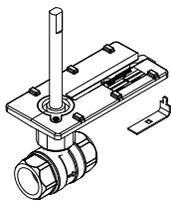


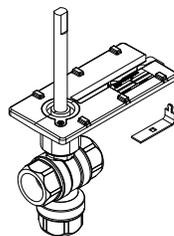
# Ball Valve Assemblies with SmartX Actuators

## Product Description

The Schneider Electric VA, VF, and VS-2xx3-xxx-9-xx series Ball Valve Assemblies are complete actuator/valve assemblies that accept two-position, floating, or proportional control signals from a DDC system or a thermostat, for control of hot or chilled water, or solutions of up to 50% glycol. They consist of direct-coupled, SmartX, spring return or non-spring return actuators mounted on 2-way (½" to 3") and 3-way (½" to 2") ball valve bodies. Typical applications include reheat on VAV boxes, fan coil units, hot and chilled water coils in air handling units, and unit ventilators.



VB-22x3-500-9-xx  
Body/Linkage Assembly  
with 2-Way Ball Valve



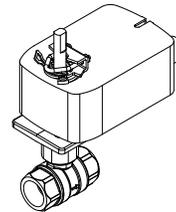
VB-2313-500-9-xx  
Body/Linkage Assembly  
with 3-Way Ball Valve

Ball valve body/linkage assemblies allow field mounting of SmartX actuators.

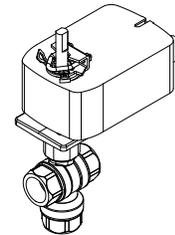
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Vx-2xx3-5xx-9-xx series ball valve assemblies are available with either spring return or non-spring return SmartX® Actuators.

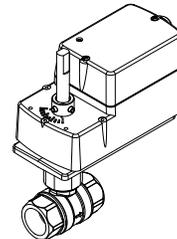


Vx-22x3-5xx-9-xx  
2-Way Assembly with  
Spring Return Actuator

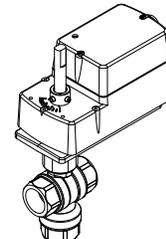


Vx-2313-5xx-9-xx  
3-Way Assembly with  
Spring Return Actuator

Vx-2xx3-8xx-9-xx Spring return valve assemblies equipped with Mx4D-x0x3 SmartX Actuators, respectively.



Vx-22x3-8xx-9-xx  
2-Way Assembly with  
Mx4D Series Actuator



Vx-2313-8xx-9-xx  
3-Way Assembly with  
Mx4D Series Actuator

## Applicable Literature



MA40-704x, MA4x-707x, MA4x-715x Installation .....	F-26642
MF4x-7xx3, MF4x-7xx3-50x Installation .....	F-26644
MS4x-7xx3, MS4x-7xx3-50x Installation .....	F-26645
MF41-6043, MF41-6083 Installation .....	F-27213
MA4D-xxxx, MF4D-xxxx, MS4D-xxxx Installation.....	F-27170
MS41-6043, MS41-6083 Installation .....	F-27214
Mx40-704x Mounting and Wiring Instruction.....	F-27003
Mx41-6043 Data Sheet.....	F-26737
VX/B-2xx3-5xx-9-xx Installation .....	F-27087
EN205 Water and Steam Systems.....	F-26080

Life Is On



## Features and Benefits

Feature	Benefit
Close-offs of 40 to 130 psi.	Accommodates most close-off requirements.
Available in full range of line sizes, ½" to 3" for 2-way valves and ½" to 2" for 3-way valves.	Satisfies a wide range of applications.
Cvs from 0.33 to 266.	Permits optimal valve sizing, minimizing the need for pipe reducers.
Flow characterizing insert, made of glass-filled Noryl™.	Provides equal percentage flow characteristic so that the heat output of the coil is linear with respect to valve position.
Available in both spring return and non-spring return models.	Allows power loss mode requirement to be met for any given application.
Utilizes SmartX Actuators with two-position, floating, and proportional control.	Models to fit a wide range of applications.
All models equipped with pigtail leads.	Eases installation. Reduced electrician costs.
Low-friction seals and o-rings.	Allows the use of lower-torque actuators, reducing cost.
Valve body made of forged brass ASTM B283-06.	Rated for static pressure of 360 psi at fluid temperatures of 20 to 250 °F (-7 to 121 °C).
ANSI Class IV (0.01% of Cv) shutoff with 2-way valves.	Allows accurate control, saves energy.
Choices of spring return direction.	Provides Normally Closed or Normally Open spring return.
Thermally isolated mounting plate.	Protects the actuator from excess cold or heat from chilled or hot water passing through the valve. Discourages condensation.
Ball Valve Body/Linkage Assemblies are available separately. They include anti-rotation clips for SmartX Actuators.	Increases flexibility and minimizes inventory.

## Ball Valve Assembly Selection Procedure

When selecting a ball valve assembly, you must determine the applicable codes for the control signal type, valve body configuration, end connection, port size, and actuator. Select a ball valve assembly part number as follows:

1. Control Signal Type, Valve Body Configuration, and End Connection  
Refer to Ball Valve Assemblies on Page 3 and select the appropriate codes for these part number fields.
2. Valve Size (Flow Coefficient)  
If the required flow coefficient (Cv) has not yet been determined, do so as follows:
  - a. Refer to Sizing and Selection to calculate the required Cv.
  - b. Select the nearest available Cv and corresponding valve body port code.
3. Actuator  
Select the appropriate actuator and code according to Ball Valve Assemblies on "Ball Valve Assemblies Using SmartX 5xx Actuators" on page 3, based on the control signal type, required valve normal position, and voltage requirements. For detailed actuator information, refer to the applicable actuator specifications.

**NOTE:** Ball Valve Assemblies with SmartX Actuators use the basic actuators. However, if an actuator with auxiliary switch(es) is required, you may field-assemble a ball valve assembly using a ball valve body/linkage assembly. For information on switch-equipped actuators, refer to actuator specifications.

4. Close-off Pressure  
Confirm that the selected actuator and valve body combination provides sufficient close-off pressure. If no close-off pressure is shown, the valve body/actuator combination is not valid.
5. Available Space  
If available space is a consideration, check the appropriate dimensional figure (Figure 1 through Figure 6) and its accompanying table for any potential fit problems.

## Part Numbering System

### Ball Valve Assemblies Using SmartX 5xx Actuators

**V x - 2 x x 3 - 5 x x - 9 - x x**

**Control Signal Type**  
A = Two Position  
F = Floating  
S = Proportional  
B = Valve Body & Linkage<sup>a</sup> (less actuator)

**Configuration**  
2 = 2-Way  
3 = 3-Way

**Material**  
1 = Nickel/Chromium Plated Brass <sup>4</sup>  
5 = Stainless Steel <sup>3</sup>

**Connection**  
3 = Threaded NPT

**Port Code**  
Refer to separate Port Code table

Actuator Code <sup>1</sup> <sup>2</sup>				Valves Used On <sup>3</sup> <sup>4</sup>					
Model	Code	Normal Position	Voltage	1/2 to 1"		1-1/4"		1-1/2" to 3"	1-1/2" to 2"
				2-way	3-way	2-way	3-Way	2-Way	3-way
<b>Two-Position</b>									
MA40-7040	522	SR Close	120 Vac	X	X	X	X	X	X
MA40-7040	532	SR Open	120 Vac	X	X	X	X	X	X
MA40-7043	526	SR Close	24 Vac	X	X	X	X	X	X
MA40-7043	536	SR Open	24 Vac	X	X	X	X	X	X
<b>Floating</b>									
MF41-6043	505	NSR	24 Vac	X	X	X	X	—	—
MF41-6083	506	NSR	24 Vac	—	—	—	—	X	X
MF40-7043	526	SR Close	24 Vac	X	X	X	X	X	X
MF40-7043	536	SR Open	24 Vac	X	X	X	X	X	X
<b>Proportional</b>									
MS41-6043	505	NSR	24 Vac	X	X	X	X	—	—
MS41-6083	506	NSR	24 Vac	—	—	—	—	X	X
MS40-7043	526	SR Close	24 Vac	X	X	X	X	X	X
MS40-7043	536	SR Open	24 Vac	X	X	X	X	X	X

**Valve Body/Linkage Assembly<sup>a</sup>** VB-22x3-500-9-xx, VB-2313-500-9-xx

SR = Spring Return  
NSR = Non-Spring Return

<sup>a</sup> Includes valve body, linkage, and anti-rotation clips for spring return and non-spring return SmartX actuators, listed above. Ordered separately.

**Note:** Not all model configurations are available as factory assemblies. You can purchase the the actuator and a VB-22x3-500-9-xx valve body and linkage separately for field assembly.

<sup>1</sup> Normal position for 3-way spring return ball valve assemblies refers to A to AB ports.

<sup>3</sup> Stainless steel ball is available only on 2-way versions.

<sup>4</sup> 2-way assemblies are only available in stainless steel; 3-way only available in nickel/chromium plated brass.

### Ball Valve Assemblies Using SmartX 8xx Actuators

**V x - 2 x x 3 - 8 x x - 9 - x x**

**Control Signal Type**  
A = Two Position  
F = Floating  
S = Proportional  
B = Valve Body & Linkage<sup>c</sup> (less actuator)

**Configuration**  
2 = 2-Way  
3 = 3-Way

**Material**  
1 = Nickel/Chromium Plated Brass <sup>4</sup>  
5 = Stainless Steel <sup>3</sup>

**Connection**  
3 = Threaded NPT

**Port Code**  
Refer to separate Port Code table

Actuator Code <sup>1</sup>				Valves Used On <sup>3</sup> <sup>4</sup>					
Model	Code	Normal Position	Voltage	Type	1/2" to 1"		1-1/4" to 3"	1-1/4" to 2"	
					2-way	3-way	2-way	3-way	
<b>Two-Position</b>									
MA4D-7030 <sup>a</sup>	815	SR Open	120 Vac	—	X	X	—	—	
MA4D-8030 <sup>a</sup>	817	SR Closed	120 Vac	—	X	X	—	—	
MA4D-7033-100	821	SR Open	24 Vac	—	X	X	—	—	
MA4D-8033-100	831	SR Closed	24 Vac	—	X	X	—	—	
<b>Floating</b>									
MF4D-7033-100	821	SR Open	24 Vac	—	X	X	—	—	
MF4D-8033-100	831	SR Closed	24 Vac	—	X	X	—	—	
<b>Proportional</b>									
MS4D-7033-100	821	SR Open	24 Vac	2-10 Vdc	X	X	—	—	
MS4D-7033-150	N/A <sup>b</sup>	SR Open	24 Vac	0-10 Vdc	X	X	—	—	
MS4D-7033-160	N/A <sup>b</sup>	SR Open	24 Vac	4-20 mA	X	X	—	—	
MS4D-8033-100	831	SR Closed	24 Vac	2-10 Vdc	X	X	—	—	
MS4D-8033-150	N/A <sup>b</sup>	SR Closed	24 Vac	0-10 Vdc	X	X	—	—	
MS4D-8033-160	N/A <sup>b</sup>	SR Closed	24 Vac	4-20 mA	X	X	—	—	

**Valve Body/Linkage Assembly<sup>c</sup>** VB-22x3-500-9-xx, VB-2313-500-9-xx

SR = Spring Return      NSR = Non-Spring Return

<sup>a</sup> - models have appliance cables. "1x0" models have plenum cables.

