Zero Differential Pressure Type Pilot Operated

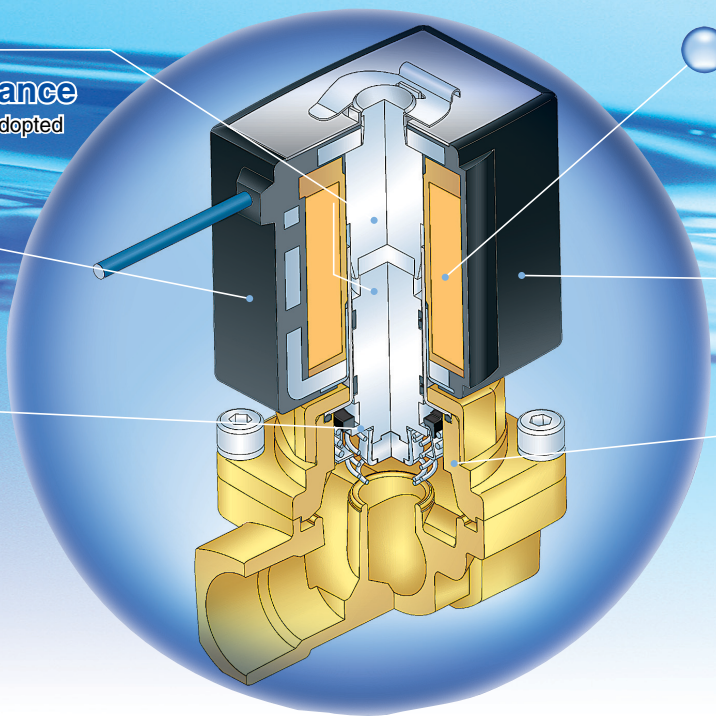
2 Port Solenoid Valve

For Air, Water, Oil

SMC

CAT.ES70-31A

Solenoid valves for various fluids used in a wide variety of



Improved corrosion resistance
Special magnetic material adopted

Enclosure: IP65

Low-noise construction
Special construction enables to reduce the metal noise. (DC spec.)

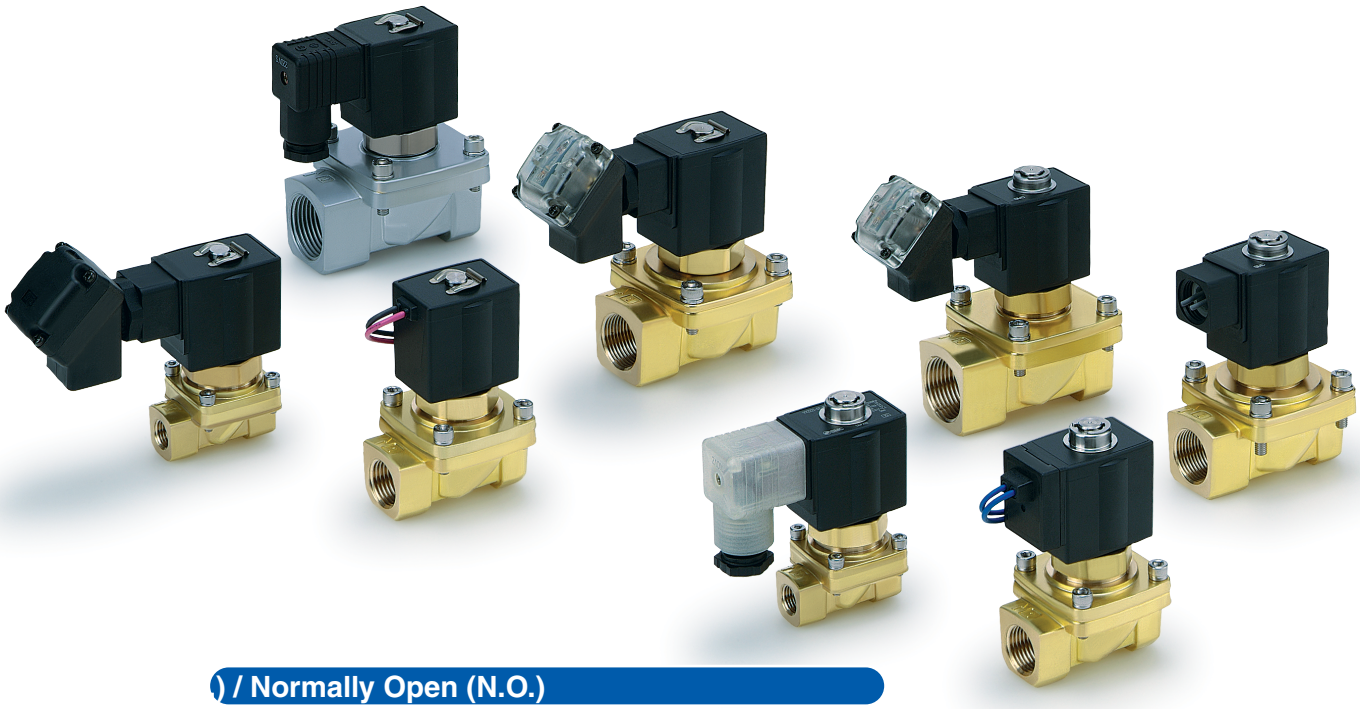
Reduced power consumption (DC spec.)
VXZ22: 8 W → **7 W**
VXZ23: 11.5 W → **10.5 W**

Flame resistance UL94V-0 conformed
Flame resistant mold coil material

Improved maintenance performance
Maintenance is performed easily due to the threaded assembly.

Pilot Operated 2 Port Solenoid Valve

For Air, Water, Oil | **New Series VXZ22/23**



) / Normally Open (N.O.)

Solenoid valve (Port size)			Orifice size				Material	
Model	VXZ22	VXZ23	3 (10 mmø)	4 (15 mmø)	5 (20 mmø)	6 (25 mmø)	Body	Seal
Port no. (Port size)	**02** (1/4)	—	●	—	—	—	Brass (C37) Stainless steel	NBR
	03 (3/8)	—	●	—	—	—		
	04 (1/2)	—	—	●	—	—		
	—	**06** (3/4)	—	—	●	—		
	—	**10** (1)	—	—	—	●		

applications — New VX Series variations

Direct Operated 2 Port

New VX21/22/23

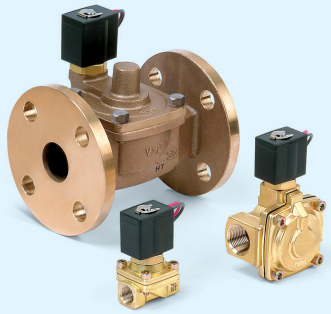
For Air, Vacuum, Water, Steam, Oil

Valve type	Port size	Orifice size mmø
N.C./N.O.	1/8 to 1/2	2 to 10

Pilot Operated 2 Port

New VXD21/22/23

For Water, Oil, Air

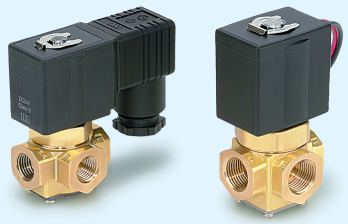


Valve type	Port size	Orifice size mmø
N.C./N.O.	1/4 to 1 32 A to 50 A	10 to 50

Direct Operated 3 Port

New VX31/32/33

For Air, Vacuum, Water, Steam, Oil

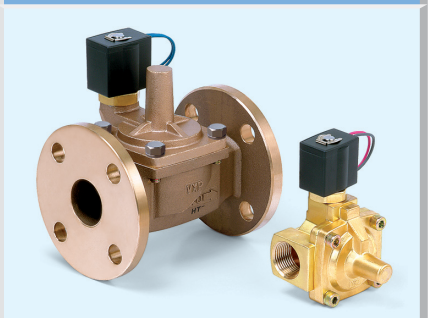


Valve type	Port size	Orifice size mmø
N.C./N.O. COM.	1/8 to 3/8	1.5 to 4

Pilot Operated 2 Port

VXP21/22/23

For Steam (Air, Water, Oil)

