Instrumentation Technology
INST-1010

Symbology
Process and Instrumentation Diagrams - P&IP

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Department of Engineering and Technology

Today's meeting

- Call Attendance
- Announcements
- Collect Homework
- Give examination
  - Display time clock
- Collect examinations
- Previous examination
  - Return
  - Discussion
- Introduce topic
  - Provide Handouts
  - Socratic discussion
  - Practice - Problems

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  - Socratic discussion
  - Practice – Problems
- Reminder: Obey the rules

Themes

- Define P&ID
- Identify various instruments by the shapes of balloons that represent them
- Identify and interpret functional identifiers in balloon symbols
- Describe how tag numbers pertain to an instrumentation loop
- Describe the function of line symbols

Themes

- Identify the symbols for various actuators and valves
- Read a simple loop on a P&ID
- Describe the various types of information on a title block

Themes

- Process Control
- Variables
- Automation
- Control Elements
- Control Loops
- Common Control Strategies
- Instrumentation
- Instrumentation and Industry
- Training
- Industry and Standards Organizations

HISTORICAL INTRODUCTION

SIGNALS

- Discuss Signals

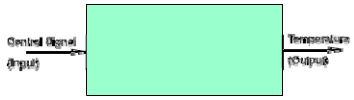
GENERAL INSTRUMENT SYMBOLS

Symbols in Control Engineering
Signal flow diagrams

- A signal flow diagram is the symbolic representation of the functional interactions in a system.
- The essential components of control systems are represented by means of block diagrams.
- If required, the task represented by a block symbol can be further described by adding a written text.
- However, block diagrams are not suitable for very detailed representations.
- The symbols described below are better suited to represent functional details clearly.

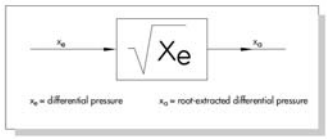
Symbols in Control Engineering
Blocks and lines of action

- The functional relationship between an output signal and an input signal is symbolized by a rectangle (block).
- Input and output signals are represented by lines and their direction of action (input or output) is indicated by arrows.



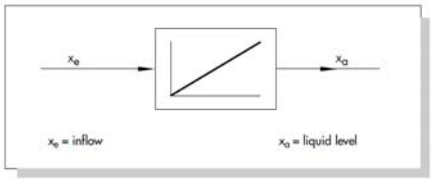
Example: Root-extracting a quantity

- Root-extracting a differential pressure signal
- (e.g. flow rate measurement via differential pressure sensors)



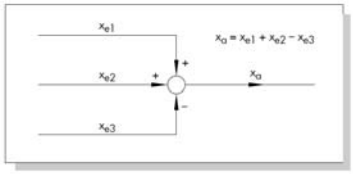
Development of a liquid level over time

- Example: Representing dynamic behavior (Fig. 4)
  (e.g. liquid level in a tank with constant supply)



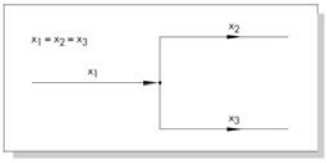
Example: Summing point

- The output signal is the algebraic sum of the input signals.
- This is symbolized by the summing point.
- Any number of inputs can be connected to one summing point which is represented by a circle.
- Depending on their sign, the inputs are added or subtracted.



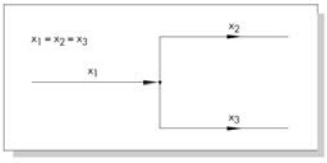
Example: Branch point

- A branch point is represented by a point.
- Here, a line of action splits up into two or more lines of action.
- The signal transmitted remains unchanged.



Example: Branch point

- The signal transmitted remains unchanged.
- Flow?
- Pressure?

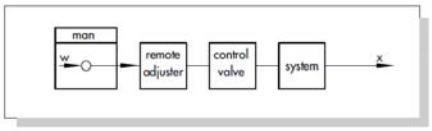


Block diagram of manual open loop control

- Example: Signal flow diagram of open loop and closed loop control systems
- The block diagram symbols described above help illustrate the difference between open loop and closed loop control processes clearly.

