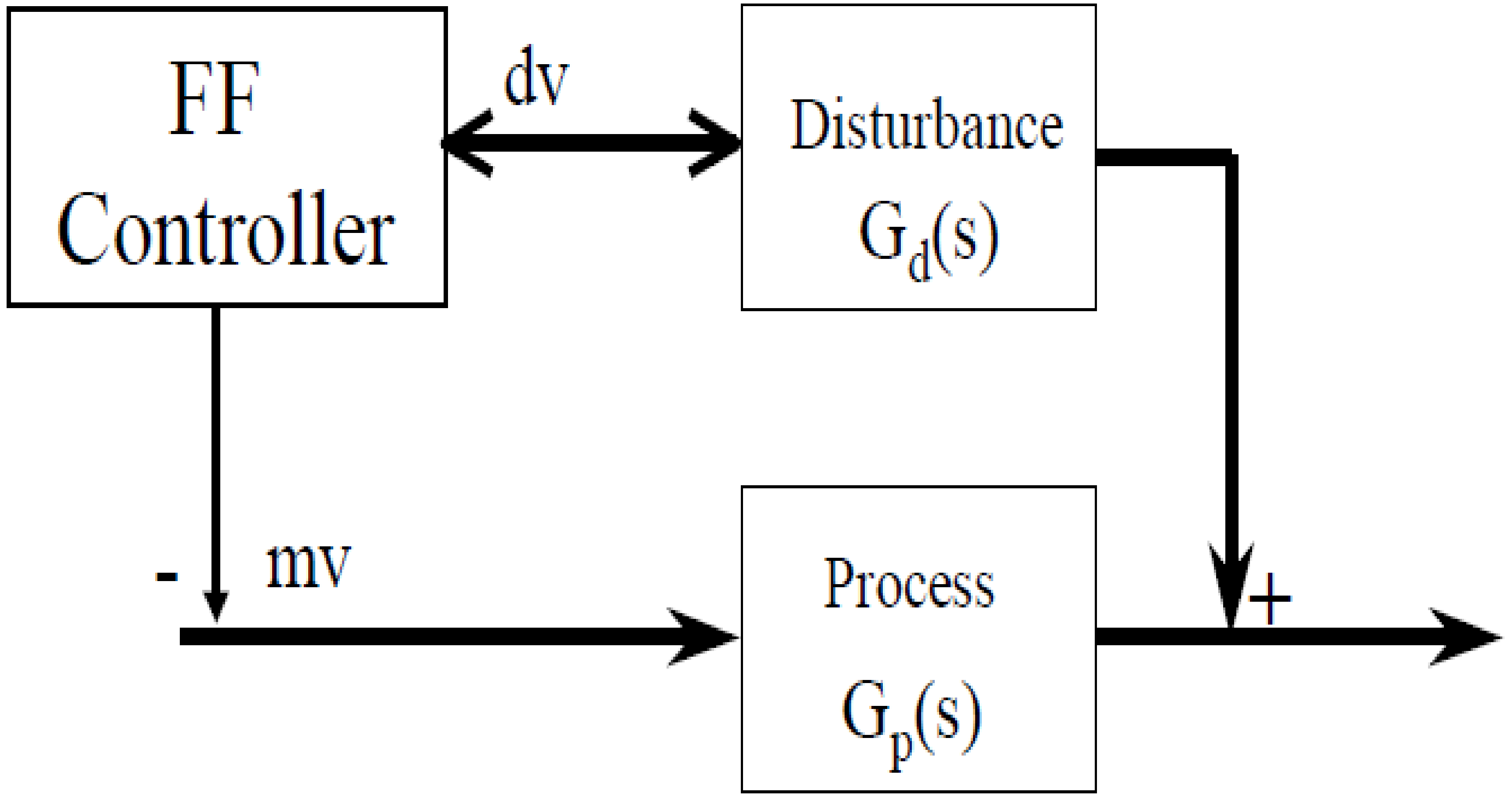