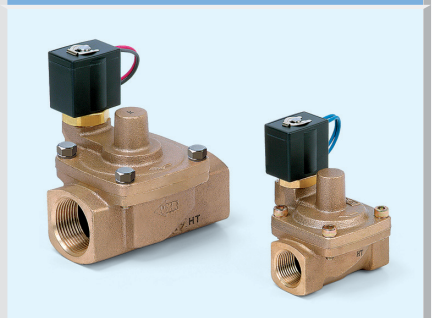


Valve type	Port size	Orifice size mmø
N.C./N.O.	1/4 to 2 32 A to 50 A	10 to 50

Water Hammer Relief, Pilot Operated 2 Port

VXR21/22/23

For Water, Oil

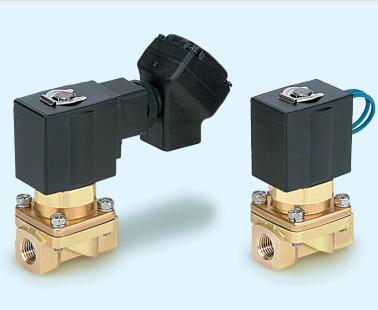


Valve type	Port size	Orifice size mmø
N.C./N.O.	1/2 to 2	20 to 50

Pilot Operated 2 Port for High Pressure

VXH22

For Air, Water, Oil

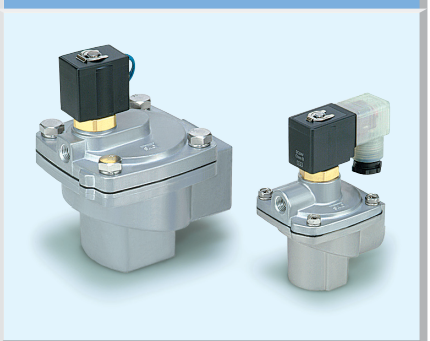


Valve type	Port size	Orifice size mmø
N.C.	1/4 to 1/2	10

2 Port for Dust Collector (Solenoid type, Air Operated type)

VXF21/22, VXFA21/22

For Air

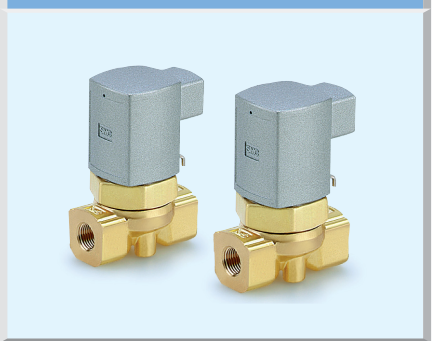


Valve type	Port size	Orifice size mmø
N.C.	3/4 to 1 1/2	20 to 40

Air Operated 2/3 Port

VXA21/22, VXA31/32

For Air, Vacuum, Water, Oil

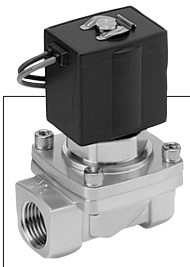


Model	Valve type	Port size	Orifice size mmø
VXA21/22	N.C./N.O.	1/8 to 1/2	3 to 10
VXA31/32	COM.	1/8 to 3/8	1.5 to 4

The **new VX series,** with its improved construction, replaces our prevous VX range.

Zero Differential Pressure Type
Pilot Operated
2 Port Solenoid Valve
Series VXZ22/23

For Air, Water, Oil



■ Valve

Normally closed (N.C.)
Normally open (N.O.)

■ Solenoid Coil

Coil: Class B, Class H

■ Rated Voltage

100 VAC, 200 VAC, 110 VAC,
220 VAC, 240 VAC, 230 VAC,
48 VAC, 24 VDC, 12 VDC

■ Material

Body — Brass (C37), Stainless steel
Seal — NBR, FKM, EPDM

■ Electrical Entry

- Grommet
- Conduit
- DIN terminal
- Conduit terminal

Model		VXZ223$^{2}_{0}$	VXZ224$^{2}_{0}$	VXZ235$^{2}_{0}$	VXZ236$^{2}_{0}$
Orifice size	10 mmø	●	—	—	—
	15 mmø	—	●	—	—
	20 mmø	—	—	●	—
	25 mmø	—	—	—	●
Port size (Flange)		1/4 (8A) 3/8 (10A)	1/2 (15A)	3/4 (20A)	1 (25A)

Common Specifications

Standard Specifications

Valve specifications	**Valve construction**		Zero differential pressure type pilot operated 2 port diaphragm type
	Withstand pressure (MPa)		5.0
	Body material		Brass (C37), Stainless steel
	Seal material		NBR, FKM, EPDM
	Enclosure		Dusttight, Low jetproof (equivalent to IP65)*
	Environment		Location without corrosive or explosive gases
	Vibration resistance/Impact resistance (m/s^2)		30/150 or less
Coil specifications	**Rated voltage**	**AC (Class B coil, Built-in full-wave rectifier type)**	100 VAC, 200 VAC, 110 VAC, 220 VAC, 230 VAC, 240 VAC, 48 VAC
		AC (Class H coil)	
		DC (Class B coil only)	24 VDC, 12 VDC
	Allowable voltage fluctuation		10% of rated voltage
	Allowable leakage voltage	**AC (Class B coil, Built-in full-wave rectifier type)**	10% or less of rated voltage
		AC (Class H coil)	20% or less of rated voltage
		DC (Class B coil only)	2% or less of rated voltage
	Coil insulation type		Class B, Class H

* Electrical entry: Grommet with surge voltage suppressor (GS) has a rating of IP40.

Solenoid Coil Specifications

DC Specification (Class B coil only)

Model	Power consumption (W)	Temperature rise (C) Note)
VXZ22	7	45
VXZ23	10.5	60

Note) The value at ambient temperature of 20C and when the rated voltage is applied.

AC Specification (Class B coil, Built-in full-wave rectifier type)

Model	Apparent power (VA) Note 2)	Temperature rise (C) Note 1)
VXZ22	9.5	60
VXZ23	12	65

Note 1) The value at ambient temperature of 20C and when the rated voltage is applied.

Note 2) There is no difference in the frequency and the inrush and energized apparent power, since a rectifying circuit is used in the AC (Class B coil, built-in full-wave rectifier type).

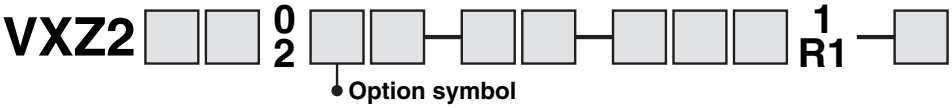
AC Specification (Class H coil)

Model		Apparent power (VA)		Temperature rise (C) Note)
	Frequency (Hz)	Inrush	Energized	
VXZ22	50	65	33	100
	60	55	27	95
VXZ23	50	94	50	120
	60	79	41	115

Note) The value at ambient temperature of 20C and when the rated voltage is applied.

Applicable Fluid Check List

All Options



Fluid and application	Option symbol	Seal material	Body/ Shading coil material Note 5)	Guide ring and push rod (N.O. only) material	Coil insulation type Note 3)	Note
Air	**Nil**	NBR	Brass (C37)/–	PPS	B	
	G		Stainless steel/–			
Water	**Nil**	NBR	Brass (C37)/–		B	
	G		Stainless steel/–			
Heated water	**E**	EPDM	Brass (C37)/Cu		H	
	P		Stainless steel/Ag			
Oil Note 2)	**A**	FKM	Brass (C37)/–		B	
	H		Stainless steel/–			
	D		Brass (C37)/Cu		H	
	N		Stainless steel/Ag			
High corrosive spec., Oil-free	**L** Note 1)	FKM	Stainless steel/–		B	
Copper-free, Fluoro-free Note 4)	**J**	EPDM	Stainless steel/–		B	
	P		Stainless steel/Ag		H	
Other combinations	**B**	EPDM	Brass (C37)/–		B	

Note 1) "L" option is the oil-free treatment.
Note 2) The dynamic viscosity of the fluid must not exceed 50 mm^2/s.
The special construction of the armature adopted in the built-in full-wave rectifier type gives an improvement in OFF response by providing clearance on the absorbed surface when it is switched ON.
Select the DC spec. or AC spec. built-in full-wave rectifier type when the dynamic viscosity is higher than water or when the OFF response is prioritized.
Note 3) Coil insulation type Class H: AC spec. only
Note 4) The nuts (non-wetted parts) are nickel-plated on the C37 material.
Note 5) There is no shading coil attached to the DC spec. or AC spec built-in full-wave rectifier type.

∗ Please contact SMC when fluids other than above are used.

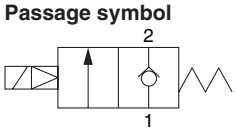
For Air

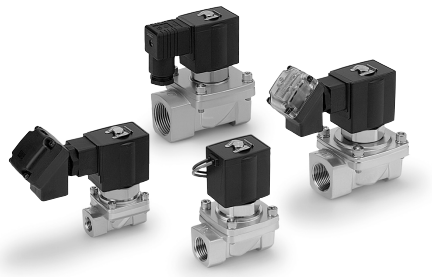
(Inert gas)

Model/Valve Specifications

N.C.

