

PTC3421 – Instrumentação Industrial

Documentação e Assuntos Relacionados – Parte II

V2017A

PROF. R. P. MARQUES

Normas ISA

ISA

1945: Instrument **S**ociety of **A**merica

2000: Instrumentation, **S**ystems and **A**utomation Society

2008: International **S**ociety for **A**utomation

A norma ISA é o padrão *de facto* para a produção do principal documento que envolve instrumentação: o P&ID.

Normas ISA

Por que normatizar?

- Normas são importantes para garantir uma ‘língua comum’ para diferentes pessoas, empresas e instituições envolvidas no projeto.
- Normas garantem uma metodologia consistente para a produção dos documentos, sem lapsos e com propostas lógicas para diferentes representações (i.e. geralmente as normas propõem boas soluções de trabalho).
- Normas oferecem uma garantia mínima de qualidade e completude do ponto de vista dos clientes e de eventuais órgãos reguladores.
- Normas movimentam um grande negócio, baseado em
 - Produção de normas;
 - Produção de soluções compatíveis (e.g. software);
 - Consultoria e auditoria;
 - Treinamento;
 - Certificação.

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- Normas movimentam um grande negócio, baseado em
 - Produção e distribuição de normas;
 - Produção de soluções compatíveis (e.g. software);
 - Consultoria e auditoria;
 - Treinamento;
 - Certificação.

Normas ISA

A ISA publica as seguintes normas sobre documentação que são relevantes para o nosso curso:

ANSI/ISA-5.1-2009	Instrumentation Symbols and Identification
ISA-5.2-1976 (R1992)	Binary Logic Diagrams for Process Operations
ISA-5.3-1983	Graphic Symbols for Distributed Control/ Shared Display Instrumentation, Logic and Computer Systems
ISA-5.4-1991	Instrument Loop Diagrams
ISA-5.5-1985	Graphic Symbols for Process Displays
ANSI/ISA-5.06.01-2007	Functional Requirements Documentation for Control Software Applications

Normas ISA

As normas podem ser adquiridas em

www.isa.org

e custam entre US\$ 60,00 e US\$ 150,00 para não associados.

Para mais detalhes procurem no Google por

“ANSI/ISA-5.1-2009”

“ISA-5.4-1991”

etc.

Outras normas

A ISO publica a seguinte família de normas sobre documentação que é relevante para o nosso curso:

ISO 14617 (partes 1-15)

Graphical symbols for diagrams

A norma pode ser adquirida em

www.iso.org

e custa entre CHF 58,00 e CHF 178,00 por parte.

Para mais detalhes procurem por “ISO 14617” no Google.

OBS. Não usaremos as normas ISO. Os P&IDs deste curso serão baseados na norma ANSI/ISA-5.1-2009.

P&IDs

Aspectos gerais

Os diagramas de processo e tubulação (P&IDs – Piping and instrumentation Diagrams) são a principal documentação no que se refere a instrumentação.

P&IDs representam a convergência entre

Engenharia de Processo;

Engenharia de Automação e Controle;

Engenharia de Instrumentação

e apontam para as etapas de implementação do processo (especificação de equipamentos, materiais, instrumentos, cabeamento, etc.).

Por serem documentos utilizados por pessoal tão diverso, é importante que sejam normatizados, para garantir a exatidão da troca de informações.

P&IDs

Aspectos gerais

Do ponto de vista da aparência, P&IDs são documentos similares aos diagramas de processo (eles são a complementação natural destes), com as seguintes diferenças:

- Todos os equipamentos e conexões que tenham relação com a instrumentação devem constar de algum P&ID do processo;
- Todos os instrumentos e malhas devem aparecer em pelo menos um P&ID do processo.

O ponto-chave é que os P&IDs devem representar a instrumentação completa do processo.

P&IDs

Normatização

A normatização ISA para P&IDs começou com um texto de 12 páginas em 1949 e hoje consiste na norma ANSI/ISA-5-1-2009 (com 127 páginas) e diversos documentos associados.

A bem da verdade, o padrão é bastante adequado para instrumentação tradicional – com transmissão analógica e instrumentos clássicos, mas deixa a desejar quando o projeto envolve conceitos modernos como redes de processo, instrumentos multicanais, etc.