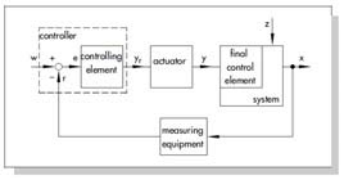
Block diagram of manual open loop control

- The operator positions the remote adjuster only with regard to the reference variable w.
- Adjustment is carried out according to an assignment specification (e.g. a table: set point w1 = remote adjuster position v1; w2 = v2; etc.) determined earlier.



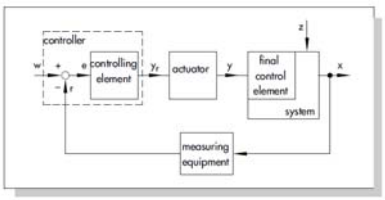
Block diagram of manual closed loop control

- In the closed action flow of closed loop control (Fig.), the controlled variable x is measured and fed back to the controller, in this case man.
- The controller determines whether this variable assumes the desired value of the reference variable w.



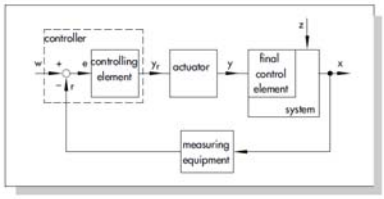
Block diagram of manual closed loop control

- When x and w differ from each other, the remote adjuster is being adjusted until both variables are equal.



Block diagram of a control loop Device-related representation

- Using the symbols and terminology defined above, Fig. shows the typical action diagram of a closed loop control system (abbreviations see page 10)

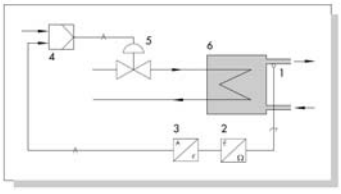


graphical symbols for detailed, solution related representations

- Whenever the technical solution of a process control system shall be pointed out, it is recommended to use graphical symbols in the signal flow diagram (Fig. 10).
- As this representation method concentrates on the devices used to perform certain tasks in a process control system, it is referred to as solution-related representation.
- Such graphical representations make up an essential part of the documentation when it comes to planning, assembling, testing, start-up and maintenance.

Graphical symbols for describing temperature control

- *Temperature control of a heat exchanger system*
  - *1 Sensor (temperature)* *2 Transmitter*
  - *3 Signal converter* *4 Controller*
  - *5 Pneumatic linear valve* *6 Heat exchanger*



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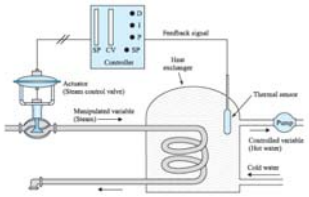
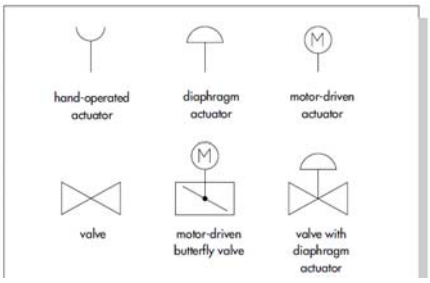


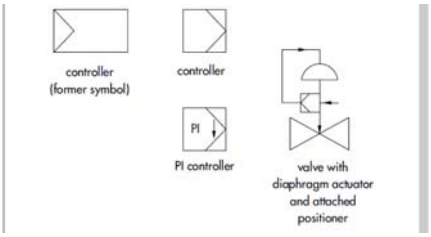
symbols

- Each unit has its own graphical symbol that is usually standardized.
- Equipment consisting of various units is often represented by several lined-up symbols.

symbols



symbols



Graphical symbols for controllers, control valves and software-based functions

- According to DIN 19227 Part 2
  - functions performed by
  - software are marked
  - with a flag
    - Deutsches Institut für Normung e.V. (DIN;
    - in English, the German Institute for Standardization)

graphical symbols for process control

- Graphical symbols used for process control are specified in DIN 19227, including symbols for sensors, adapters, controllers, control valves, operating equipment, generators, conduits and accessories (Figs. 11 and 12).
- However, there are a number of other DIN standards covering graphical symbols, such as DIN 1946, DIN 2429, DIN2481, DIN 19239 and DIN 30600 (main standard containing approximately 3500 graphical symbols).
- It is recommended to always use standardized graphical symbols.
- In case a standardized symbol does not exist, you may use your own.