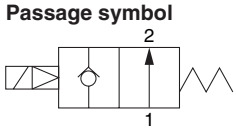
Passage symbol

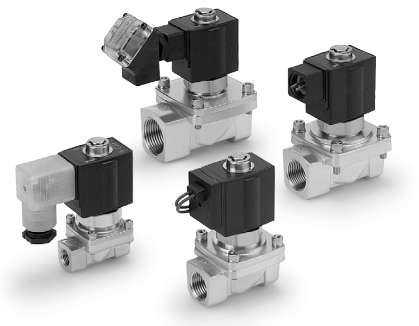




N.O.

Passage symbol





Normally Closed (N.C.)

Port size (Nominal size)	Orifice size (mmø)	Model	Min. operating pressure differential (MPa)	Max. operating pressure differential (MPa)		Flow characteristics			Max. system pressure (MPa)	Weight (g)
				AC	DC	C	b	Cv		
1/4 (8A)	10	**VXZ2230-02**	0	1.0	0.7	8.5	0.44	2.4	1.5	550
3/8 (10A)		**VXZ2230-03**				11.0	0.42	2.8		
1/2 (15A)	15	**VXZ2240-04**				23.0	0.34	6.0		760
3/4 (20A)	20	**VXZ2350-06**				38.0	0.20	9.5		1300

Port size (Nominal size)	Orifice size (mmø)	Model	Min. operating pressure differential (MPa)	Max. operating pressure differential (MPa)		Flow characteristics	Max. system pressure (MPa)	Weight (g)
				AC	DC	Effective area (mm^2)		
1 (25A)	25	**VXZ2360-10**	0	1.0	0.7	215	1.5	1480

Note) Weight of grommet type. Add 10 g for conduit type, 30 g for DIN terminal type, 60 g for conduit terminal type respectively.

• Refer to “Glossary of Terms” on page 20 for details on the max. operating pressure differential and the max. system pressure.

Normally Open (N.O.)

Port size (Nominal size)	Orifice size (mmø)	Model	Min. operating pressure differential (MPa)	Max. operating pressure differential (MPa)		Flow characteristics			Max. system pressure (MPa)	Weight (g)
				AC	DC	C	b	Cv		
1/4 (8A)	10	**VXZ2232-02**	0	0.7	0.6	8.5	0.44	2.4	1.5	600
3/8 (10A)		**VXZ2232-03**				11.0	0.42	2.8		
1/2 (15A)	15	**VXZ2242-04**				23.0	0.34	6.0		850
3/4 (20A)	20	**VXZ2352-06**				38.0	0.20	9.5		1370

Port size (Nominal size)	Orifice size (mmø)	Model	Min. operating pressure differential (MPa)	Max. operating pressure differential (MPa)		Flow characteristics	Max. system pressure (MPa)	Weight (g)
				AC	DC	Effective area (mm^2)		
1 (25A)	25	**VXZ2362-10**	0	0.7	0.6	215	1.5	1550

Note) Weight of grommet type. Add 10 g for conduit type, 30 g for DIN terminal type, 60 g for conduit terminal type respectively.

• Refer to “Glossary of Terms” on page 20 for details on the max. operating pressure differential and the max. system pressure.

Ambient and Fluid Temperature

Power source	Fluid temperature (C)	Ambient temperature (C)
	Solenoid valve option symbol	
	Nil, G	
AC/Class B coil	–10 to 60 Note)	–10 to 60
DC	–10 to 60 Note)	–10 to 60

Note) Dew point temperature: –10C or less

Valve Leakage Rate

Internal Leakage

Seal material	Leakage rate (Air)
NBR	1 cm^3/min or less

External Leakage

Seal material	Leakage rate (Air)
NBR	1 cm^3/min or less

How to Order

DC

AC/Class B coil (Built-in full-wave rectifier type)

VXZ 22 3 0 □ □ — 02 □ — 5 G 1 — □
VXZ 22 3 0 □ □ — 02 □ — 1 G R1 — □

Model
Refer to the table (1) shown below for availability.

Orifice size
Refer to the table (1) shown below for availability.

Valve/Body configuration

0	N.C. / Single unit
2	N.O. / Single unit

Solenoid valve option
Refer to the table (2) shown below for availability.

Suffix

Nil	—
Z	Oil-free spec.

Port size
Refer to the table (1) shown below for availability.

Thread type

Nil	Rc
T	NPTF
F	G
N	NPT

Rated voltage

1	100 VAC 50/60 Hz	**6**	12 VDC
2	200 VAC 50/60 Hz	**7**	240 VAC 50/60 Hz
3	110 VAC 50/60 Hz	**8**	48 VAC 50/60 Hz
4	220 VAC 50/60 Hz	**J**	230 VAC 50/60 Hz
5	24 VDC		

∗ Refer to the table (3) shown below for availability.

Refer to page 12 for ordering coil only.

Bracket

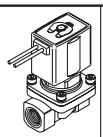
Nil	None
B	With bracket

∗ Bracket is not removable.

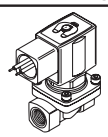
Built-in full-wave rectifier type

Electrical entry

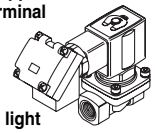
G -Grommet
GS-With grommet surge voltage suppressor



C-Conduit

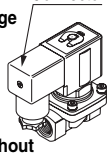


T -With conduit terminal
TS -With conduit terminal and surge voltage suppressor
TL -With conduit terminal and light
TZ -With conduit terminal, surge voltage suppressor and light



D -DIN terminal
DS -DIN terminal with surge voltage suppressor
DL -DIN terminal with light
DZ -DIN terminal with surge voltage suppressor and light
DO -For DIN terminal (without connector, gasket is included.)

Connector



∗ DIN type is available with class B only.

∗ Refer to the table (3) for the available combinations between each electrical option (S, L, Z) and rated voltage.
∗ Surge voltage suppressor is integrated into the AC/Class B, as a standard.

Table (1) Model – Orifice Size – Port Size
Normally Closed (N.C.) / Normally Open (N.O.)

Solenoid valve (Port size)			Orifice symbol (Diameter)				Material	
Model	**VXZ22**	**VXZ23**	3 (10 mmø)	4 (15 mmø)	5 (20 mmø)	6 (25 mmø)	Body	Seal
Port no. (Port size)	**02** (1/4)	—	●	—	—	—	Brass (C37), Stainless steel	NBR
	03 (3/8)	—	●	—	—	—		
	04 (1/2)	—	—	●	—	—		
	—	**06** (3/4)	—	—	●	—		
	—	**10** (1)	—	—	—	●		

Table (2) Solenoid Valve Option

Option symbol	Seal material	Body material	Coil insulation type	Note
Nil	NBR	Brass (C37)	B	—
G		Stainless steel		

Table (3) Rated Voltage – Electrical Option

Rated voltage			Class B			Class H		
			S	**L**	**Z**	**S**	**L**	**Z**
AC/DC	Voltage symbol	Voltage	With surge voltage suppressor	With light	With light and surge voltage suppressor	With surge voltage suppressor	With light	With light and surge voltage suppressor
AC	**1**	100 V	—	●	—	●	●	●
	2	200 V	—	●	—	●	●	●
	3	110 V	—	●	—	●	●	●
	4	220 V	—	●	—	●	●	●
	7	240 V	—	—	—	●	—	—
	8	48 V	—	—	—	●	—	—
	J	230 V	—	—	—	●	—	—
DC	**5**	24 V	●	●	●	DC spec. is not available.		
	6	12 V	●	—	—			

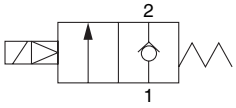
∗ Option “S”, “Z” are not available as surge voltage suppressor is integrated into the AC/Class B, as a standard.

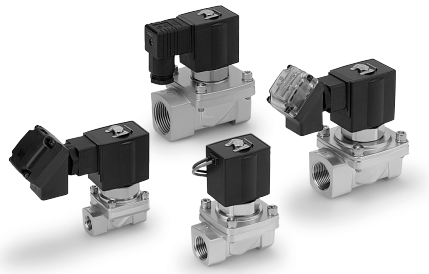
For Water

Model/Valve Specifications

N.C.

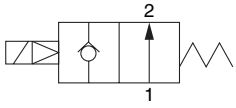
Passage symbol

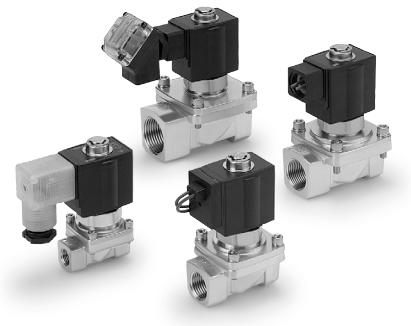




N.O.

