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Intro to Industrial Control

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University of Memphis
TECH 3821
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Ch 6 + 7

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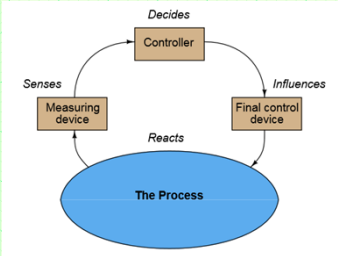

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Definitions

- **Process**: The physical system we are attempting to control or measure.
- **Process Variable** (PV): The specific quantity we are measuring in a process.
- **Setpoint** (SP): The value at which we desire the process variable to be maintained at ("target" value for the process variable).

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Definitions 4

- **Primary Sensing Element** (PSE): A device directly sensing the process variable and translating that sensed quantity into an analog representation (electrical voltage, current, resistance; mechanical force, motion, etc.).
- **Transducer**: A device converting one standardized instrumentation signal into another standardized instrumentation signal, and/or performing some sort of processing on that signal.(Examples: I/P converter (converts 4-20 mA electric signal into 3-15 PSI pneumatic signal)

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Definitions 5

- **Transmitter**: A device translating the signal produced by a primary sensing element (PSE) into a standardized instrumentation signal such as 3-15 PSI air pressure, 4-20 mA DC electric current.
- **Lower- and Upper-range values** (LRV / URV): the values of process measurement deemed to be 0% and 100% of a transmitter's calibrated range. (aka Zero and Span)

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Definitions 6

- **Controller**: A device receiving a process variable (PV) signal from a primary sensing element (PSE) or transmitter, comparing that signal to the desired value (called the set point) for that process variable, and calculating an appropriate output signal value to be sent to a final control element (FCE) such as an electric motor or control valve.
- **Final Control Element** (FCE): A device receiving the signal output by a controller to directly influence the process.

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Definitions

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- **Manipulated Variable** (MV): The quantity in a process we adjust or otherwise manipulate in order to influence the process variable (PV).
- **Automatic mode**: When the controller generates an output signal based on the relationship of process variable (PV) to the setpoint (SP).
- **Manual mode**: When the controller's decision-making ability is bypassed to let a human operator directly determine the output signal sent to the final control element.

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Diagrams

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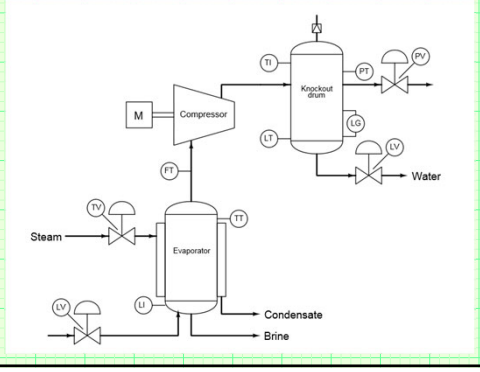
- Process Flow Diagram



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Diagrams

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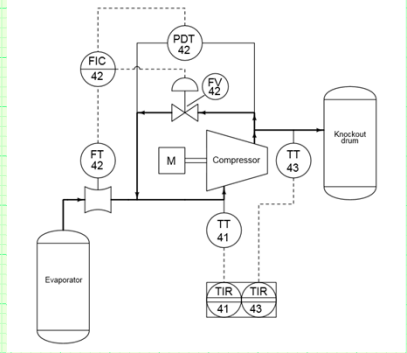
- Process and Instrument Diagrams



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Diagrams

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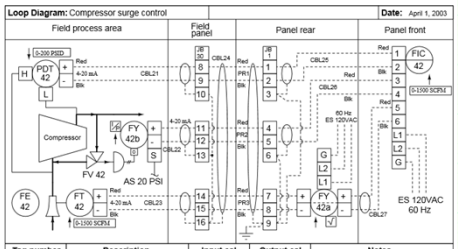
- Loop Diagram