Graphical symbols used for process control

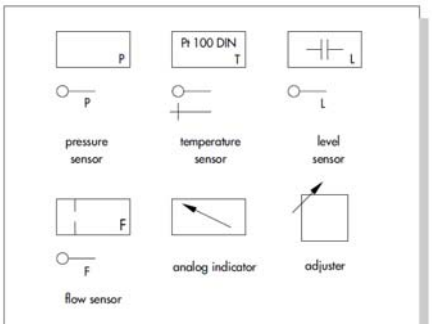
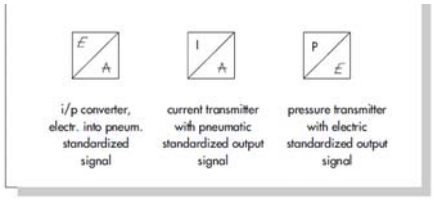
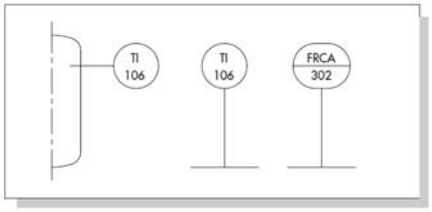


Fig. 12: Graphical symbols for sensors, transmitters, adjusters and indicators according to DIN 19227 Part 2



Instrumentation and control tags

- According to DIN 19227 Part 1

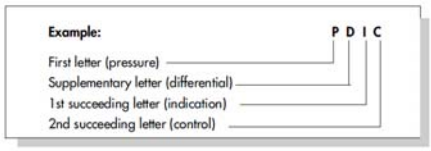


instrumentation and control tags

- Instrumentation and control tags
- Apart from the solution-related representation, process control systems can also be represented by means of instrumentation and control tags (DIN 19227 Part 1) which describe the task to be done.
- An instrumentation and control tag is represented by a circle.
- When the circle is divided by an additional line, editing and operating procedures are not carried out on site, but in a centralized control station.
- In the bottom half of the circle, you will find the instrumentation and control tag number.
- The identifying letters in the top half specify the measuring or input variable as well as the type of signal processing, organizational information and the signal flow path.
- If additional space is needed, the circle is elongated to form an oval (Fig. 13).

identifying letters in an instrumentation

- The typical use of identifying letters in an instrumentation and control tag is shown below:



The meaning and the order of the identifying letters are listed in the following

	Group 1: Measuring or input variable		Group 2: Processing
	First letter	**Supplementary letter**	**Succeeding letter** (order: I, R, C, ...any)
A			Fault message, alarm
C			Automatic control
D	Density	Differential	
E	Electric quantities		Sensing function
F	Flow rate, troughput	Ratio	
G	Distance, length, position		
H	Hand (manually initiated)		High limit
I			Indication
K	Time		

The meaning and the order of the identifying letters are listed in the following

K	Time		
L	Level		Low limit
O			Visual signal, yes/no indication
P	Pressure		
Q	Material properties	Integral, sum	
R	Radiation		Record or print
S	Speed, rotational speed, frequency		Circuit arrangement, sequence control
T	Temperature		Transmitter function

The meaning and the order of the identifying letters are listed in the following table.

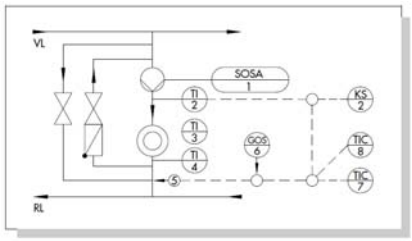
U	Multivariable		
V	Viscosity		Control valve function
W	Velocity, mass		
Y			Calculating function
Z			Emergency interruption, safety device

instrumentation and control tags

- The two possible methods of graphical representation are compared with each other in the Figs. 14 and 15.
- The device-related representation according
- to DIN19227 Part 2 (Fig. 15) is in general easily understood.
- Whereas instrumentation and control tags according to DIN19227 Part 1 (Fig. 14) are more suitable for plotting complex systems.