Passage symbol





Normally Closed (N.C.)

Port size (Nominal size)	Orifice size (mmø)	Model	Min. operating pressure differential (MPa)	Max. operating pressure differential (MPa)		Flow characteristics		Max. system pressure (MPa)	Weight (g)
				AC	DC	Av x $10^{-6}m^2$	Cv converted		
1/4 (8A)	10	**VXZ2230-02**	0	1.0	0.7	46	1.9	1.5	550
3/8 (10A)		**VXZ2230-03**				58	2.4		
1/2 (15A)	15	**VXZ2240-04**				130	5.3		760
3/4 (20A)	20	**VXZ2350-06**			1.0	220	9.2		1300
1 (25A)	25	**VXZ2360-10**				290	12.0		1480

Note) Weight of grommet type. Add 10 g for conduit type, 30 g for DIN terminal type, 60 g for conduit terminal type respectively.
• Refer to “Glossary of Terms” on page 20 for details on the max. operating pressure differential and the max. system pressure.

Normally Open (N.O.)

Port size (Nominal size)	Orifice size (mmø)	Model	Min. operating pressure differential (MPa)	Max. operating pressure differential (MPa)		Flow characteristics		Max. system pressure (MPa)	Weight (g)
				AC	DC	Av x $10^{-6}m^2$	Cv converted		
1/4 (8A)	10	**VXZ2232-02**	0	0.7	0.6	46	1.9	1.5	600
3/8 (10A)		**VXZ2232-03**				58	2.4		
1/2 (15A)	15	**VXZ2242-04**				130	5.3		850
3/4 (20A)	20	**VXZ2352-06**				220	9.2		1370
1 (25A)	25	**VXZ2362-10**				290	12.0		1550

Note) Weight of grommet type. Add 10 g for conduit type, 30 g for DIN terminal type, 60 g for conduit terminal type respectively.
• Refer to “Glossary of Terms” on page 20 for details on the max. operating pressure differential and the max. system pressure.

Ambient and Fluid Temperature

Power source	Fluid temperature (C)		Ambient temperature (C)
	Solenoid valve option symbol		
	Nil, G, L	**E, P**	
AC/Class B coil	1 to 60	—	–10 to 60
AC/Class H coil	—	1 to 99	–10 to 60
DC	1 to 60	—	–10 to 60

Note) With no freezing

Valve Leakage Rate

Internal Leakage

Seal material	Leakage rate (Water)
NBR, FKM, EPDM	0.1 cm^3/min or less

External Leakage

Seal material	Leakage rate (Water)
NBR, FKM, EPDM	0.1 cm^3/min or less

How to Order

DC VXZ 22 3 0 □ □ — 02 □ — 5 G 1 — □
AC/Class H coil VXZ 22 3 0 □ □ — 02 □ — 1 G 1 — □
AC/Class B coil (Built-in full-wave rectifier type) VXZ 22 3 0 □ □ — 02 □ — 1 G R1 — □

Model
Refer to the table (1) shown below for availability.

Orifice size
Refer to the table (1) shown below for availability.

Valve/Body configuration

0	N.C. / Single unit
2	N.O. / Single unit

Solenoid valve option
Refer to the table (2) shown below for availability.

Bracket

Nil	None
B	With bracket

∗ Bracket is not removable.

Suffix

Nil	—
Z	Oil-free spec.

Select nil because the solenoid valve option "L" is the oil-free treatment.

Port size
Refer to the table (1) shown below for availability.

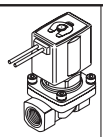
Built-in full-wave rectifier type

Thread type

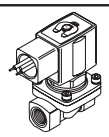
Nil	Rc
T	NPTF
F	G
N	NPT

Electrical entry

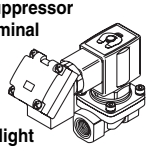
G -Grommet
GS-With grommet surge voltage suppressor



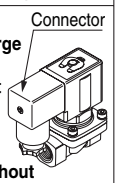
C-Conduit



T -With conduit terminal
TS -With conduit terminal and surge voltage suppressor
TL -With conduit terminal and light
TZ -With conduit terminal, surge voltage suppressor and light



D -DIN terminal
DS -DIN terminal with surge voltage suppressor
DL -DIN terminal with light
DZ -DIN terminal with surge voltage suppressor and light
DO -For DIN terminal (without connector, gasket is included.)



∗ DIN type is available with class B only.

Rated voltage

1	100 VAC 50/60 Hz	**6**	12 VDC
2	200 VAC 50/60 Hz	**7**	240 VAC 50/60 Hz
3	110 VAC 50/60 Hz	**8**	48 VAC 50/60 Hz
4	220 VAC 50/60 Hz	**J**	230 VAC 50/60 Hz
5	24 VDC		

∗ Refer to the table (3) shown below for availability.

Refer to page 12 for ordering coil only.

∗ Refer to the table (3) for the available combinations between each electrical option (S, L, Z) and rated voltage.
∗ Surge voltage suppressor is integrated into the AC/Class B, as a standard.

Table (1) Model – Orifice Size – Port Size
Normally Closed (N.C.) / Normally Open (N.O.)

Solenoid valve (Port size)			Orifice symbol (Diameter)				Material	
Model	VXZ22	VXZ23	3 (10 mmø)	4 (15 mmø)	5 (20 mmø)	6 (25 mmø)	Body	Seal
Port no. (Port size)	**02** (1/4)	—	●	—	—	—	Brass (C37), Stainless steel	NBR FKM EPDM
	03 (3/8)	—	●	—	—	—		
	04 (1/2)	—	—	●	—	—		
	—	**06** (3/4)	—	—	●	—		
	—	**10** (1)	—	—	—	●		

Table (2) Solenoid Valve Option

Option symbol	Seal material	Body/Shading coil material∗	Coil insulation type	Note
Nil	NBR	Brass (C37)/—	B	—
G		Stainless steel/—		
E	EPDM	Brass (C37)/Cu	H	Heated water (AC only)
P		Stainless steel/Ag		
L	FKM	Stainless steel/—	B	High corrosive, Oil-free

∗ There is no shading coil attached to the AC/Class B coil and DC spec.

Table (3) Rated Voltage – Electrical Option

Rated voltage			Class B			Class H		
			S	**L**	**Z**	**S**	**L**	**Z**
AC/DC	Voltage symbol	Voltage	With surge voltage suppressor	With light	With light and surge voltage suppressor	With surge voltage suppressor	With light	With light and surge voltage suppressor
AC	**1**	100 V	—	●	—	●	●	●
	2	200 V	—	●	—	●	●	●
	3	110 V	—	●	—	●	●	●
	4	220 V	—	●	—	●	●	●
	7	240 V	—	—	—	●	—	—
	8	48 V	—	—	—	●	—	—
	J	230 V	—	—	—	●	—	—
DC	**5**	24 V	●	●	●	DC spec. is not available.		
	6	12 V	●	—	—			

∗ Option "S", "Z" are not available as surge voltage suppressor is integrated into the AC/Class B, as a standard.
∗ Class B and H coils cannot be interchanged in order to exchange the coils.
∗ AC/Class B (with built-in full wave rectifier type) can be interchanged with DC.

⚠ When the fluid is oil.

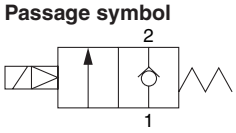
The dynamic viscosity of the fluid must not exceed 50 mm²/s.
The special construction of the armature adopted in the built-in full-wave rectifier type gives an improvement in OFF response by providing clearance on the absorbed surface when it is switched ON.
Select the DC spec. or AC spec. built-in full-wave rectifier type when the dynamic viscosity is higher than water or when the OFF response is prioritized.

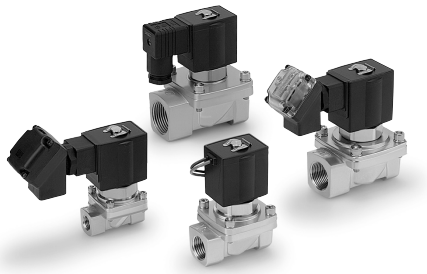
For Oil

Model/Valve Specifications

N.C.