<sup>b</sup> - Factory assemblies not available. Purchase actuator and valve body separately and field assemble.

<sup>c</sup> - Includes valve body, linkage, and anti-rotation clips for spring return and non-spring return SmartX actuators, listed above. Ordered separately.

<sup>1</sup> Normal position for 3-way spring return ball valve assemblies refers to A to AB ports.

<sup>3</sup> Stainless steel ball is available only on 2-way versions.

<sup>4</sup> 2-way assemblies are only available in stainless steel; 3-way only available in nickel/chromium plated brass.

## Port Codes

### 2-Way Ball Valve Assemblies with Sizes, Port Codes, and Cvs.

Size in.	2-Way		
	Port Code	Cv <sup>a</sup>	Kvs <sup>a</sup>
½	01	0.38	0.33
	02	0.68	0.59
	03	1.3	1.1
	04	2.6	2.2
	05	4.7	4.1
	06	8.0	6.9
	07	11.7 <sup>b</sup>	10.1
¾	11	0.31	0.27
	12	0.63	0.54
	13	1.2	1.0
	14	2.5	2.2
	15	4.3	3.7
	16	10.1	8.7
	17	14.7 <sup>b</sup>	12.7
1	18	28.6 <sup>b</sup>	24.7
	21	4.4	3.8
	22	9.0	7.8
	23	15.3	13.2
	24	26.1	22.6
	25	28.4 <sup>b</sup>	24.6
	26	43.9 <sup>b</sup>	38.0
1¼	27	54.2 <sup>b</sup>	46.9
	41	4.4	3.8
	42	8.3	7.2
	43	14.9	12.9
	44	36.5	31.6
1½	45	41.1 <sup>b</sup>	35.6
	46	102.3 <sup>b</sup>	88.5
	51	22.8	19.7
	52	41.3	35.7
2	53	73.9 <sup>b</sup>	63.9
	54	171.7 <sup>b</sup>	148.5
	61	41.7	36.1
	63	71.1	61.5
	65	108 <sup>b</sup>	93.4
2½	66	210	181.7
	67	266 <sup>b</sup>	230.1
	71	45	38.9
	72	55	47.6
	73	72.3	62.5
	74	101	87.4
3	75	162	140.1
	76	202 <sup>b</sup>	174.7
	82	63	54.5
	85	145 <sup>b</sup>	125.4

a -  $Cv = \frac{gpm}{\sqrt{\Delta P}}$  (where DP is measured in psi)

$kvs = \frac{Cv}{1.156}$

$kvs = \frac{m^3/h}{\sqrt{\Delta P}}$  (where DP is measured in bar; 1 bar = 100 kPa)

b - Denotes a full port valve, without the characterized insert.

### 3-Way Ball Valve Assemblies with Sizes, Port Codes, and Cvs

Size in.	3-Way		
	Port Code	A Port Cv <sup>a,b</sup>	Kvs <sup>a</sup>
½	01	0.33	0.28
	02	0.59	0.51
	03	1	0.86
	04	2.4	2.1
	05	4.3	3.7
	06	8.0 <sup>c</sup>	6.9
	¾	11	0.40
12		0.66	0.57
13		1.3	1.1
14		2.4	2.1
15		3.8	3.3
16		11 <sup>c</sup>	9.5
1		21	0.40
	22	0.65	0.56
	23	1.3	1.1
	24	2.3	2.0
	25	3.5	3.0
	26	4.5	3.9
	27	8.6	7.4
	28	10	8.6
	29	14.9	12.9
	30	22.3 <sup>c</sup>	19.3
	31	30.8 <sup>c</sup>	26.6
1¼	41	4.1	3.5
	43	8.7	7.5
	44	12.7	11.0
	45	19.4 <sup>c</sup>	16.8
	46	34.1 <sup>c</sup>	29.5
1½	51	4	3.5
	52	8.3	7.2
	53	13.4	11.6
	54	23.5	20.3
	55	32 <sup>c</sup>	27.7
	56	61.1 <sup>c</sup>	52.8
2	61	23.9	20.7
	62	38.2	33.0
	63	56.7 <sup>c</sup>	49.0
	64	108.5 <sup>c</sup>	93.8

a -  $Cv = \frac{gpm}{\sqrt{\Delta P}}$  (where DP is measured in psi)

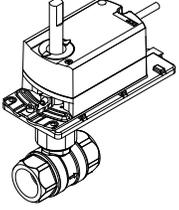
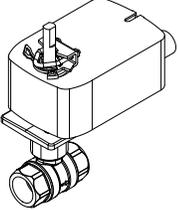
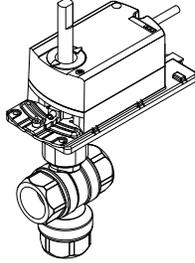
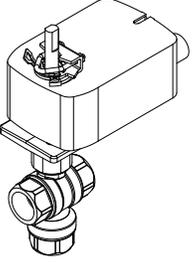
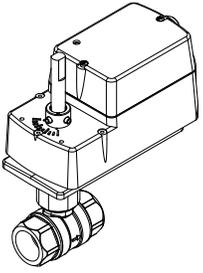
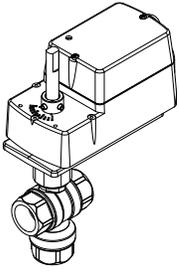
$kvs = \frac{Cv}{1.156}$

$kvs = \frac{m^3/h}{\sqrt{\Delta P}}$  (where DP is measured in bar; 1 bar = 100 kPa)

b - B port Cv is 80% of A port Cv.

c - Denotes a full port valve, without the characterized insert.

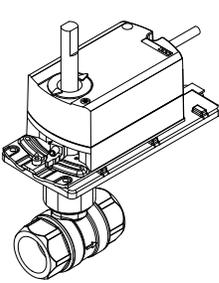
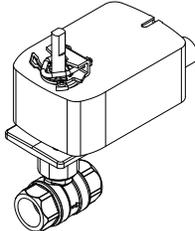
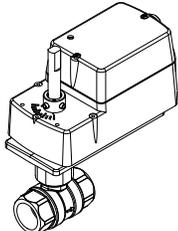
## Ball Valve Specifications

Valve Assembly Series		2-Way	3-Way
Ball Valve Assemblies using SmartX Actuators		 <b>Non-Spring Return</b> Vx-22x3-505-9-P Vx-22x3-506-9-P	 <b>Spring Return</b> Vx-22x3-5xx-9-P
		 <b>Non-Spring Return</b> Vx-2313-505-9-P Vx-2313-506-9-P	 <b>Spring Return</b> Vx-2313-5xx-9-P
	 <b>Spring Return</b> VA-22x3-81x-9-P Vx-22x3-82x-9-P Vx-22x3-83x-9-P	 <b>Spring Return</b> VA-2313-81x-9-P Vx-2313-82x-9-P Vx-2313-83x-9-P	
Applications		Chilled or Hot Water, up to 50% Glycol Solution	
Type of End Fitting		NPT Screwed	
Size		½" through 3"	½" through 2"
Valve Assembly Series		Vx-22x3-xxx-9-P	Vx-2313-xxx-9-P
Flow Type		Equal Percentage	
Material	Body	Forged Brass (ASTM B283-06)	
	Ball	1 = Nickel/Chromium-Plated Brass 5 = Stainless Steel	Nickel/Chromium-Plated Brass
	Characterizing Insert	Glass-filled Noryl	
	Stem	Stainless Steel	
	Ball Seals	Reinforced Teflon® Seals with EPDM O-Rings	
	Stem Seals	EPDM O-Rings	
	Mounting Plate	Glass-filled Polymer	
Maximum Static Pressure		360 psig (25 bar) at 250 °F (121 °C)	
Maximum Operating Differential Pressure		Same as close-off pressures shown in Table 4 or Table 6. Refer to "Cavitation Limitations on Valve Pressure Drop" on page 18.	Same as close-off pressures shown in Table 4 or Table 6. Refer to "Cavitation Limitations on Valve Pressure Drop" on page 18.
Seat Leakage		ANSI Class IV (0.01% of Cv)	ANSI Class IV (0.01% of Cv), piped coil-side outlet to A only
Fluid (water) Temperature	Minimum	20 °F (-7 °C)	
	Maximum	250 °F (121 °C)	

Note: Not all model configurations are available as factory assemblies. You can purchase the the actuator and a VB-2253-500-9-xx valve body and linkage separately for field assembly. All valve sizes - ANSI Class IV (0.01% of Cv) shut-off.

