Control Valves
HB-Series

Watson Mc Daniel HB-Series Control Valves

- 2-Way and 3-Way Valves
- Sizes: 1/2 - 4"
- Threaded (NPT/BSPT) and Flanged (ANSI/DIN)
- Stainless Steel Bodies
- Pneumatically-Actuated and Electrically-Actuated

A **Control Valve** is a device capable of modulating flows at varying degrees between minimal flow and full capacity in response to a signal from an external control device to the valve's actuator. The valve modulates flow through movement of a valve plug in relation to the port(s). The actuator, which can be pneumatically or electrically operated, directs the movement of the stem as dictated by the external control device.

2-Way Valves

2-Way Valve
(shown with)
Pneumatic-Actuator

2-Way Valve
(shown with)
Electric-Actuator

3-Way Valves

3-Way Valve
(shown with)
Pneumatic-Actuator

Options & Accessories:
Controller, Positioners, I/P Transducers, Air Regulator, Temperature Sensors & Noise Attenuation

A **Control Valve** is one component of a control loop and relies upon other components for proper function of operation (i.e. controller, sensor, transducer, etc.).

Control Valves with PNEUMATIC Actuator

HB-Series 2-Way Valve shown with Air Filter & Positioner

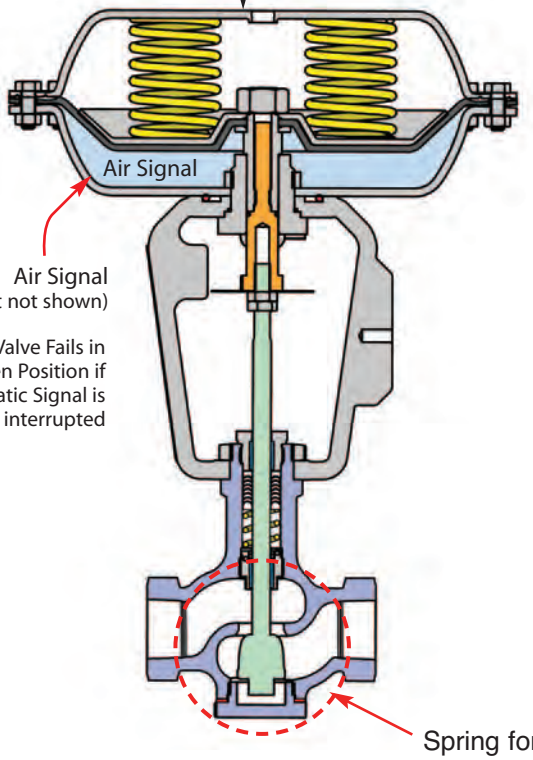
For **HEATING** applications, a **Normally-Closed/Air-to-Open (ATO)** Valve should be selected. If the Pneumatic Signal to the actuator is interrupted, the valve will automatically fail in the closed position to prevent overheating.

For **COOLING** applications, a **Normally-Open/Air-to-Close (ATC)** Valve should be selected. If the signal to the actuator is interrupted, the valve will automatically fail in the open position to prevent overheating.

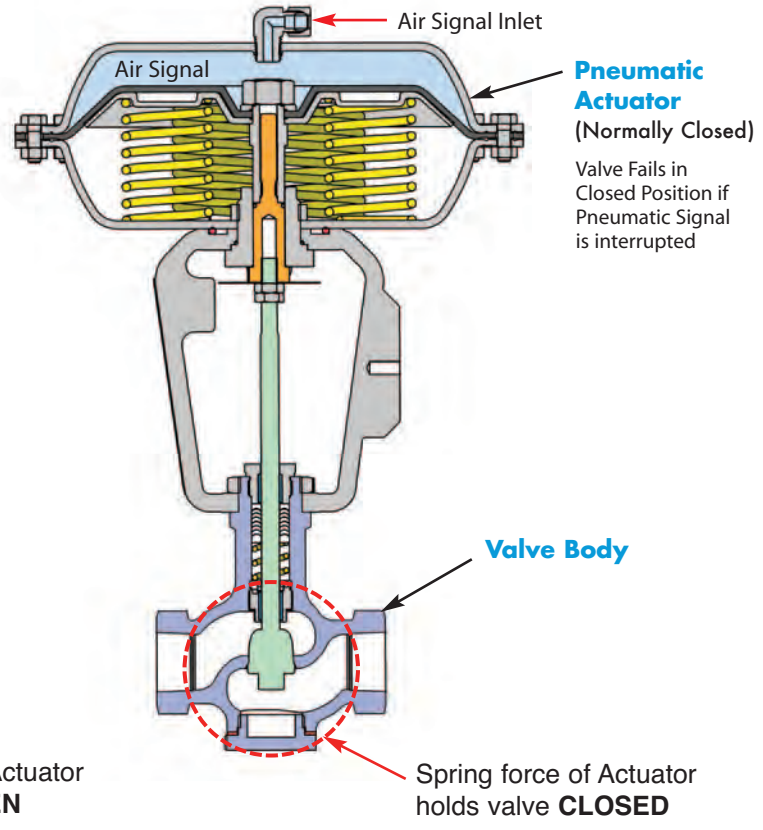
The **Max Close-Off Pressure (PSI△P)** of the valve must exceed the inlet pressure to the valve or the valve will not operate. See Max **(PSI△P)** Chart. In applications where the Maximum Close-Off Pressure of the valve is insufficient, a **Valve Positioner** can be utilized to increase the close-off pressure capability of the valve.

Selecting the correct size valves requires using the capacity charts or specialized sizing software which can me made availabe by the factory. Proper sizing of the control valve is an important aspect of the selection process. Be careful to not oversize the valve. See Engineering Section for more detailed information on valve selection.

Pneumatic Actuator
Air-to-Close
(Normally Open)



Pneumatic Actuator
Air-to-Open
(Normally Closed)



Control Valves with ELECTRIC Actuators

The **HB Series** Stainless Steel 2-Way Control Valve with **Electric Actuator** is a robust, user-friendly alternative to the Pneumatically-Actuated unit. It is ideal for installations where an instrument air source is not available. Electric Actuators utilize either **Super Capacitors** or **Springs** to fail-safe in the event of power loss or signal failure.

E-Series

On the **E-Series Electric Acutator** there is a choice between using **Super Capacitors (EC Model)** or **Spring Return (ES Model)** as the power source to return the valve to an open or closed position in the event of signal or power failure.

When ultra-fast response times are required, the **EC Actuator** with its ability to fully-cycle the valve in as little as 6 seconds, should be selected.

SK-Series

The **SK Actuator** is for general purpose use and is only available with fail-closed spring return. These actuators may require 30 seconds to fully stroke the valve. **2-Way Valves with SK Actuators fail-closed in the event of power failure.**

E-Series Electric Actuator

2-Way Valve
with
Fast-Acting EC Actuator
uses Capacitors as power source for Fail-Safe Mode

2-Way Valve
with
ES Actuator
uses Springs as power source for Fail-Safe Mode

SK-Series Electric Actuator

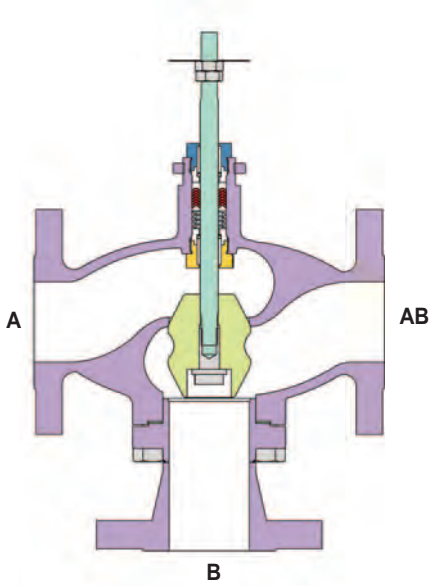
2-Way Valve
with
SK Actuator
Economical Model uses Springs as power source to Fail in the Closed position

3-Way Valves
with PNEUMATIC or ELECTRIC Actuators

A 3-Way Control Valve is used for either **Mixing** or **Diverting.** In a **Mixing** application, two separate liquid streams are mixed together in a desired proportion.

In a **Diverting** application, a single incoming stream is split into two separate streams. A typical example of this is a Bypass application. In order to produce a consistent flow for stable operation, the pressure drop across both flow paths (from inlet to outlet) must be nearly equal.

3-Way Valves are ONLY used for liquid applications.



Mixing:	Ports "A" and "B" are Inlets Port "AB" is Outlet
Diverting:	Port "AB" is Inlet Ports "A" and "B" are Outlets

3-Way Valve
Shown with
Pneumatic Actuator

3-Way Valve
Shown with
Electric Actuator

2-Way Valves with PNEUMATIC ACTUATORS

Pages 320-323

The **HB Series** Stainless Steel 2-Way Control Valves are made to withstand the rigorous nature of **steam and water service** and are compatible with most other fluids as well. The standard configuration has an equal percentage flow characteristic with metal-to-metal seating, spring-loaded Teflon V-ring stem packing.

The Pneumatic Actuator is controlled by a 3-15 PSIG standard instrument air signal that will modulate the position of the valve. The Actuator can be specified to operate the valve for either **Air-To-Open (Normally Closed)**, typical for **HEATING** applications) or **Air-To-Close (Normally Open)**, typical for **COOLING** applications). Fail-safe Mode can also be re-configured in the field if needed.

2-Way Valves with **Pneumatic** Actuator
1/2" - 4" • Threaded & Flanged

3-Way Valves with PNEUMATIC ACTUATORS

Pages 324-327

The **HB Series** Stainless Steel 3-Way Control Valves are used for **mixing** two liquid streams, or for **diverting** the flow of a single liquid stream into two streams (bypass).

The disc type design is constructed of Stainless Steel for extended service life.

Teflon seat rings are available for increased shut-off tightness or for water or glycol type service, up to a maximum of 450°F.

3-Way Valves with **Pneumatic** Actuator
1/2" - 4" • Threaded & Flanged

Valve Positioner – Pneumatic or Electro-Pneumatic

Pages 328-331

Valve positioners improve control accuracy and increase maximum close-off pressure capability of the valve. The Positioner is mounted to the valve's yoke assembly and linked to the valve stem. It receives a transduced air signal or direct electrical signal from the electronic controller and compares the control signal to the actual position of the valve plug. The Positioner then sends a corrected air signal to the valve's actuator, thereby positioning the valve plug for optimum flow modulation. Available options include **Intrinsically Safe, Explosion-Proof** and **Digital** designs.

2 & 3-Way Valves with ELECTRIC ACTUATORS

Pages 332-337

The **HB Series** Stainless Steel 2 & 3-Way Control Valves with **Electric Actuators** are robust, user-friendly alternative to the Pneumatically-Actuated unit. Ideal for installations where an instrument air source is not available. The **E-Series Actuators** utilize either **Capacitors** or **Springs** in order to fully-open or fully-close the valve in the event of signal or power failure. The **SK-Series Actuator** uses springs to Fail in the Closed position in the event of power failure.

E-Series Electric Actuators for 2 & 3-Way Valves

Why use E-Series Actuators?

When Ultra-fast response times are needed, the **EC Model** with **Super Capacitors** should be selected. Unit cycles from Open-to-Close in approximately 6 seconds.

When medium response times are adequate, the **ES Model** with **Spring Return Actuators** is a more economical choice.

2-Way Valves

Super Capacitor
Fast-Acting
Actuator
EC

Spring Return
ES

3-Way Valves

Super Capacitor
Fast-Acting
Actuator
EC

Spring Return
ES

SK-Series Electric Actuators for 2 & 3-Way Valves

The **SK Series Electric Actuators** are an economical choice for **Heating, Boiler Feed Water**, as well as **On/Off HVAC Steam Control** where extremely fast response times are not required.

These Electric Actuators utilize **Spring Return** to retract the stem which allows 2-Way valves to fail fully-closed or 3-Way valves to fail with the “A” Port fully-closed (refer to diagram) in the event of power loss or signal failure.

2-Way Valves

3-Way Valves

Spring Return
SK

TR890 Series Electronic PID Controllers

Pages 344-349

The TR890 Series Electronic PID Controller is the user-interface which allows adjustment of the set point and controls the electrical signals received from the sensor and outputted to the I/P Transducer or directly to an Electro-Pneumatic Valve Positioner or Electric Actuator. The TR893 is the most common controller model due to its larger, more user-friendly size.

The NANOADAC Series is a PID Controller with added features such as data recording and Modbus Communications (BACnet is optional).

I/P Transducer, Air Filter/Regulator & Electronic Temperature Sensors

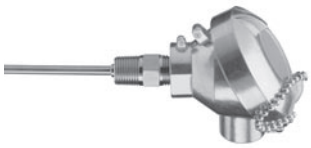
Page 350-352

TA901 Electro-Pneumatic (I/P) Transducer

The TA901 is an electro-pneumatic transducer that converts an electrical signal (4-20 mA) from the Controller to an air signal (3-15 PSIG) for supply to the control valve Actuator or valve Positioner.

TA987 Air Filter & Regulator

The TA987 is recommended for filtering and regulating the pressure of plant compressed air, and for delivering clean, dry air at the proper pressure to pneumatic control devices. The filtering element removes particles as small as 5 microns.



TDD & TMD – 100 Ω & 1000 Ω RTDs
TJD & TKD – Type J & Type K Thermocouples

Both RTD (Resistance Temperature Device) and Thermocouple sensors are available options. These devices sense the temperature of the fluid or product being heated or cooled and transmit an electrical signal to the PID controller.

76 Series Thermowells for RTD & Thermocouple Temperature Sensors

Page 353

Thermowells are used for applications where the process media may be corrosive or contained under pressure – to prevent damage to the sensor and to facilitate removal of the sensor from the process. To prevent leakage of the process fluid, spring-loaded sensors must always be installed in a thermowell.

2-Way Valve with Pneumatic Actuator

for HEATING • COOLING • FLUID TRANSFER • Steam, Air, & Water

2-Way • 1/2" – 4"

Valve Design conforms to ANSI/ASME B 16.34

Models	**HB 2-Way Valve with Pneumatic Actuator**
Service	Steam, Air, Water
Sizes	1/2" - 4"
Connections	NPT, 150# FLG, 300# FLG
Body Material	316 Stainless Steel
Plug and Seat Material	Stainless Steel (Std.)
PMO Max. Operating Pressure	720 PSIG @ 100˚F
TMO Max. Operating Temperature	450˚F @ 497 PSIG
Min Operating Temperature	-20˚F
Max Air Supply Pressure	50 PSIG
Max Ambient Temperature	280˚F
Min Ambient Temperature	-20˚F

DESIGN PRESSURE/TEMPERATURE RATING – PMA/TMA

NPT	497 PSIG	@ 450˚F
150# FLG	182 PSIG	@ 450˚F
300# FLG	497 PSIG	@ 450˚F

The HB Series Stainless Steel 2-Way Control Valves are made to withstand the rigorous nature of steam service and are compatible with air, water, and other fluids as well. These stainless steel valves are a cost-effective alternative when compared to valves with bronze, cast iron or cast steel bodies. The standard configuration has an equal percentage flow characteristic with metal-to-metal seating, spring-loaded Teflon V-ring stem packing and Pneumatic Actuator. The Pneumatic Actuator is controlled by a 3-15 PSIG standard instrument air signal that will modulate the position of the valve.

The Actuator can be specified to operate the valve for either **Air-to-Open** (**Normally Closed**, typically for "**HEATING**" applications) **or Air-to-Close (Normally Open**, typically for "**COOLING**" applications), but can also be re-configured in the field if needed.

TECHNICAL INFORMATION

Plug Design	Equal Percentage
	Linear
	Soft-Seat
Leakage Rating	ANSI/FCI-70-2 Class IV, VI
Rangeability	50:1
Travel (1/2" - 2" Body)	3/4"
(2 1/2" - 4" Body)	1 1/8"
Body Design Rating	ASME 150/300
Diaphragm Design	Semi-rolling, Multi-spring
Action Options	Fail Open
	Fail Closed
	Field Reversible
Positioner Mounting	IEC 60534-6-1 (NAMUR)

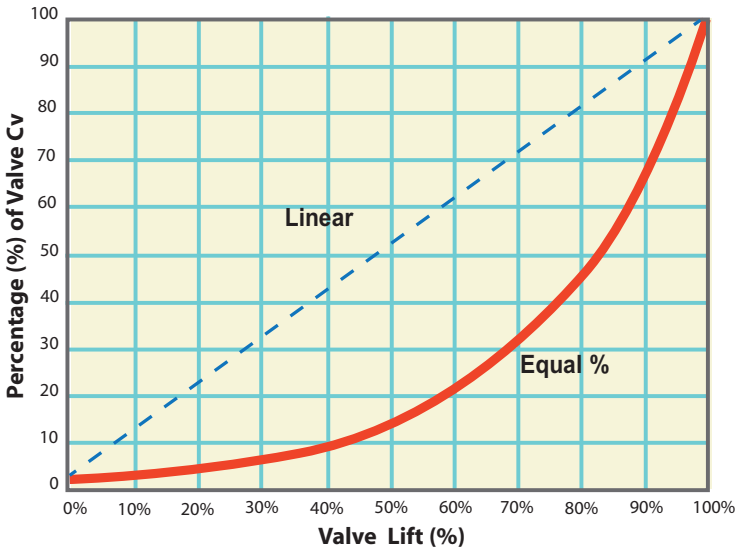
Description & Operation

A control valve is a device capable of modulating flow at varying degrees between minimal flow and full capacity in response to a signal from an external control device. The valve modulates flow through movement of a valve plug in relation to the port(s) located within the valve body. The valve plug is attached to a valve stem, which, in turn, is connected to the actuator. The actuator, which can be pneumatically or electrically operated, directs the movement of the stem as dictated by the external control device.