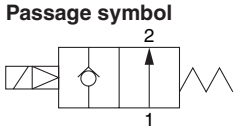
Passage symbol

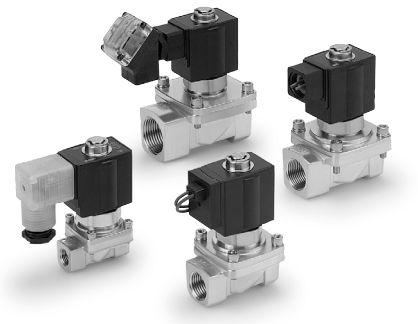




N.O.

Passage symbol





Normally Closed (N.C.)

Port size (Nominal size)	Orifice size (mmø)	Model	Min. operating pressure differential (MPa)	Max. operating pressure differential (MPa)		Flow characteristics		Max. system pressure (MPa)	Weight (g)
				AC	DC	Av x $10^{-6}m^2$	Cv converted		
1/4 (8A)	10	**VXZ2230-02**	0	0.7		46	1.9	1.5	550
3/8 (10A)		**VXZ2230-03**				58	2.4		
1/2 (15A)	15	**VXZ2240-04**				130	5.3		760
3/4 (20A)	20	**VXZ2350-06**				220	9.2		1300
1 (25A)	25	**VXZ2360-10**				290	12.0		1480

Note) Weight of grommet type. Add 10 g for conduit type, 30 g for DIN terminal type, 60 g for conduit terminal type respectively.
• Refer to “Glossary of Terms” on page 20 for details on the max. operating pressure differential and the max. system pressure.

Normally Open (N.O.)

Port size (Nominal size)	Orifice size (mmø)	Model	Min. operating pressure differential (MPa)	Max. operating pressure differential (MPa)		Flow characteristics		Max. system pressure (MPa)	Weight (g)
				AC	DC	Av x $10^{-6}m^2$	Cv converted		
1/4 (8A)	10	**VXZ2232-02**	0	0.7	0.6	46	1.9	1.5	600
3/8 (10A)		**VXZ2232-03**				58	2.4		
1/2 (15A)	15	**VXZ2242-04**				130	5.3		850
3/4 (20A)	20	**VXZ2352-06**				220	9.2		1370
1 (25A)	25	**VXZ2362-10**				290	12.0		1550

Note) Weight of grommet type. Add 10 g for conduit type, 30 g for DIN terminal type, 60 g for conduit terminal type respectively.
• Refer to “Glossary of Terms” on page 20 for details on the max. operating pressure differential and the max. system pressure.

Ambient and Fluid Temperature

Power source	Fluid temperature (C)		Ambient temperature (C)
	Solenoid valve option symbol		
	A, H	**D, N**	
AC/Class B coil	–5 to 60	—	–10 to 60
AC/Class H coil	—	–5 to 100	–10 to 60
DC	–5 to 60	—	–10 to 60

Note) Dynamic viscosity: 50 mm²/s or less

Valve Leakage Rate

Internal Leakage

Seal material	Leakage rate (Oil)
FKM	0.1 cm^3/min or less

External Leakage

Seal material	Leakage rate (Oil)
FKM	0.1 cm^3/min or less

How to Order

DC VXZ 22 3 0 □ □ — 02 □ — 5 G 1 — □
AC/Class H coil VXZ 22 3 0 □ □ — 02 □ — 1 G 1 — □
AC/Class B coil (Built-in full-wave rectifier type) VXZ 22 3 0 □ □ — 02 □ — 1 G R1 — □

Model
Refer to the table (1) shown below for availability.

Orifice size
Refer to the table (1) shown below for availability.

Valve/Body configuration

0	N.C. / Single unit
2	N.O. / Single unit

Solenoid valve option
Refer to the table (2) shown below for availability.

Bracket

Nil	None
B	With bracket

∗ Bracket is not removable.

Suffix

Nil	—
Z	Oil-free spec.

Port size
Refer to the table (1) shown below for availability.

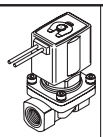
Built-in full-wave rectifier type

Thread type

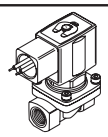
Nil	Rc
T	NPTF
F	G
N	NPT

Electrical entry

G -Grommet
GS-With grommet surge voltage suppressor



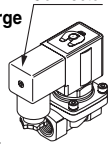
C-Conduit



T -With conduit terminal
TS -With conduit terminal and surge voltage suppressor
TL -With conduit terminal and light
TZ -With conduit terminal, surge voltage suppressor and light

D -DIN terminal
DS -DIN terminal with surge voltage suppressor
DL -DIN terminal with light
DZ -DIN terminal with surge voltage suppressor and light
DO -For DIN terminal (without connector, gasket is included.)

Connector



∗ DIN type is available with class B only.

Rated voltage

1	100 VAC 50/60 Hz	**6**	12 VDC
2	200 VAC 50/60 Hz	**7**	240 VAC 50/60 Hz
3	110 VAC 50/60 Hz	**8**	48 VAC 50/60 Hz
4	220 VAC 50/60 Hz	**J**	230 VAC 50/60 Hz
5	24 VDC		

∗ Refer to the table (3) shown below for availability.

Refer to page 12 for ordering coil only.

∗ Refer to the table (3) for the available combinations between each electrical option (S, L, Z) and rated voltage.
∗ Surge voltage suppressor is integrated into the AC/Class B, as a standard.

Table (1) Model – Orifice Size – Port Size
Normally Closed (N.C.) / Normally Open (N.O.)

Solenoid valve (Port size)			Orifice symbol (Diameter)				Material	
Model	**VXZ22**	**VXZ23**	3 (10 mmø)	4 (15 mmø)	5 (20 mmø)	6 (25 mmø)	Body	Seal
Port no. (Port size)	**02** (1/4)	—	●	—	—	—	Brass (C37), Stainless steel	FKM
	03 (3/8)	—	●	—	—	—		
	04 (1/2)	—	—	●	—	—		
	—	**06** (3/4)	—	—	●	—		
	—	**10** (1)	—	—	—	●		

Table (2) Solenoid Valve Option

Option symbol	Seal material	Body/Shading coil material∗	Coil insulation type
A	FKM	Brass (C37)/—	B
H		Stainless steel/—	
D		Brass (C37)/Cu	H
N		Stainless steel/Ag	

∗ There is no shading coil attached to the AC/Class B coil and DC spec.

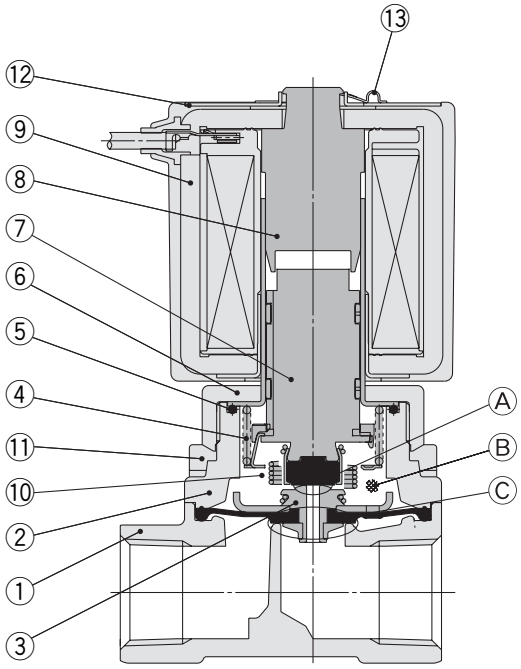
Table (3) Rated Voltage – Electrical Option

Rated voltage			Class B			Class H		
			S	**L**	**Z**	**S**	**L**	**Z**
AC/DC	Voltage symbol	Voltage	With surge voltage suppressor	With light	With light and surge voltage suppressor	With surge voltage suppressor	With light	With light and surge voltage suppressor
AC	**1**	100 V	—	●	—	●	●	●
	2	200 V	—	●	—	●	●	●
	3	110 V	—	●	—	●	●	●
	4	220 V	—	●	—	●	●	●
	7	240 V	—	—	—	●	—	—
	8	48 V	—	—	—	●	—	—
	J	230 V	—	—	—	●	—	—
DC	**5**	24 V	●	●	●	DC spec. is not available.		
	6	12 V	●	—	—			

∗ Option “S”, “Z” are not available as surge voltage suppressor is integrated into the AC/Class B, as a standard.
∗ Class B and H coils cannot be interchanged in order to exchange the coils.
∗ AC/Class B (with built-in full wave rectifier type) can be interchanged with DC.