## Valve/Actuator Combinations

### 2-Way Ball Valve Assemblies With SmartX Actuators

 <p>Vx-22x3-505-9-P</p>  <p>Vx-22x3-5xx-9-P</p>  <p><b>Spring Return</b> VA-22x3-81x-9-P Vx-22x3-82x-9-P Vx-22x3-83x-9-P</p>			Non-Spring Return <sup>a</sup>		Spring Return	
			Actuator Models (Actuator Codes)			
			24 Vac			
			Floating MF41-6043 (505) Proportional MS41-6043 (505)	Floating MF41-6083 (506) Proportional MS41-6083 (506)	Two-Position MA40-7043 (N.C.) (526) MA40-7043 (N.O.) (536) MA40-7043-501 Floating MF40-7043 (N.C.) (526) MF40-7043 (N.O.) (536) MF40-7043-501 Proportional MS40-7043 (N.C.) (526) MS40-7043 (N.O.) (536) MS40-7043-501 MS40-7043-MP MS40-7043-MP5	Two-Position MA4D-7033-100 (N.O.) (821) MA4D-8033-100 (N.C.) (831) Floating MF4D-7033-100 (N.O.) (821) MF4D-8033-100 (N.C.) (831) Proportional MS4D-7033-100 (N.O.) (821) MS4D-7033-150 MS4D-7033-160 MS4D-8033-100 (N.C.) (831) MS4D-8033-150 MS4D-8033-160
120 Vac						
		Two-position MA40-7040 (N.C.) (522) MA40-7040 (N.O.) (532) MA40-7040-501	Two-position MA4D-7030 (N.O.) (815) MA4D-8030 (N.C.) (817)			
		230 Vac MA40-7041 MA40-7041-501				
Valve Assembly Part Number	Size (in.)	P Code <sup>b</sup>	Close-Off Pressure, psi (kPa)			
Ball Valve Assembly With SmartX Vx-22x3-5xx-9-P <sup>c</sup>	½	1, 2, 3, 4, 5, 6, 7	130 (896) (field assemble)	-	130 (896) (field assemble)	130 (896)
	¾	11, 12, 13, 14, 15, 16, 17, 18				
	1	21, 22, 23, 24, 25, 26, 27	100 (689)			100 (689)
Valve/Linkage Assembly VB-2253-500-9-P	1¼	41, 42, 43, 44, 45, 46	70 (482)	70 (482)	70 (482)	-
	1½	51, 52, 53, 54				
	2	61, 63, 65, 66, 67				
	2½	71, 72, 73, 74, 75, 76				
	3	82, 85				

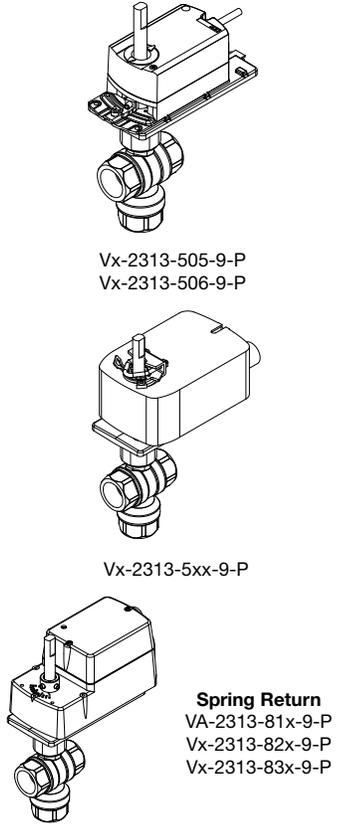
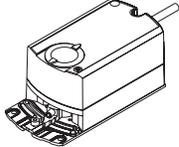
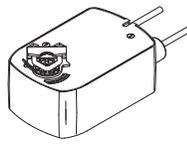
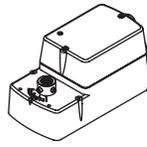
a - For non-spring return, 2-way ball valve assemblies are shipped NO (normally open).

b - To find the corresponding flow coefficients for these port codes, refer to "2-Way Ball Valve Assemblies with Sizes, Port Codes, and Cvs." on page 4.

c - To determine a specific part number, identify the actuator's control signal type ("A," "F," or "S"), actuator code, and P code. Refer to "Part Numbering System" on page 3 in document F-27086.

### 3-Way Ball Valve Assemblies With SmartX Actuators

Note: Not all model configurations are available as factory assemblies. You can purchase the the actuator and a VB-2253-500-9-xx valve body and linkage separately for field assembly. All valve sizes - ANSI Class IV (0.01% of Cv) shut-off piped coil-side outlet to A.

			Non-Spring Return		Spring Return	
						
			24 Vac			
			Floating MF41-6043 (505) Proportional MS41-6043 (505)	Floating MF41-6083 (506) Proportional MS41-6083 (506)	Two-Position MA40-7043 (N.C.) (526) MA40-7043 (N.O.) (536) MA40-7043-501 Floating MF40-7043 (N.C.) (526) MF40-7043 (N.O.) (536) MF40-7043-501 Proportional MS40-7043 (N.C.) (526) MS40-7043 (N.O.) (536) MS40-7043-501 MS40-7043-MP MS40-7043-MP5	Two-Position MA4D-7033-100 (N.O.) (821) MA4D-8033-100 (N.C.) (831) Floating MF4D-7033-100 (N.O.) (821) MF4D-8033-100 (N.C.) (831) Proportional MS4D-7033-100 (N.O.) (821) MS4D-7033-150 MS4D-7033-160 MS4D-8033-100 (N.C.) (831) MS4D-8033-150 MS4D-8033-160
			120 Vac			
		Two-position MA40-7040 (N.C.) (522) MA40-7040 (N.O.) (532) MA40-7040-501	Two-position MA4D-7030 (N.O.) (815) MA4D-8030 (N.C.) (817)			
		230 Vac MA40-7041 MA40-7041-501				
Valve Assembly Part Number	Size (in.)	P Code <sup>c</sup>	Close-Off Pressure, psi (kPa)			
Ball Valve Assembly with SmartX Vx-2313-5xx-9-P <sup>d</sup>	½	1, 2, 3, 4, 5, 6	50 (344) (field assemble)		50 (344) (field assemble)	50 (344)
	¾	11, 12, 13, 14, 15, 16				
Valve/Linkage Assembly VB-2313-500-9-P	1	21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31	50 (344)			
	1¼	41, 43, 44, 45, 46	40 (275)			
	1½	51, 52, 53, 54, 55, 56	-	40 (275)	40 (275)	-
	2	61, 62, 63, 64	-	40 (275)		

a - Non-spring return 3-way ball valve assemblies are shipped open A to AB and a control voltage increase will close A to AB and open B to AB  
 b - Spring return, 3-way valves are normally closed, A to AB and a control voltage increase will close A to AB and open B to AB  
 c - To find the corresponding flow coefficients for these port codes, refer to "3-Way Ball Valve Assemblies with Sizes, Port Codes, and Cvs" on page 4.  
 d - To determine a specific part number, identify the actuator's control signal type ("A," "F," or "S"), actuator code, and P code. Refer to "Ball Valve Assemblies Using SmartX 8xx Actuators" on page 3 in document F-27086.

## Specifications

### MF/MS41-6043/83 NSR SmartX Actuators

<b>Inputs</b>	Control Signal		
MF41-6043 and MF41-6083	Floating three-position control, 24 Vac		
MS41-6043 and MS41-6083	Proportional, 0...10 Vdc; input resistance 100K ohms		
Power Requirements (see table)	All 24 Vac circuits are Class 2		
Connections	3 ft. (0.9 m) long, 18 AWG plenum-rated leads		
Motor Type	Synchronous		
<b>Outputs</b>			
Electrical			
Position feedback voltage for MS41-6043/6083	0...10 Vdc, 1 mA		
Timing: 90°			
Timing in Sec.	At 60 Hz	At 50 Hz	
MF41-6043, MS41-6043	90	108	
MF41-6083, MS41-6083	125	150	
<b>Mechanical</b>			
Output torque rating	44 lb-in. (5 N-m) for Mx41-6043; 88 lb-in. (10 N-m) for Mx41-6083		
Stroke	Normal angle of rotation is 90°, limited to a maximum of 95°. Field adjustable to limit travel on either end of stroke		
Position indicator	Adjustable pointer is provided for position indication		
Output shaft setscrew			
Tightening torque	55...60 lb-in. (6.3...6.8 N-m)		
Environmental			
Temperature Limits			
Shipping and storage	-40...70 °C (-40...158 °F) ambient		
Operating	-32...55 °C (-25...130 °F) ambient		
NOTE: Check the valve operating temperature limit. The minimum valve media temperature limit is -7 °C (20 °F)			
Humidity	5...95% RH, non-condensing		
Enclosure Rating	IEC IP54 (NEMA Type 2)		
<b>Agency Listings (Actuator)</b>			
UL	UL-873, Underwriters Laboratories		
cUL	Canadian Standards C22.2 No. 24-93		
European Community	EMC Directive (89/336/EEC)		
	Emissions (EN50081-1)		
	Immunity (EN50081-2)		

Part Number	Power Input @ 50/60 Hz			
	Voltage	Running VA	Holding VA	Watts
MF41-6043 and MF41-6083	24 Vac +20/-15%	2.3	—	2.0
MS41-6043 and MS41-6083		3.3	1.2	3.0

### Mx40-704x SR SmartX Actuators

<b>Inputs</b>	Control Signal	
MA40-7043	ON/OFF SPST control contacts or Triacs (500 mA rated)	
MS40-7043	Proportional, 0...10 Vdc or 4...20 mA DC with 500 ohm resistor	
MS40-7043 MP/MP5	Proportional 6...9 Vdc	
MF40-7043	Floating point control, 24 Vac	
Power Requirements (See table)	All 24 Vac circuits are Class 2	
Connections		
MA40-704x and MA40-704x-501	0.9 m (3 ft.) long, appliance cable For M20 Metric conduit, use AM-756 adaptor	
MF40-7043 and MF40-7043-501, MS40-7043 and MS40-7043-501	0.9 m (3 ft.) long, plenum rated cable. For M20 Metric conduit, use AM-756 adaptor	
Motor Type	Brush DC	
MA40-704x	Brushless DC	
MF40-7043, MS40-7043		
<b>Outputs</b>		
Electrical		
Auxiliary Switches: Available when actuators are ordered as separate units. Auxiliary switches are not offered with factory ball valve assemblies.		
Mx40-7043-501 and MS40-7043-MP5	One auxiliary switch available. SPDT 6 A resistive @ 24 Vac, adjustable 0 to 95° (0 to 1 scale). Switch meets VDE requirements for 6 (1.5) A, 24 Vac	
MA40-7040-501	One auxiliary switch available. SPDT 6 A resistive @ 250 Vac, adjustable 0 to 95° (0 to 1 scale). Switch meets VDE requirements for 6 (1.5) A, 250 Vac	
Position Feedback Voltage	For 2...10 Vdc proportional actuators, the feedback signal is the same voltage range as the input signal. The feedback signal can supply up to 0.5 mA to operate up to four additional slave actuators (proportional (MS) models only).	
Control Mode	Switch provided for selection of direct acting or reverse acting control mode on proportional models	
Timing		
MA40-704x	Approximately 50 sec.	
MF40- and MS40-7043	Approximately 130 sec.	
Auxiliary Power Supply		
MS40-7043-MP and MS40-7043-MP5	+20 Vdc @ 25 mA (max.)	
<b>Mechanical</b>		
Stroke	Angle of rotation is limited to a maximum of 95°, with mechanical stop	
Output torque rating: Mx40-704x	35 lb-in. (4 N-m)	
Position indicator	Visual scale numbered from 0...90°, provided for position indication	
<b>Environmental</b>		
Temperature Limits		
Shipping and storage	-40...71 °C (-40...160 °F) ambient	
Operating	-30...60 °C (-22...140 °F) ambient	
NOTE: Check the valve operating temperature limit. The minimum valve media temperature limit is -7 °C (20 °F)		
Humidity	5...95% RH, non-condensing	
Enclosure Rating	IEC IP54 (NEMA 2, UL Type 2)	
<b>Agency Listings (Actuator)</b>		
UL	UL 873, Underwriters Laboratories (File #9429 Category Temperature-Indicating and Regulating Equipment)	
cUL	Canadian Standards C22.2 No. 24-93.	
European Community	EMC Directive (89/336/EEC)	
Australia	Low Voltage Directive (72/23/EEC)	
	This product meets requirements to bear the RSM according to the terms specified by the Communications Authority under the Radio communications Act 1992	