Por outro lado, essas ainda não são tecnologias maduras (no sentido de ainda não terem convergido para padrões amplamente reconhecidos) e se encontram em constante evolução. Não há ainda um bom e relevante consenso na Indústria sobre como documentar sistemas desse tipo.

Para os requisitos típicos da indústria de hoje, os P&IDs ainda são a mais relevante e útil forma de documentação, e devem continuar sendo no futuro próximo.

P&IDs

Tags

O conceito central dos P&IDs é o de “tag” (rótulo em português), que é o código que indica cada sensor e malha do processo.

Tags não são importantes apenas para os diagramas P&I em si, mas também para indexar e consolidar outros documentos de projeto como listas de materiais, listas de instrumentos, diagramas de malha, folhas de instrumentos, etc.

Os tags têm a seguinte estrutura geral:

Identificação do Instrumento					
Grupo de Letras		Grupo de Números			Sufixo
Identificação Funcional		Identificação da Malha			
Tipo da Variável	Função do Instrumento	Área ou Subsistema	Malha		
X até XX	X até XXX	N	n		

P&IDs

Tags

Identificação do Instrumento				
Grupo de Letras		Grupo de Números		Sufixo
Identificação Funcional		Identificação da Malha		
Tipo da Variável	Função do Instrumento	Área ou Substistema	Malha	
X até XX	X até XXX	N	n	

TIPO DA VARIÁVEL – Uma única letra maiúscula
Indica a variável medida ou atuada. A segunda letra, caso
houver, modifica a variável.

Exemplos: P (pressão), F (vazão), Z (posição)
 PD (pressão diferencial),
 ZX (posição no eixo 'x')

P&IDs

Tags

Identificação do Instrumento					
Grupo de Letras		Grupo de Números			Sufixo
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Tipo da Variável	Função do Instrumento	Área ou Substema	Malha		
X até XX	X até XXX	N	n		

FUNÇÃO DO INSTRUMENTO – Uma a três letras maiúsculas
Indica a função do instrumento (como indicador, transmissor, etc.).
Exemplos: PIC (**I**ndicador e **C**ontrolador de **P**ressão),
 FR (**R**egistrador de **V**azão)
 TAA (**A**larme de **T**emperatura **A**lta)

P&IDs

Tags

Identificação do Instrumento				
Grupo de Letras		Grupo de Números		Sufixo
Identificação Funcional		Identificação da Malha		
Tipo da Variável	Função do Instrumento	Área ou Substema	Malha	
X até XX	X até XXX	N	n	

ÁREA OU SUBSISTEMA – Número
Substema ou local a que pertence a malha. É um código definido para cada projeto.
Exemplos: 001, 30, 2000, etc.

P&IDs

Tags

Identificação do Instrumento					
Grupo de Letras		Grupo de Números			Sufixo
Identificação Funcional		Identificação da Malha			
Tipo da Variável	Função do Instrumento	Área ou Substema	Malha		
X até XX	X até XXX	N	n		

MALHA – Número sequencial da malha
Número atribuído à malha dentro da área ou subsistema.
Exemplo: TI-02015 (ou TI02015 ou TI-020.15 etc.)
(indicador de temperatura no. 15 da área 020).

P&IDs

Tags

Identificação do Instrumento					
Grupo de Letras		Grupo de Números			Sufixo
Identificação Funcional		Identificação da Malha			
Tipo da Variável	Função do Instrumento	Área ou Subistema	Malha		
X até XX	X até XXX	N	n		

SUFIXO – Tipicamente a, b, c, ...

Caso haja mais de um instrumento do mesmo tipo numa mesma malha pode-se usar um sufixo para diferenciá-los.

Exemplo: TI-02015a e TI-02015b

P&IDs

Tags

Observações:

- O tipo da variável é uma indicação funcional, e não física.
Por exemplo, se um indicador de nível utiliza a pressão no fundo de um tanque para inferir o nível (que é uma configuração bastante comum), trata-se de um LI (e não de um PI).
- É boa prática manter a identificação funcional tão curta quanto razoável para facilitar a leitura.
- Notem que as letras são baseadas no inglês
Por exemplo: F (e não V) indica vazão. V é o código para “Vibração”.
- É comum a utilização de códigos WBS (Work Breakdown Structure) do projeto global para a identificação das áreas ou subsistemas.
- Também é comum definir a área como um equipamento ou processo local ou mesmo um prédio ou instalação.
- A numeração da malha costuma ser sequencial, mas outros esquemas podem ser utilizados.
- Sufixos podem ser substituídos por esquemas similares.
Por exemplo: Em vez de numerar as malhas como 14, 15 e usar 15a e 15b, pode-se numerá-las como 140, 150 e usar 151 e 152.