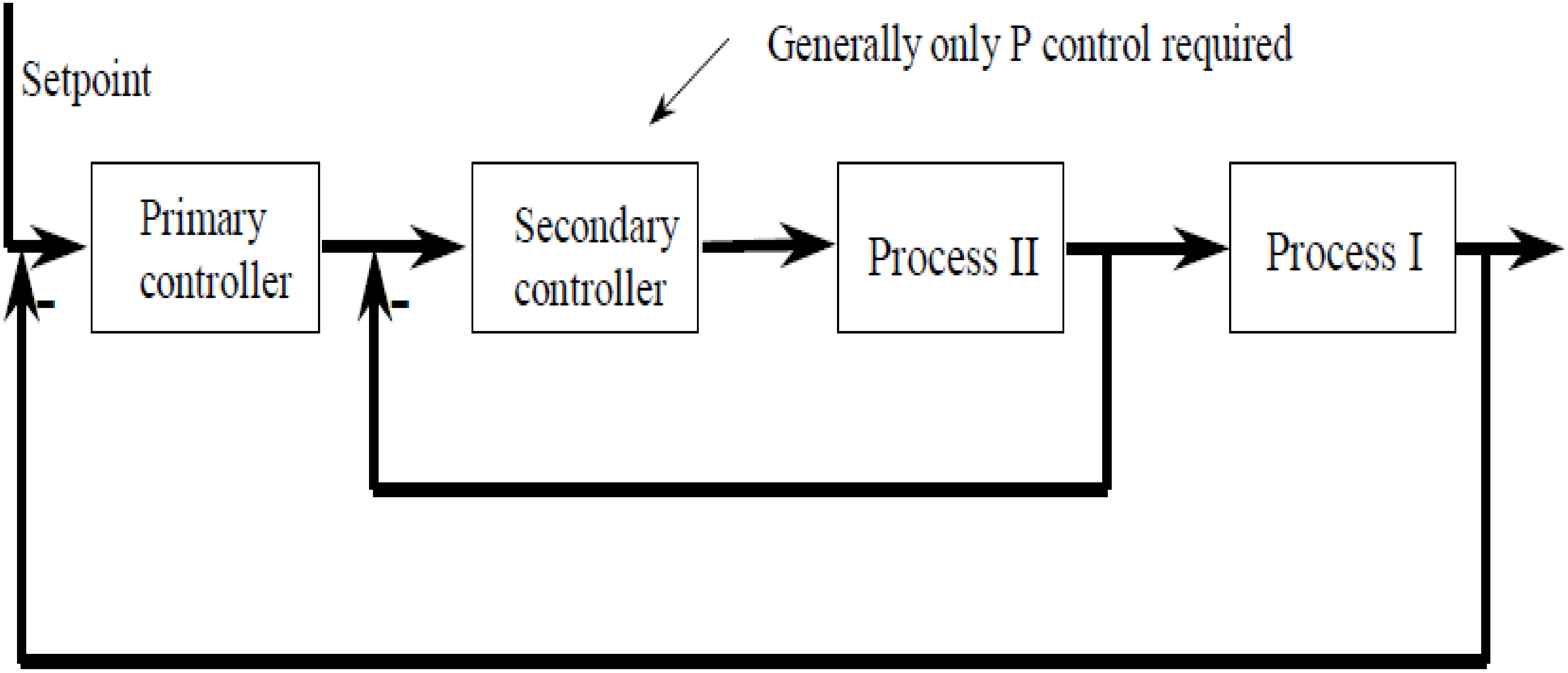