\* Not available as an assembly

Part Number	Voltage 50/60 Hz	Voltage Vdc	Running				Holding (Hz)	
			50 Hz		60 Hz		50	60
			VA	W	VA	W	W	W
MA40-7043	24 Vac ± 20%	22... 30	4.4	2.9	4.4	2.9	0.8	0.8
MA40-7043-501								
MS40-7043			5.6	4.2	5.6	4.2	2.4	2.4
MS40-7043-501								
MF40-7043			5.9	4.4	5.9	4.4	2.9	2.9
MF40-7043-501								
MS40-7043-MP*			6.9	5.0	6.6	5.0	3.2	3.2
MS40-7043-MP5*								
MA40-7040*	120 Vac ± 10%	-	6.4	3.8	4.3	3.4	1.6	1.2
MA40-7040-501*								
MA40-7041	230 Vac		5.8	4.1	4.6	3.9	1.5	
MA40-7041-501								

### Mx4D-7033/8033-xxx SmartX Actuators

**Inputs**

Control Signal and Power Requirements (see table)

a - 4 to 20 mAdc with field-installed 500 W resistor.

**Connections**

Mx4D-703x-1x0 and Mx4D-803x

1x0 10 ft. (3.05 m) long, plenum cable ½" (13 mm) conduit connector. For M20 Metric conduit, use AM-756 adaptor Brush DC

**Motor Type**

**Outputs**

Electrical

Timing

Approximate Timing in Sec. @ 70 °F (21 °C) <sup>a</sup>

Part Number	Powered	Spring Return	
		CCW <sup>b</sup>	CW <sup>b</sup>
MA4D-7033-100	56	26	-
MF4D-7033-100	85	21	-
MS4D-7033-100	85	21	-
MA4D-8033-100	56	-	26
MF4D-8033-100	85	-	21
MS4D-8033-1x0	85	-	21

a. Timing was measured with no load applied to actuator. b. CCW or CW as viewed from cover side of actuator.

Position Feedback Voltage: For 0...3 Vdc, 0...9 Vdc, 2...10Vdc, and 0...10 Vdc proportional actuators, the feedback signal is the same voltage range as the input signal. The 4...20 mA proportional actuators and floating actuators have a 2...10 Vdc feedback signal. The feedback signal can supply up to 0.5 mA to operate up to four additional slave actuators.

**Mechanical**

Stroke

93° nominal

Manual override

Allows positioning of valve shaft, using a manual crank 30 lb-in (3.4 N-m)

Output torque rating

RA/DA Jumper (Proportional Models)

Permits selection of reverse acting or direct acting control

Position indicator

Visual indicator

**Environmental**

Temperature Limits

Shipping and storage

Operating

NOTE: Check the valve operating temperature limit. The minimum valve media temperature

limit is 20 °F (6.7 °C)

Humidity

Enclosure Rating

-40...160 °F (-40...71 °C) ambient

-22...140 °F (-30...60 °C) ambient

15 to 95% RH, non-condensing

NEMA 1, NEMA 2, UL Type 2

(IEC IP54) with customer-supplied watertight conduit connectors

Enclosure is air plenum rated

**Agency Listings (Actuator)**

UL

UL 873, Underwriters Laboratories

File #9429 Category Temperature-

Indicating and Regulating Equipment

Plenum rated

cUL

Canadian Standards C22.2 No. 24-93

European Community

EMC Directive (89/336/EEC)

Low Voltage Directive (72/23/EEC)

This product fits into Installation

Category (Overvoltage Category)

II per EN 61010-1

Australia

This product meets requirements

to bear the RCM mark according to the terms specified

by the Communications Authority under the

Radiocommunications Act 1992

Part Number for Mx4D-703x-xxx Mx4D-803x-xxx	Control Signal	Voltage	Actuator Power Input			
			Running			Holding
			50/60 Hz		DC Amps	50/ 60 Hz
			VA	W		W
MA4D-x033-100	2-position	24 Vac ±20%	5.1	3.6	0.14	1.3
MF4D-x033-100	Floating		6.8	4.2		
MS4D-x033-100	2 to 10 Vdc <sup>a</sup> Proportional	20 to 30 Vdc	6.1	3.4	0.12	1.4
MS4D-x033-150	0 to 10 Vdc Proportional					
MS4D-x033-160	4 to 20 mAdc Proportional					

### 2-Way Ball Valve Assembly Dimensions

Valve Assembly Part Number	Valve Size in.	P Code <sup>a</sup>	Valve Dimensions in inches (mm) Refer to Figure 1			
			A	B	C	D
2-Way VF-22x3-505-9-P VF-22x3-506-9-P VS-22x3-505-9-P VS-22x3-506-9-P	1/2	1, 2, 3, 4, 5, 7	2-3/8 (60)	7 (178)	8 1/4 (210)	3-1/8 (79)
		6	2-5/8 (67)	7 (178)	8 1/2 (216)	3-3/8 (86)
	3/4	11, 12, 13, 14, 15, 17	2-7/16 (62)	7 (178)	8 1/4 (210)	3 1/4 (83)
		16, 18	2 3/4 (70)	7 (178)	8 1/2 (216)	3-3/8 (86)
	1	21, 23	3-1/16 (78)	7 (178)	8-7/8 (225)	3-5/8 (92)
		22, 25	2 3/4 (70)	7 (178)	8 1/2 (216)	3-3/8 (86)
		24, 26	4 1/2 (114)	7-3/8 (187)	9-3/8 (238)	3-7/8 (98)
		27	3 (76)	7 (178)	8-7/8 (225)	3-5/8 (92)
	1 1/4	41, 42, 43, 45	3 (76)	7 (178)	8-7/8 (225)	3-5/8 (92)
		44, 46	3-5/8 (92)	7-1/8 (181)	9-3/8 (238)	3-3/4 (95)
	1 1/2	51, 53	3-7/16 (87)	7-1/8 (181)	9-3/8 (238)	3-3/4 (95)
		52, 54	4-1/16 (103)	7 1/4 (184)	9-7/8 (251)	4-1/16 (103)
	2	61, 65	3-15/16 (100)	7 1/4 (184)	9-7/8 (251)	4 (102)
		63, 66, 67	4-15/16 (125)	7-3/4 (197)	10 1/2 (267)	4-7/16 (113)
	2 1/2	71, 72, 76, 73, 74, 75	5-3/8 (137)	8 (203)	10-3/4 (273)	4 1/2 (114)
	3	82, 85	5-11/16 (144)	8-1/8 (206)	10-11/16 (271)	4 1/4 (108)

a - To find the corresponding flow coefficients for these port codes, refer to "2-Way Ball Valve Assemblies with Sizes, Port Codes, and Cvs." on page 4 of document F-27086.

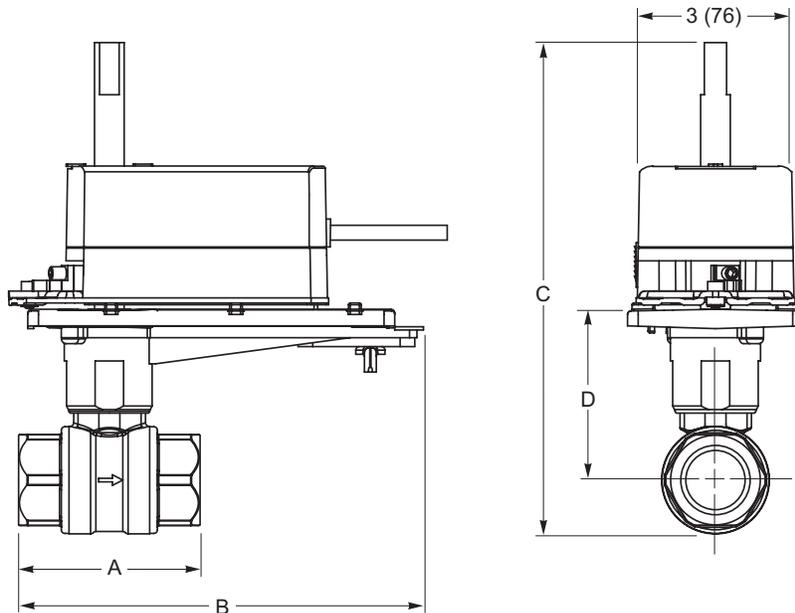


Figure 1. Mx41-6043 or Mx41-6083 with 2-Way Ball Valve.