LETRAS IDENTIFICADORAS

De ANSI/ISA-5.1-2009, pág. 30.

MUITO IMPORTANTE

	First letters (1)		Succeeding letters (15)		
	Column 1	Column 2	Column 3	Column 4	Column 5
	Measured/Initiating Variable	Variable Modifier (10)	Readout/Passive Function	Output/Active Function	Function Modifier
A	Analysis (2)(3)(4)		Alarm		
B	Burner, Combustion (2)		User's Choice (5)	User's Choice (5)	User's Choice (5)
C	User's Choice (3a)(5)			Control (23a)(23e)	Close (27b)
D	User's Choice (3a)(5)	Difference, Differential, (11a)(12a)			Deviation (28)
E	Voltage (2)		Sensor, Primary Element		
F	Flow, Flow Rate (2)	Ratio (12b)			
G	User's Choice		Glass, Gauge, Viewing Device (16)		
H	Hand (2)				High (27a)(28a)(29)
I	Current (2)		Indicate (17)		
J	Power (2)		Scan (18)		
K	Time, Schedule (2)	Time Rate of Change (12c)(13)		Control Station (24)	
L	Level (2)		Light (19)		Low (27b)(28)(29)
M	User's Choice (3a)(5)				Middle, Intermediate (27c)(28) (29)
N	User's Choice (5)		User's Choice (5)	User's Choice (5)	User's Choice (5)
O	User's Choice (5)		Orifice, Restriction		Open (27a)
P	Pressure (2)		Point (Test Connection)		
Q	Quantity (2)	Integrate, Totalize (11b)	Integrate, Totalize		
R	Radiation (2)		Record (20)		Run
S	Speed, Frequency (2)	Safety(14)		Switch (23b)	Stop
T	Temperature (2)			Transmit	
U	Multivariable (2)(6)		Multifunction (21)	Multifunction (21)	
V	Vibration, Mechanical Analysis (2)(4)(7)			Valve, Damper, Louver (23c)(23e)	
W	Weight, Force (2)		Well, Probe		
X	Unclassified (8)	X-axis (11c)	Accessory Devices (22), Unclassified (8)	Unclassified (8)	Unclassified (8)
Y	Event, State, Presence (2)(9)	Y-axis (11c)		Auxiliary Devices (23d)(25)(26)	
Z	Position, Dimension (2)	Z-axis (11c), Safety Instrumented System (30)		Driver, Actuator, Unclassified final control element	

OBS.: Há mais de 40 notas de rodapé.

P&IDs

Símbolos





















A norma ANSI/ISA-5.1-2009 inclui as seguintes classes de símbolos:

- Dispositivos e funções (símbolos principais)
- Dispositivos e funções (símbolos diversos)
- Medidas – Elementos primários e transmissores
- Medidas – Notação
- Medidas – Elementos primários (várias tabelas)
- Medidas – Instrumentos secundários
- Medidas – Dispositivos auxiliares e acessórios
- Linhas – Conexões de instrumentos com equipamentos e processos
- Linhas – Conexões de instrumentos com instrumentos (várias tabelas)
- Elementos finais de controle
- Atuadores de elementos finais de controle
- Elementos finais de controle auto-atuados
- Válvulas de controle (posição em caso de falha ou desenergização)
- Diagramas funcionais
- Blocos de processamento de sinais
- Lógica binária
- Diagramas elétricos

DISPOSITIVOS E FUNÇÕES

De ANSI/ISA-5.1-2009, pág. 36.