Figure (1). Feedback control scheme.

Feedforward control: a block diagram description

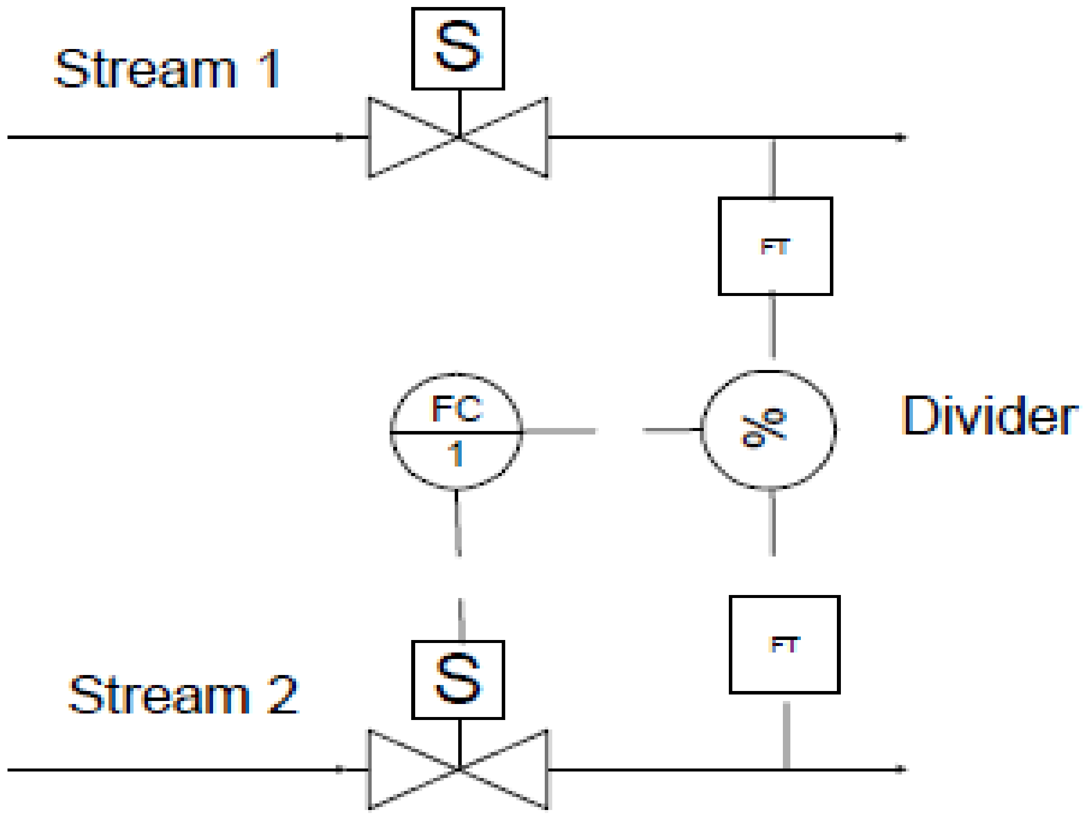


Cascade control Loop



Ratio control system

Implementation: method I



Overview of Industry Requirements from Fresh Graduates
(Technical& soft skillsets)

- Selection, Testing, Installation, Commissioning & Maintenance / Calibration of field Instrumentation sensors / Transmitters / Converters & Final control Elements / Control systems.
- Thorough with ALL kinds of instrumentation engineering documents and diagrams.(P& I D’s, Inst. Index, Hook Up Dwg, Loop wiring Diag., Panel wiring Drawings , JB / AH / EWD / Cable schedule / many More…)
- Work Environment safety awareness.
- Use of Software's for Design & Detailing work.
- Awareness of soft skills.

- **Technical skills required for instrumentation Graduates**

1.Design and development of instrumentation and control systems

2. selection of appropriate sensors / instrumentation and systems.

3. Drafting technical specifications of instruments

4. Installation of Field instruments as per Hook up drawings

5. Calibration / Testing & maintenance of instruments

6. Integration of instrumentation & control system

7. Strong communication skills

8.ability to translate project ideas into suitable design

9. Maintain Existing control systems

10.Troubleshooting and Loop Testing

11. Commissioning of transmitters , process controller and Valves,(control Loop)

12. PLC LD Programming

13. development of GUI on DCS / SCADA software

14. coordination, communication and Mobilization with other engineering department like piping, chemical , electronic & electrical for site activities

15. Execution of Pre- commissioning activities.

16. commissioning of PLC system and DCS based Loops

17. maintenance of Field instrumentation

18. Inspection of instrumentation / FAT /SAT Execution

19. knowing to read and understand manuals / leaflet of the instruments like Sensors, Transmitters. I to p converter , vp. Control valves . Controller , Plc.DCS, VFD , etc.

20. Basic knowledge of electrical , chemicals,QC, Mechanicals.piping , MOC. Etc.

21.knowledge of Terms & conditions in PO, quotation ,BID . Techno commercial comparison

22. knowing Engineering Procurement procedure

23.ability to think outside the box.

24.ability to learn on your own

25.solve problems & think diagnostically

26.knowledge of reading instrumentation data sheet. P& I D. Hook ups. I/O wiring, interlock drawings, LD. Panel GA drawings . Index. Development of technical operating procedures.

27.proficiency in using computer. Software.

28. knowledge of ISA, ANSI. NEMA . IP standards

29.knowledge of electronic & instrumentation Tool kit and Erection Material

30. knowledge and effects of hazardous Area . Safety Equipment's and Ex proof equipment

31.development of Imaginative power with self.

32.Monitoring consumption of Utilities and Developing methods to reduce it through maintenance planning

33. Maintaining the system running / working

Soft skills.

- Leadership skill
- Communication skill
- Sense of Urgency
- Positive Thinking
- Management skills
- Fast Learner
- Good Problem solver
- Creative / innovative
-
  - Self-motivation
  - Planning and organising
  - Problem solving
  - Decision making
  - Time management and prioritising
  - Flexibility and adaptability
  - Willingness to learn
  - Interpersonal and negotiating skills

Teamwork

Decision making

QA session

Thank you…

email ID: Prasad.godse@ves.ac.in