### 3-Way Ball Valve Assembly Dimensions

Valve Assembly Part Number	Valve Size in.	P Code <sup>a</sup>	Valve Dimensions in inches (mm) Refer to Figure 2				
			A	B	C	D	E
3-Way VF-2313-505-9-P VF-2313-506-9-P VS-2313-505-9-P VS-2313-506-9-P	½	1, 2, 3, 4, 5, 6	2-5/8 (67)	7 (178)	9-¾ (248)	3-5/16 (84)	2 (51)
	¾	11, 12, 13, 14, 15, 16	2¾ (70)	7 (178)	9-¾ (248)	3¼ (83)	2 (51)
	1	21, 22, 23, 24, 25, 28	2¾ (70)	7 (178)	9-13/16 (249)	3¼ (83)	2-1/8 (54)
			4¼ (108)	7-3/8 (187)	11-5/8 (295)	3-5/8 (92)	3-1/16 (78)
			4¼ (108)	7½ (191)	11½ (292)	3½ (89)	3-1/8 (79)
	1¼	45	3 (76)	7 (178)	10-5/8 (270)	3-5/8 (92)	2-3/8 (60)
		41, 43, 44, 46	3-5/8 (92)	7-1/8 (181)	10-7/8 (276)	3½ (89)	2¾ (70)
	1½	51, 52, 53, 55	3-5/8 (92)	7-1/8 (181)	10-7/8 (276)	3-5/8 (92)	2¾ (70)
			4 (102)	7¼ (184)	11-¾ (298)	4 (102)	3¼ (83)
			4 (102)	7-¾ (197)	11-¾ (298)	4 (102)	3¼ (83)
	2	61, 63	3-15/16 (100)	7¼ (184)	11-¾ (298)	3-7/8 (98)	3-1/16 (78)
			62, 64	4-7/8 (124)	7-¾ (197)	12-11/16 (322)	4½ (114)

a - To find the corresponding flow coefficients for these port codes, refer to "3-Way Ball Valve Assemblies with Sizes, Port Codes, and Cvs" on page 4 of document F-27086.

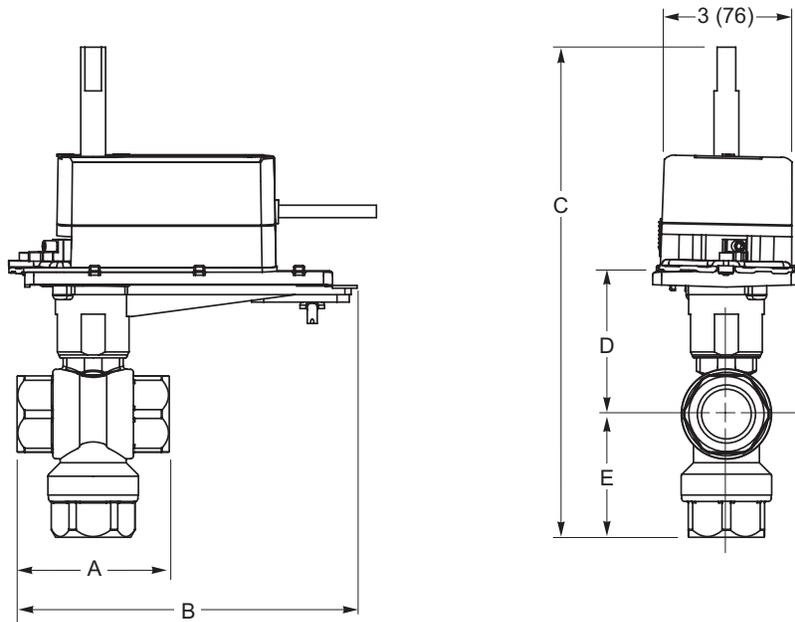


Figure 2. Mx41-6043 or Mx41-6083 with 3-Way Ball Valve.

### 2-Way Ball Valve Assembly Dimensions

Valve Assembly Part Number	Valve Size in.	P Code <sup>a</sup>	Valve Dimensions in inches (mm) Refer to Figure 3			
			A	B	C	D
2-Way VA-22x3-522-9-P VA-22x3-526-9-P VA-22x3-532-9-P VA-22x3-536-9-P VF-22x3-526-9-P VF-22x3-536-9-P VS-22x3-526-9-P VS-22x3-536-9-P	1/2	1, 2, 3, 4, 5, 7	2-3/8 (60)	7-3/8 (187)	8 1/4 (210)	3-1/8 (79)
		6	2-5/8 (67)	7-3/8 (187)	8 1/2 (216)	3-3/8 (86)
	3/4	11, 12, 13, 14, 15, 17	2-7/16 (62)	7-3/8 (187)	8 1/4 (210)	3 1/4 (83)
		16, 18	2 3/4 (70)	7-3/8 (187)	8 1/2 (216)	3-3/8 (86)
	1	21, 23	3-1/16 (78)	7-3/8 (187)	8-7/8 (225)	3-5/8 (92)
		22, 25	2 3/4 (70)	7-3/8 (187)	8 1/2 (216)	3-3/8 (86)
		24, 26	4 1/2 (114)	8 (203)	9-3/8 (238)	3-7/8 (98)
		27	3 (76)	7-3/8 (187)	8-7/8 (225)	3-5/8 (92)
	1 1/4	41, 42, 43, 45	3 (76)	7-3/8 (187)	8-7/8 (225)	3-5/8 (92)
		44, 46	3-5/8 (92)	7-3/4 (197)	9-3/8 (238)	3-3/4 (95)
	1 1/2	51, 53	3-7/16 (87)	7-3/4 (197)	9-3/8 (238)	3-3/4 (95)
		52, 54	4-1/16 (103)	7-7/8 (200)	9-7/8 (251)	4-1/16 (103)
	2	61, 65	3-15/16 (100)	7-7/8 (200)	9-7/8 (251)	4 (102)
		63, 66, 67	4-15/16 (125)	8-3/8 (123)	10 1/2 (267)	4-7/16 (113)
	2 1/2	71, 72, 76, 73, 74, 75	5-3/8 (137)	8-5/8 (219)	10-3/4 (273)	4 1/2 (114)
	3	82, 85	5-11/16 (144)	8-3/4 (222)	10-11/16 (271)	4 1/4 (108)

a - To find the corresponding flow coefficients for these port codes, refer to "2-Way Ball Valve Assemblies with Sizes, Port Codes, and Cvs." on page 4 of document F-27086.

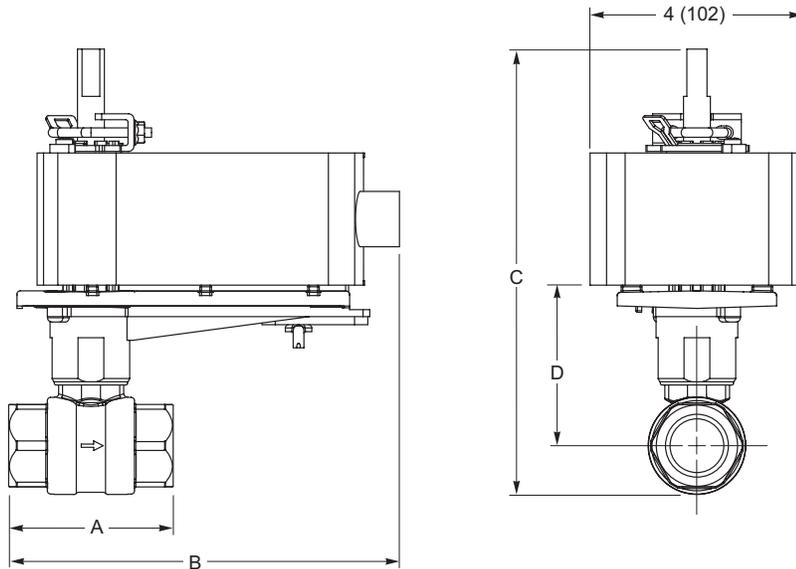


Figure 3. Mx40-704x with 2-Way Ball Valve.

### 3-Way Ball Valve Assembly Dimensions

Valve Assembly Part Number	Valve Size in.	P Code <sup>a</sup>	Valve Dimensions in inches (mm) Refer to Figure 4				
			A	B	C	D	E
3-Way VA-2313-526-9-P VA-2313-536-9-P VF-2313-526-9-P VF-2313-536-9-P VS-2313-526-9-P VS-2313-536-9-P	½	1, 2, 3, 4, 5, 6	2-5/8 (67)	7-3/8 (187)	9-¾ (248)	3-5/16 (84)	2 (51)
	¾	11, 12, 13, 14, 15, 16	2¾ (70)	7-3/8 (187)	9-¾ (248)	¾ (83)	2 (51)
	1	21, 22, 23, 24, 25, 28	2¾ (70)	7-3/8 (187)	9-13/16 (249)	¾ (83)	2-1/8 (54)
			4¼ (108)	8 (203)	11-5/8 (295)	3-5/8 (92)	3-1/16 (78)
		26, 29, 31	4¼ (108)	8-1/8 (206)	11½ (292)	¾ (89)	3-1/8 (79)
	1¼	45	3 (76)	7-3/8 (187)	10-5/8 (270)	3-5/8 (92)	2-3/8 (60)
		41, 43, 44, 46	3-5/8 (92)	7-¾ (197)	10-7/8 (276)	¾ (89)	2¾ (70)
	1½	51, 52, 53, 55	3-5/8 (92)	7-¾ (197)	10-7/8 (276)	3-5/8 (92)	2¾ (70)
			4 (102)	7-7/8 (200)	11-¾ (298)	4 (102)	¾ (83)
		56	4 (102)	8-3/8 (213)	11-¾ (298)	4 (102)	¾ (83)
	2	61, 63	3-15/16 (100)	7-7/8 (200)	11-¾ (298)	3-7/8 (98)	3-1/16 (78)
			62, 64	4-7/8 (124)	8-3/8 (213)	12-11/16 (322)	4½ (114)

a - To find the corresponding flow coefficients for these port codes, refer to "3-Way Ball Valve Assemblies with Sizes, Port Codes, and Cvs" on page 4 of document F-27086.

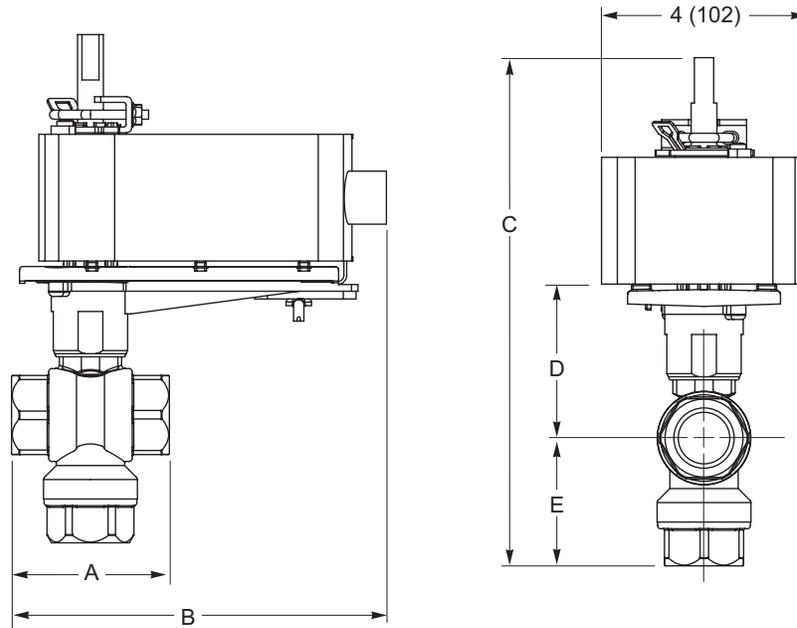


Figure 4. Mx40-704x with 3-Way Ball Valve.