Options & Associated Control Loop Accessories

- Positioner: Pneumatic, Electro-Pneumatic or Explosion-Proof
- PID Electronic Controllers (TR890 Series)
- I/P converters (Model TA901)
- Air Filter Regulators (Air Sets-Model TA987)
- Thermocouples
- RTD's
- Pressure Transmitters

Flow Characteristic Curve



CONTROL VALVES

2-Way Valve with Pneumatic Actuator

2-Way • 1/2" – 4"

I/P = Close-Off Pressures using I/P Transducer Only
w/Pos. = Close-Off Pressures with Positioner

Size	Connection	Partial Valve Model Code†		Actuator in²	Max Close-Off Pressure (PSI△P)						
					Air-to-Open (Fail Close)					Air-to-Close (Fail Open)	
					Standard Actuator Range (PSIG)		Optional Actuator Range (PSIG)			Standard Actuator Range (PSIG)	
		Full Port	Cv		3-15 PSIG Signal 8-15 PSIG Bench		3-15 PSIG Signal 5-15 PSIG Bench	3-21 PSIG Signal 12-21 PSIG Bench	3-15 PSIG Signal 13-23 PSIG Bench	3-15 PSIG Signal 3-8 PSIG Bench	
					I/P	w/Pos.	I/P	with Positioner		I/P	w/Pos.
1/2"	NPT	HB1000F-12N	5	50	315	515	145	720	-	430	720
3/4"	NPT	HB1000F-13N	6.5		315	515	145	720	-	430	720
1"	NPT	HB1000F-14N	10		315	515	145	720	-	430	720
1 1/2"	NPT	HB1000F-16N	22		170	270	75	430	-	220	665
2"	NPT	HB1000F-17N	42		85	140	40	225	-	115	350
1/2"	150# FLG	HB1000F-121	5	50	275*	275*	145	275*	-	275*	275*
3/4"	150# FLG	HB1000F-131	6.5		275*	275*	145	275*	-	275*	275*
1"	150# FLG	HB1000F-141	10		275*	275*	145	275*	-	275*	275*
1 1/2"	150# FLG	HB1000F-161	22		170	270	75	275*	-	220	275*
2"	150# FLG	HB1000F-171	42		85	120	40	225	-	115	275*
2 1/2"	150# FLG	HB1000F-181	70		35	60	15	100	-	50	160
2 1/2"	150# FLG	HB1000F-181	70	100	100	160	-	-	245	140	435
3"	150# FLG	HB1000F-191	110		75	120	-	-	185	106	331
4"	150# FLG	HB1000F-201	170		40	65	-	-	100	56	180
1/2"	300# FLG	HB1000F-123	5	50	315	515	145	720	-	430	720
3/4"	300# FLG	HB1000F-133	6.5		315	515	145	720	-	430	720
1"	300# FLG	HB1000F-143	10		315	515	145	720	-	430	720
1 1/2"	300# FLG	HB1000F-163	22		170	270	75	430	-	220	665
2"	300# FLG	HB1000F-173	42		85	140	40	225	-	115	350
2 1/2"	300# FLG	HB1000F-183	70	100	100	160	-	-	245	140	435
3"	300# FLG	HB1000F-193	110		75	120	-	-	185	106	331
4"	300# FLG	HB1000F-203	170		40	65	-	-	100	56	180

* Shut-off pressure limited by flange class rating.

Special High Thrust Actuator available for increased shut-off pressures on 2 1/2" - 4" valve bodies; Consult factory.

† To complete Full Model Code, Must Specify: Trim, Packing, Actuator and Control Signal Type

Example (Air-to-Open): **HB1000F-12N-PA1-00**
Example (Air-to-Close): **HB1000F-12N-PA2-00**

Model Code Configuration Chart

2-Way VALVE BODY

Model	Code	Trim Style	Code	Seat Type	Code	Packing	Code	Port Type
HB1	0	Equal Percentage	0	Metal Seat Stainless	0	Teflon	F	Full Port
	1	Linear	1	Soft Seat Teflon	1	Graphite	R	Reduced
			C.F.	Elastomers EPDM				
			C.F.	Viton				

CONNECTION

Code	Size	Code	Connection
12	1/2"	N	NPT
13	3/4"	1	150# FLG
14	1"	3	300# FLG
16	1 1/2"	6	600# FLG
17	2"	B	BSP
18	2 1/2"	P	PN16
19	3"	Q	PN25
20	4"		

ACTUATOR - 50 in² (PSIG)

Code	Actuator	Code	Control Signal	Bench Set
PA1	Air-to-Open- *(Fail-Closed)*	00	3-15	8-15
		05	3-15	5-15
		10	3-21	12-21
PA2	Air-to-Close- *(Fail-Open)*	00	3-15	3-8

ACTUATOR - 100 in²

Code	Actuator	Code	Control Signal	Bench Set
PB1	Air-to-Open- *(Fail-Closed)*	00	3-15	8-15
		11	3-23	13-23
PB2	Air-to-Close- *(Fail-Open)*	00	3-15	3-8

Options	Code
Other Elastomer Trim	C.F.
Positioner Mounting Kit:	W-KIT-NP-HB-ATO/ATC
Direct Mount I/P Transducer	TA901
Direct Mount Air Filter/Regulator	TA987
Air Filter/Regulator Mounting Kit:	W-KIT-TA987-HB (50in² act.)
	W-KIT-TA987-HB-L (100in² act.)
Stainless Steel 50 in² Actuator	C.F.
Solenoid valve for pneumatic On/Off operation.	C.F.
Handwheel for Actuator	C.F.

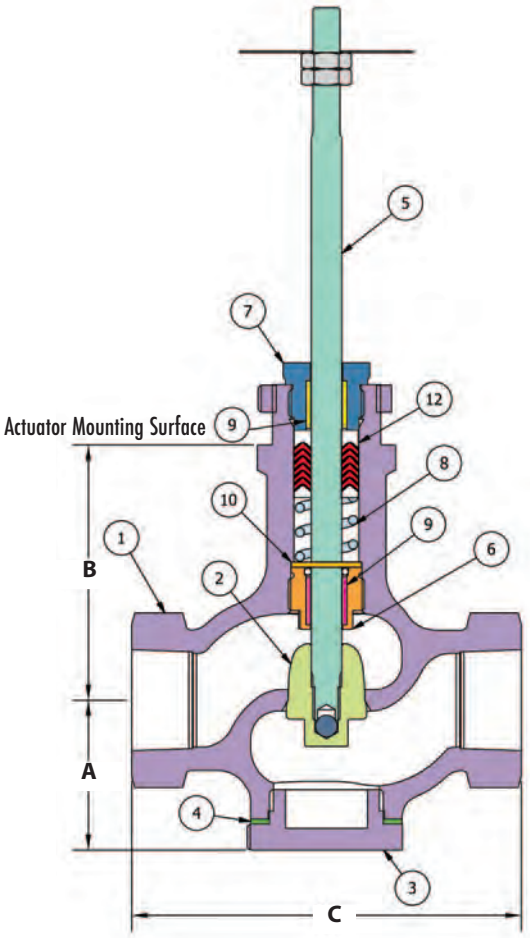
CONTROL VALVES

2-Way Valve with Pneumatic Actuator

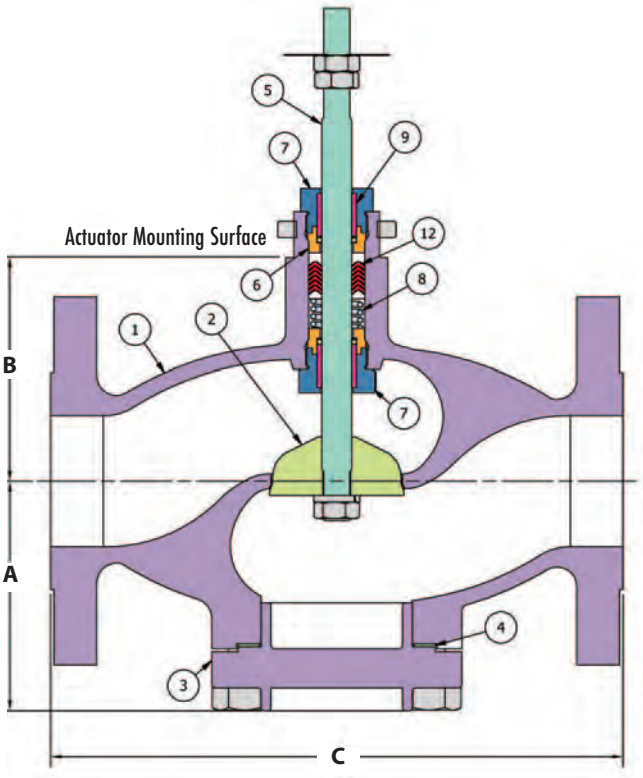
for HEATING • COOLING • FLUID TRANSFER • Steam, Air, & Water

2-Way • 1/2" – 4"

1/2" to 2" Threaded & Flanged



2½" to 4" Flanged



Item	Description	Material
1	Body	316 Stainless Steel
2	Valve Plug*	Hardened Stainless Steel
3	Body Plug	316 Stainless Steel
4	Body Gasket*	303 Stainless Steel
5	Stem*	316 Stainless Steel
6	Lower Seal Bushing	303 Stainless Steel
7	Gland Nut	303 Stainless Steel
8	Stem Seal Spring*	302 Stainless Steel
9	Guide Bushing*	Rulon 641 / PTFE
10	Washer / Retainer	303 Stainless Steel
12	V-ring Stem Seals*	PTFE

* Recommended Spare Parts

Size	A	B	C NPT	C 150#	C 300#	Weight (lbs) NPT	150#	300#
1/2"	1.76	2.95	4.50	7.25	7.75	3.5	6	7
3/4"	1.76	2.95	4.50	7.25	7.75	3.5	7	9
1"	1.74	2.95	4.50	7.25	7.75	5.5	10	13
1½"	2.15	2.95	5.00	8.75	9.25	6.8	14	19
2"	2.31	2.95	6.00	10	10.5	10	21	25
2½"	4.38	4.25	–	10.88	11.5	–	41	46
3"	5.56	4.25	–	11.75	12.5	–	65	74
4"	6.19	4.25	–	13.88	14.5	–	92	112

MAXIMUM FLOW COEFFICIENT (C_V)

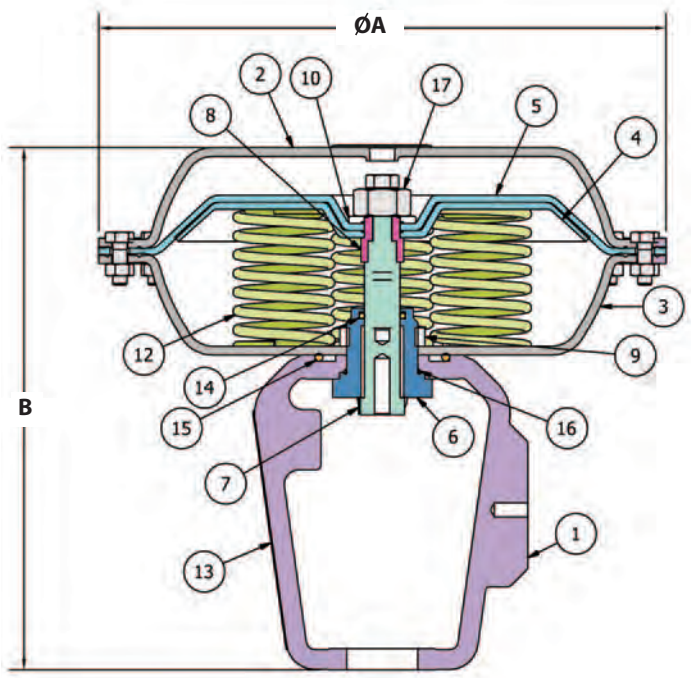
Valve Body Size	1/2" (Reduced Port)	1/2"	3/4"	1"	1½"	2"	2½"	3"	4"
	3.5	5	6.5	10	22	42	70	110	170

2-Way Valve with Pneumatic Actuator

for HEATING • COOLING • FLUID TRANSFER • Steam, Air, & Water

2-Way • 1/2" – 4"

Pneumatic Actuator 50 in²

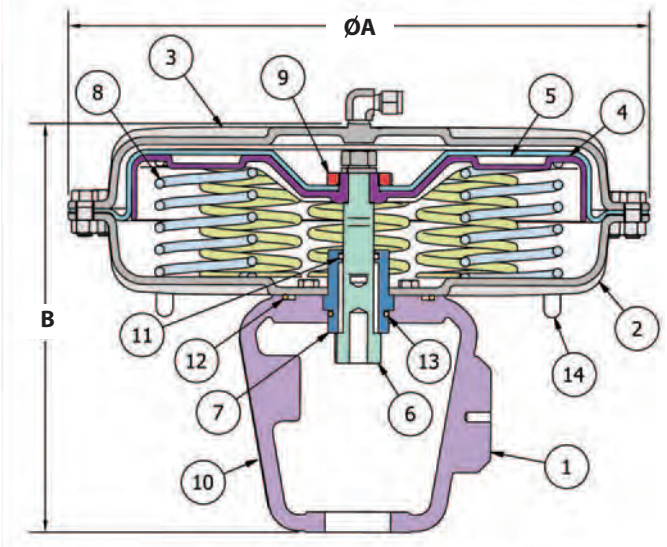


Pneumatic Actuator 50 in²

Item	Description	Material
1	Yoke	Stainless steel
2**	Upper diaphragm case	Epoxy painted steel
3**	Lower diaphragm case	Epoxy painted steel
4	Diaphragm plate	Nickel plated steel
5*	Diaphragm	Nylon reinforced Neoprene
6	Upper guide bush	Stainless Steel / Bronze
7	Lower actuator stem	Stainless steel
8	Upper actuator stem	Stainless steel
9	Ring nut	Stainless steel
10	Diaphragm washer	Stainless steel
11	Position indicator disc	Stainless steel
12*	Spring**	Stainless steel
13	Nameplate	Stainless steel
14*	Stem O-ring	Viton
15*	Yoke O-ring	Viton
16*	Upper guide O-ring	Viton
17	Hex nut Stainless	Steel

* Recommended Spare Parts
** Available in Stainless Steel
Optional Actuator Handwheel for manual Adjustment. C.F.

Pneumatic Actuator 100 in²



Pneumatic Actuator 100 in²

Item	Description	Material
1	Yoke	Stainless steel
2	Lower diaphragm case	Stainless steel
3	Upper diaphragm case	Stainless steel
4	Diaphragm plate	Stainless steel
5*	Diaphragm	Nylon reinforced Neoprene
6	Spindle	Stainless steel
7	Guide bushing Assembly	Stainless Steel / Bronze
8*	Spring (x8)	Stainless steel
9	Diaphragm nut	Stainless steel
10	Nameplate	Stainless steel
11*	Spindle O-ring	Viton
12*	Yoke O-ring	Viton
13*	Guide O-ring	Viton
14	Thread Protector	Viton

* Recommended Spare Parts

Actuator Size	A	B	Weight (lbs)
50 in²	10.00	9.25	18
100 in²	14.38	10.00	50

Special High Thrust Actuator available for increased shut-off pressures on 2 1/2" - 4" valve bodies; Consult factory.

3-Way Valve with Pneumatic Actuator

for MIXING & DIVERTING • Water & Other Liquids

3-Way • 1/2" – 4"

Valve Design conforms to ANSI/ASME B 16.34

Models	**HB 3-Way Valve with Pneumatic Actuator**
Service	Steam, Air, Water
Sizes	**1/2" - 4"**
Connections	**NPT, 150# FLG, 300# FLG**
Body Material	**316 Stainless Steel**
Plug and Seat Material	**Stainless Steel (Std.)**
PMO Max. Operating Pressure	720 PSIG @ 100˚F
TMO Max. Operating Temperature	450˚F @ 497 PSIG
Min Operating Temperature	-20˚F
Max Air Supply Pressure	50 PSIG
Max Ambient Temperature	280˚F
Min Ambient Temperature	-20˚F

DESIGN PRESSURE/TEMPERATURE RATING – PMA/TMA		
NPT	497 PSIG	@ 450˚F
150# FLG	182 PSIG	@ 450˚F
300# FLG	497 PSIG	@ 450˚F

3-WAY VALVES ARE NOT FOR USE WITH STEAM

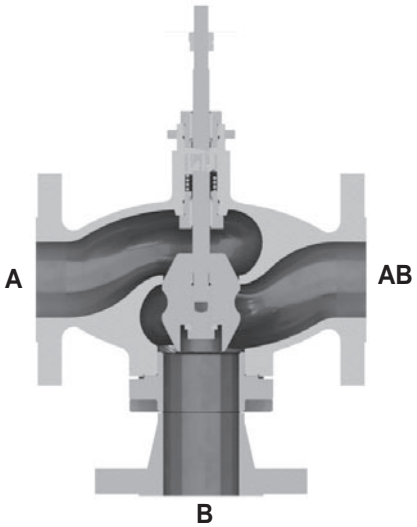
TECHNICAL INFORMATION	
Seat Type	Metal Seat
	Soft-Seat
Leakage Rating	ANSI/FCI-70-2 Class IV, VI
Rangeability	50:1
Travel (1/2" - 2" Body)	3/4"
(2 1/2" - 4" Body)	1 1/8"
Body Design Rating	ASME 150/300
Diaphragm Design	Semi-rolling, Multi-spring
Action Options	Fail Open
	Fail Closed
	Field Reversible
Positioner Mounting	IEC 60534-6-1 (NAMUR)

Typical Applications

The **HB Series 3-Way** valves are used for **mixing** two separate liquid streams, or for **diverting** the flow of a single liquid stream (bypass). In order to produce a consistent flow for stable operation, the pressure drop across both flow paths (inlet to outlet) must be nearly equal. The valve plug is constructed of stainless steel for extended service life. A Teflon plug option is available for increased shut-off tightness or for water or glycol type service, up to a maximum of 450˚F.

Description & Operation

A control valve is comprised of an actuator mounted to a valve. The valve modulates flow through movement of a valve plug in relation to the port(s) located within the valve body. The valve plug is attached to a valve stem, which, in turn, is connected to the actuator. The pneumatic actuator directs the movement of the stem as dictated by the external control device.