Tag number	Description	Input cal.	Output cal.	Notes
FE 42	Venturi tube	0-1500 SCFM	0-100 "WC	
FT 42	Suction flow transmitter	0-100 "WC	4-20 mA	
FY 42a	Square root extractor	4-20 mA	4-20 mA	
FY 42b	Current-to-pressure converter	4-20 mA	3-15 PSI	
FV 42	Anti-surge control valve	3-15 PSI	100%-0%	Air-to-close
PDT 42	Differential pressure transmitter	0-200 PSI	20-4 mA	Reverse action
FIC 42	Anti-surge controller	4-20 mA	4-20 mA	

Diagrams

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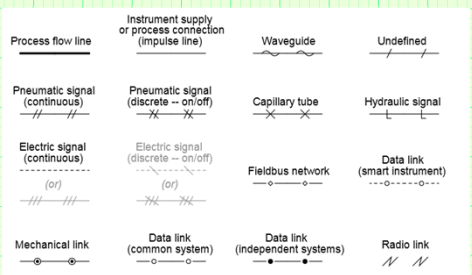
- Lines



Diagrams

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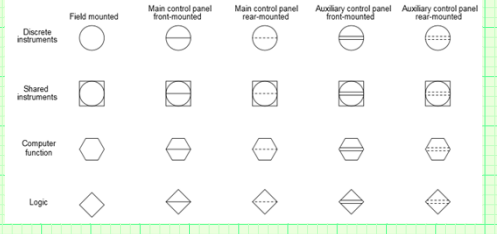
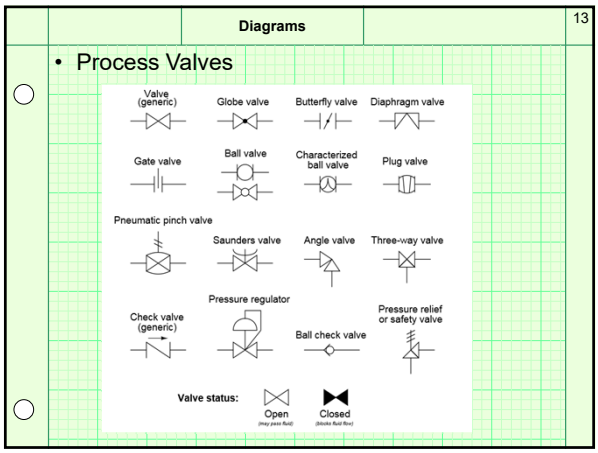
- Instrument bubbles




Diagrams
13
• Process Valves
Valve (generic)
Globe valve
Butterfly valve
Diaphragm valve
Gate valve
Ball valve
Characterized ball valve
Plug valve
Pneumatic pinch valve
Saunders valve
Angle valve
Three-way valve
Check valve (generic)
Pressure regulator
Ball check valve
Pressure relief or safety valve
Valve status:
Open
Closed

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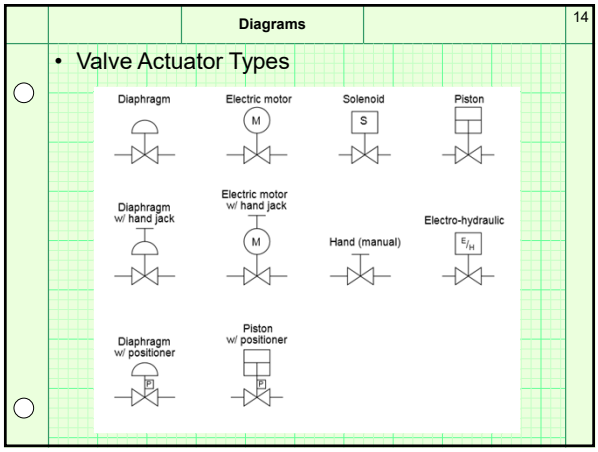
Diagrams
14
• Valve Actuator Types
Diaphragm
Electric motor
Solenoid
Piston
Diaphragm w/ hand jack
Electric motor w/ hand jack
Hand (manual)
Electro-hydraulic
Diaphragm w/ positioner
Piston w/ positioner