### 2-Way Ball Valve Assembly Dimensions

Valve Assembly Part Number	Valve Size in.	P Code <sup>a</sup>	Valve Dimensions in inches (mm) Refer to Figure 5			
			A	B	C	D
2-Way VA-22x3-815-9-P	½	1, 2, 3, 4, 5, 7	2-3/8 (60)	8¼ (210)	8¼ (210)	3-1/8 (79)
		6	2-5/8 (67)	8¼ (210)	8½ (216)	3-3/8 (86)
VA-22x3-817-9-P VA-22x3-821-9-P VA-22x3-831-9-P	¾	11, 12, 13, 14, 15, 17	2-7/16 (62)	8¼ (210)	8¼ (210)	¾ (83)
		16, 18	2¾ (70)	8¼ (210)	8½ (216)	3-3/8 (86)
VF-22x3-821-9-P VF-22x3-831-9-P	1	21, 23	3-1/16 (78)	8¼ (210)	8-7/8 (225)	3-5/8 (92)
		22, 25	2¾ (70)	8¼ (210)	8½ (216)	3-3/8 (86)
		24, 26	4½ (114)	8-7/8 (225)	9-3/8 (238)	3-7/8 (98)
VS-22x3-821-9-P VS-22x3-831-9-P		27	3 (76)	8¼ (210)	8-7/8 (225)	3-5/8 (92)

a - To find the corresponding flow coefficients for these port codes, refer to "2-Way Ball Valve Assemblies with Sizes, Port Codes, and Cvs." on page 4 of document F-27086.

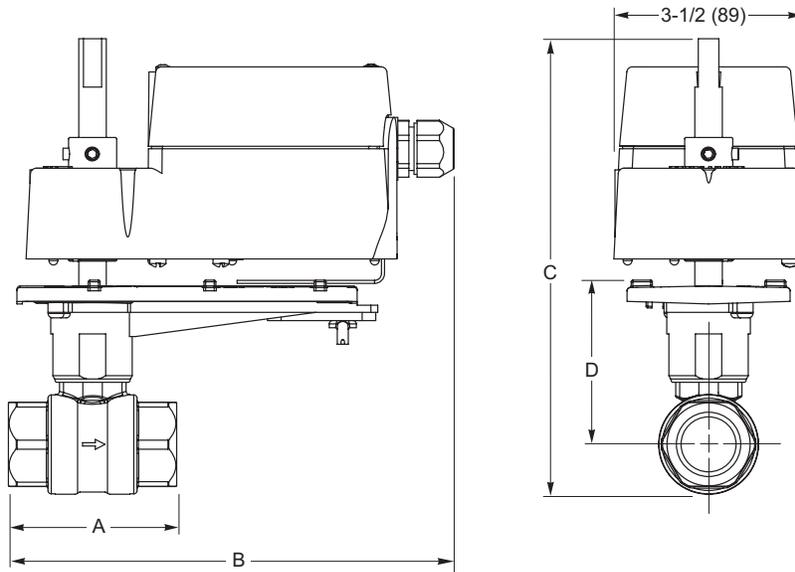


Figure 5. MA4D-7033, MF4D-7033, MS4D-7033, MA4D-8033, MF4D-8033, or MS4D-8033 with 2-Way Ball Valve.

### 3-Way Ball Valve Assembly Dimensions

Valve Assembly Part Number	Valve Size in.	P Code <sup>a</sup>	Valve Dimensions in inches (mm) Refer to Figure 6				
			A	B	C	D	E
3-Way	½	1, 2, 3, 4, 5, 6	2-5/8 (67)	8½ (216)	9-¾ (248)	3-5/16 (84)	2 (51)
VA-2313-815-9-P VA-2313-817-9-P	¾	11, 12, 13, 14, 15, 16	2¾ (70)	8½ (216)	9-¾ (248)	¾ (83)	2 (51)
VA-2313-821-9-P VA-2313-831-9-P	1	21, 22, 23, 24, 25, 28	2¾ (70)	8½ (216)	9-13/16 (249)	¾ (83)	2-1/8 (54)
		27, 30	4¼ (108)	8-7/8 (225)	11-5/8 (295)	3-5/8 (92)	3-1/16 (78)
VF-2313-821-9-P VF-2313-831-9-P		26, 29, 31	4¼ (108)	9 (229)	11½ (292)	¾ (89)	3-1/8 (79)
VS-2313-821-9-P VS-2313-831-9-P							

a - To find the corresponding flow coefficients for these port codes, refer to "3-Way Ball Valve Assemblies with Sizes, Port Codes, and Cvs" on page 4 of document F-27086.

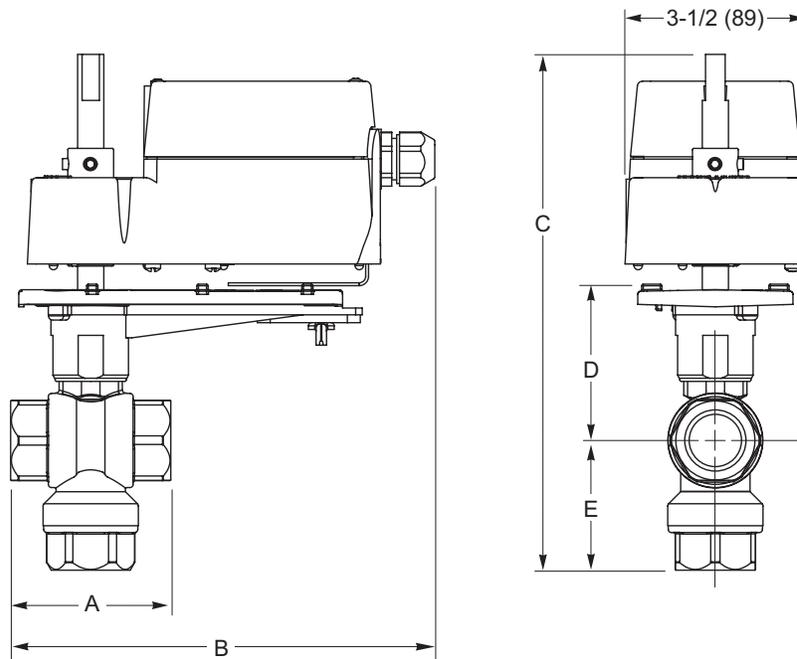


Figure 6. MA4D-7033, MF4D-7033, MS4D-7033, MA4D-8033, MF4D-8033, or MS4D-8033 with 3-Way Ball Valve.

## Installation Considerations

### Mounting Angle of Valve Assembly

Be sure to allow the necessary clearance around the valve assembly. The valve assembly must be mounted so that the actuator is horizontally even with, or above, the valve. This ensures that any condensate that forms on the valve body will not travel into the actuator, where it may cause corrosion or electrical malfunction. See Vx-2x13-5xx-9-xx Series Ball Valve Assembly Installation Instructions, F-27087 or Mx4D-xxxx Series SmartX Rotary Overshaft Actuators Installation Instructions, F-27170.

### Piping

Figure 7 illustrates 2-Way, 3-Way Mixing and 3-Way Diverting ball valve assembly piping.

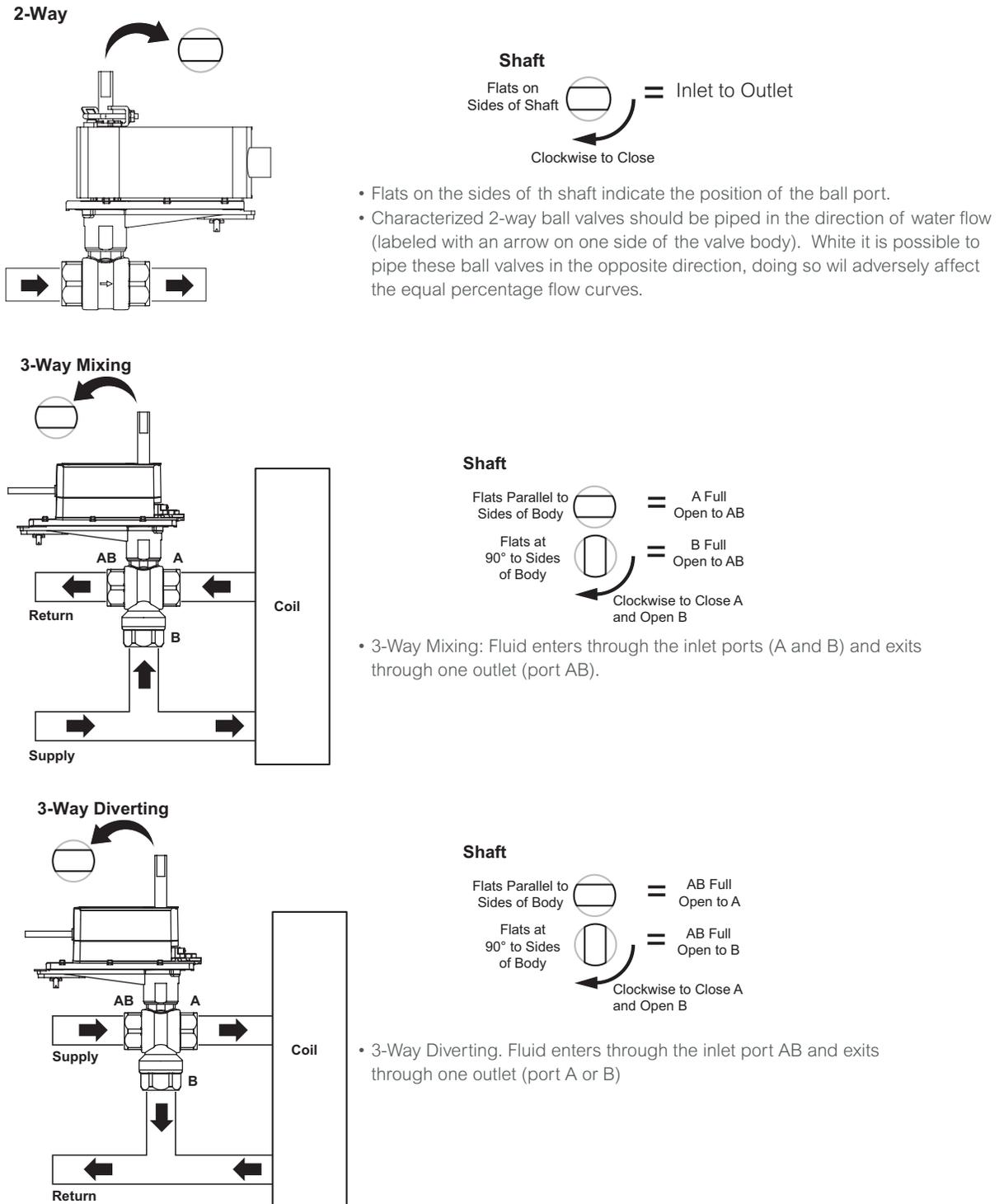


Figure 7. 2-Way, 3-Way Mixing and 3-Way Diverting Valve Assemblies Piping Diagram.