Mixing:
Ports "A" and "B" are Inlets
Port "AB" is Outlet

Diverting:
Port "AB" is Inlet
Ports "A" and "B" are Outlets

3-Way Valve
2 1/2" – 4"
shown with Optional Positioner and Filter/Regulator

CONTROL VALVES

3-Way Valve with Pneumatic Actuator

3-Way • 1/2" – 4"

I/P = Close-Off Pressures using I/P Transducer Only
w/Pos. = Close-Off Pressures with Positioner

Size	Connection	Partial Valve Model Code †		Actuator in²	Max Close-Off Pressure (PSI△P)						Weight lbs
					Standard Actuator Range (PSIG)		Optional Actuator Range (PSIG)				
		Full Port	Cv		3-15 PSIG Signal 6-11 PSIG Bench		3-22 PSIG Signal 13-22 PSIG Bench		3-22 PSIG Signal 13-22 PSIG Bench		
					I/P	w/ Positioner	I/P	w/ Positioner	I/P	w/Positioner	
1/2"	NPT	HB1300F-12N	5	50	220	425	-	-	-	-	23
3/4"	NPT	HB1300F-13N	6.5		220	425	-	-	-	-	23
1"	NPT	HB1300F-14N	10		220	425	-	-	-	-	25
1 1/2"	NPT	HB1300F-16N	22		110	215	-	-	-	-	29
2"	NPT	HB1300F-17N	42		55	110	-	-	-	-	36
1/2"	150# FLG	HB1300F-121	5	50	220	275*	-	275*	-	-	25
3/4"	150# FLG	HB1300F-131	6.5		220	275*	-	275*	-	-	25
1"	150# FLG	HB1300F-141	10		220	275*	-	275*	-	-	29
1 1/2"	150# FLG	HB1300F-161	22		110	215	-	275*	-	-	36
2"	150# FLG	HB1300F-171	42		55	110	-	220	-	-	43
2 1/2"	150# FLG	HB1300F-181	70	100	59	118	-	-	245	245	100
3"	150# FLG	HB1300F-191	110		44	90	-	-	185	185	124
4"	150# FLG	HB1300F-201	170		22	47	-	-	100	100	156
1/2"	300# FLG	HB1300F-123	5	50	220	425	-	720	-	-	26
3/4"	300# FLG	HB1300F-133	6.5		220	425	-	720	-	-	26
1"	300# FLG	HB1300F-143	10		220	425	-	720	-	-	31
1 1/2"	300# FLG	HB1300F-163	22		110	215	-	430	-	-	39
2"	300# FLG	HB1300F-173	42		55	110	-	220	-	-	52
2 1/2"	300# FLG	HB1300F-183	70	100	59	118	-	-	-	245	108
3"	300# FLG	HB1300F-193	110		44	90	-	-	-	185	138
4"	300# FLG	HB1300F-203	170		22	47	-	-	-	100	186

* Shut-off pressure limited by flange class rating.

† To complete Full Model Code, Must Specify: Trim, Packing, Actuator and Control Signal Type

Example (Fail-Closed A-Port): **HB1300F-12N-PA1-31**
Example (Fail-Closed B-Port): **HB1300F-12N-PA2-31**

Model Code Configuration Chart

3-Way VALVE BODY

Model	Code	Trim Style	Code	Seat Type	Code	Packing	Code	Port Type
HB1	3	3-Way	0	Metal Seat Stainless	0	Teflon	F	Full Port
					1	Graphite		
			1	Soft Seat Teflon				

CONNECTION

Code	Size	Code	Connection
12	1/2"	N	NPT
13	3/4"	1	150# FLG
14	1"	3	300# FLG
16	1 1/2"	6	600# FLG
17	2"	B	BSP
18	2 1/2"	P	PN16
19	3"	Q	PN25
20	4"		

ACTUATOR - 50 in² (PSIG)

Code	Actuator	Code	Control Signal	Bench Set
PA1	Fail-Closed "A" Port	31	3-15	6-11
		32	3-22	13-22
PA2	Fail-Closed "B" Port			

ACTUATOR - 100 in²

PB1	Fail-Closed "A" Port	31	3-15	6-11
PB2	Fail-Closed "B" Port	11	3-23	13-23

Note: 3-Way Valve Actuator action is as follows:
PA1/PB1- Fails with Stem Retracted
PA2/PB2- Fails with Stem Extended

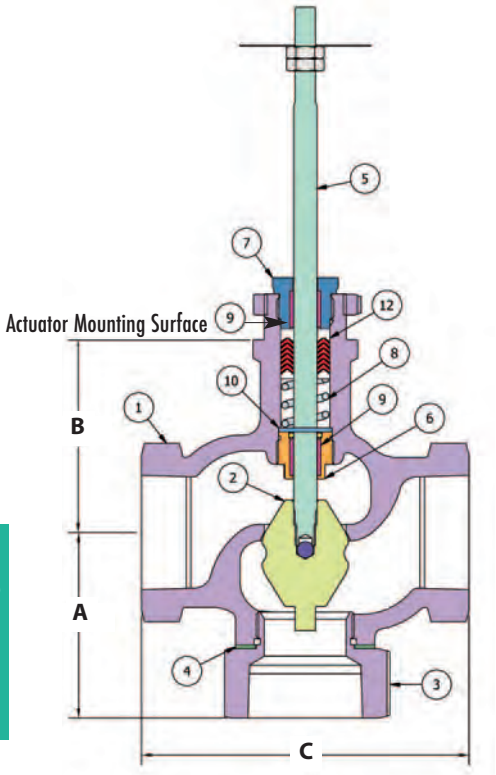
Options	Code
Other Elastomer Trim	C.F.
Positioner Mounting Kit:	W-KIT-NP-HB-AT0/ATC
Direct Mount I/P Transducer	TA901
Direct Mount Air Filter/Regulator	TA987
Air Filter/Regulator Mounting Kit:	W-KIT-TA987-HB (50in² act.)
	W-KIT-TA987-HB-L (100in² act.)
Stainless Steel 50 in² Actuator	C.F.
Solenoid valve for pneumatic On/Off operation.	C.F.
Handwheel for Actuator	C.F.

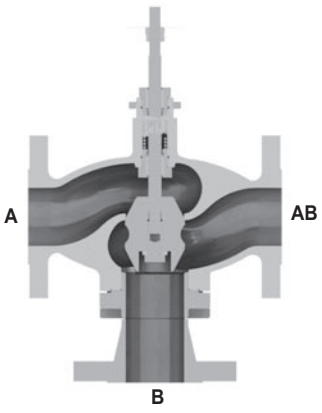
for MIXING & DIVERTING • Water & Other Liquids

3-Way • 1/2" – 4"

3-Way for Mixing or Diverting

1/2" to 2"
Threaded & Flanged





Mixing:
Ports "A" and "B" are Inlets
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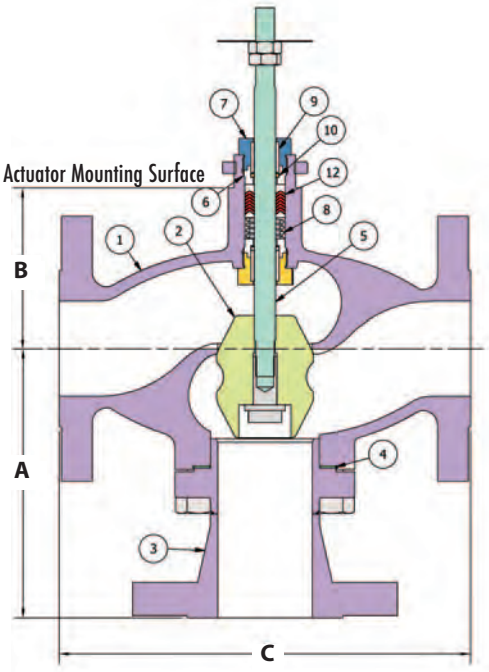
Diverting:
Port "AB" is Inlet
Ports "A" and "B" are Outlets

2 1/2" to 4"
Flanged



Item	Description	Material
1	Body	316 Stainless Steel
2	Valve Plug*	Hardened Stainless Steel
4	Body Gasket*	303 Stainless Steel
5	Stem*	316 Stainless Steel
6	Lower Seal Bushing	303 Stainless Steel
7	Gland Nut	303 Stainless Steel
8	Stem Seal Spring*	302 Stainless Steel
9	Guide Bushing*	Rulon 641 / PTFE
10	Washer	303 Stainless Steel
12	V-ring Stem Seals*	PTFE

* Recommended Spare Parts

Size	A NPT	B	A 150	A 300	C NPT	C 150#	C 300#	Weight (lbs) NPT	Weight (lbs) 150#	Weight (lbs) 300#
1/2"	2.31	2.95	4	4	4.50	7.25	7.75	4	8.5	9
3/4"	2.31	2.95	4	4	4.50	7.25	7.75	4	8.5	9
1"	2.31	2.95	4	4	4.50	7.25	7.75	5.5	12	13.5
1 1/2"	2.84	2.95	4.3	4.3	5.00	8.75	9.25	7	18.5	22
2"	3.19	2.95	5	5	6.00	10	10.5	11	26	35
2 1/2"	–	4.25	7.13	7.38	–	10.88	11.5	–	50	58
3"	–	4.25	8.32	8.5	–	11.75	12.5	–	74	88
4"	–	4.25	9.19	9.5	–	13.88	14.5	–	106	136

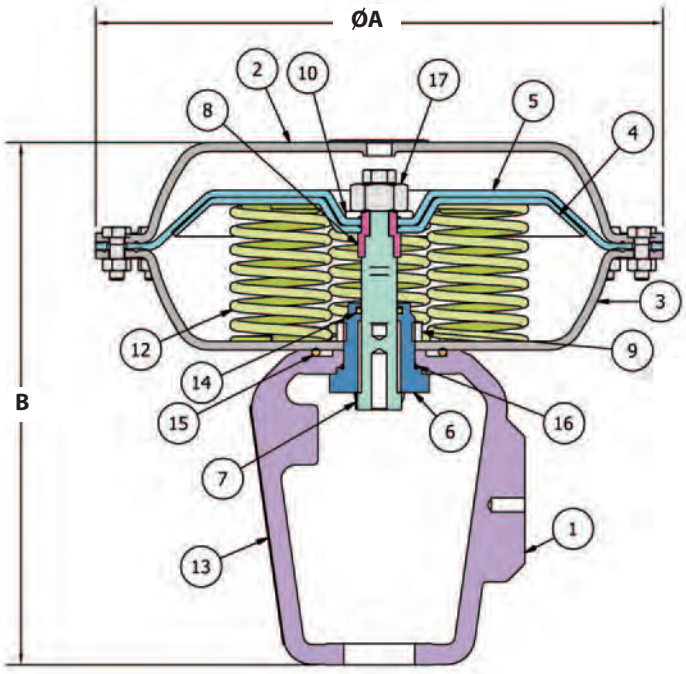
MAXIMUM FLOW COEFFICIENT (C_V)

Valve Body Size	1/2" (Reduced Port)	1/2"	3/4"	1"	1 1/2"	2"	2 1/2"	3"	4"
	3.5	5	6.5	10	22	42	70	110	170

for MIXING & DIVERTING • Water & Other Liquids

3-Way • 1/2" – 4"

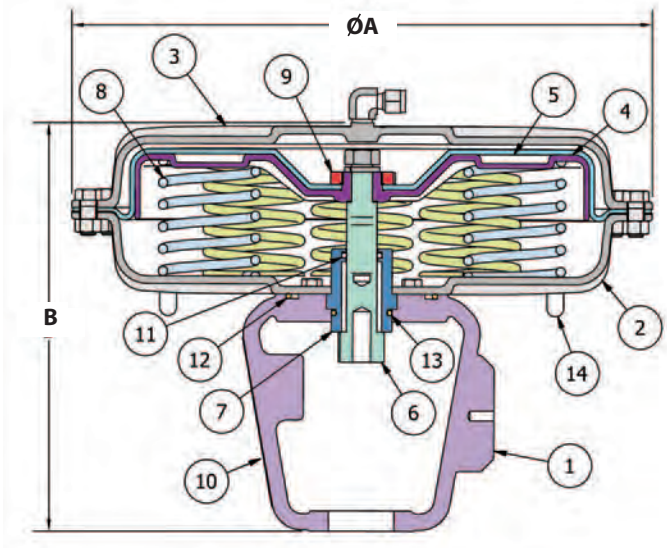
Pneumatic Actuator 50in²



Item	Description	Material
1	Yoke	Stainless steel
2**	Upper diaphragm case	Epoxy painted steel
3**	Lower diaphragm case	Epoxy painted steel
4	Diaphragm plate	Nickel plated steel
5*	Diaphragm	Nylon reinforced Neoprene
6	Upper guide bush	Stainless Steel / Bronze
7	Lower actuator stem	Stainless steel
8	Upper actuator stem	Stainless steel
9*	Ring nut	Stainless steel
10	Diaphragm washer	tainless steel
11	Position indicator disc	Stainless steel
12*	Spring**	Stainless steel
13	Nameplate	Stainless steel
14*	Stem O-ring	Viton
15*	Yoke O-ring	Viton
16*	Upper guide O-ring	Viton
17	Hex nut Stainless	Steel

* Recommended Spare Parts
** Available in Stainless Steel
Optional Actuator Handwheel for manual Adjustment. C.F.

Pneumatic Actuator 100in²



Item	Description	Material
1	Yoke	Stainless steel
2	Lower diaphragm case	Stainless steel
3	Upper diaphragm case	Stainless steel
4	Diaphragm plate	Stainless steel
5*	Diaphragm	Nylon reinforced Neoprene
6	Spindle	Stainless steel
7	Guide bushing Assembly	Stainless Steel / Bronze
8*	Spring (x8)	Stainless steel
9	Diaphragm nut	Stainless steel
10	Nameplate	Stainless steel
11*	Spindle O-ring	Viton
12*	Yoke O-ring	Viton
13*	Guide O-ring	Viton
14	Thread Protector	Viton

* Recommended Spare Parts

Actuator Size	A	B	Weight (lbs)
50 in²	10.00	9.25	18
100 in²	14.38	10.00	50

Special High Thrust Actuator available for increased shut-off pressures on 2-1/2" - 4" valve bodies; Consult factory.

for 2-Way or 3-Way Pneumatically-Actuated Valves

Valve Positioners (Electro-Pneumatic)

The **CE100 Series Electro-Pneumatic Positioners** improve control accuracy and increase maximum close-off pressure capability of the valve. The Positioner is mounted to the valve's yoke assembly and linked to the valve stem. It receives a transduced air signal or direct electrical signal from the electronic controller and compares the control signal to the actual position of the valve plug. The Positioner then sends a corrected air signal to the valve's actuator, thereby positioning the valve plug for optimum flow modulation.

The **Electro-Pneumatic Positioner** receives an electrical 4-20 mA signal directly from the PID Controller and therefore eliminates the need for a separate I/P Transducer.

	Electro-Pneumatic **CE100**
Input Signal	4-20 mA
Supply Air Pressure	20 to 100 PSIG
Action	Single-Acting
Air Connection	1/4" NPT (Gauge 1/8" NPT)
Electrical Connection	1/2" NPT
Pressure Gauges	Included
Cam	Linear Characteristics
Ambient Temperature	-4° to 185° F (-20° - 83° C)
Enclosure Material	Die Cast Aluminum
Enclosure Rating	IP65 (dust and drip-proof)
Weight	4.8 lbs. (2.2 kg)
Optional Explosion Protection	ATEX: D = Gas Ex d P = Gas/Dust Ex d E = Gas Ex ia
Linear Error	0.7% full span
Hysteresis	0.4% full span
Repeatability	0.3% full span
Media	Oil-free instrument Air Filtered to 5 micron
Flow Capacity	SCFM
@20 PSI	9.5
@87 PSI	28.3
Air Consumption	SCFM
@20 PSI	0.2
@87 PSI	0.6

HB-Series Control Valve
shown with
CE100 Positoner
and TA987 Air/Filter Regulator

CONTROL VALVES

CE100 Electro-Pneumatic Positioner Options

Type	Model Code	Features	Weight lbs.	Explosion Protection Options	
				Suffix Code	Description
Standard	CE100	Electro-Pneumatic	5	-D	ATEX: Gas Ex d
				-P	ATEX: Gas/Dust Ex d
				-E	ATEX: Gas Ex ia

V100 Series Pneumatic & Electro-Pneumatic Positioners

for 2-Way or 3-Way Pneumatically-Actuated Valves

Valve Positioners (Pneumatic or Electro-Pneumatic)

The **V100 Series** Valve Positioners (Pneumatic/Electro-Pneumatic) offer enhanced features ideal for applications where extreme accuracy is required. Designed to mount to a pneumatically-actuated control valve to improve control accuracy and increase maximum close-off pressure capability of the valve.

The **V100P Pneumatic Positioner** receives a 3-15 PSIG air signal normally taken from an I/P Transducer.

The **V100E Electro-Pneumatic Positioner** receives an electrical 4-20 mA signal directly from the PID Controller and therefore eliminates the need for a separate I/P Transducer.