MUITO IMPORTANTE



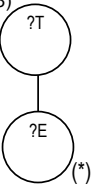
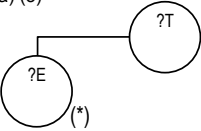
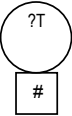
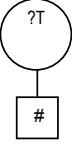
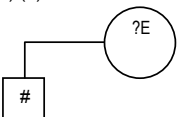
No.	Shared display, Shared control (1)		C	D	Location & accessibility (6)
	A	B			
	Primary Choice or Basic Process Control System (2)	Alternate Choice or Safety Instrumented System (3)	Computer Systems and Software (4)	Discrete (5)	
1					<ul style="list-style-type: none"> • Located in field. • Not panel, cabinet, or console mounted. • Visible at field location. • Normally operator accessible.
2					<ul style="list-style-type: none"> • Located in or on front of central or main panel or console. • Visible on front of panel or on video display. • Normally operator accessible at panel front or console.
3					<ul style="list-style-type: none"> • Located in rear of central or main panel. • Located in cabinet behind panel. • Not visible on front of panel or on video display. • Not normally operator accessible at panel or console.
4					<ul style="list-style-type: none"> • Located in or on front of secondary or local panel or console. • Visible on front of panel or on video display. • Normally operator accessible at panel front or console.
5					<ul style="list-style-type: none"> • Located in rear of secondary or local panel. • Located in field cabinet. • Not visible on front of panel or on video display. • Not normally operator accessible at panel or console.

ELEMENTOS PRIMÁRIOS E TRANSMISSORES

De ANSI/ISA-5.1-2009, pág. 38.

Trata da simbologia da conexão entre elementos primários e transmissores.

IMPORTANTE

No	Symbol	Description
1	(1a) (2) 	<ul style="list-style-type: none"> Generic primary element, bubble format. Notation (*) from Table 5.2.2 should be used to identify type of element. Connect to process or other instruments by symbols from Tables 5.3.1 and 5.3.2. Insert in or on process flow line, vessel, or equipment.
2	(1a) ((2) (3) 	<ul style="list-style-type: none"> Transmitter with integral primary element, bubble format. Notation (*) from Table 5.2.2 should be used to identify type of element. Connect to process or other instruments by symbols from Tables 5.3.1 and 5.3.2. Insert in or on process flow line, vessel, or equipment.
3	(1a) (2) (3) 	<ul style="list-style-type: none"> Transmitter with close coupled primary element, bubble format Notation (*) from Table 5.2.2 should be used to identify type of element. Connecting line shall be equal to or less than 0.25 inches (6 millimeters). Connect to process or other instruments by symbols from Tables 5.3.1 and 5.3.2. Insert element in or on process flow line, vessel, or equipment.
4	(1a) (3) 	<ul style="list-style-type: none"> Transmitter with remote primary element, bubble format. Notation (*) from Table 5.2.2 should be used to identify type of element. Connecting line shall be equal to or greater than 0.5 inches (12 millimeters). Connect to process or other instruments by symbols from Tables 5.3.1 and 5.3.2. Insert element in or on process flow line, vessel, or equipment.
5	(1b) (3) 	<ul style="list-style-type: none"> Transmitter with integral primary element inserted in or on process flow line, vessel, or equipment, bubble/graphic format. Insert primary element symbol from Table 5.2.3 at #. Connect to other instruments by symbols from Table 5.3.2.
6	(1b) (3) 	<ul style="list-style-type: none"> Transmitter with close-coupled primary element inserted in or on process flow line, vessel, or equipment, bubble/graphic format. Insert primary element symbol from Table 5.2.3 at #. Connecting line shall be equal to or less than 0.25 inches (6 millimeters). Connect to other instruments by symbols from Table 5.3.2.
7	(1b) (3) 	<ul style="list-style-type: none"> Transmitter with remote primary element inserted in or on process flow line, vessel, or equipment, bubble/graphic format. Insert primary element symbol from Table 5.2.3 at #. Connecting line may be any signal line from Table 5.2.3. Connecting line shall be equal to or greater than 0.5 inches (12 millimeters). Connect to other instruments by symbols from Table 5.3.2.

NOTAÇÃO


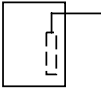
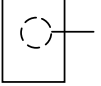



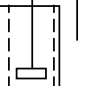
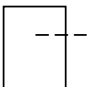
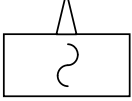
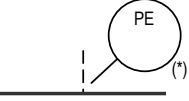
De ANSI/ISA-5.1-2009,
pág. 39.