Construction

Normally closed (N.C.)
Body material: Brass (C37), Stainless steel



Working principles

<Valve opened – when there is pressure>
When the coil ⑨ is energized, the armature assembly ⑦ is attacted into the core of the tube assembly ⑧ and the pilot valve Ⓐ is opened.
When the pilot valve is opened and the pressure inside the pilot chamber Ⓑ decreases, resulting in the pressure difference from the inlet pressure. Then the diaphragm assembly ③ is lifted and the main valve Ⓒ is opened.

<Valve opened – when there is no pressure or under low minute pressure>
The armature assembly ⑦ and the diaphragm assembly ③ are connected with each other with the lift spring ⑩. When the armature assembly is attracted, the diaphragm assembly is pulled up and the main valve Ⓒ is opened.

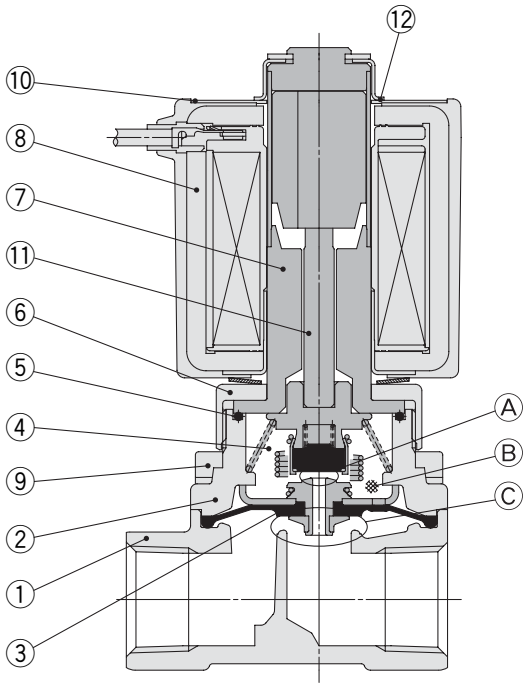
<Valve closed>
When the coil ⑨ is de-energized, the armature assembly ⑦ returns by the reacting force of the return spring ④ and the pilot valve Ⓐ is closed.
When the pilot valve is closed, the pressure inside the pilot chamber Ⓑ increases, resulting that the pressure difference from the inlet pressure is lost and the main valve Ⓒ is closed.

Component Parts

No.	Description	Material	
		Body material brass (C37) specification	Body material stainless steel specification
1	**Body**	Brass (C37)	Stainless steel
2	**Bonnet**	Brass (C37)	Stainless steel
3	**Diaphragm assembly**	Stainless steel (NBR, FKM, EPDM)	
4	**Return spring**	Stainless steel	
5	**O-ring**	(NBR, FKM, EPDM)	
6	**Nut**	Brass (C37)	Brass (C37), Ni plated
7	**Armature assembly**	Stainless steel	
8	**Tube assembly** Note)	Stainless steel, Cu	Stainless steel, Ag
9	**Solenoid coil**	—	
10	**Lift spring**	Stainless steel	
11	**Hexagon socket bolt**	Stainless steel	
12	**Name plate**	Aluminum	
13	**Clip**	SK	

The materials in parentheses are the seal materials.
Note) Cu and Ag are inapplicable to the DC spec and to the AC spec with built-in full-wave rectifier.

Normally open (N.O.)
Body material: Brass (C37), Stainless steel



Working principles

<Valve closed>
When the coil ⑨ is energized, the armature attacted by the core of the tube assembly ⑧ closes the pilot valve Ⓐ via the push rod assembly ⑪.
When the pilot valve is closed, the pressure inside the pilot chamber Ⓑ increases, resulting the the pressure difference from the inlet pressure is lost and the main valve Ⓒ is closed.

<Valve opened – when there is pressure>
The coil ⑨ is de-energized, the armature returns by the reacting force of the return spring ④ via the push rod assembly ⑪ and the pilot valve Ⓐ is opened.
When the pilot valve is opened, the pressure inside the chamber Ⓑ decreases, resulting in the pressure difference from the inlet pressure. Then the diaphragm assembly ③ is lifted and the main valve Ⓒ is opened.

<Valve opened – when there is no pressure or under low minute pressure>
The push rod assembly ⑪ and the diaphragm assembly ③ are connected with each other with the lift spring ⑩. When the push rod assembly returns, the diaphragm assembly is pulled up and the main valve Ⓒ is opened.

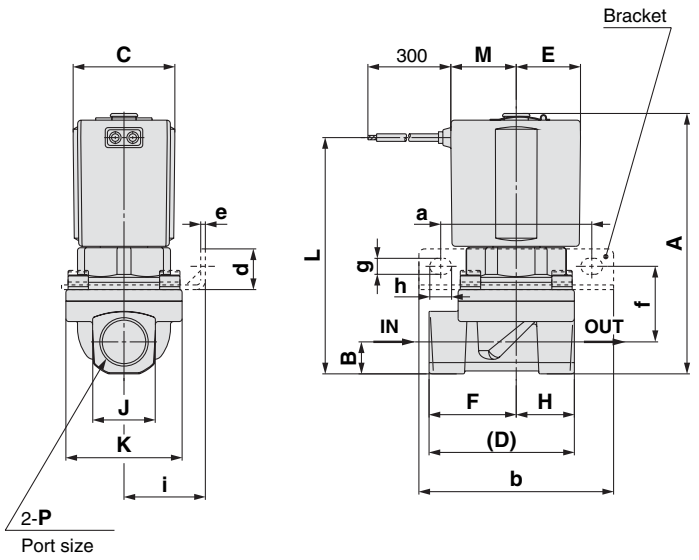
Component Parts

No.	Description	Material	
		Body material brass (C37) specification	Body material stainless steel specification
1	**Body**	Brass (C37)	Stainless steel
2	**Bonnet**	Brass (C37)	Stainless steel
3	**Diaphragm assembly**	Stainless steel (NBR, FKM, EPDM)	
4	**Return spring**	Stainless steel	
5	**O-ring**	NBR	FKM, EPDM
6	**Nut**	Brass (C37)	Brass (C37), Ni plated
7	**Armature assembly**	Stainless steel	
8	**Tube assembly** Note)	Stainless steel, Cu	Stainless steel, Ag
9	**Solenoid coil**	—	
10	**Lift spring**	Stainless steel	
11	**Push rod assembly**	PPS, Stainless steel, NBR	Stainless steel, FKM, EPDM
12	**Name plate**	Aluminum	
13	**Cover**	Stainless steel	

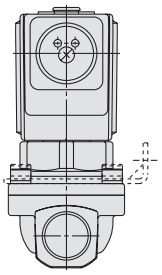
Dimensions/Body Material: Brass (C37), Stainless Steel

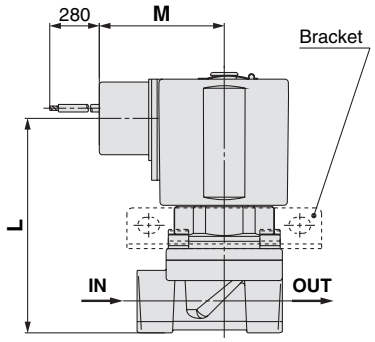
Normally closed (N.C.): VX21□0/VX22□0/VX23□0
Normally open (N.O.): VX21□2/VX22□2/VX23□2

Grommet: G

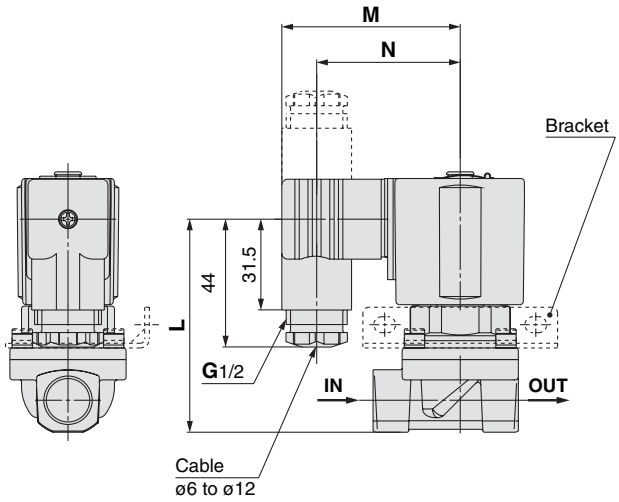


Conduit: C

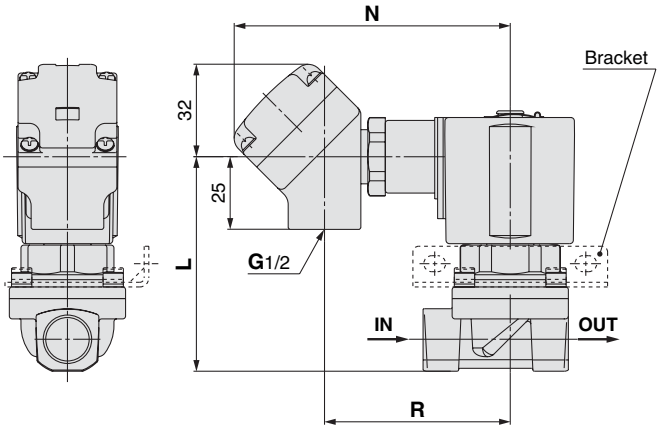




DIN terminal: D



Conduit terminal: T



(mm)