HB-Series Control Valve
shown with V100E Positoner with Gauge Blocks and Gauges (included) and optional Stainless Steel 50in² Actuator

	Pneumatic V100P	Electro-Pneumatic V100E
Input Signal	3-15 PSI (0.2 - 1.0 Bar)	4-20 mA
Supply Air Pressure	145 PSI maximum	20 to 145 PSIG
Action	Single-Acting	Single-Acting
Air Connection	1/4" NPT (Gauge 1/8" NPT)	1/4" NPT (Gauge 1/8" NPT)
Electrical Connection	N / A	1/2" NPT
Pressure Gauges	Included	Included
Cam	Linear Characteristics	Linear Characteristics
Ambient Temperature	-40˚ to 185˚ F (-40˚ - 85˚ C)	-40˚ to 185˚ F (-40˚ - 85˚ C)
Enclosure Material	Die Cast Aluminum with Polyester Epoxy Coating	Die Cast Aluminum with Polyester Epoxy Coating
Enclosure Rating	NEMA 4X / IP66	NEMA 4X / IP66
Weight	3.5 lbs. (1.6 kg)	3.8 lbs. (1.7 kg)
Optional Explosion Protection	Consult Factory	Refer to Options Chart Below
Linear Error	0.7% full span	
Hysteresis	0.4% full span	
Repeatability	0.3% full span	
Media	Oil-free instrument Air Filtered to 5 micron	
Flow Capacity	SCFM	
@20 PSI	9.5	
@87 PSI	28.3	
Air Consumption	SCFM	SCFM
@20 PSI	0.18	0.2
@87 PSI	0.53	0.6

CONTROL VALVES

V100 Pneumatic & Electro-Pneumatic Positioner Options

Type	Model Code	Features	Weight lbs.	Options	
				Suffix Code	Description
Standard Positioners	V100E	Electro-Pneumatic	5	V250001	(2) SPDT Mechanical Switches
	V100P	Pneumatic	5		
Optional	V100-EX	Electro-Pneumatic (Explosion-Proof)	5	V250001	(2) SPDT Mechanical Switches
	V100-EX-ATEX	Electro-Pneumatic (Explosion-Proof w/ ATEX Approval)	5		
	V100-EX-IS	Electro-Pneumatic (Intrinsically Safe)	5	V250007	4-20mA Feedback
	V100-EX-10V	Electro-Pneumatic (0-10V 1/P)	5		

for 2-Way or 3-Way Pneumatically-Actuated Valves

HB-Series Control Valve

shown with MVP3500 Positoner with Gauge Blocks (inlcuded) optional Stainless Steel 50in² Actuator

The **MVP3500** is a digital positioner that mounts to the pneumatic actuator of control valves to improve accuracy and increase maximum close-off pressure capability of the valve. Digital positioners use piezo-electric valves for the air supply which limit leakage, making them much more efficient than electro-pneumatic positioners.

Set-up and calibration are also greatly simplified by the use of local push-buttons and LCD, eliminating the need for expensive handheld devices for basic set up and calibration. The **MVP3500** comes standard with 4-20mV feedback, Hart communication, gauge blocks and gauges.

The **MVP3600** is an Explosion-Proof model.

SPECIFICATIONS	
Model	**MVP3500** 
Signal	4-20mA
Feedback	4-20mA
Supply Pressure	22 - 101 PSIG
Air Consumption	.020 SCFM
Ambient Temperature Range	-40˚ - 158˚F
Rotation Range	30˚ - 120˚F
Linear Stroke Range	0.39 - 3.94 in.
Characteristics Curves	Linear, 1:30, 30:1, Custom
Deadband	0.1% - 10% Adjustable
Communication	HART
Enclosure Rating	IP65
Air Connections	1/4" NPT
Electrical Connections	1/2" NPT
Explosion Protection	Ex ia IIC T4-T6 Ga Ex iaD 20 T80˚C/T95˚C/T130˚C
	MVP3600
	ATEX: Ex d IIC T4 - T6 Ga Ex td A21 IP65 T80˚C / T90˚C / T105˚C

HB Series "SMART" Positioner Options

Model Code	Features	Weight lbs.	Options	
			Model Code	Description
MVP3500L-10H-KF0-M00-EWM	Standard Digital (Single-Action), 4-20mV Feedback - Included: HART Communication, Gauge Blocks & Gauges.	5	All Options Included	
MVP3600L-1PH-F0-M00-EWM	Explosion Protection Digital (Single-Action), 4-20mV Feedback Included: HART Communication, Gauge Blocks & Gauges.	5		

for 2-Way or 3-Way Pneumatically-Actuated Valves

HB-Series Control Valve

shown with
D400 Positoner
with Gauge Blocks (inlcuded)
optional Stainless Steel
50in² Actuator

The **D400** is a digital positioner with Intrinsically-Safe or Explosion-Proof options. These positioners are designed to be highly accurate and efficient in a wide range of application environments. HART communication and 4-20mA feedback are available as options.

SPECIFICATIONS	
Model	**D400** 
Signal	4-20mA
Feedback	Optional 4-20mA
Supply Pressure	22 - 90 PSIG
Air Consumption	.015 SCFM
Ambient Temperature Range	-40˚ - 185˚F
Rotation Range	250˚ - 120˚F
Linear Stroke Range	0.4 - 4.0 in.
Characteristics Curves	Linear ,Eq %, 1:25, 1:50 50:1, Custom
Deadband	0.1% - 10% Adjustable
Communication	Optional HART
Enclosure Rating	NEMA 4X / IP65
Air Connections	1/4" NPT
Electrical Connections	1/2" NPT
	D400-IS (Intrinsically Safe)
	ATEX: II 2G EEx ib IIC T6 II 2G EEx ia IIC T6 II 3G EEx n A II T6 II 2D IP 6X T 46˚C IECEX: EXIB IIC T6
	D400-EX (Explosion-Proof)
	ATEX: II 2G EEx ib IIC T6 IECEX: EXIB IIC T6

CONTROL VALVES

HB Series "SMART" Positioner Options

Model Code	Features	Weight lbs.	Options	
			Suffix Code	Description
D400	Standard Digital (Single-Action) - No Communication	5	-H	Hart Communication
D400-IS	Digital (Intrinsically Safe) - No Communication	5	V240007	Single Gauge Block
D400-EX	Digital Explosion-Proof - No Communication	5	-FB	4-20mV Feedback
			-HFB	Hart Communication & Feedback

Other Options Available; Contact Factory

Electric Actuators for 2-Way or 3-Way

Models	2 & 3-Way Valves with E -Series or SK-Series Electric Actuators
Service **2-Way Valve**	Steam, Air, Water
Service **3-Way Valve**	Liquid ONLY **(NO STEAM)**
Sizes	**1/2" - 4"**
Connections	**NPT, 150# FLG, 300# FLG**
Body Material	**316 Stainless Steel**
Plug and Seat Material	**Stainless Steel (Std.)**
PMO Max. Operating Pressure	720 PSIG @ 100˚F
TMO Max. Operating Temperature	450˚F @ 497 PSIG
Min Operating Temperature	-20˚F
Max Air Supply Pressure	50 PSIG
Max Ambient Temperature	Actuator Dependent

EC
Super Capacitor

ES
Spring Return

SKD
Spring Return

DESIGN PRESSURE/TEMPERATURE RATING – PMA/TMA		
NPT	497 PSIG	@ 450˚F
150# FLG	182 PSIG	@ 450˚F
300# FLG	497 PSIG	@ 450˚F

The **HB Series** Stainless Steel 2-Way & 3-Way Control Valves with **Electric Actuators** are a robust, user-friendly alternative to the Pneumatically-Actuated unit. They are ideal for installations where an instrument air source is not available or when the benefits for electric actuation are preferred.

Electric Actuators utilize either **Super Capacitors** or **Spring Return** which allow for the valve to fail in either the fully-open or fully-closed position in the event of power loss or signal failure.

The **EC Model** using Super Capacitor should be selected when Ultra-fast response times are needed such as in instantaneous hot water heater applications. The **EC Model Actuator** will cycle from Open to Close in approximately 6 seconds.

The **ES Model** using Spring Return are an economical choice when medium response times are sufficient. They have Fail-Open and Fail-Close options as well as 24 VDC service.

TECHNICAL INFORMATION

Plug Design	Equal Percentage
	Linear
	Soft-Seat
Leakage Rating	ANSI/FCI-70-2 Class IV, VI
Rangeability	50:1
Travel (1/2" - 2" Body)	3/4"
(2 1/2" - 4" Body)	1 1/8"
Body Design Rating	ASME 150/300
Action Options	Fail Open*
	Fail Closed
Actuator Options	Fast-acting, Super Capacitors
	On-Off, Spring Return

* 2-way HB-Series with SK-Series Actuators are Fail-Closed only.

Valve Design conforms to ANSI/ASME B 16.34

The **SK Series Electric Actuators** are used for general purpose applications where medium response times are sufficient. They are an economical choice for **Heating, Boiler Feed Water** applications as well as **On/Off HVAC Steam Control**.

SK Actuators Fail Closed, typically not used for Cooling applications.

	E-Series			SK-Series		
Fail-Safe Operator	Capacitor		Spring	Spring		
Actuator	EC10	EC	ES	SKB	SKC	SKD
Voltage	115VAC / 24VAC / 24VDC			24VAC*		
Max Ambient Temp	140˚F			130˚F		122˚F
Enclosure Rating	IP65			IP54 / NEMA 1		
Stroke (in)	1.97	1.97	1.57	0.75	1.50	0.75
Thrust (lbs)	2,248	1,011	449	629		224
Cycle Time open (s)	15	8	120	120	120	60
Cycle Time close (s)	15	8	90	15	20	15
Weight (lbs)	22	18	12.4	18.9	22.5	8.5

* 115VAC service available with optional power adapter.

Electric Actuators for 2-Way or 3-Way

Size	Connection	Valve Model Code	Cv	E-Series Actuator: EC Super Capacitor	E-Series Actuator: EC10 Super Capacitor	E-Series Actuator: ES Spring Return	SK-Series Actuator: SKD STANDARD	SK-Series Actuator: SKB	SK-Series Actuator: SKC
		Full Port		Max Close-Off Pressure (PSI△P)					
1/2"	NPT	HB1000F-12N	5	720	N/A	605	290	720	720
3/4"	NPT	HB1000F-13N	6.5	720	N/A	605	290	720	720
1"	NPT	HB1000F-14N	10	720	N/A	605	290	720	720
1 1/2"	NPT	HB1000F-16N	22	720	N/A	315	150	450	450
2"	NPT	HB1000F-17N	42	380	N/A	160	75	280	230
1/2"	150# FLG	HB1000F-121	5	275*	N/A	275*	275*	275*	275*
3/4"	150# FLG	HB1000F-131	6.5	275*	N/A	275*	275*	275*	275*
1"	150# FLG	HB1000F-141	10	275*	N/A	275*	275*	275*	275*
1 1/2"	150# FLG	HB1000F-161	22	275*	N/A	275*	150	275*	275*
2"	150# FLG	HB1000F-171	42	275*	N/A	160	75	230	230
2 1/2"	150# FLG	HB1000F-181	70	175	380	74	N/A	N/A	108
3"	150# FLG	HB1000F-191	110	134	290	54	N/A	N/A	80
4"	150# FLG	HB1000F-201	170	72	160	29	N/A	N/A	43
1/2"	300# FLG	HB1000F-123	5	720	N/A	605	290	720	720
3/4"	300# FLG	HB1000F-133	6.5	720	N/A	605	290	720	720
1"	300# FLG	HB1000F-143	10	720	N/A	605	290	720	720
1 1/2"	300# FLG	HB1000F-163	22	720	N/A	315	150	450	450
2"	300# FLG	HB1000F-173	42	380	N/A	160	75	230	230
2 1/2"	300# FLG	HB1000F-183	70	175	380	74	N/A	N/A	108
3"	300# FLG	HB1000F-193	110	134	290	54	N/A	N/A	80
4"	300# FLG	HB1000F-203	170	72	160	29	N/A	N/A	43

* Shut-off pressure limited by flange class rating.

CONTROL VALVES

To complete Full Model Code, Must Specify: Trim, Packing, Port, Actuator, Power Supply and Control Signal Type

Example: (Spring-Fail Closed): **HB1000F-12N-ESA10**
Example: (Spring-Fail Open): **HB1000F-12N-ESB10**

Model Code Configuration Chart

HB Series; 1/2" - 4", Electrically-Actuated, 2-Way or 3-Way Valve Bodies

VALVE BODY Selection

Model	Code	Trim Style*
HB1	0	Equal Percentage (2-way)
	1	Linear (2-way)
	3	3-Way

Code	Seat Type
0	Metal Seat Stainless Steel
1	Soft Seat Teflon
	Elastomers
C.F	EPDM
C.F.	Viton

Code	Packing
0	Teflon
1	Graphite

Code	Port Type
F	Full Port
R	Reduced Port

CONNECTION

Code	Size
12	1/2"
13	3/4"
14	1"
16	1 1/2"
17	2"
18	2 1/2"
19	3"
20	4"

Code	Connection
N	NPT
1	150# FLG
3	300# FLG
6	600# FLG
B	BSP
P	PN16 FLG
Q	PN25 FLG

* Note: For 2-Way Valves Equal Percentage trim style should be used for steam service. Linear trim style should be used for water service.

EC ACTUATOR -Super Capacitor Fail-Safe

Code	Actuator
ECA	Capacitor-Fail-Closed
EC10A	
ECB	Capacitor-Fail-Open
EC10B	

Code	Power Supply
1	115 VAC
2	24 VAC/DC

Code	Control Signal
0	4-20mA
1	0-10V
2	0-20mA
3	2-10V
4	12-20mA
6	Split-range

ES ACTUATOR - Spring Fail-Safe

Code	Actuator
ESA	Spring-Fail-Closed
ESB	Spring-Fail-Open

Code	Power Supply
1	115 VAC
2	24 VAC/DC

Code	Control Signal
0	4-20mA
1	0-10V
2	0-20mA
3	2-10V

SK ACTUATOR - Spring Fail-Safe

Code	Actuator
SKD62UA	
SKB62UA	
SKC62UA	

SK Actuators are standard 24VAC with 4-20mA control signal. For 115VAC, add Power Adapter. 0-10V control signal option can be field set.

Failure Mode on SK Actuators:
2-Way Valves Fail-Closed.
3-Way Valves close-off the "A" Port.

ELECTRIC ACTUATOR OPTIONS

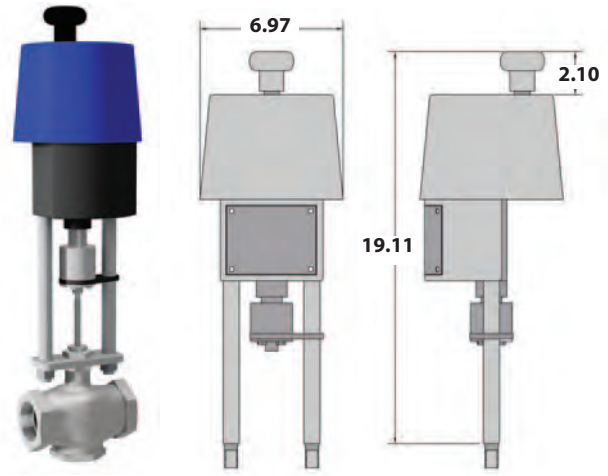
EC Series		ES Series	SK Series	
Heating Resistor for protection in cold outdoor climates	Contact Factory	None	Weather Shield Assembly Kit for outdoor use. UL Listed to meet NEMA 3R rating.	Contact Factory
Communication Kit for field adjustments, data access, etc.	EC-COMM-KIT		115 VAC Power Adapter	266010
Transformer for 230 VAC Service	Contact Factory			

E-Series Electric Actuators for 2-Way or 3-Way

EC/EC10 Electric Actuator

Uses Super Capacitors as the Fail-Safe Operator

Extrememly Fast Acting

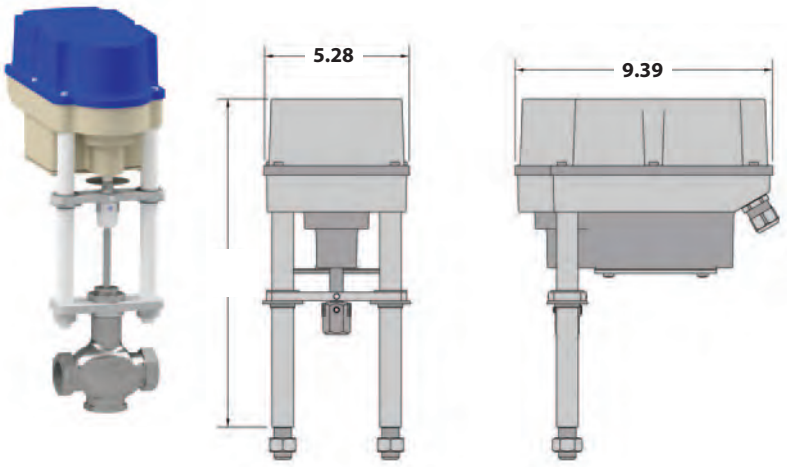


The **EC/EC10 Electric Actuator** are used for High-performance applications such as instantaneous hot water heaters.

ES Electric Actuator

Uses a Spring as the Fail-Safe Operator

Reduced Response Time & Close-Off Pressures



The **ES Electric Actuator** are used where high-speed actuation is not required.

CONTROL VALVES

Actuator Specifications	EC			EC10			ES	
Power Supply	**115VAC**	**24VAC**	**24VDC**	**115VAC**	**24VAC**	**24VDC**	**115VAC**	**24VAC**	**24VDC**
Force	1,100 lbs			2,248 lbs			448 lbs		
Velocity	0.177 in/sec			0.067 in/sec			0.012 in/sec		
Nominal 1" Travel Time	**8 sec**			**15 sec**			**60 sec**		
Nominal Current (A)	0.66	3.15	2	.84	4	2.5	0.14	.35	
Max Current (A)	0.86	4.1	2.6	1.1	5.3	3.3	0.14	.35	
Max Power Consumption	57	53	48	78	73	61	9	9	
Duty Cycle, IEC 60034-1, 8	S2 30 min S4 50% ED @ 77° F						S2 30min S4-1200c/h-50%ED		

Motor Protection	Electric motor current monitoring with safety cut-off
Set Value Feedback	0 (4)-20mA or 0 (2)-10V selectable, split range operation
Binary Control	24V for On/Off Control (1s min pulse duration)
Valve Positioner Function	Integrated positioner, deadband adjustable from 0.5 to 5%, shutoff min.
Automatic Start-up	Recognizing the end position(s) and autoscaling set and feedback values
Internal Fault Monitoring	Torque, set value, temperature, power supply, positioning deviation, etc.
Diagnostics Function EC-Series ONLY	Stores accumulated operation data (motor & total run time, number of starts) and data of current values (set value, feedback value, torque, temp, and error message
Communication Interface	USB interface with Software / enables parameter adjustments
Cable Glands	2x M20x1.5 & 1x M16x1.5

Options for EC
Transformer for 230 VAC Service
Limit Switch
Heater Element

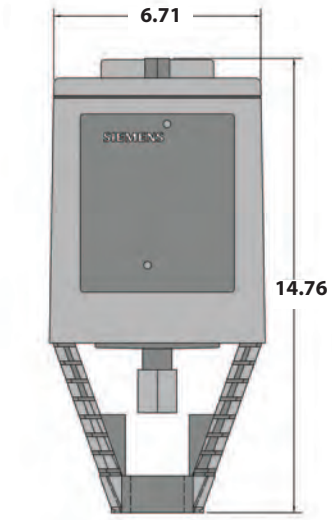
The EC Actuator can be factory set or field configurable (with COMM-KIT) as follows:

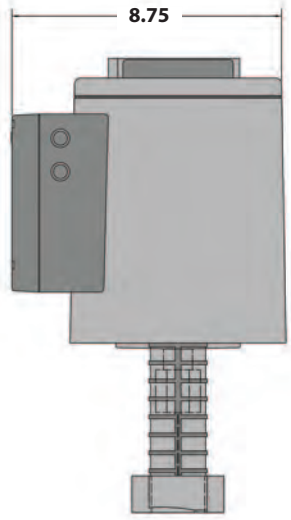
- Stroke adjustment
- Stroke velocity
- Response time
- Fail-safe direction and position
- Flow characteristic (i.e. equal %, linear, quick open)

SK-Series Electric Actuators for 2-Way or 3-Way

SKB • SKC • SKD

Electric Actuators





The **SK Series Electric Actuator**s are a robust choice for **Boiler Feed Water** applications as well as **On/Off HVAC Steam Control** applications where ***Fail-Closed is required***. For general purpose applications, where medium response times are sufficient. In the event of a signal failure, the stem of the SK Actuator retracts. Therefore the Failure Mode of a 2-Way valve is closed and a 3-Way valve will close off the "A" port.