Substituir o quadrado da
tabela anterior pelo
símbolo correspondente
(tabelas das págs. 40-43
não apresentadas aqui) e
“#” pela notação da
tabela ao lado.

Analysis			
AIR = Excess air	H2O = Water	O2 = Oxygen	UV = Ultraviolet
CO = Carbon monoxide	H2S = Hydrogen sulfide	OP = Opacity	VIS = Visible light
CO2 = Carbon dioxide	HUM = Humidity	ORP = Oxidation reduction	VISC = Viscosity
COL = Color	IR = Infrared	pH = Hydrogen ion	=
COMB = Combustibles	LC = Liquid chromatograph	REF = Refractometer	=
COND = Elec. conductivity	MOIST = Moisture	RI = Refractive index	=
DEN = Density	MS = Mass spectrometer	TC = Thermal conductivity	=
GC = Gas chromatograph	NIR = Near infrared	TDL = Tunable diode laser	=
Flow			
CFR = Constant flow regulator	OP = Orifice plate	PT = Pitot tube	VENT = Venturi tube
CONE = Cone	OP-CT = Corner taps	PV = Pitot venturi	VOR = Vortex Shedding
COR = Coriolis	OP-CQ = Circle quadrant	SNR = Sonar	WDG = Wedge
DOP = Doppler	OP-E = Eccentric	SON = Sonic	=
DSON = Doppler sonic	OP-FE = Flange taps	TAR = Target	=
FLN = Flow nozzle	OP-MH = Multi-hole	THER = Thermal	=
FLT = Flow tube	OP-P = Pipe taps	TTS = Transit time sonic	=
LAM = Laminar	OP-VC = Vena contracta taps	TUR = Turbine	=
MAG = Magnetic	PD = Positive displacement	US = Ultrasonic	=
Level			
CAP = Capacitance	GWR = Guided wave radar	NUC = Nuclear	US = Ultrasonic
d/p = Differential pressure	LSR = Laser	RAD = Radar	=
DI = Dielectric constant	MAG = Magnetic	RES = Resistance	=
DP = Differential pressure	MS = Magnetostrictive	SON = Sonic	=
Pressure			
ABS = Absolute	MAN = Manometer	VAC = Vacuum	=
AVG = Average	P-V = Pressure-vacuum	=	=
DRF = Draft	SG = Strain gage	=	=
Temperature			
BM = Bi-metallic	RTD = Resistance temp detector	TCK = Thermocouple type K	TRAN = Transistor
IR = Infrared	TC = Thermocouple	TCT = Thermocouple type T	=
RAD = Radiation	TCE = Thermocouple type E	THRM = Thermistor	=
RP = Radiation pyrometer	TCJ = Thermocouple type J	TMP = Thermopile	=
Miscellaneous			
Burner, Combustion	Position	Quantity	Radiation
FR = Flame rod	CAP = Capacitance	PE = Photoelectric	α = Alpha radiation
IGN = Igniter	EC = Eddy current	TOG = Toggle	β = Beta radiation
IR = Infrared	IND = Inductive	=	γ = Gamma radiation
TV = Television	LAS = Laser	=	n = Neutron radiation
UV = Ultraviolet	MAG = Magnetic	=	=
=	MECH = Mechanical	=	=
=	OPT = Optical	=	=
=	RAD = Radar	=	=
=	=	=	=
Speed	Weight, Force		
ACC = Acceleration	LC = Load cell	=	=
EC = Eddy current	SG = Strain gauge	=	=
PROX = Proximity	WS = Weigh scale	=	=
VEL = Velocity	=	=	=
=	=	=	=

ELEMENTOS PRIMÁRIOS (alguns exemplos)

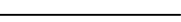
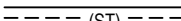

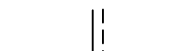


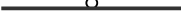


De ANSI/ISA-5.1-2009, pág. 42.