Model		Port size P	A	B	C	D	E	F	H	J	K	Electrical entry (DC, AC/Class H coil)									
												Grommet		Conduit		DIN terminal			Conduit terminal		
N.C.	N.O.											L	M	L	M	L	M	N	L	M	N
VXZ2230	**VXZ2232**	1/4, 3/8	90 (97)	11	35	50	22.5	30	20	22	40	81.5 (83)	22.5	74 (75.5)	43	73.5 (75)	61.5	49.5	74 (75.5)	95	64
VXZ2240	**VXZ2242**	1/2	98 (105)	14	35	63	22.5	37	26	29.5	52	89.5 (91)	22.5	82 (83.5)	43	81.5 (83)	61.5	49.5	82 (83.5)	95	64
VXZ2350	**VXZ2352**	3/4	110 (117.5)	18	40	80	25	47.5	32.5	36	65	101.5 (103.5)	25.5	94 (96)	46	93.5 (95.5)	64	52	94 (96)	98	66.5
VXZ2360	**VXZ2362**	1/1	116.5 (123)	21	40	90	25	55	35	40.5	70	108 (109)	25.5	100.5 (101.5)	46	100 (101)	64	52	100.5 (101.5)	98	66.5

( ) denotes the value for N.O.

(mm)

Model		Port size P	a	b	d	e	f	g	h	i	Electrical entry (AC/Class B coil)*									
											Grommet		Conduit		DIN terminal			Conduit terminal		
N.C.	N.O.										N	Q	N	Q	N	Q	R	N	Q	R
VXZ2230	**VXZ2232**	1/4, 3/8	52	67	14	1.6	26	5.5	7.5	28	77.5	33	72.5	51.5	73.5	68.5	56.5	72.5	103.5	72.5
VXZ2240	**VXZ2242**	1/2	60	75	17	2.3	33	6.5	8.5	35	85.5	33	80.5	51.5	81.5	68.5	56.5	80.5	103.5	72.5
VXZ2350	**VXZ2352**	3/4	68	87	22	2.6	40	6.5	9	43	97.5	36	92.5	54	93.5	71	59	92.5	106	75
VXZ2360	**VXZ2362**	1/1	73	92	22	2.6	45.5	6.5	9	45	104	36	99	54	100	71	59	99	106	75

* Coil with built-in full-wave rectifier (electrical option "R")

Replacement Parts

● Solenoid coil assembly part no.

DC

VX02 2 N — 5 G — □

Series

2	VXZ22□□
3	VXZ23□□

Rated voltage Note)

5	24 VDC
6	12 VDC

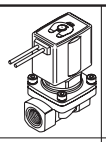
Note) Refer to the table (1) for the available combinations.

Valve

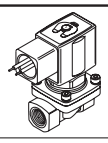
Symbol	Valve
Nil	N.C.
2	N.O.

Electrical entry

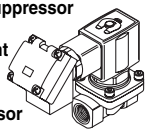
G -Grommet
GS-With grommet surge voltage suppressor



C-Conduit

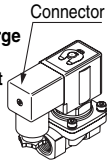


T -With conduit terminal
TS-With conduit terminal and surge voltage suppressor
TL-With conduit terminal and light
TZ-With conduit terminal, surge voltage suppressor and light



D -DIN terminal
DS-DIN terminal with surge voltage suppressor
DL-DIN terminal with light
DZ-DIN terminal with surge voltage suppressor and light
DO-For DIN terminal (without connector)

Connector



∗ Refer to the table (1) for the available combinations between each electrical option and rated voltage.

AC/Class H coil (DIN terminal is not available.)

VX02 2 N — 1 G — H — Z

Series

2	VXZ22□□
3	VXZ23□□

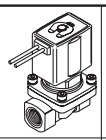
Rated voltage Note)

1	100 VAC 50/60 Hz
2	200 VAC 50/60 Hz
3	110 VAC 50/60 Hz
4	220 VAC 50/60 Hz
7	240 VAC 50/60 Hz
8	48 VAC 50/60 Hz
J	230 VAC 50/60 Hz

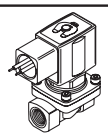
Note) Refer to the table (1) for the available combinations.

Electrical entry

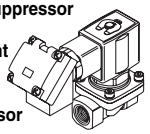
G -Grommet
GS-With grommet surge voltage suppressor



C-Conduit



T -With conduit terminal
TS-With conduit terminal and surge voltage suppressor
TL-With conduit terminal and light
TZ-With conduit terminal, surge voltage suppressor and light



∗ Refer to the table (1) for the available combinations between each electrical option and rated voltage.

AC/Class B coil (Built-in full-wave rectifier)

VX02 2 N — 1 G R — □

Series

2	VXZ22□□
3	VXZ23□□

Rated voltage Note)

1	100 VAC 50/60 Hz
2	200 VAC 50/60 Hz
3	110 VAC 50/60 Hz
4	220 VAC 50/60 Hz
7	240 VAC 50/60 Hz
8	48 VAC 50/60 Hz
J	230 VAC 50/60 Hz

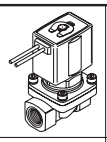
Note) Refer to the table (1) for the available combinations.

Valve

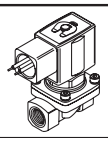
Symbol	Valve
Nil	N.C.
2	N.O.

Electrical entry

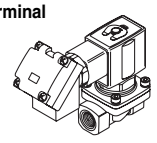
G-Grommet



C-Conduit

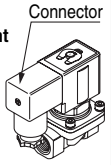


T -With conduit terminal
TL-With conduit terminal and light



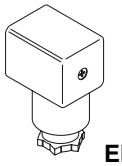
D -DIN terminal
DL-DIN terminal with light
DO-For DIN terminal (without connector, gasket is included.)

Connector



∗ Refer to the table (1) for the available combinations between each electrical option and rated voltage.
∗ The rectifier and the surge voltage suppressor are integrated as a standard.

● DIN connector part no.



Without electrical option **GDM2A**

With electrical option **GDM2A — □□**

Electrical option

L	With light

∗ Refer to the table (1) for the available combinations between each electrical option (S, L, Z) and rated voltage.

Rated voltage

1	100 VAC, 110 VAC
2	200 VAC, 220 VAC, 230 VAC, 240 VAC
5	24 VDC
6	12 VDC
15	48 VAC

● Gasket part no. for DIN connector

VCW20-1-29-1

Table (1) Rated Voltage – Electrical Option

Rated voltage			Class B			Class H		
			S	L	Z	S	L	Z
AC/DC	Voltage symbol	Voltage	With surge voltage suppressor	With light	With light and surge voltage suppressor	With surge voltage suppressor	With light	With light and surge voltage suppressor
AC	1	100 V	—	●	—	●	●	●
	2	200 V	—	●	—	●	●	●
	3	110 V	—	●	—	●	●	●
	4	220 V	—	●	—	●	●	●
	7	240 V	—	—	—	●	—	—
	8	48 V	—	—	—	●	—	—
	J	230 V	—	—	—	●	—	—
DC	5	24 V	●	●	●	DC spec. is not available.		
	6	12 V	●	—	—			

∗ Option “S”, “Z” are not available as surge voltage suppressor is integrated into the AC/Class B, as a standard.
∗ Replacement of solenoid coils:
• DC and AC coils cannot be interchanged in order to change the voltage.
• DC and AC (built-in full-wave rectifier type) coils can be interchanged in order to change the voltage.
• All DC coil voltages are interchangeable.
• All AC coil voltages are interchangeable.

● **Name plate part no.**

AZ-T-VX **Valve model**

↑ Enter by referring to "How to Order" (Single Unit).