Actuator Specifications	SKB	SKC	SKD
Power Supply	24VAC		
Force	629 lbs		224 lbs
Velocity	0.006 in/s	0.013 in/s	0.025 in/s
Nominal 1" Travel Time	120	60	30
Nominal Current (A)	.5	.84	.5
Max Current (A)	.5	.84	.5
Max Power Consumption (W)	12	20	12
Agency Certification	UL873, CE 89/336/EEC		

Option:

Power Adapter for 115 VAC Service

Actuator Selection

SKD Series

Standard for 1/2" to 2" valve bodies where a 30 second stroke time is prefereable.

SKC Series

Standard for 2½" to 4" valve bodies and also when higher shut-off pressures are required for 1/2" to 2" valve bodies.

SKB Series

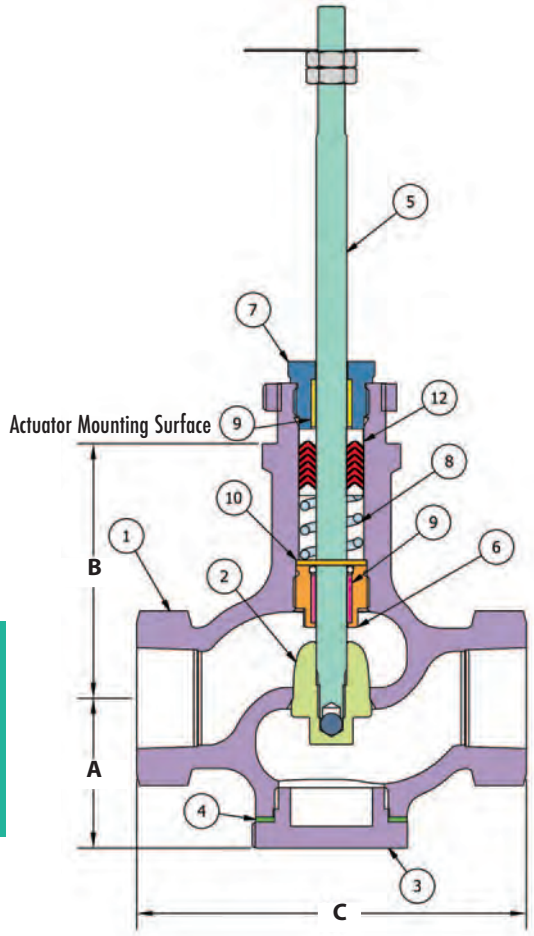
Option for higher shut-off pressure applications where increased stroke time can be tolerated.

2-Way Valves with Electric Actuators

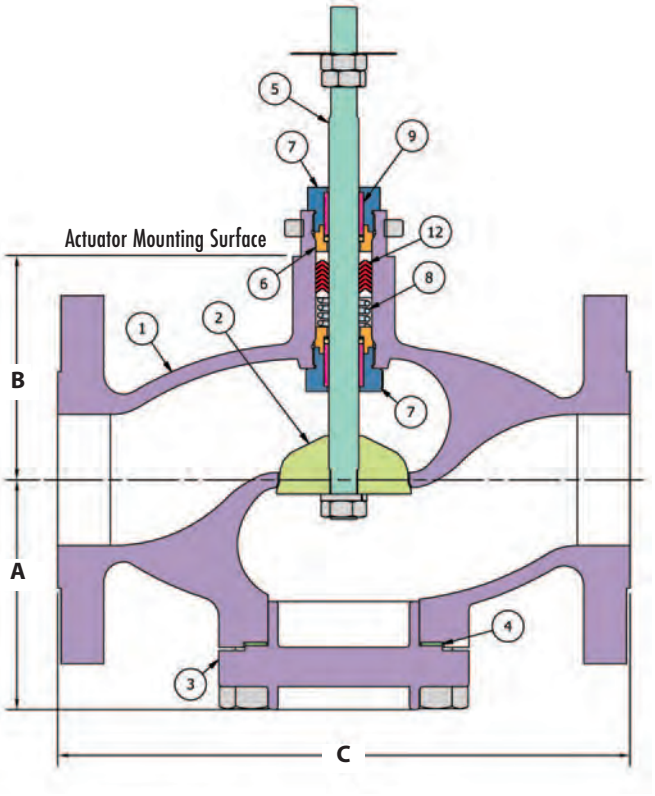
for HEATING • COOLING • FLUID TRANSFER • Steam, Air, & Water

2-Way • 1/2" – 4"

1/2" to 2" Threaded & Flanged



2½" to 4" Flanged



Item	Description	Material
1	Body	316 Stainless Steel
2	Valve Plug*	Hardened Stainless Steel
3	Body Plug	316 Stainless Steel
4	Body Gasket*	303 Stainless Steel
5	Stem*	316 Stainless Steel
6	Lower Seal Bushing	303 Stainless Steel
7	Gland Nut	303 Stainless Steel
8	Stem Seal Spring*	302 Stainless Steel
9	Guide Bushing*	Rulon 641 / PTFE
10	Washer	303 Stainless Steel
12	V-ring Stem Seals*	PTFE

* Recommended Spare Parts

Size	A	B	C NPT	C 150#	C 300#	Weight (lbs) NPT	Weight (lbs) 150#	Weight (lbs) 300#
1/2"	1.76	2.95	4.50	7.25	7.75	3.5	6	7
3/4"	1.76	2.95	4.50	7.25	7.75	3.5	7	9
1"	1.74	2.95	4.50	7.25	7.75	5.5	10	13
1½"	2.15	2.95	5.00	8.75	9.25	6.8	14	19
2"	2.31	2.95	6.00	10	10.5	10	21	25
2½"	4.38	4.25	-	10.88	11.5	-	41	46
3"	5.56	4.25	-	11.75	12.5	-	65	74
4"	6.19	4.25	-	13.88	14.5	-	92	112

Insulation Blankets; Contact Factory

Note: Insulation blankets are recommended for electrically actuated valves when steam supply pressure exceeds 55 PSIG or fluid temperature 300 ° F and above.

MAXIMUM FLOW COEFFICIENT (C_V)

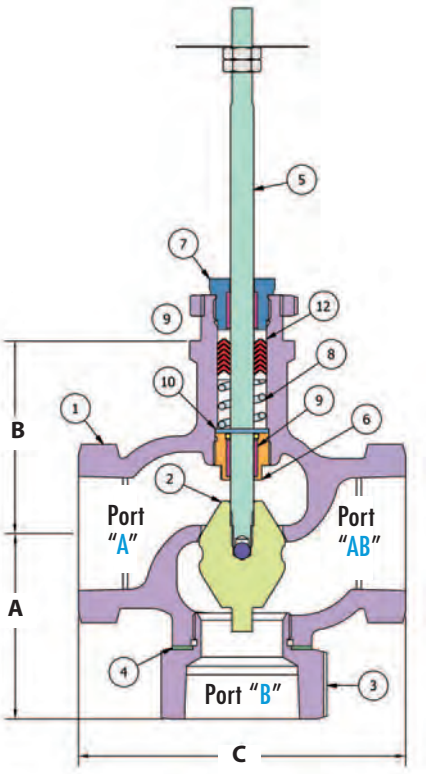
Valve Body Size	1/2" (Reduced Port)	1/2"	3/4"	1"	1½"	2"	2½"	3"	4"
	3.5	5	6.5	10	22	42	70	110	170

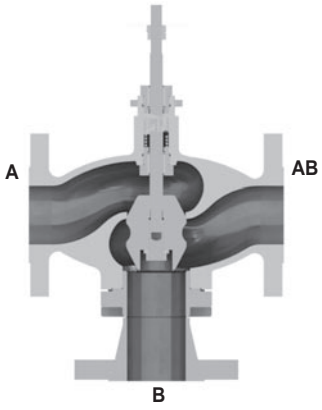
for MIXING & DIVERTING • Liquid ONLY (NO STEAM)

3-Way • 1/2 – 4"

3-Way for Mixing or Diverting

1/2" to 2"
Threaded & Flanged

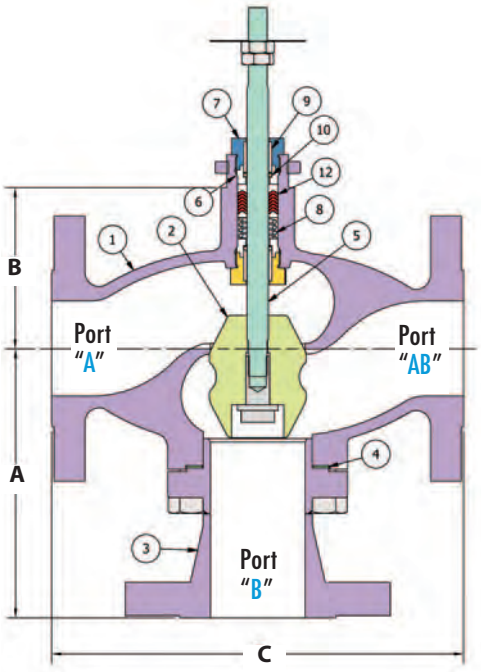




Mixing:
Ports "A" and "B" are Inlets
Port "AB" is Outlet

Diverting:
Port "AB" is Inlet
Ports "A" and "B" are Outlets

2 1/2" to 4"
Flanged



Item	Description	Material
1	Body	316 Stainless Steel
2	Valve Plug*	Hardened Stainless Steel
4	Body Gasket*	303 Stainless Steel
5	Stem*	316 Stainless Steel
6	Lower Seal Bushing	303 Stainless Steel
7	Gland Nut	303 Stainless Steel
8	Stem Seal Spring*	302 Stainless Steel
9	Guide Bushing*	Rulon 641 / PTFE
10	Washer	303 Stainless Steel
12	V-ring Stem Seals*	PTFE

* Recommended Spare Parts

Size	A NPT	B	A 150	A 300	C NPT	C 150#	C 300#	Weight (lbs) NPT	Weight (lbs) 150#	Weight (lbs) 300#
1/2"	2.31	2.95	4	4	4.50	7.25	7.75	4	8.5	9
3/4"	2.31	2.95	4	4	4.50	7.25	7.75	4	8.5	9
1"	2.31	2.95	4	4	4.50	7.25	7.75	5.5	12	13.5
1 1/2"	2.84	2.95	4.3	4.3	5.00	8.75	9.25	7	18.5	22
2"	3.19	2.95	5	5	6.00	10	10.5	11	26	35
2 1/2"	-	4.25	7.13	7.38	-	10.88	11.5	-	50	58
3"	-	4.25	8.32	8.5	-	11.75	12.5	-	74	88
4"	-	4.25	9.19	9.5	-	13.88	14.5	-	106	136

Insulation Blankets; Contact Factory

Note: Insulation blankets are recommended for electrically-actuated valves when fluid temperature 300 ° F and above.

MAXIMUM FLOW COEFFICIENT (C_V)

Valve Body Size	1/2" (Reduced Port)	1/2"	3/4"	1"	1 1/2"	2"	2 1/2"	3"	4"
	3.5	5	6.5	10	22	42	70	110	170

CONTROL VALVES

STEAM

CAPACITIES – Steam (lbs/hr)

Inlet Pressure (PSIG)	Outlet Pressure (PSIG)	ΔP PSI	Reduced Port 1/2"	1/2"	3/4"	1"	1 1/2"	2"	2 1/2"	3"	4"
	C_V Factors		3.5	5.0	6.5	10	22	42	70	110	170
	Orifice Size (in)		0.88	0.88	0.88	0.88	1.25	1.75	2.5	2.88	3.88
5	4	1	48	68	89	136	300	573	955	1501	2320
	0	5	96	137	178	274	602	1149	1915	3009	4650
	-4	9	114	162	211	325	714	1363	2272	3570	5518
	-8	13	119	170	220	339	746	1424	2374	3730	5765
10	9	1	53	76	99	153	336	641	1068	1678	2593
	5	5	110	156	203	313	689	1315	2191	3443	5321
	0	10	138	197	255	393	865	1651	2751	4324	6682
	-7	17	148	211	274	422	929	1773	2955	4643	7176
15	10	5	122	174	226	348	765	1460	2433	3824	5909
	5	10	156	223	290	447	983	1876	3127	4913	7593
	0	15	172	246	320	492	1082	2066	3444	5412	8364
	-5	20	177	252	328	505	1110	2119	3532	5550	8578
20	15	5	133	189	246	379	833	1591	2652	4167	6440
	10	10	173	247	321	494	1088	2076	3460	5438	8404
	5	15	194	277	361	555	1221	2330	3883	6103	9431
	-3	23	205	293	381	587	1291	2464	4106	6453	9972
30	25	5	152	217	282	434	955	1822	3037	4773	7377
	15	15	232	331	431	663	1459	2785	4641	7293	11271
	5	25	260	371	482	742	1631	3115	5191	8157	12606
	0	30	262	375	487	750	1649	3149	5248	8247	12745
50	40	10	250	357	464	714	1570	2997	4995	7850	12132
	30	20	324	463	601	925	2035	3886	6476	10177	15728
	15	35	370	529	687	1057	2326	4440	7399	11628	17970
	7	43	376	537	697	1073	2361	4507	7511	11804	18242
80	70	10	307	438	570	877	1929	3682	6136	9643	14903
	50	30	472	675	877	1350	2970	5670	9450	14850	22950
	30	50	534	763	992	1525	3356	6407	10678	16780	25932
	17	63	544	777	1010	1554	3418	6526	10876	17091	26413
100	85	15	406	580	754	1160	2552	4872	8121	12761	19722
	60	40	586	837	1089	1675	3684	7034	11723	18422	28470
	40	60	643	918	1193	1836	4039	7710	12851	20194	31209
	23	77	655	936	1217	1872	4119	7864	13107	20596	31831
125	110	15	452	645	839	1290	2838	5418	9030	14190	21930
	85	40	668	954	1240	1908	4199	8015	13359	20993	32443
	50	75	782	1117	1452	2233	4913	9380	15634	24567	37968
	31	94	794	1135	1475	2270	4993	9532	15887	24965	38582
150	130	20	560	800	1040	1600	3519	6718	11197	17595	27192
	100	50	800	1143	1485	2285	5027	9598	15996	25137	38847
	70	80	904	1291	1678	2582	5680	10844	18074	28402	43893
	40	110	933	1333	1733	2666	5865	11196	18661	29324	45319
175	150	25	666	952	1237	1903	4187	7994	13323	20936	32356
	115	60	931	1329	1728	2659	5850	11167	18612	29248	45201
	75	100	1052	1503	1953	3005	6612	12622	21037	33058	51089
	48	127	1072	1531	1990	3062	6736	12859	21432	33679	52049
200	175	25	713	1018	1324	2037	4481	8554	14257	22404	34625
	130	70	1061	1515	1970	3031	6668	12730	21216	33340	51425
	90	110	1183	1690	2196	3379	7434	14192	23654	37170	57444
	56	144	1210	1729	2247	3457	7606	14521	24202	38031	58775
250	225	25	798	1140	1482	2281	5017	9578	15964	25086	38770
	170	80	1273	1819	2364	3637	8002	15276	25259	40008	61830
	120	130	1443	2062	2680	4124	9072	17319	28865	45359	70100
	73	177	1487	2125	2762	4249	9348	17846	29744	46740	72235
300	270	30	951	1359	1766	2718	5979	11414	19023	29894	46199
	200	100	1535	2193	2850	4385	9648	18418	30697	48238	74549
	140	160	1723	2461	3199	4922	10828	20672	34454	54142	83674
	89	211	1765	2521	3277	5042	11093	21177	35296	55465	85718

Note: The Steam Capacity Chart is based on ISA Standard 75.01.01-2007 (60534-2-1 Mod). It assumes pipe sizes equal to the size of the valve ports, with no attached fittings.