No	Symbol (4)	Description
Flow 31		<ul style="list-style-type: none"> Open channel flume.
Level 32		<ul style="list-style-type: none"> Displacer internally mounted in vessel.
Level 33		<ul style="list-style-type: none"> Ball float internally mounted in vessel. May be installed through top of vessel.
Level 34		<ul style="list-style-type: none"> Radiation, single point. Sonic.
Level 35		<ul style="list-style-type: none"> Radiation, multi-point or continuous.
Level 36		<ul style="list-style-type: none"> Dip tube or other primary element and stilling well. May be installed through side of vessel. May be installed without stilling well.
Level 37		<ul style="list-style-type: none"> Float with guide wires. Location of readout should be noted, at grade, at top, or accessible from a ladder. Guide wires may be omitted.
Level 38		<ul style="list-style-type: none"> Insert probe. May be through top of vessel.
Level 39		<ul style="list-style-type: none"> Radar.
Pressure 40		<ul style="list-style-type: none"> Strain gage or other electronic type sensor. Notation (*) from Table 5.2.2 should be used to identify type of element. Connection symbols 6, 7, 8, or 9 in Table 5.3.1 are used if connection type is to be shown. Bubble may be omitted if connected to another instrument.

CONEXÕES INSTRUMENTO/PROCESSO

De ANSI/ISA-5.1-2009, pág. 45.

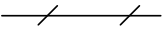
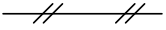

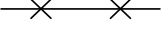



IMPORTANTE

No	Symbol	Application
1		<ul style="list-style-type: none"> Instrument connections to process and equipment. Process impulse lines. Analyzer sample lines.
2		<ul style="list-style-type: none"> Heat [cool] traced impulse or sample line from process. Type of tracing indicated by: [ET] electrical, [ST] steam, [CW] chilled water, etc.
3		<ul style="list-style-type: none"> Generic instrument connection to process line. Generic instrument connection to equipment.
4		<ul style="list-style-type: none"> Heat [cool] traced generic instrument impulse line. Process line or equipment may or may not be traced.
5		<ul style="list-style-type: none"> Heat [cool] traced instrument. Instrument impulse line may or may not be traced.
6		<ul style="list-style-type: none"> Flanged instrument connection to process line. Flanged instrument connection to equipment.
7		<ul style="list-style-type: none"> Threaded instrument connection to process line. Threaded instrument connection to equipment.
8		<ul style="list-style-type: none"> Socket welded instrument connection to process line. Socket welded instrument connection to equipment.
9		<ul style="list-style-type: none"> Welded instrument connection to process line. Welded instrument connection to equipment.

CONEXÕES INSTRUMENTO/INSTRUMENTO

De ANSI/ISA-5.1-2009, pág. 46.

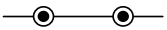




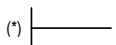

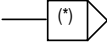
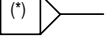
MUITO IMPORTANTE

No	Symbol	Application
1	(1) IA _____	<ul style="list-style-type: none"> IA may be replaced by PA [plant air], NS [nitrogen], or GS [any gas supply]. Indicate supply pressure as required, e.g., PA-70 kPa, NS-150 psig, etc.
2	(1) ES _____	<ul style="list-style-type: none"> Instrument electric power supply. Indicate voltage and type as required, e.g. ES-220 Vac. ES may be replaced by 24 Vdc, 120 Vac, etc.
3	(1) HS _____	<ul style="list-style-type: none"> Instrument hydraulic power supply. Indicate pressure as required, e.g., HS-70 psig.
4	(2) 	<ul style="list-style-type: none"> Undefined signal. Use for Process Flow Diagrams. Use for discussions or diagrams where type of signal is not of concern.
5	(2) 	<ul style="list-style-type: none"> Pneumatic signal, continuously variable or binary.
6	(2) -----	<ul style="list-style-type: none"> Electronic or electrical continuously variable or binary signal. Functional diagram binary signal.
7	(2) _____	<ul style="list-style-type: none"> Functional diagram continuously variable signal. Electrical schematic ladder diagram signal and power rails.
8	(2) 	<ul style="list-style-type: none"> Hydraulic signal.
9	(2) 	<ul style="list-style-type: none"> Filled thermal element capillary tube. Filled sensing line between pressure seal and instrument.
10	(2) 	<ul style="list-style-type: none"> Guided electromagnetic signal. Guided sonic signal. Fiber optic cable.
11	(3) a)  b) 	<ul style="list-style-type: none"> Unguided electromagnetic signals, light, radiation, radio, sound, wireless, etc. Wireless instrumentation signal. Wireless communication link.
12	(4) —○—○—	<ul style="list-style-type: none"> Communication link and system bus, between devices and functions of a shared display, shared control system. DCS, PLC, or PC communication link and system bus.
13	(5) —●—●—	<ul style="list-style-type: none"> Communication link or bus connecting two or more independent microprocessor or computer-based systems. DCS-to-DCS, DCS-to-PLC, PLC-to-PC, DCS-to-Fieldbus, etc. connections.
14	(6) —◇—◇—	<ul style="list-style-type: none"> Communication link and system bus, between devices and functions of a fieldbus system. Link from and to "intelligent" devices.
15	(7) --○--○--	<ul style="list-style-type: none"> Communication link between a device and a remote calibration adjustment device or system. Link from and to "smart" devices.