## Insulation of Ball Valve Assembly

The ball valve should be completely insulated to minimize the effect of heat transfer and condensation at the actuator.

Caution: The actuator itself must not be insulated. Doing so can result in excess heat or condensation within the actuator.

## Temperature Limits for Ball Valve Assembly

When installing the ball valve assembly, observe the minimum and maximum temperature limits. Refer to the valve and actuator specifications..

## Water System Maintenance

All heating and cooling systems are susceptible to valve and system problems caused by improper water treatment and system storage procedures. Durability of valve stems and packings is dependent on maintaining non-damaging water conditions. Inadequate water treatment or filtration, not in accordance with chemical supplier or ASHRAE handbook recommendations, can result in corrosion, scale, and abrasive particle formation. Scale and particulates can cause scratches in the stem and packing, and can adversely affect packing life and other parts of the hydronic system. Consult EN-205, Water System Guidelines Engineering Information, F-26080, for further details.

## Sizing and Selection

### Flow Coefficient (Cv)

When sizing a valve, you must select a flow coefficient (Cv), which is defined as the flow rate in gallons per minute (GPM) of 60 °F water that will pass through the fully open valve with a 1 psi pressure drop (ΔP). It is calculated according to this formula:

$$Cv = \frac{gpm}{\sqrt{\Delta P}}$$

where ΔP is measured in psi.

Since the flow rate through the heat exchanger is usually specified, the only variable normally available in sizing a valve is the pressure drop. The following information in this section can be used to determine what pressure drop to use in calculating a valve Cv. Once you have calculated the Cv, select the valve body having the nearest available Cv.

NOTE: Metric equivalent

The metric measure of flow coefficient is kvs, which is calculated according to the formula:  $kvs = \frac{m^3/h}{\sqrt{\Delta P}}$  (where ΔP is measured in bar; 1 bar = 100 kPa).

If the Cv is already known, it may be converted directly to its kvs equivalent:  $kvs = \frac{Cv}{1.156}$

## Two-position Control

Two-position control valves are normally selected “line size” to keep pressure drop at a minimum. If it is desirable to reduce the valve below line size, then 10% of “available pressure” (that is, the pump pressure differential available between supply and return mains, with design flow at the valve location) is normally used to select the valve.

## Flow Characterization: Proportional/Floating Control

The Vx-2x13-xxx-9-xx series ball valve assemblies provide equal percentage flow, which is achieved with a flow characterizing insert (Figure 8). The parabolic shape of the orifice allows a gradual change in flow, so that equal movements of the valve stem, at any point of the flow range, change the existing flow an equal percentage, regardless of the flow rate. As shown in the graph in Figure 9, a ball valve equipped with the flow insert mirrors the flow characteristic of the coil, resulting in linear heat transfer.

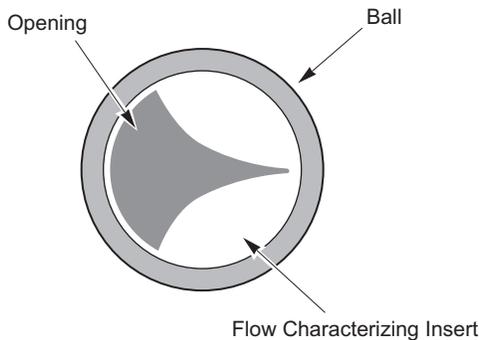


Figure 8. Flow Characterizing Insert.

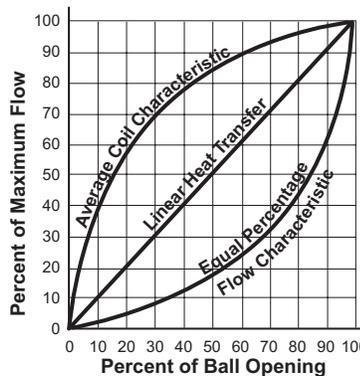


Figure 9. Equal Percentage Flow Control.

Proportional control valves are usually selected to take a pressure drop equal to at least 50% of the “available pressure.” As “available pressure” is often difficult to calculate, the normal procedure is to select the valve using a pressure drop at least equal to the drop in the coil or other load being controlled (except where small booster pumps are used) with a minimum recommended pressure drop of 5 psi (34 kPa). When the design temperature drop is less than 60 °F (33 °C) for conventional heating systems, higher pressure drops across the valve are needed for good results.

### Conventional Heating System

Design Temperature Load Drop °F (°C)	Recommended Pressure Drop (% of Available Pressure)	Multiplier on Load Drop
60 (33) or More	50%	1 x Load Drop
40 (22)	66%	2 x Load Drop
20 (11)	75%	3 x Load Drop

Secondary Circuits with Small Booster Pumps: 50% of available pressure difference (equal to the drop through load, or 50% of the booster pump head).

### 3-Way Valves

3-way valves used in variable flow applications (Figure 7) should be sized using the preceding guidelines. 3-way valves used in constant flow applications, such as boiler bypass, should be sized to use 20% of "available pressure," or equal to 25% of the pressure drop through the load at full flow.

### Cavitation Limitations on Valve Pressure Drop

A valve selected with too high a pressure drop can cause erosion and/or wire drawing of the flow characterizing insert. In addition, cavitation can cause noise, damage to the valve trim (and possibly the body), and choke the flow through the valve.

A valve selected with too high a pressure drop can cause erosion of seals and/or wire drawing of the seat. In addition, can cause noise, damage to the valve trim (and possibly the body), and choke the flow. Do not exceed the maximum differential pressure (pressure drop) for the valve selected.

The following formula can be used on higher temperature water systems, where cavitation could be a problem, to estimate the maximum allowable pressure drop across the valve:

$$P_m = 0.5 (P_1 - P_v)$$

Where:

$P_m$  = Maximum allowable pressure drop (psi)

$P_1$  = Absolute inlet pressure (psia)

$P_v$  = Absolute vapor pressure (psia)

Note: Add 14.7 psi to gauge supply pressure to obtain absolute pressure value.

For example, if a valve is controlling 200°F water at an inlet pressure of 18 psig, the maximum pressure drop allowable would be:

$$P_m = 0.5 [(18 + 14.7) - 11.53] = 10.6 \text{ psi}$$

(Vapor pressure of 200°F water is 11.53 psia)

Systems where cavitation is shown to be a problem can sometimes be adjusted to provide higher downstream back pressures. Valves having harder seat materials should be furnished if velocities are excessive.

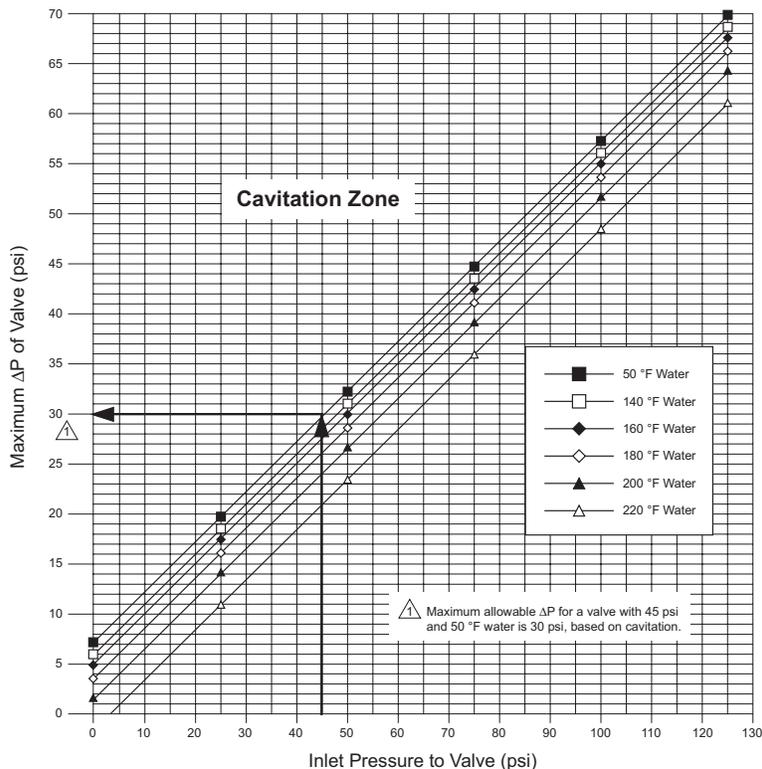


Figure 10. Maximum Allowable Differential Pressure (ΔP) for Water Valves.

## Using Pipe Reducers with 2-Way Ball Valve Assemblies

The following table provides estimated effective Cvs when using a 2-way valve assembly on the same or larger pipe size. Use these estimated effective Cvs in place of the rated Cvs along with at least 6 valve size diameters of straight pipe upstream and 3 valve size diameters of straight pipe downstream of the valve body.

Notice: Do not reduce the valve size to less than one-half the line size, as this may weaken the pipe reduction area. Physical injury can result if the weakened piping fails.