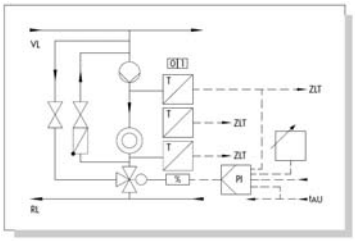
Instrumentation and control tags

- Fig. 14: Representation of a control loop according to DIN 19227 Part 1

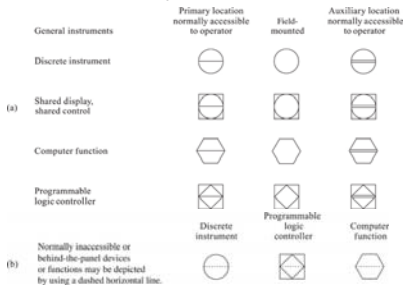


Representation of a control loop

- According to DIN 19227 Part 2 device-related symbols



General instrument or functional symbols



General instrument or functional symbols

- Individual instruments
- Represented with a balloon
- Circle by itself
- Stand-alone instrument
- Circle in a square
- Shared device

Tag Numbers

- Alphanumeric code
- Placed inside each symbol to identify it
- Functional identifiers
- First letter:
- P, T, F, and L
- Second letter:
- R, C, and T
- Third and fourth letters
- Example: PDAH

Tag Numbers

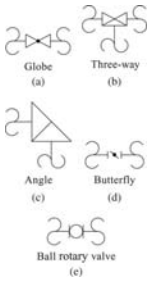
- List of standard identifiers
- See Table 16-1 in the text
- Loop identifiers
- Located in bottom portion of the symbol
- Loop
- One or more instruments arranged to measure and control a process variable

Line symbols

- Instrument Supply
- Connection to Process
- Pneumatic Signal
- Electrical Signal
- Hydraulic Signal
- Capillary Tube
- Electromagnetic or Sonic Signal (Guided)
- Software Link
- Mechanical Connection

Valve and Actuator Symbols

- Control valves
- Linear-motion valves
- Globe
- Three-way
- Angle
- Rotary-motion valves
- Butterfly
- Ball
- Dampers

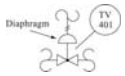


Valve and Actuator Symbols

- Flow actuator

Valve and Actuator Symbols

- Pneumatically activated diaphragm symbol

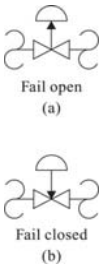


Valve and Actuator Symbols

- Identifiers for various actuators

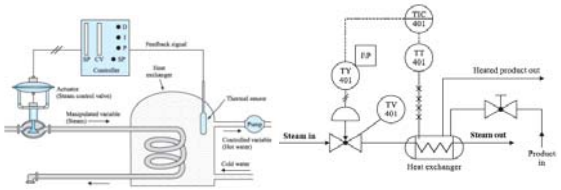
Valve and Actuator Symbols

- Symbols that show the failure mode of a valve



Reading a Single Loop

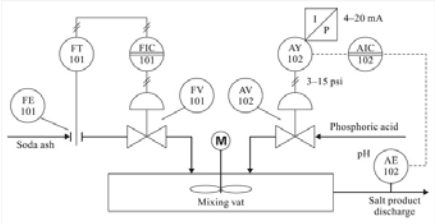
- Six steps
- Control loop (401) for a heat exchanger application



Information Block

- Includes:
  - Title block
  - Revisions
  - Materials list
  - Notes

Information Block



In loop 101, soda ash flows into the mixing vat. The flow is detected by an orifice flow sensor, which is shown connected directly to the process. It sends a pneumatic feedback signal to a flow/indicator/controller mounted behind the panel. FIC 101 sends a pneumatic signal to a diaphragm that controls the valve that regulates flow.