CONEXÕES INSTRUMENTO/INSTRUMENTO





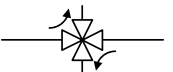



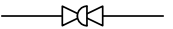



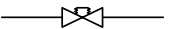
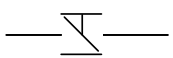
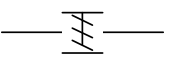
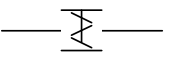
De ANSI/ISA-5.1-2009, pág. 47.

MUITO IMPORTANTE

No	Symbol	Application
16		<ul style="list-style-type: none"> Mechanical link or connection.
17	<p>(3)</p> <p>a) </p> <p>a) </p> <p>b) </p> <p>b) </p>	<ul style="list-style-type: none"> Drawing-to-drawing signal connector, signal flow from left to right. (#) = Instrument tag number sending or receiving signal. (##) = Drawing or sheet number receiving or sending signal.
18		<ul style="list-style-type: none"> Signal input to logic diagram. (*) = Input description, source, or instrument tag number.
19		<ul style="list-style-type: none"> Signal output from logic diagram. (*) = Output description, destination, or instrument tag number.
20		<ul style="list-style-type: none"> Internal functional, logic, or ladder diagram signal connector. Signal source to one or more signal receivers. (*) = Connection identifier A, B, C, etc.
21		<ul style="list-style-type: none"> Internal functional, logic, or ladder diagram signal connector. Signal receiver, one or more from a single source. (*) = Connection identifier A, B, C, etc.



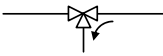
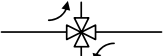



ELEMENTOS FINAIS DE CONTROLE

De ANSI/ISA-5.1-2009, pág. 48.

No	Symbol	Description
1	(1) (2) a)  b) 	<ul style="list-style-type: none"> • Generic two-way valve. • Straight globe valve. • Gate valve.
2	(2) (3) 	<ul style="list-style-type: none"> • Generic two-way angle valve. • Angle globe valve. • Safety angle valve.
3	(2) 	<ul style="list-style-type: none"> • Generic three-way valve. • Three-way globe valve. • Arrow indicates failure or unactuated flow path.
4	(2) 	<ul style="list-style-type: none"> • Generic four-way valve. • Four-way four-ported plug or ball valve. • Arrows indicates failure or unactuated flow paths.
5	(2) 	<ul style="list-style-type: none"> • Butterfly valve.
6	(2) 	<ul style="list-style-type: none"> • Ball valve.
7	(2) 	<ul style="list-style-type: none"> • Plug valve
8	(2) 	<ul style="list-style-type: none"> • Eccentric rotary disc valve.
9	(1) (2) a)  b) 	<ul style="list-style-type: none"> • Diaphragm valve.
10	(2) 	<ul style="list-style-type: none"> • Pinch valve.
11	(2) 	<ul style="list-style-type: none"> • Bellows sealed valve.
12	(2) 	<ul style="list-style-type: none"> • Generic damper. • Generic louver.
13	(2) 	<ul style="list-style-type: none"> • Parallel blade damper. • Parallel blade louver.
14	(2) 	<ul style="list-style-type: none"> • Opposed blade damper. • Opposed blade louver.