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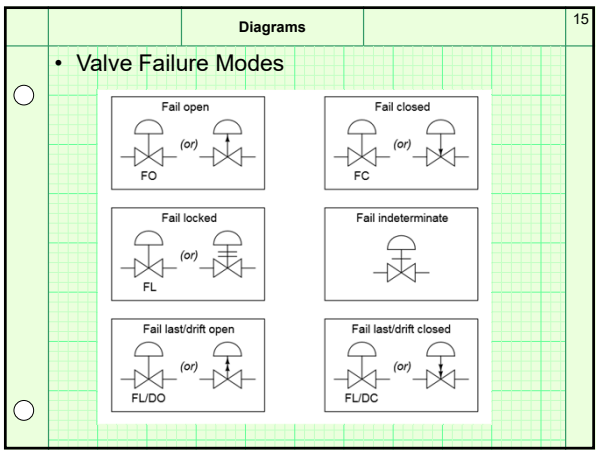
Diagrams
15
• Valve Failure Modes
Fail open
(or)
FO
Fail closed
(or)
FC
Fail locked
(or)
FL
Fail indeterminate
Fail last/drift open
(or)
FL/DO
Fail last/drift closed
(or)
FL/DC

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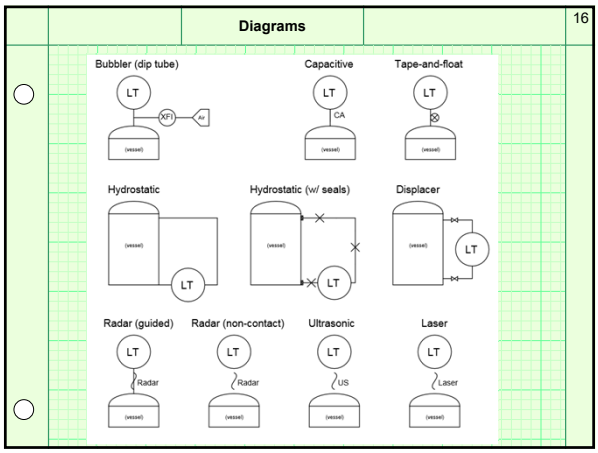
Diagrams
16
Bubbler (dip tube)
Capacitive
Tape-and-float
Hydrostatic
Hydrostatic (w/ seals)
Displacer
Radar (guided)
Radar (non-contact)
Ultrasonic
Laser
LT
XFI
CA
Radar
US
Laser

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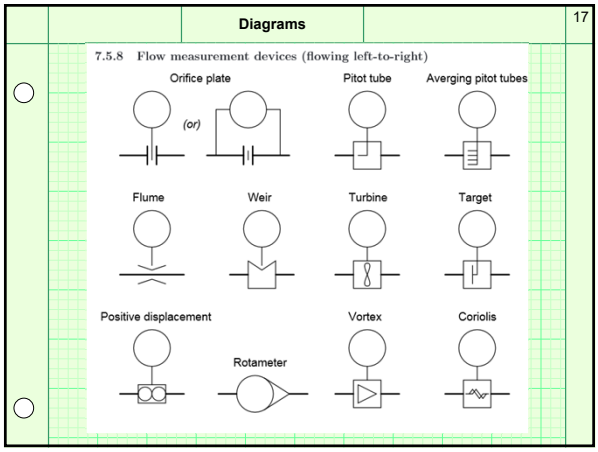
Diagrams
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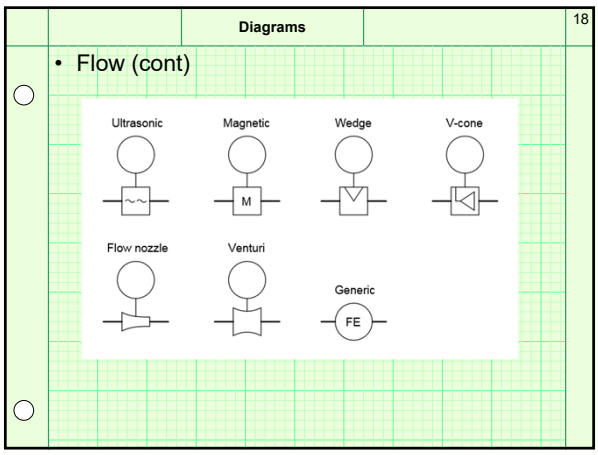
7.5.8 Flow measurement devices (flowing left-to-right)
Orifice plate
(or)
Pitot tube
Averging pitot tubes
Flume
Weir
Turbine
Target
Positive displacement
Rotameter
Vortex
Coriolis