In loop 102, an analyzer sensor that monitors pH sends an electrical signal to an indicator/controller. An analyzer transducer converts the electrical signal from the controller to pressure, which causes a diaphragm to change the valve that controls the flow of phosphoric acid.

The title block

ACME PROCESS CORP.	
MIXING SYSTEM #1	
DRAWN BY:	DATE
CHECKED BY:	DATE
APPROVED BY:	DATE
SHEET NO.: 1 of 1	DRAWING NO.: 3250-7A

Revisions

REVISIONS					
REV #	DATE	DESCRIPTION	BY	CH'K	APRV

(a)

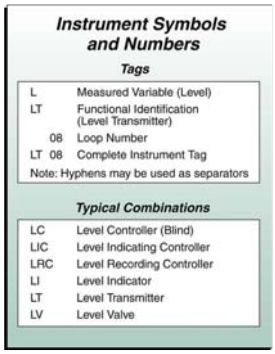
Material list

MATERIAL LIST			
TAG #	MANUFACTURER	MODEL	PART #
TV-302	FISHER	513RP	61121-41
PV-309	MASONEILAN	47-21134	54378-39
FIC-301	FOXBORO	130M	22447-12
PT-309	FISHER	4157	61247-33
TT-302	FOXBORO	45P-F2	22336-19
LV-305	FISHER	667F7	62458-20
PIC-308	MOORE	528M	14436-38
TIC-302	MOORE	528M	14436-38
LIC-305	FOXBORO	130M	22447-12
LT-305	TAYLOR	4807A	43741-80
LT-307	TAYLOR	4807A	43741-80
FV-308	MASONEILAN	48211-35	54267-37

(b)

SYNOPSIS

•The ISA has developed standard symbols and nomenclature used in instrumentation diagrams.



Instrument Symbols and Numbers

Tags

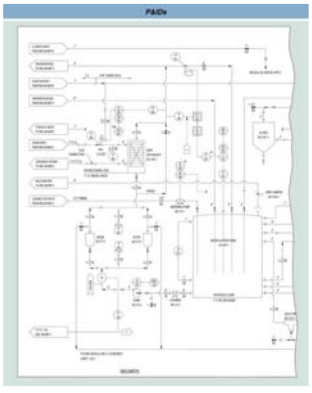
L	Measured Variable (Level)
LT	Functional Identification (Level Transmitter)
08	Loop Number
LT 08	Complete Instrument Tag

Note: Hyphens may be used as separators

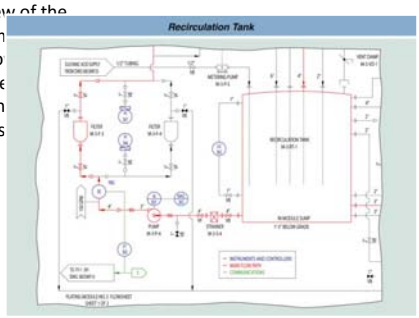
Typical Combinations

LC	Level Controller (Blind)
LIC	Level Indicating Controller
LRC	Level Recording Controller
LI	Level Indicator
LT	Level Transmitter
LV	Level Valve

•Piping and instrumentation diagrams contain information about the instruments being used as well as the equipment employed.



•A detail view of the recirculation drawing sho the instrume related to th pumping sys



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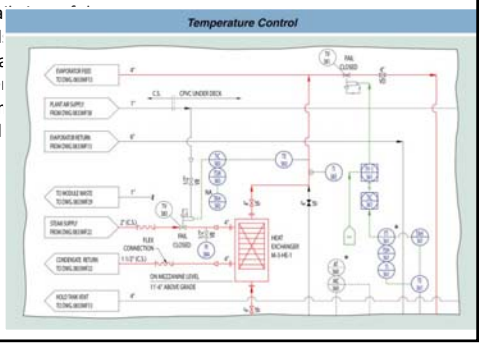

APPENDIX:


The WORLD WITHOUT ENGINEERS
Agilent Technologies
Anvari.org