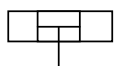
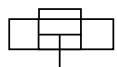




ELEMENTOS FINAIS DE CONTROLE

De ANSI/ISA-5.1-2009, pág. 49.

No	Symbol	Description
15	(4) 	<ul style="list-style-type: none">Two-way on-off solenoid valve.
16	(4) 	<ul style="list-style-type: none">Angle on-off solenoid valve.
17	(4) 	<ul style="list-style-type: none">Three-way on-off solenoid valve.Arrow indicates de-energized flow path.
18	(4) 	<ul style="list-style-type: none">Four-way plug or ball on-off solenoid valve.Arrows indicates de-energized flow paths.
19	(4) 	<ul style="list-style-type: none">Four-way five-ported on-off solenoid valve.Arrows indicates de-energized flow paths.
20	(5) 	<ul style="list-style-type: none">Permanent magnet variable speed coupling.
21	(6) 	<ul style="list-style-type: none">Electric motor.











ATUADORES DE ELEMENTOS FINAIS DE CONTROLE

De ANSI/ISA-5.1-2009, pág. 50.

No	Symbol	Description
1	(7) 	<ul style="list-style-type: none"> Generic actuator. Spring-diaphragm actuator.
2	(7) 	<ul style="list-style-type: none"> Spring-diaphragm actuator with positioner.
3	(7) 	<ul style="list-style-type: none"> Pressure-balanced diaphragm actuator.
4	(7) 	<ul style="list-style-type: none"> Linear piston actuator. Single acting spring opposed Double acting.
5	(7) 	<ul style="list-style-type: none"> Linear piston actuator with positioner.
6	(7) 	<ul style="list-style-type: none"> Rotary piston actuator. May be single acting spring opposed or double acting.
7	(7) 	<ul style="list-style-type: none"> Rotary piston actuator with positioner.
8	(7) 	<ul style="list-style-type: none"> Bellows spring opposed actuator.
9	(7) 	<ul style="list-style-type: none"> Rotary motor operated actuator. Electric, pneumatic, or hydraulic. Linear or rotary action.
10	(7) 	<ul style="list-style-type: none"> Modulating solenoid actuator. Solenoid actuator for process on-off valve.
11	(7) 	<ul style="list-style-type: none"> Actuator with side-mounted handwheel.

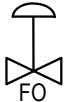



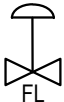

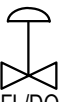

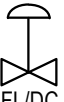

ATUADORES DE ELEMENTOS FINAIS DE CONTROLE

De ANSI/ISA-5.1-2009, pág. 51.

No	Symbol	Description
12	(7) 	<ul style="list-style-type: none"> Actuator with top-mounted handwheel.
13	(7) 	<ul style="list-style-type: none"> Manual actuator. Hand actuator.
14	(7) 	<ul style="list-style-type: none"> Electrohydraulic linear or rotary actuator.
15	(7) 	<ul style="list-style-type: none"> Actuator with manual actuated partial stroke test device.
16	(7) 	<ul style="list-style-type: none"> Actuator with remote actuated partial stroke test device.
17	(8) 	<ul style="list-style-type: none"> Automatic reset on-off solenoid actuator. Non-latching on-off solenoid actuator.
18	(8) 	<ul style="list-style-type: none"> Manual or remote reset on-off solenoid actuator. Latching on-off solenoid actuator.
19	(8) 	<ul style="list-style-type: none"> Manual and remote reset on-off solenoid actuator. Latching on-off solenoid actuator.
20	(9) 	<ul style="list-style-type: none"> Spring or weight actuated relief or safety valve actuator.
21	(9) 	<ul style="list-style-type: none"> Pilot actuated relief or safety valve actuator. Pilot pressure sensing line deleted if sensing is internal.

ATUADORES DE ELEMENTOS FINAIS DE CONTROLE

De ANSI/ISA-5.1-2009, pág. 55.

No	Method A (1) (10)	Method B (1) (10)	Definition
1			<ul style="list-style-type: none"> Fail to open position.
2			<ul style="list-style-type: none"> Fail to closed position.
3			<ul style="list-style-type: none"> Fail locked in last position.
4			<ul style="list-style-type: none"> Fail at last position. Drift open.
5			<ul style="list-style-type: none"> Fail at last position. Drift closed.