CONTROL VALVES

Sizing & Capacity Chart

WATER

CAPACITIES – Water (GPM)											
Inlet Pressure (PSIG)	Outlet Pressure (PSIG)	ΔP PSI	Reduced Port 1/2"	1/2"	3/4"	1"	1 1/2"	2"	2 1/2"	3"	4"
		C_V Factors	3.5	5.0	6.5	10	22	42	70	110	170
		Orifice Size (in)	0.88	0.88	0.88	0.88	1.25	1.75	2.5	2.88	3.88
5	4	1	3.5	5.0	6.5	10	22	42	70	110	170
	0	5	7.8	11	15	22	49	94	157	246	380
10	7	3	6.1	8.7	11	17	38	73	121	191	294
	5	5	7.8	11	15	22	49	94	198	311	481
	0	10	11	16	21	32	70	133	251	246	380
15	10	5	7.8	11	15	22	49	94	157	246	380
	5	10	11	16	21	32	70	133	221	348	538
	0	15	14	20	26	39	86	165	275	432	668
30	25	5	7.8	11	15	22	49	94	157	246	380
	15	15	14	19	25	39	85	163	271	426	658
	7	23	17	24	31	48	106	203	338	531	821
50	40	10	11	16	21	32	70	133	221	348	528
	30	20	16	22	29	45	98	188	313	492	760
	16	34	20	29	38	58	128	244	407	640	898
80	70	10	11	16	21	32	70	133	221	348	538
	50	30	19	27	36	55	120	230	383	602	931
	30	50	25	35	46	70	155	296	493	775	1198
100	85	15	14	19	25	39	85	163	271	426	658
	65	35	21	30	38	59	130	248	414	651	1006
	40	60	27	39	50	78	171	326	543	853	1319
125	110	15	14	19	25	39	85	163	271	426	658
	85	40	22	32	41	63	139	266	443	696	1075
	52	73	30	43	56	86	188	360	600	492	760
150	130	20	16	22	29	45	98	188	313	492	760
	100	50	25	35	46	71	156	297	495	778	1202
	63	87	33	47	60	93	205	391	651	1023	1581
200	175	25	18	25	33	50	110	210	350	550	850
	130	70	29	42	54	84	184	351	586	920	1422
	87	113	37	53	69	106	234	446	744	1169	1806
250	225	25	18	25	33	50	110	210	350	550	850
	170	80	31	45	58	89	197	376	626	984	1521
	111	139	41	59	77	118	260	495	826	1298	2006
300	270	30	19	27	36	55	120	230	383	602	931
	200	100	35	50	65	100	220	420	700	1100	1700
	134	166	45	64	84	129	283	540	901	1415	2187

Notes: 1) Capacities based on 70°F water (SG = 1.00).
2) Capacities based on 100% of Cv.
3) Maximum capacities are based on pressure drop at constant cavitation at 70°F.
4) Cavitation adapters available to prevent cavitation.

HB Series Mixing & Diverting (3-Way Valves)

CAPACITIES – Water (GPM) **3-WAY VALVES**

Inlet pressures should be within 5% of each other. Specify if service is for other than water.

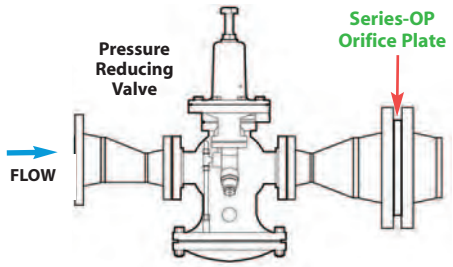
Pressure Drop (PSI△P)	Size, Body Number & Coefficient (Cv) 1/2" Cv = 5	3/4" Cv = 6.5	1" Cv = 10	1 1/2" Cv = 22	2" Cv = 42	2 1/2" Cv = 70	3" Cv = 110	4" Cv = 170
1	5	6.5	10	22	42	70	110	170
3	8.7	11.3	17.3	38	73	121	191	294
5	11.2	15	22	49	94	157	246	380
10	15.8	21	32	70	133	221	348	538
15	19	25	39	85	163	271	426	658
20	22	29	45	98	188	313	492	760
25	25	33	50	110	210	350	550	850
30	27	36	55	120	230	383	602	931
40	32	41	63	139	266	443	696	1075
50	35	46	71	156	297	495	778	1202
60	39	50	77	170	325	542	852	1317
70	42	54	84	184	351	586	920	1422
80	45	58	89	197	376	626	984	1521
90	47	62	95	209	398	664	1044	1613
100	50	65	100	220	420	700	1100	1700
125	56	73	112	246	470	783	1230	1901
150	61	80	122	269	514	857	1347	2082
175	66	86	132	291	556	926	1455	2249
200	71	92	141	311	594	990	1556	2404
225	75	98	150	330	630	1050	1650	2550
250	79	103	158	348	664	1107	1739	2688

Notes: 1) Capacities based on 70°F water (SG = 1.00).
2) Capacities based on 100% of Cv.
3) Maximum capacities are based on pressure drop at constant cavitation at 70°F.
4) Cavitation adapters available to prevent cavitation.

Orifice Plates

Noise Reduction Capability: 5-10+ dBA

The **Series OP** Orifice Plate with its drilled orifice pattern is installed after the pressure regulating valve to smooth out turbulence caused by the pressure drop across the regulator. Typical noise reduction levels of 5-10 dBA; higher possible. Manufactured from SA-105 Carbon Steel, 304 SST, or 316 SST.



Helpful Selection Information

All Orifice Plates are custom designed to optimize noise attenuation and control. They are sized in conjunction with PRVs. Therefore, the following information is required for proper selection: Steam Inlet Pressure to PRV, Reduced Outlet Pressure, and Load/Capacity (lb/hr).

X = Material	## = Number of Holes	0.000 = Diameter of Holes
1 = A105 CS	Factory Determined	Factory Determined
2 = 304 SST*		
3 = 316 SST*		

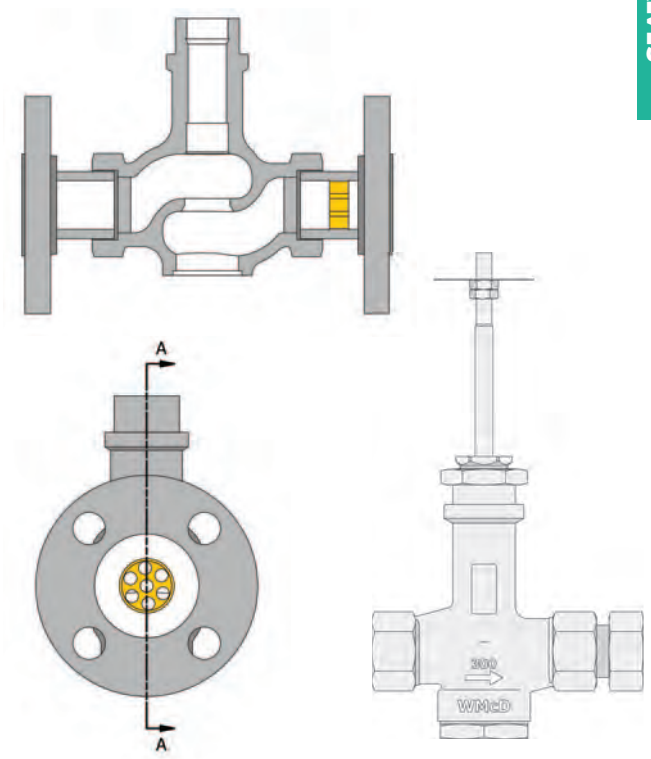
Notes: 1) Other sizes and flange connections available; Consult Factory.
2) Orifice Plates may be available for other valves; Consult Factory.
* Consult Factory for SST pricing.

Cavitation Adapters

Cavitation is a condition found in liquid flow through a control valve. The two stage process occurs during the rapid formation and collapse of vapor cavities or bubbles. When the flow through the valve orifice causes a pressure drop below the liquid vapor pressure the cavities form. When the pressure in the valve recovers above the liquid vapor pressure, the vapor bubbles collapse and the energy from the implosion can cause premature wear on the valve near the plug and seat. Cavitation can cause noise, vibration, and damage to control valves.

Valve Size	Valve Cv	Adapter Cv	Combo Cv	Adapter* Part No.	Overall Length
1/2 R	3.5	3.6	2.7	CA121	5.5
		2.4	2.2	CA122	
		1.6	1.9	CA123	
1/2	5	3.6	3.2	CA121	5.5
		2.4	2.8	CA122	
		1.6	2.5	CA123	
3/4	6.5	7.6	5.3	CA131	5.5
		5.5	4.5	CA132	
		13.1	3.9	CA133	
1	10	13.1	8.6	CA141	5.6
		9.5	7.3	CA142	
		7.0	6.4	CA143	
1 1/2	22	30.4	19.6	CA161	6
		18.9	15.3	CA162	
		12.0	12.7	CA163	
2	42	52.3	35.3	CA171	7.1
		38.7	30.3	CA172	
		28.1	26.3	CA173	

Note: Cavitation Adapters available for valve sizes 2 1/2" -4"; Consult factory.
* Specify end connection: NPT, 150# or 300# FLG.

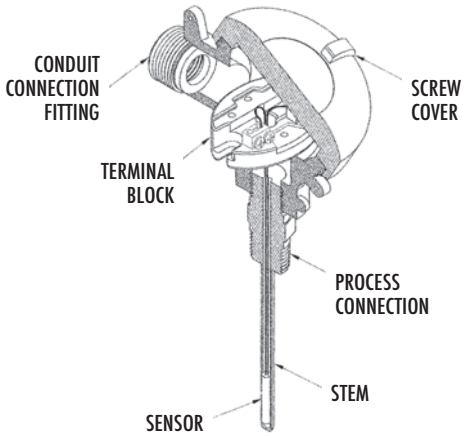


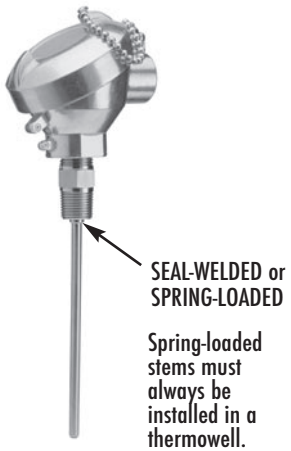
CONTROL VALVES

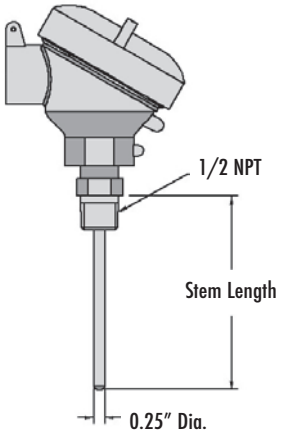
Understanding a Control Loop

Sensor for Temperature Control (Thermocouple or RTD)

Electronic Temperature Sensors are available with both Type J and Type K Thermocouples, as well as RTD sensors. A thermocouple (T/C) is made from two dissimilar metals that generate electrical voltage directly with changes in temperature. An RTD (Resistance Temperature Detector) is a variable resistor that will change its electrical resistance in direct proportion to changes in temperature in a precise, repeatable and nearly linear manner. The weatherproof head provides a conduit connection and can be used to house a transmitter (optional). The stem is either welded directly to the 1/2" NPT threaded connection, or is spring-loaded.







CONTROL VALVES

Stem (Sheath)

All Thermocouples and RTDs are furnished with a 316 stainless steel stem, with the internal wiring packed in powdered ceramic. The screw head cover style is available in two stem types: welded and spring loaded. The welded stem is suitable for use in liquid applications. The spring-loaded stem is designed to bottom out inside a thermowell, providing maximum heat sensitivity. Spring-loaded stems are not pressure tight and may allow process media to escape; therefore, they must always be installed in a thermowell.

The insertion length (U) of a thermocouple or RTD represents its depth into the process vessel or thermowell. Thermocouples and RTDs are available in standard U-lengths from 2" to 24". Other lengths are available upon special order; consult factory.

TR890
Series Controller

The user-interface which allows adjustment of the set point and controls the electrical signals received from the sensor and outputted to the I/P Transducer. The TR893 is the most common controller model due to its larger, more user-friendly size.

NANODAC
Series Controller

The NANODAC Series is a PID Controller with added features such as data recording and Modbus Communication. (BACnet is optional.) Standard features include (4) universal analog inputs, (2) 4-20mA outputs, (3) mechanical 2A relays, and 110-230VAC power supply. 24VAC/DC and other options available; Consult factory.

TA901
Electropneumatic (I/P) Transducer

An electro-pneumatic transducer that converts an electrical signal (4-20 mA) from the Controller to an air signal (3-15 PSI) for supply to the top of the actuator of the control valve.

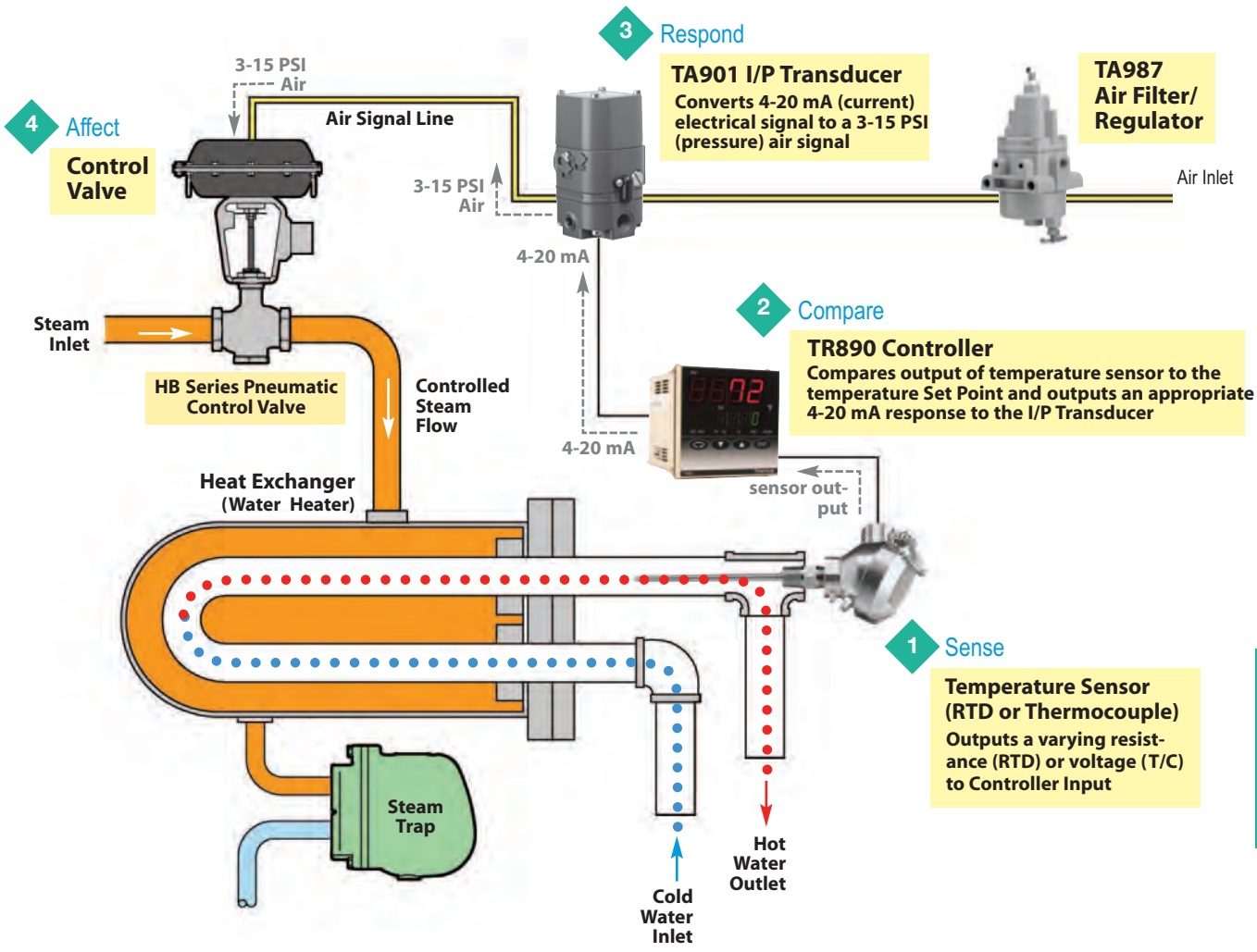
TA987
Air Filter/Regulator

This device is recommended for filtering and regulating the pressure of plant compressed air to the inlet of the I/P Transducer, which ensures the delivery of clean, dry air at the proper pressure to the pneumatic actuator.

Introduction

Understanding a Control Loop

Heat Exchanger (Instantaneous Water Heater)



Control Loop

A control loop is a process management system designed to maintain a process variable at a desired set point. Each step in the loop works in conjunction with the others to manage the system. Once the set point has been established, the control loop operates using a four-step process.

1 Sense
Measure the current condition of the process using a sensor, which can be a thermocouple or RTD transmitter.

2 Compare
Evaluate the measurement of the current condition against the set point using an electronic PID controller.

3 Respond
Reacts to any error that may exist between the measured temperature value and the temperature set point by generating a corrective pneumatic signal.

4 Affect
Actuate the control valve that will produce a change in the process variable.

The loop continually cycles through the steps, affecting the process variable (water temperature) in order to maintain the desired temperature set point.

Design and Operation of an Electronic PID Controller

Description

A controller is a comparative device that receives an input signal from a measured process variable, compares this value with that of a predetermined control point value (set point), and determines the appropriate amount of output signal required by the final control element to provide corrective action within a control loop.

Principle of Operation (Electronic PID Controller)

An electronic sensor (thermocouple, RTD or transmitter) installed at the measurement location continuously sends an input signal to the controller. At set intervals, the controller compares this signal to a predefined set point. If the input signal deviates from the set point, the controller sends a corrective electric output signal to the control element. This electric signal must be converted to a pneumatic signal when used with an air operated valve, such as a Watson McDaniel HB Series Control Valve. The conversion can be made using a Watson McDaniel TA901 I/P Transducer, which converts a 4 to 20 mA electric signal to a 3 to 15 PSI air signal. As an option, a Valve Positioner such as the Watson McDaniel CE100 may be used to send an air signal to the Control Valve. These Positioners can be controlled with a 3-15 psi air signal from a Pneumatic Controller or a 4-20 mA signal from a PID Controller.

Features (Electronic PID Controller)

Watson McDaniel Electronic Controllers have full auto-tuning and PID capabilities, and offer a host of available options, including user selectable inputs, outputs and ranges.

PID Control is a feature of Watson McDaniel TR890 & Nanodac Electronic Controllers. PID combines the proportional, integral and derivative functions into a single unit.