**Estimated Effective Cv when Using Pipe Reducers with 2-Way Ball Valve Assemblies.**

Valve Size in.	P Code	C <sub>v</sub>	Estimated Effective Cv (Kvs)																	
			Pipe Size - inches (NPT)																	
			½	¾	1	1¼	1½	2	2½	3	4	5								
½	01	0.38	0.38 (0.33)	0.38 (0.33)	0.38 (0.33)															
	02	0.68	0.68 (0.59)	0.68 (0.59)	0.68 (0.59)															
	03	1.3	1.3 (1.12)	1.3 (1.12)	1.3 (1.12)															
	04	2.6	2.6 (2.24)	2.5 (2.16)	2.5 (2.16)															
	05	4.7	4.7 (4.06)	4.3 (3.71)	4.1 (3.54)															
	06	8.0	8.0 (6.9)	6.5 (5.6)	5.7 (4.9)															
	07	11.7 <sup>a</sup>	11.7 (10.1)	7.9 (6.8)	6.7 (5.8)															
¾	11	0.31		0.31 (0.27)	0.31 (0.27)	0.31 (0.27)	0.31 (0.27)													
	12	0.63		0.63 (0.54)	0.63 (0.54)	0.63 (0.54)	0.63 (0.54)													
	13	1.2		1.2 (1.04)	1.2 (1.04)	1.2 (1.04)	1.2 (1.04)													
	14	2.5		2.5 (2.16)	2.5 (2.16)	2.5 (2.16)	2.5 (2.16)													
	15	4.3		4.3 (3.71)	4.3 (3.71)	4.2 (3.63)	4.2 (3.63)													
	16	10.1		10.1 (8.7)	9.6 (8.3)	9.1 (7.9)	8.8 (7.6)													
	17	14.7 <sup>a</sup>		14.7 (12.7)	7.1 (6.1)	6.5 (5.6)	6.2 (5.4)													
18	28.6 <sup>a</sup>		28.6 (24.7)	21.1 (18.2)	17.1 (14.8)	15.4 (13.3)														
1	21	4.4			4.4 (3.8)	4.4 (3.8)	4.4 (3.8)	4.4 (3.8)												
	22	9.0			9.0 (7.8)	8.9 (7.4)	8.8 (7.6)	8.7 (7.5)												
	23	15.3			15.3 (13.2)	14.9 (12.9)	14.4 (12.5)	13.8 (11.9)												
	24	26.1			26.1 (22.5)	24.4 (21.1)	22.4 (19.4)	20.3 (17.5)												
	25	28.4 <sup>a</sup>			28.4 (24.6)	26.2 (22.7)	23.8 (20.6)	21.4 (18.5)												
	26	43.9 <sup>a</sup>			43.9 (38.0)	36.8 (31.8)	31.0 (26.8)	26.1 (22.6)												
	27	54.2 <sup>a</sup>			54.2 (46.8)	42.3 (36.6)	34.1 (29.5)	27.9 (24.1)												
1¼	41	4.4				4.4 (3.8)	4.4 (3.8)	4.4 (3.8)	4.4 (3.8)											
	42	8.3				8.3 (7.2)	8.3 (7.2)	8.2 (7.1)	8.2 (7.1)											
	43	14.9				14.9 (12.9)	14.8 (12.8)	14.5 (12.5)	14.3 (12.3)											
	44	36.5				36.5 (31.6)	35.0 (30.3)	31.5 (27.2)	29.6 (25.6)											
	45	41.1 <sup>a</sup>				41.1 (35.5)	39.0 (33.7)	34.3 (29.7)	31.9 (27.5)											
	46	102.3 <sup>a</sup>				102.3 (88.1)	79.1 (68.4)	53.3 (46.1)	45.5 (39.3)											
1½	51	22.8					22.8 (19.7)	22.4 (19.4)	22.0 (19.0)	21.8 (18.9)										
	52	41.3					41.3 (35.7)	39.3 (33.9)	37.2 (32.1)	36.0 (31.1)										
	53	73.9 <sup>a</sup>					73.9 (63.9)	63.7 (55.1)	55.9 (48.4)	52.0 (45.0)										
	54	171.7 <sup>a</sup>					171.7 (148.5)	101.2 (87.5)	76.6 (66.3)	67.2 (58.0)										
2	61	41.7						41.7 (36.1)	41.2 (35.6)	40.6 (35.1)	39.7 (34.3)									
	63	71.1						71.1 (61.4)	68.8 (59.5)	65.9 (57.0)	62.4 (53.9)									
	65	108.0 <sup>a</sup>						108.0 (93.4)	100.3 (86.8)	92.0 (79.6)	83.0 (71.8)									
	66	210.0						210.0 (181.7)	165.9 (143.5)	134.6 (116.4)	110.5 (95.6)									
	67	266.0 <sup>a</sup>						266.0 (229.7)	189.7 (164.1)	146.4 (126.6)	116.7 (100.8)									
2½	71	45.0							45.0 (38.9)	43.6 (37.7)	42.5 (36.8)	42.0 (36.3)								
	72	55.0							55.0 (47.5)	52.5 (45.3)	50.6 (43.7)	49.7 (42.9)								
	73	72.3							72.3 (62.5)	66.6 (57.6)	63.0 (54.5)	61.2 (52.9)								
	74	101.0							101.0 (87.4)	87.5 (75.7)	79.7 (68.9)	76.2 (65.9)								
	75	162.0							162.0 (140.0)	119.0 (102.9)	101.3 (87.6)	94.3 (81.6)								
	76	202.0 <sup>a</sup>							202.0 (174.4)	132.4 (114.5)	109.3 (94.5)	100.6 (87.0)								
3	82	63.0								63.0 (54.4)	56.7 (49.0)	55.5 (47.9)								
	85	145.0 <sup>a</sup>								145.0 (125.2)	96.8 (83.7)	90.6 (78.4)								

a - Denotes a full port valve, without the characterized insert.

## Using Pipe Reducers with 3-Way Ball Valve Assemblies

The following table provides estimated effective Cvs when using a 3-way valve assembly on the same or larger pipe size. Use these estimated effective Cvs in place of the rated Cvs along with at least 6 valve size diameters of straight pipe upstream and 3 valve size diameters of straight pipe downstream of the valve body.

Notice: Do not reduce the valve size to less than one-half the line size, as this may weaken the pipe reduction area. Physical injury can result if the weakened piping fails.

**Estimated Effective Cv when Using Pipe Reducers with 3-Way Ball Valve Assemblies.**

Valve Size in.	P Code	Cv	Estimated Effective Cv (kvs)						
			Pipe Size - inches (NPT)						
			½	¾	1	1¼	1½	2	2½
½	01	0.33	0.33 (0.29)	0.33 (0.29)	0.33 (0.29)				
	02	0.59	0.59 (0.51)	0.59 (0.51)	0.59 (0.51)				
	03	1.0	1.0 (0.86)	1.0 (0.86)	1.0 (0.86)				
	04	2.4	2.4 (2.1)	2.3 (2.0)	2.3 (2.0)				
	05	4.3	4.3 (3.7)	4.0 (3.5)	3.8 (3.3)				
	06	8.0 <sup>a</sup>	8.0 (6.9)	7.9 (6.8)	5.7 (4.9)				
¾	11	0.40		0.40 (0.35)	0.40 (0.35)	0.40 (0.35)	0.40 (0.35)		
	12	0.66		0.66 (0.57)	0.66 (0.57)	0.66 (0.57)	0.66 (0.57)		
	13	1.3		1.3 (1.12)	1.3 (1.12)	1.3 (1.12)	1.3 (1.12)		
	14	2.4		2.4 (2.1)	2.4 (2.1)	2.4 (2.1)	2.4 (2.1)		
	15	3.8		3.8 (3.3)	3.8 (3.3)	3.74 (3.23)	3.7 (3.2)		
	16	11		11 (9.5)	10.4 (9.0)	9.8 (8.5)	9.4 (8.1)		
1	21	0.40			0.40 (0.35)	0.40 (0.35)	0.40 (0.35)	0.40 (0.35)	
	22	0.65			0.65 (0.56)	0.60 (0.52)	0.60 (0.52)	0.60 (0.52)	
	23	1.3			1.3 (1.1)	1.3 (1.1)	1.3 (1.1)	1.3 (1.1)	
	24	2.3			2.3 (2.0)	2.3 (2.0)	2.3 (2.0)	2.3 (2.0)	
	25	3.5			3.5 (3.0)	3.5 (3.0)	3.5 (3.0)	3.5 (3.0)	
	26	4.5			4.5 (3.9)	4.5 (3.9)	4.5 (3.9)	4.5 (3.9)	
	27	8.6			8.6 (7.4)	8.5 (7.3)	8.4 (7.2)	8.3 (7.2)	
	28	10.0 <sup>a</sup>			10.0 (8.6)	9.9 (8.6)	9.7 (8.4)	9.6 (8.3)	
	29	14.9			14.9 (12.9)	14.6 (12.6)	14.1 (12.2)	13.5 (11.7)	
	30	22.3 <sup>a</sup>			22.3 (19.2)	21.2 (18.3)	19.9 (17.2)	18.4 (15.9)	
31	30.8 <sup>a</sup>			30.8 (26.6)	28.0 (24.2)	25.2 (21.8)	22.3 (19.3)		
1¼	41	4.1				4.1 (3.5)	4.0 (3.5)	4.0 (3.5)	4.0 (3.5)
	43	8.7				8.7 (7.5)	8.6 (7.4)	8.6 (7.4)	8.5 (7.4)
	44	12.7				12.7 (11.0)	12.6 (10.9)	12.4 (10.7)	12.3 (10.6)
	45	19.4 a				19.4 (16.8)	19.2 (16.6)	18.5 (16.0)	18.1 (15.7)
	46	34.1 a				34.1 (29.4)	32.9 (28.4)	29.9 (25.9)	28.3 (24.4)
1½	51	4.0					4.0 (3.5)	4.0 (3.5)	4.0 (3.5)
	52	8.3					8.3 (7.2)	8.2 (7.1)	8.2 (7.1)
	53	13.4					13.4 (11.6)	13.3 (11.5)	13.2 (11.4)
	54	23.5					23.5 (20.3)	23.1 (19.9)	22.7 (19.6)
	55	32.0 <sup>a</sup>					32.0 (27.7)	31.0 (26.8)	30.0 (25.9)
	56	61.1 <sup>a</sup>					61.1 (52.8)	54.9 (47.5)	49.7 (43.0)
2	61	23.9						23.9 (20.7)	23.5 (20.3)
	62	38.2						38.2 (33.0)	37.8 (32.7)
	63	56.7 <sup>a</sup>						56.7 (49.0)	55.5 (47.9)
	64	108.5 <sup>a</sup>						108.5 (93.9)	100.7 (87.1)

a - Denotes a full port valve, without the characterized insert.