17


Diagrams
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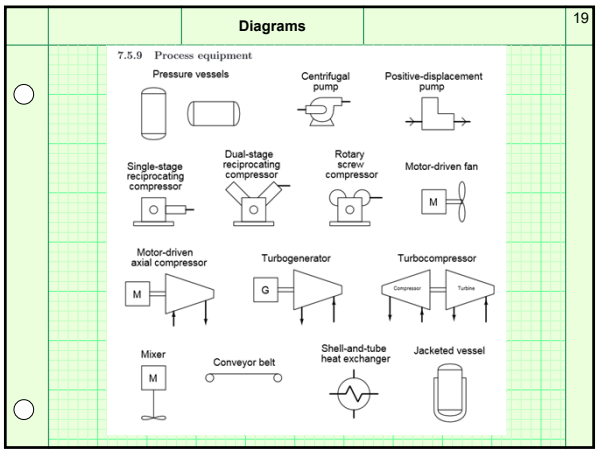
• Flow (cont)
Ultrasonic
Magnetic
Wedge
V-cone
M
Flow nozzle
Venturi
Generic
FE

18


Diagrams
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7.5.9 Process equipment
Pressure vessels
Centrifugal pump
Positive-displacement pump
Single-stage reciprocating compressor
Dual-stage reciprocating compressor
Rotary screw compressor
Motor-driven fan
M
Motor-driven axial compressor
Turbogenerator
Turbocompressor
Compressor
Turbine
M
G
Mixer
M
Conveyor belt
Shell-and-tube heat exchanger
Jacketed vessel

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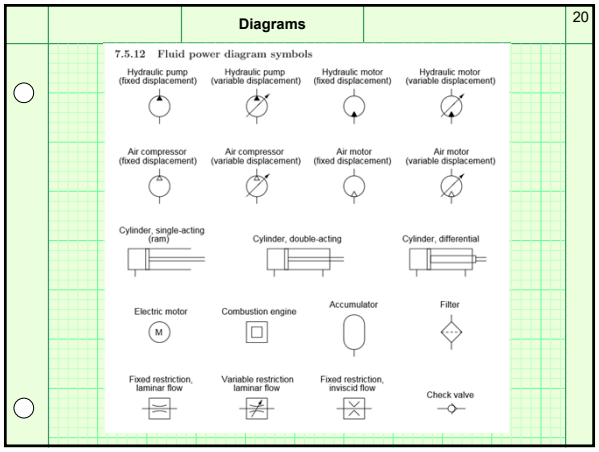
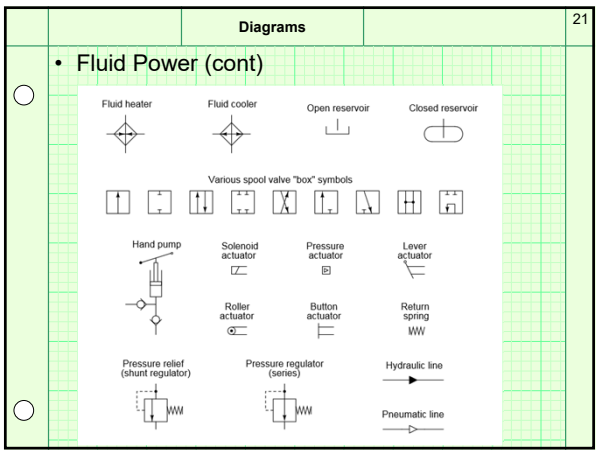