- **Proportional (P)** — Proportional control reacts to the size of the deviation from set point when sending a corrective signal. The size of the corrective signal can be adjusted in relation to the size of the error by changing the width of the proportional band. A narrow proportional band will cause a large corrective action in relation to a given amount of error, while a wider proportional band will a cause smaller corrective action in relation to the same amount of error.

- **Integral (I)** — Integral control reacts to the length of time that the deviation from set point exists when sending a corrective signal. The longer the error exists, the greater the corrective signal.

- **Derivative (D)** — Derivative control reacts to the speed in which the deviation is changing. The corrective signal will be proportional to the rate of change within the process.

Auto-Tuning will automatically select the optimum values for **P**, **I** and **D**, thus eliminating the need for the user to calculate and program these values at system startup. This feature can be overridden when so desired. On some models, the control element can be manually operated.

Introduction

Design and Operation of an Electronic PID Controller

Selecting an Electronic PID Controller

When selecting a PID controller, the following parameters must be specified. (Refer to the TR890 Series Electronic PID Controller Specifications and Model Coding chart on the following two pages.)

1) Model (Case Size)

The Case Size selection is determined by both available and designed space, and controller features. Watson McDaniel Electronic Controllers are available in the following panel sizes:

TR891: 48 x 48 mm (1/16 DIN)
TR892: 72 x 72 mm
TR893: 96 x 96 mm (1/4 DIN)
TR894: 96 (H) x 48 (W) mm (1/8 DIN)
NANODAC: 96 x 96mm (1/4 DIN)

2) Input

The Input is the measurement signal received by the controller from the sensor. One of the following three input types can be specified for the controller: 8: Universal, 4: Current or 6: Voltage. The Universal input type is switchable between Thermocouple, RTD and mV input signals.

If temperature will be measured with a thermocouple or RTD sensor, the Universal input type must be selected for the controller (Model Code Position 2 = 8). If another process variable such as PRESSURE is being measured, verify the type of output signal from that sensor. If it's 4-20 mA or 0-10 Volts then the Current or Voltage input option would be chosen, respectively.

3) Control Output

The Control Output is the corrective signal transmitted from the controller to the control device. One of the following four control output types can be specified for the controller: I: 4-20 mA DC, Y: On/Off Contact, P: Solid State Relay (SSR) Driver or V: 0-10 VDC.

The most common control devices are the TA901 Electro-pneumatic (I/P) Transducer and CE100-Series Valve Positioner with built-in I/P transducer, both of which accept a 4-20 mA signal. For these devices, the 4-20 mA control output type must be selected for the controller (Model Code Position 3 = I). The TA901 or CE1 00-Series output an air signal to the actuator of the Control Valve, which is the final control element of the feedback loop.

The On/Off Contact and SSR Driver control output types are typically used to switch on AC power to a load. If the SSR Driver control output is selected, an external solid state relay (SSR) is required and can be used for activating electrical equipment with larger current requirements.

4) Power Supply

The power supply requirement for the electronic controller must be specified. The available choices are: 100-240 VAC, 50/60 Hz or 24 V AC/DC, 50/60Hz.

5) Event Output (Option)

The Event Output is used to signal an external device when an alarm condition is detected. Various alarm types can be detected by the controller. These include deviation of the measured value from the set value, the measured value exceeding absolute limits (i.e., high and low level alarm) and heater break/loop alarm (i.e., heater current outside of normal limits). If selected as an option, the controller will have two Event Outputs. In the case of a high/low alarm, one output is used for the high level alarm and the other for the low level alarm.

6) Options: Analog Output & Digital Input

The Analog Output is an optional secondary signal that transmits either the measured process value (PV), the target set value (SV) or the Control Output value from the controller to a remote data acquisition device, such as a recorder, personal computer or display unit. One of the following three analog output types can be specified for the controller: 0-10 mV DC, 4-20 mA DC or 0-10 V DC. The analog output type is independent of the measured input type or the control output type. However, the analog output type selection must be compatible with the data acquisition device input.

The Digital Input is an optional input that can be specified for the controller. The digital input functions as an On/Off switch and can be programmed to activate the Set Value Bias or Standby mode, or switch the Control Action type (i.e., to Reverse Acting or Direct Acting).

Note: The Analog Output and Digital Input combination is not available for Model TR891. Only one of these options can be selected for this model.

TR890 Series

Features PID & Auto-tuning

- **Multiple Sizes**
- **± 0.3% Accuracy**
- **Keyboard Programmable**
- **Reverse or Direct Acting**
- **Manual Output Override**

The **TR890 Series** Electronic PID Controller is designed for use on applications where large load changes are expected, or extreme accuracy and fast response times are needed. With full auto-tune capabilities and a large selection of available inputs, the TR890 Series is ideally suited for use with a Watson McDaniel Control Valve.

Use of a Watson McDaniel No. TA987 Air Filter/Regulator is recommended for filtering and regulating the pressure of plant compressed air, and for delivering clean, dry air at the proper pressure to pneumatic control devices.

Approximate Shipping Weights:
TR891: 0.4 lbs [0.17 kg]
TR892: 0.6 lbs [0.28 kg]
TR893: 0.7 lbs [0.33 kg]
TR894: 0.5 lbs [0.24 kg]

Specifications

Models	**TR891:** 48 x 48 mm (1/16 DIN) **TR892:** 72 x 72 mm **TR893:** 96 x 96 mm (1/4 DIN) **TR894:** 96 x 48 mm (1/8 DIN)
Control	**Control Mode:** Auto-Tuning PID **Action:** Reverse acting (field switchable to direct acting)
Proportional Band	Off, 0.1-999.9% Full Scale Integral Time: Off, 1-6000 sec. Derivative Time: Off, 1-3600 sec.
Accuracy	± 0.3%
Display	Process Value: 4 Digit, 20 mm red LED Set Value: 4 digit, 10.2 mm green LED Sampling Cycle: 0.25 seconds
Inputs	**Universal:** (switchable between) ▶ Thermocouple: B, R, S, K, E, J, T, N, PL II, WRe5-26 (U,L (DIN 43710) ▶ RTD: Platinum 100 Ω, 3-Wire ▶ mV: (scalable) -10–10, 0-10, 0-20, 0-50, 10-50, 0-100 mV DC **Current:** (scalable) 4-20, 0-20 mA **Voltage:** -1–1, 0-1, 0-2, 0-5, 1-5, 0-10 VDC
Control Output	**Current:** 4-20 mA (load resistance: 600 Ω maximum) **Contact:** Proportional cycle, 1-120 sec. (capacity: 240 VAC 2 A resistive / 1.2 A inductive) **SSR Drive Voltage:** Proportional cycle 1-120 sec. (output rating: 12 ± 1.5 VDC / 30 mA maximum) **Voltage:** 0-10 VDC Load Current 2 mA max
Power Requirements	**Supply Voltage:** 100-240 VAC, 50/60 Hz **or** 24 VAC/VDC 50/60 Hz **Consumption:** 100-240 VAC, 15VA 24 VDC, 8W 24 VAC, 9VA
Data Storage	Nonvolatile EEPROM memory
Case Material	Polyphenylene Oxide (PPO)
Ambient Temp.	14°F (-10°C) to 122°F (50°C)
Humidity	Maximum: 90% RH, non-condensing

Event Outputs
(Contact Capacity: 240 VAC, 1 A/resistive load)
Dual Event Outputs (High and/or Low Alarms)
Single Event Output + Heater Break Alarm (includes CT30A sensor)
Single Event Output + Heater Break Alarm (includes CT50A sensor)

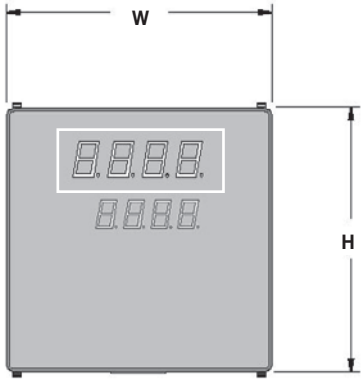
Options:
Analog Output: 0-10 mV DC (output resistance 10 Ω)
Analog Output: 4-20 mA DC (load resistance 300 Ω max)
Analog Output: 0-10 VDC (load current 2 mA max)

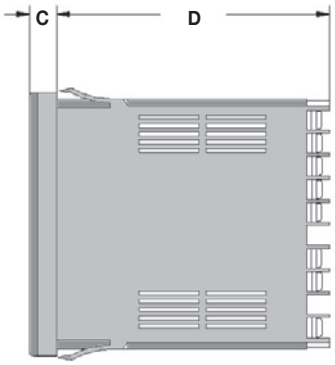
Digital Input (switch) including:
Set Value Bias setting range of -1999 - 5000, standby or DA/RA Selection
Operated by either non-voltage contact or open collector
input rated at approx. 5V DC/1mA max.

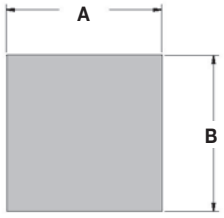
CONTROL VALVES

TR890 Series

Features PID & Auto-tuning







PANEL CUTOUT DIMENSIONS

HOW TO ORDER (Model Coding)

Sample Order Number: **TR893 8 I 90 1 00**

1	2	3	4	5	6
Model	Input	Control Output	Power Supply	Event Output	Options
TR891 **TR892** **TR893** **TR894**	**8** Universal **4** mA **6** VDC	**I** 4-20 mA **Y** On/Off Contact **P** SSR Driver **V** 0-10 VDC	**90** 100-240 VAC, 50/60 Hz **08** 24 VAC/VDC, 50/60 Hz	**0** None **1** Dual Event (high and/or low) **2** Single Event (high or low) and heater break CT30A **3** Single Event (high or low) and heater break CT50A Event Outputs 2 or 3 require Control Outputs Y or P	**00** None **30** Analog Output (0-10 mVDC) **40** Analog Output (4-20 mA) **60** Analog Output (0-10 VDC) **08** Digital Input (switch) **38** Digital Input (switch) with 0-10 mVDC* Analog Output **48** Digital Input (switch) with 4-20 mA* Analog Output **68** Digital Input (switch) with 0-10 VDC* Analog Output

**Not available with Model TR891*

CONTROL VALVES

Electronic PID Controller Dimensions – units: inches [mm]

Model	A	B	C	D	H	W
TR891	1.77 [45]	1.77 [45]	0.43 [11]	3.94 [100]	1.89 [48]	1.89 [48]
TR892	2.68 [68]	2.68 [68]	0.43 [11]	3.94 [100]	2.83 [72]	2.83 [72]
TR893	3.63 [92]	3.63 [92]	0.43 [11]	3.94 [100]	3.78 [96]	3.78 [96]
TR894	1.77 [45]	3.63 [92]	0.43 [11]	3.94 [100]	3.78 [96]	1.89 [48]

Programmable Ranges

Thermocouple Inputs					RTD Inputs				Current & Voltage Inputs	
T/C Type	Range Code	Fahrenheit Range	Range Code	Celsius Range	Range Code	Fahrenheit Range	Range Code	Celsius Range	Range Code	Range (User-scalable Readout)
B*	**15**	0° to 3300°F	**01**	0° to 1800°C	**47**	-300° to 1100°F	**31**	-200° to 600°C	**71**	-10–10 mV
E	**21**	0° to 1300°F	**07**	0° to 700°C	**48**	-150.0° to 200.0°F	**32**	-100.0° to 100.0°C	**72**	0-10 mV
J	**22**	0° to 1100°F	**08**	0° to 600°C	**49**	-150° to 600°F	**33**	-100.0° to 300.0°C	**73**	0-20 mV
K	**18**	-150° to 750°F	**04**	-100.0° to 400.0°C	**50**	-50.0° to 120.0°F	**34**	-50.0° to 50.0°C	**74**	0-50 mV
K	**19**	0° to 1500°F	**05**	0° to 800°C	**51**	0.0° to 120.0°F	**35**	0.0° to 50.0°C	**75**	10-50 mV
K	**20**	0° to 2200°F	**06**	0° to 1200°C	**52**	0.0° to 200.0°F	**36**	0.0° to 100.0°C	**76**	0-100 mV
L	**28**	0° to 1100°F	**14**	0° to 600°C	**53**	0.0° to 400.0°F	**37**	0.0° to 200.0°C	**81**	-1–1 V
N	**24**	0° to 2300°F	**10**	0° to 1300°C	**54**	0° to 1000°F	**38**	0.0° to 500.0°C	**82**	0-1 V
PL II	**25**	0° to 2300°F	**11**	0° to 1300°C					**83**	0-2 V
R	**16**	0° to 3100°F	**02**	0° to 1700°C					**84**	0-5 V
S	**17**	0° to 3100°F	**03**	0° to 1700°C					**85**	1-5 V
T	**23**	-300° to 400°F	**09**	-199.9° to 200.0°C					**86**	0-10 V
U	**24**	-300° to 400°F	**13**	-199.9° to 200°C					**94**	0-20 mA
WRe5-26	**26**	0° to 4200°F	**12**	0° to 2300°C					**95**	4-20 mA

Range Codes are not required for ordering, but are used for field programming.
**750°F (400°C) falls below the accuracy range*

NANODAC Series

Features PID & Data-Recording

The **NANODAC Series** is a PID Controller with added features such as data recording and Modbus Communication (BACnet is optional).

Standard features include (4) universal analog inputs, (2) 4-20mA outputs, (3) mechanical 2A relays, and 100-230VAC power supply. 24VAC/DC and other options available; Consult factory.

- **3.5" TFT Color Display**
- **PID Control with Data Recording**
- **Modbus or BACnet Communication Protocol**
- **4 High-Accuracy Inputs**
- **Compact 1/4 DIN Panel Mount**

CONTROL VALVES

Specifications

Panel mounting		**1/4 DIN**
Weight:	**Instrument Only:**	0.97 lbs (0.44 kg)
Panel cutout dimension:		92 mm x 92 mm (both -0.0 +0.08 in) or 3.62 in x 3.62 in (both -0.0 +0.03 in)
Depth behind panel:		90 mm (3.54) excluding wiring
Ambient Temperature:		
	Operating:	14°F (-10°C) to 122°F (50°C)
	Storage:	-4 to 158°F (-20 to +70°C)
Humidity Range	**Operating:**	5% to 85% RH non
Condensing	**Storage:**	5% to 85% RH non
Condensing Protection:		Front panel: IP65
Front panel washdown:		IP66, NEMA 12 (International)
Behind panel :		IP10 (International)
Shock / Vibration: T		o BS EN61131-2 (5 to 150 Hz. at 1g; 1 octave per min)
Altitude:		<6500 ft. (<2000 meters)
Atmosphere:		Not suitable for use in explosive or corrosive atmospheres
Electrical safety:		BS EN61010-1 (Installation category II; Pollution degree 2)
Electromagnetic compatibility Emissions:		
	(Standard units):	BS EN61326 Class B - Light Industrial
	(Low voltage option):	BS EN61326 Class A -Heavy Industrial
Immunity:		BS EN61326 Industrial

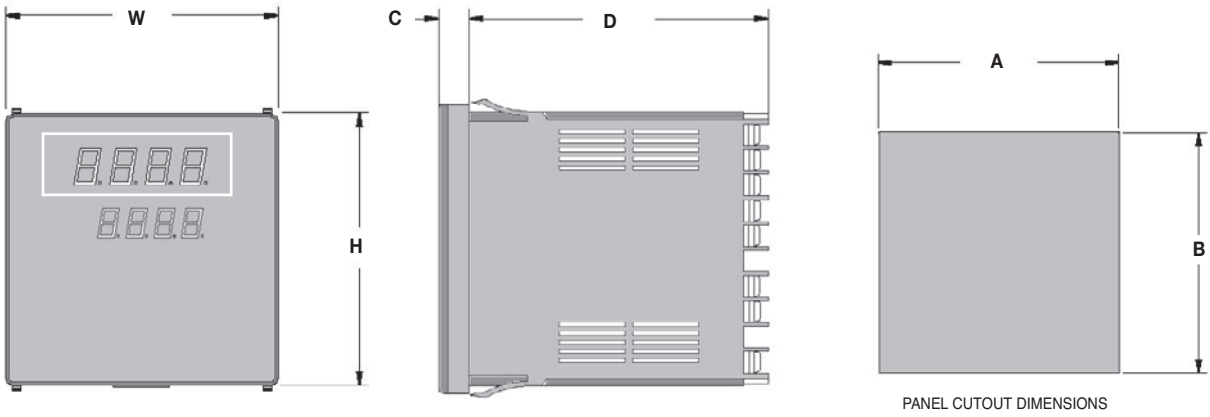
Power Requirements:

Standard:	100-230 VAC ac + 10% -15% at 48 to 62 Hz
Low voltage:	24V ac (+ 10% -15%) at 48 to 62 Hz, or 24V dc (+ 20% -15%)
Power dissipation:	9W (max.)
Fuse Type:	No internal fuse fitted
Interrupt protection	
Standard:	Holdup > 10ms at 85V RMS supply voltage
Low voltage:	Holdup > 10ms at 20.4V RMS supply voltage

Ethernet communications:

Type:	10/100base T Ethernet (IEEE802.3)
Protocols:	Modbus TCP/IP master/slave, EtherNet/IP client/server
Cable type:	Category 5
Maximum length:	110 yards (100 meters)
Termination:	RJ45. Green LED illuminated = link connected; Amber LED flashing showa link activity.

Features PID & Data-Recording



PANEL CUTOUT DIMENSIONS

HOW TO ORDER (Model Coding)

Sample Order Number: **NANODAC VH C BS**

1 Model	2 Power Supply	3 Controller	4 Communication Protocol
NANODAC	**VH** 100-230 VAC (+/- 15% at 48-62Hz)	**C** 2 Control Loops	**TS** Modbus TCP/IP slave **BS** BACnet

Electronic PID Controller Dimensions – units: inches [mm]

A	B	C	D	H	W
3.63 [92]	3.63 [92]	0.43 [11]	3.54 [90]	3.78 [96]	3.78 [96]

CONTROL VALVES

Analog Input

General

Number of Inputs: Four dc Volts, dc mV, dc mA, dual mA (external shunt required), dual mV, dual TC†, Thermocouple, RTD (2-wire and 3-wire), Digital (Contact closure)

Programmable I/O

Relay Contacts

Contact switching power (resistive): Max. 2A at 230V RMS ±15% Min. 100mA at 12V

Digital Inputs - Contact closure

Short circuit sensing current (source): 5.5mA (min.); 6.5mA (max.)

DC Output

O/P1, O/P2, O/P3 DC analogue outputs

Current outputs

(O/P1, O/P2 and O/P3)

Output ranges: Configurable within 0 to 20mA
Load resistance: 500Ωmax
Calibration accuracy: <±100µA ±1% of reading

Voltage outputs

(O/P3 only)

Voltage output across terminals: 0V (min.); 300mV (max.) Output source leakage current into short circuit: 0µA (min.); 100µA (max.)

Electropneumatic

- 4 to 20 mA Input
- 3 to 15 PSI Output
- Intrinsically Safe
- Zero and Span Adjustments

The **TA901 Electropneumatic (I/P) Transducer** converts a milliamp current signal to a linearly proportional pneumatic output pressure. This transducer is designed for control applications that require a high degree of reliability and repeatability. The TA901 is used in the control operation of valve actuators and pneumatic valve positioners in the petrochemical, HVAC, energy management, textile, paper, and food & drug industries.

The TA901 I/P Transducer is tested and approved by Factory Mutual as Intrinsically Safe Class I, II and III, Division I, Groups C, D, E, F and G when installed in accordance with the Installation, Operation and Maintenance Instructions. It should be installed in a vertical position in a vibration-free area.

The Watson McDaniel TA987 Air Filter/Regulator is recommended for filtering and regulating the pressure of plant compressed air, and for delivering clean, dry air at the proper pressure to pneumatic control devices.

Specifications

Model
TA901

Input
4-20 mA

Output
1-17 PSIG Per ANSI/FCI 87-2 (can be calibrated to provide 1-9 PSIG or 9-17 PSIG)

Volume Booster
Built-in volume booster allows flow capacity up to 20 SCFM

Connections
Pneumatic: 1/4" NPT
Electric: 1/2" NPT

Air Requirements
Clean, oil-free, dry air filtered to 40 microns

Minimum Supply Pressure: 3 PSIG

Maximum Supply Pressure: 100 PSIG

Sensitivity: < ±0.1% of span per PSIG

Air Consumption: 0.03 SCFH typical

Flow Rate: 4.5 SCFM at 25 PSIG supply

Relief Capacity: 2.0 SCFM at 5 PSIG above 20 PSIG setpoint

Mounting
Pipe, panel or bracket in a vibration-free area. Field adjustment will be required if mounted in a nonvertical position.

Adjustment
Adjustable zero and span

Accuracy
Terminal Based Linearity: < ±0.75% of span

Repeatability: < 0.5% of span

Hysteresis: < 1.0% of span

Response Time: < 0.25 sec. @ 3-15 PSIG

Intrinsic Safety
Tested and approved by Factory Mutual as Intrinsically Safe Class I, II and III, Division I, Groups C, D, E, F and G when installed in accordance with Installation, Operation and Maintenance Instructions

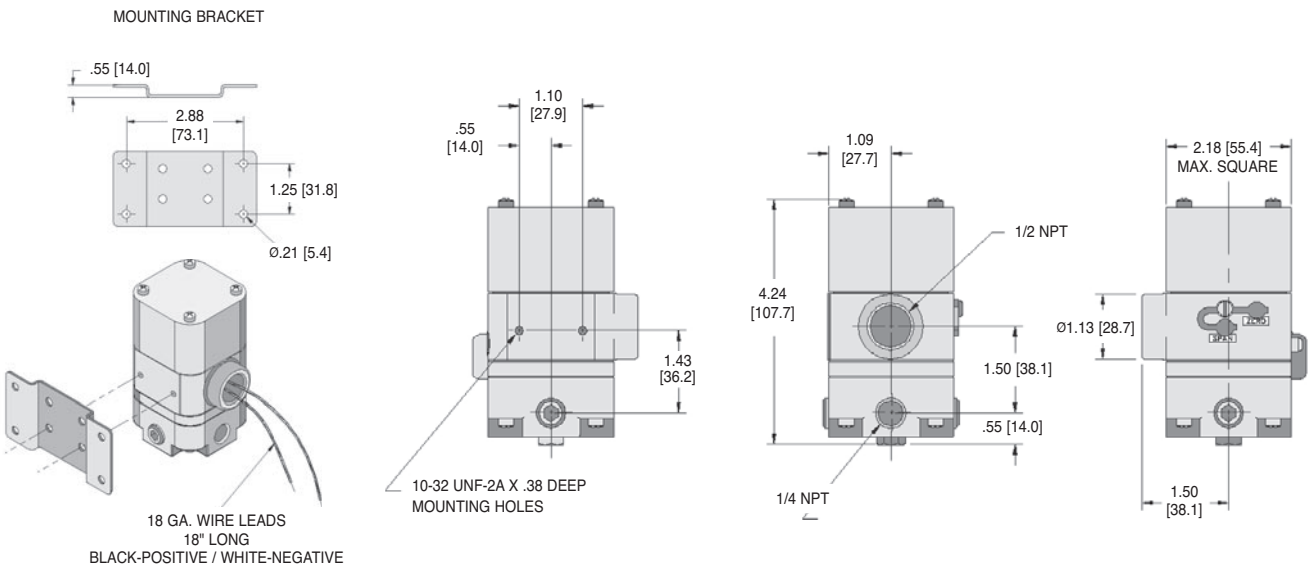
Ambient Temperature
-20°F (-30°C) to 140°F (60°C)

Approximate Shipping Weight
2.1 lbs [0.94 kg]

How to Order

Order using Item Number: **TA901**

Unit: inches [mm].



CONTROL VALVES

TA987

- **Cast Aluminum Housing**
- **Removable Nylon Mesh Filter**
- **Low Air Consumption**
- **Drip Well**

The **TA987 Air Filter/Regulator** is recommended for filtering and regulating the pressure of plant compressed air, and for delivering clean, dry air at the proper pressure to pneumatic control devices. Supply air enters the inlet port, passes through the filtering element, and exits through the reducing valve to the outlet port. The filtering element removes particles as small as 5 microns. A drip well is provided for the accumulation of oil and water and a drain cock is included to allow purging of the unit. The filtering element is readily accessible for cleaning by removal of the drip well bowl.

The maximum allowable supply pressure to TA987 Air Filter/Regulator is 250 PSIG. Improper application may cause failure of the regulator, resulting in possible personal injury or property damage.

Specifications

Model TA987

Air Requirements
Maximum Supply Pressure: 250 PSIG

Output Range
0 to 30 PSIG, adjustable

Sensitivity: 0.036 PSIG

Air Consumption: < 6 SCFH

Air Requirements (con't.)
Flow Rate: 20 SCFM at 100 PSIG supply/20 PSIG output

Relief Capacity: 0.1 SCFM at 5 PSIG above setpoint

Effect of Supply Pressure Variation: < 0.2 PSIG for 25 PSIG

Filter
Removes particles 40 microns or greater

Port Size
1/4" NPT

Housing
Cast aluminum

Mounting
Side, pipe, panel or through body

Ambient Temperature
-20°F (-30°C) to 160°F (71°C)

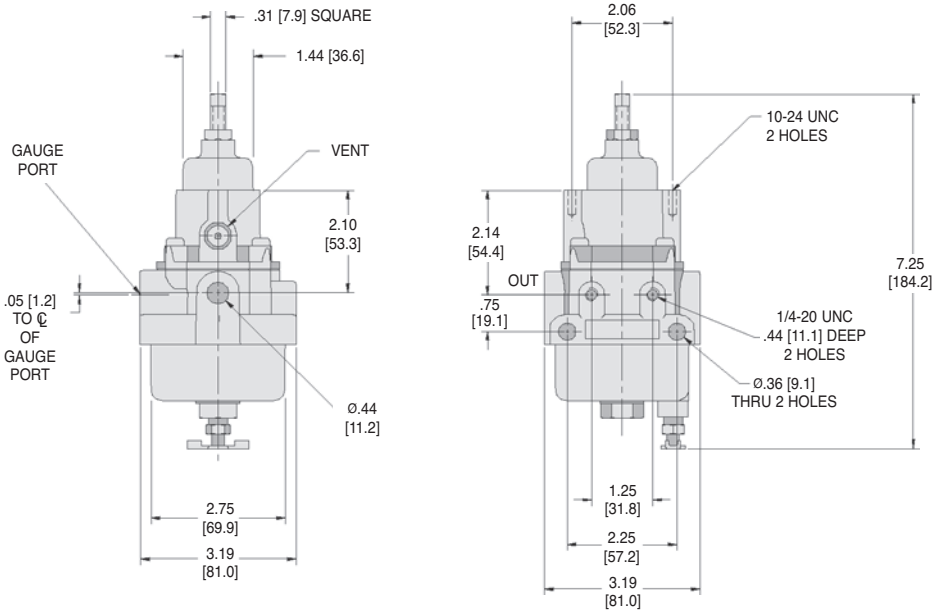
Approximate Shipping Weight
1.9 lbs [0.86 kg]

CONTROL VALVES

How to Order

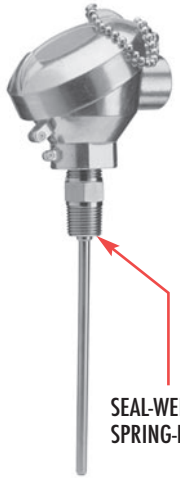
Order using Item Number: **TA987**

Units: inches [mm].



Electronic Temperature Sensors
RTD or Thermocouple

Connection Head Type



- **Thermocouple or RTD**
- **Cast Aluminum Polypropylene or Stainless Steel Head**
- **Weather-Proof**
- **Welded or Spring Loaded Stem**

The Watson McDaniel **Connection Head** is available with both Type J and Type K Thermocouples, as well as RTD sensors. The weatherproof head provides a conduit connection and is available in cast aluminum (screw cover), polypropylene (flip cover) and stainless steel (screw cover). The stem is either welded directly to the 1/2" NPT threaded connection, or is spring-loaded to provide maximum sensitivity. The spring-loaded stem must always be installed in a thermowell.

Extension wire and transmitter accessories are also available. Please consult factory.

For applications where the process media may be corrosive or contained under pressure, the use of a thermowell is required to prevent damage to the sensor and facilitate its removal from the process. To prevent leakage of the process media, spring loaded sensors must always be installed in a thermowell.

Specifications

Sensors	Description
TJD	Type J (Thermocouple)
TKD	Type K (Thermocouple)
TDD	100 Ω RTD
TMD	1000 Ω RTD

Hot Junction
T/C: Ungrounded
RTD: Platinum, 3-Wire

Stem 316 stainless steel, 1/4" diameter

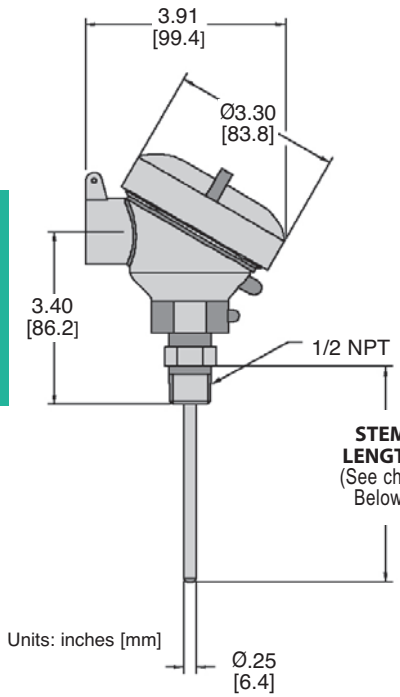
Insulation Ceramic

Head Cast aluminum, polypropylene or stainless steel

Process Connection
1/2" NPT welded or spring-loaded

Conduit Connection
3/4" NPT Female

Approximate Shipping Weight
1.1 lbs [0.50 kg]



Specifications

Thermocouple

Type	Color Code	Positive Lead	Negative Lead	Temperature Range
J	Black	Iron* (Fe) [white]	Constantan (Cu-Ni) [red]	32° to 1382°F (0° to 750°C)
K	Yellow	Nickel-Chromium (Ni-Cr) [yellow]	Nickel-Aluminum* (Ni-Al) [red]	32° to 2282°F (0° to 1250°C)

**magnetic lead*

RTD

Type	Material	Resistance @ 0°C	Temperature Coefficient	Temperature Range
D	Platinum (Pt)	100 Ω	a = 0.00385 Ω/Ω/°C	-50° to 700°F (-45° to 400°C)
M	Platinum (Pt)	1000 Ω	a = 0.00385 Ω/Ω/°C	-50° to 700°F (-45° to 400°C)

How to Order Temperature Sensors

Example Model Code: **TJD Z 04 U W A**

Sensor Type	Stem Style	STEM LENGTH	Hot Junction	Connection	Head Material
TJD Type J (T/C) **TKD** Type K (T/C) **TDD** 100 Ω RTD **TMD** 1000 Ω RTD	**Z** 316SS, 1/4" O.D.	**02** 2 1/2" Stem **04** 4" Stem **06** 6" Stem **09** 9" Stem **12** 12" Stem	**U** Ungrounded (T/C) **D** 3-Wire (RTD)	**S** Spring Loaded, 1/2" NPT **W** Welded, 1/2" NPT	**A** Aluminum **P** Polypropylene **S** Stainless Steel

Other sensor styles available.
T/C = Thermocouple

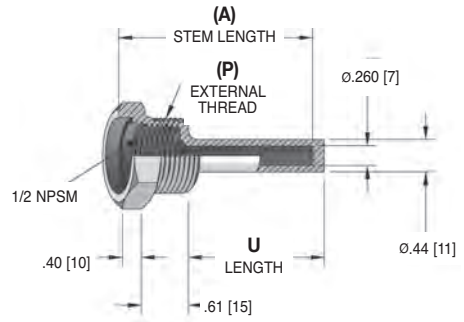
Other Lengths: Specify in inches (24" maximum)

Thermowells
for RTD & Thermocouple Temperature Sensors

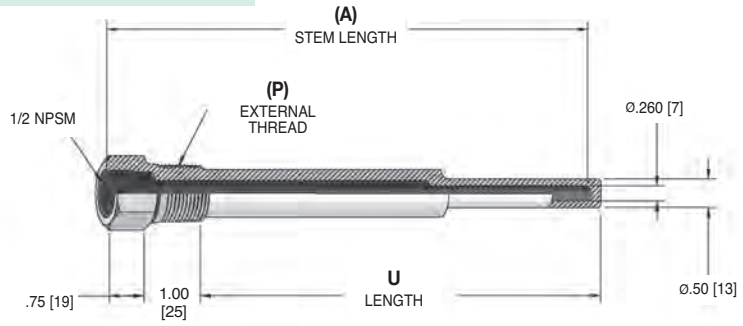
A **Thermowell** is a pressure tight receptacle designed to accept a temperature sensing element and provide a means to insert that element into a vessel or pipe. It acts as a barrier between a process medium and the sensing element of a temperature measuring device and protects against corrosive process media. A thermowell also allows the sensing element to be removed from the application while maintaining a closed system. The material chosen must be compatible with the process medium to which it is exposed.

The U-length (insertion length) of a thermowell indicates its insertion depth into a process vessel or piping system and is measured from the tip of the thermowell to the underside of the threads. Lagging extension thermowells are used on applications where insulation covers the vessel or piping system. The extension length (T-length) is the measurement between the instrument connection and process connection of the thermowell.

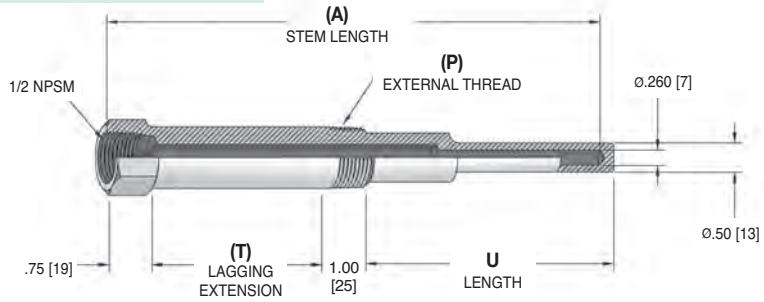
Standard (2 1/2" - 6")



Standard (9" - 24")



with Lagging Extension (4" - 24")



Units inches: [mm]

CONTROL VALVES

Lengths

(A) Stem Length	Standard U Length	Lagging (T) Lagging Extension	Lagging U Length
2 1/2"	1.75 [44]	—	—
4"	2.50 [64]	1.00 [25]	1.50 [38]
6"	4.50 [114]	2.00 [51]	2.50 [64]
9"	7.50 [191]	3.00 [76]	4.50 [114]
12"	10.50 [267]	3.00 [76]	7.50 [191]
15"	13.50 [343]	3.00 [76]	10.50 [267]
18"	16.50 [419]	3.00 [76]	13.50 [343]
24"	22.50 [572]	3.00 [76]	19.50 [495]

Pressure Ratings (PSI)

Material	Operating Temperature 70°F	200°F	400°F	600°F	800°F	1000°F
Carbon steel	5000	5000	4800	4600	3500	-
304 stainless steel	6550	6000	4860	4140	3510	3130
316 stainless steel	6540	6400	6000	5270	5180	4660

How to Order 76-Series Thermowells

Example Model Code: **76-4JN6**

Thermowell Model	(P) External Thread	(A) Stem Length	(T) Lagging Extension	Material
76 Thermowell	**3** 1/2 NPT*	**D** 2 1/2" Stem	**A** 1" Extension (4" Stem only)	**2** Brass
	4 3/4 NPT	**G** 4" Stem	**C** 2" Extension (6" Stem only)	**5** 304SS
	5 1 NPT*	**J** 6" Stem	**E** 3" Extension (9" thru 24" Stem only)	**6** 316SS
		M 9" Stem	**N** No Extension	
		R 12" Stem		
		V 15" Stem		
		Wa 18" Stem		
		Wk 24" Stem		

**Not available with 2 1/2" Stem Length*

Other thermowell styles available. Please consult factory.