Diagrams
20
7.5.12 Fluid power diagram symbols
Hydraulic pump (fixed displacement)
Hydraulic pump (variable displacement)
Hydraulic motor (fixed displacement)
Hydraulic motor (variable displacement)
Air compressor (fixed displacement)
Air compressor (variable displacement)
Air motor (fixed displacement)
Air motor (variable displacement)
Cylinder, single-acting (ram)
Cylinder, double-acting
Cylinder, differential
Electric motor
M
Combustion engine
Accumulator
Filter
Fixed restriction, laminar flow
Variable restriction laminar flow
Fixed restriction, inviscid flow
Check valve

20


Diagrams
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• Fluid Power (cont)
Fluid heater
Fluid cooler
Open reservoir
Closed reservoir
Various spool valve "box" symbols
Hand pump
Solenoid actuator
Pressure actuator
Lever actuator
Roller actuator
Button actuator
Return spring
Pressure relief (shunt regulator)
Pressure regulator (series)
Hydraulic line
Pneumatic line

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Tags

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- Instrument Identification Tags - ISA 5.1 standard

	First Letters		Succeeding Letters		
	Measured/Initiating Variable	Variable Modifier	Readout/Passive Function	Output/Active Function	Function Modifier
A	Analysis		Alarm		
B	Burner, Combustion		User's Choice	User's Choice	User's Choice
C	User's Choice			Control	Close
D	User's Choice	Difference, Differential			Deviation
E	Voltage		Sensor, Primary Element		
F	Flow, Flow Rate	Ratio			
G	User's Choice		Glass, Gauge, Viewing Device		
H	Hand				High
I	Current		Indicate		
J	Power	Scan			
K	Time, Schedule	Time Rate of Change		Control Station	
L	Level		Light		Low
M	User's Choice				Middle, Intermediate
N	User's Choice		User's Choice	User's Choice	User's Choice
O	User's Choice		Orifice, Restriction		Open
P	Pressure		Point (Test Connection)		
Q	Quantity	Integrate, Totalize	Integrate, Totalize		
R	Radiation		Record		Run
S	Speed, Frequency	Safety		Switch	Stop
T	Temperature			Transmit	
U	Multivariable		Multifunction	Multifunction	
V	Vibration, Mechanical Analysis			Valve, Damper, Louver	
W	Weight, Force		Well, Probe		
X	Unclassified	X-axis	Accessory Devices, Unclassified	Unclassified	Unclassified
Y	Event, State, Presence	Y-axis		Auxiliary Devices,	
Z	Position, Dimension	Z-axis, Safety Instrumented System		Driver, Actuator, Unclassified final control element	

Figure 7-9. ISA-5.1 Identification Letters

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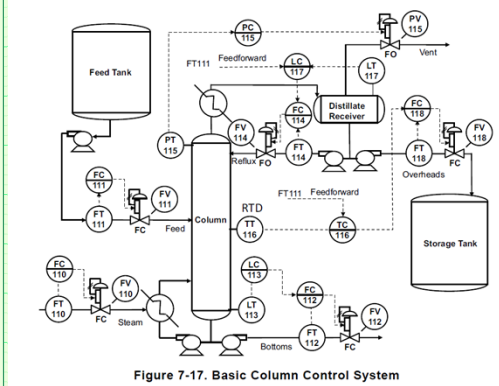

Figure 7-17. Basic Column Control System

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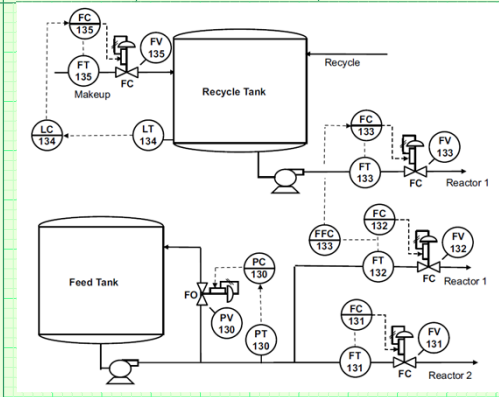

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