● **Clip part no. (For N.C.)**

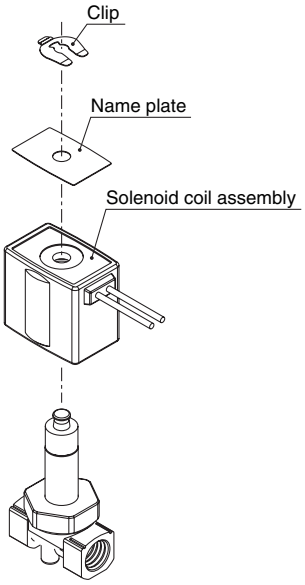
For VXZ22: VX022N-10

For VXZ23: VX023N-10

● **Clip part no. (For N.O.)**

For VXZ22: ETW-8

For VXZ23: ETW-9



Solenoid Valve Flow Characteristics
(How to indicate flow characteristics)

1. Indication of flow characteristics
The flow characteristics in equipment such as a solenoid valve, etc. are indicated in their specifications as shown in Table (1).

Table (1) Indication of Flow Characteristics

Corresponding equipment	Indication by international standard	Other indications	Conformed standard
Pneumatic equipment	*C*, *b*	—	**ISO 6358: 1989** **JIS B 8390: 2000**
	—	*S*	**JIS B 8390: 2000** **Equipment: JIS B 8373, 8374, 8375, 8379, 8381**
		Cv	**ANSI/(NFPA)T3.21.3: 1990**
Process fluid control equipment	*Av*	—	**IEC60534-2-3: 1997** **JIS B 2005: 1995** **Equipment: JIS B 8471, 8472, 8473**
	—	*Cv*	

2. Pneumatic equipment
2.1 Indication according to the international standards
(1) Conformed standard

ISO 6358: 1989 : Pneumatic fluid power—Components using compressible fluids—Determination of flow-rate characteristics

JIS B 8390: 2000 : Pneumatic fluid power—Components using compressible fluids—How to test flow-rate characteristics

(2) Definition of flow characteristics

The flow characteristics are indicated as a result of a comparison between sonic conductance ***C*** and critical pressure ratio ***b***.

Sonic conductance ***C*** : Value which divides the passing mass flow rate of an equipment in a choked flow condition by the product of the upstream absolute pressure and the density in a standard condition.

Critical pressure ratio ***b*** : Pressure ratio (downstream pressure/upstream pressure) which will turn to a choked flow when the value is smaller than this ratio.

Choked flow : The flow in which the upstream pressure is higher than the downstream pressure and where sonic speed in a certain part of an equipment is reached. Gaseous mass flow rate is in proportion to the upstream pressure and not dependent on the downstream pressure.

Subsonic flow : Flow greater than the critical pressure ratio

Standard condition : Air in a temperature state of 20C, absolute pressure 0.1 MPa (= 100 kPa = 1 bar), relative humidity 65%.
It is stipulated by adding the "(ANR)" after the unit depicting air volume.
(standard reference atmosphere)
Conformed standard: ISO 8778: 1990 Pneumatic fluid power—Standard reference atmosphere, JIS B 8393: 2000: Pneumatic fluid power—Standard reference atmosphere

(3) Formula for flow rate

It is described by the practical units as following.

When $\frac{P_2 + 0.1}{P_1 + 0.1} \leq b$, **choked flow**

$$Q = 600 \times C (P_1 + 0.1) \sqrt{\frac{293}{273 + t}} \quad \cdots\cdots (1)$$

When $\frac{P_2 + 0.1}{P_1 + 0.1} > b$, **subsonic flow**

$$Q = 600 \times C (P_1 + 0.1) \sqrt{1 - \left[\frac{\frac{P_2 + 0.1}{P_1 + 0.1} - b}{1 - b}\right]^2} \sqrt{\frac{293}{273 + t}} \quad \cdots\cdots (2)$$

Q : Air flow rate [dm³/min (ANR)], dm³ (Cubic decimeter) of SI unit are also allowed to be described by ℓ (liter). 1 dm³ = 1 ℓ

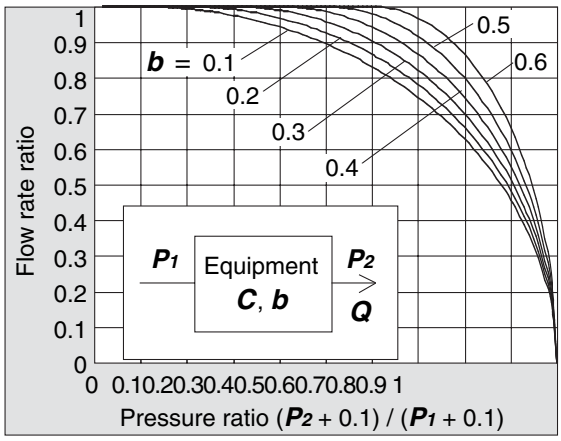
C : Sonic conductance [dm³/(s·bar)]
b : Critical pressure ratio [—]
P1 : Upstream pressure [MPa]
P2 : Downstream pressure [MPa]
t : Temperature [C]
Note) Formula of subsonic flow is the elliptic analogous curve.
Flow characteristics are shown in Graph (1) For details, please make use of SMC's "Energy Saving Program".

Example)
Obtain the air flow rate for P_1 = 0.4 [MPa], P_2 = 0.3 [MPa], t = 20 [C] when a solenoid valve is performed in C = 2 [dm³/(s·bar)] and b = 0.3.

According to formula 1, the maximum flow rate = $600 \times 2 \times (0.4 + 0.1) \times \sqrt{\frac{293}{273 + 20}} = 600$ [dm³/min (ANR)]

Pressure ratio = $\frac{0.3 + 0.1}{0.4 + 0.1} = 0.8$

Based on Graph (1), it is going to be 0.7 if it is read by the pressure ratio as 0.8 and the flow ratio to be b = 0.3.
Hence, flow rate = Max. flow x flow ratio = 600 x 0.7 = 420 [dm³/min (ANR)]



Graph (1) Flow characteristics

(4) Test method

Attach a test equipment with the test circuit shown in Fig. (1) while maintaining the upstream pressure to a certain level which does not go below 0.3 MPa. Next, measure the maximum flow to be saturated in the first place, then measure this flow rate at 80%, 60%, 40%, 20% and the upstream and downstream pressure. And then, obtain the sonic conductance C from this maximum flow rate. Besides that, substitute each data of others for the subsonic flow formula to find b, then obtain the critical pressure ratio b from that average.

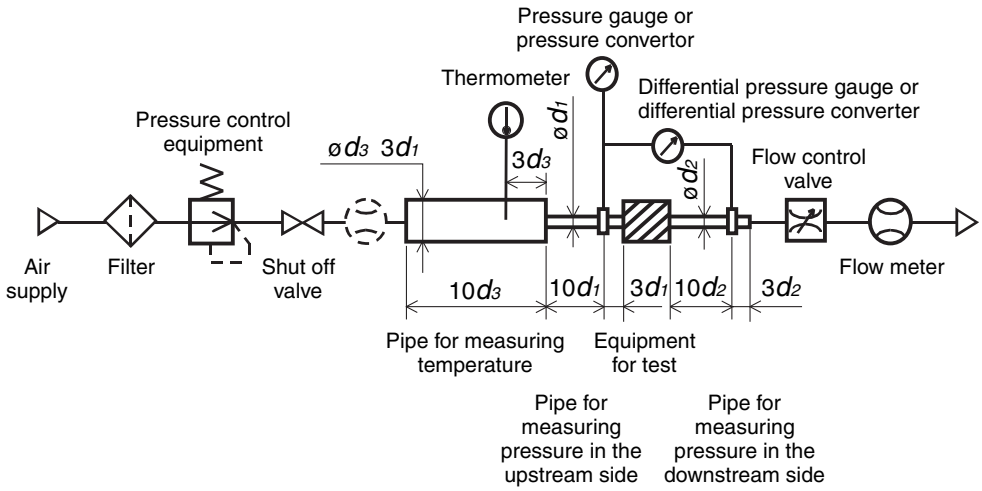


Fig. (1) Test circuit based on ISO 6358, JIS B 8390

Solenoid Valve Flow Characteristics

2.2 Effective area *S*

(1) Conformed standard

JIS B 8390: 2000: Pneumatic fluid power—Components using compressible fluids—Determination of flow rate characteristics

Equipment standards: JIS B 8373: 2 port solenoid valve for pneumatics
JIS B 8374: 3 port solenoid valve for pneumatics
JIS B 8375: 4 port, 5 port solenoid valve for pneumatics
JIS B 8379: Silencer for pneumatics
JIS B 8381: Fittings of flexible joint for pneumatics

(2) Definition of flow characteristics

Effective area ***S***: The cross-sectional area having an ideal throttle without friction deduced from the calculation of the pressure changes inside an air tank or without reduced flow when discharging the compressed air in a choked flow, from an equipment attached to the air tank. This is the same concept representing the "easy to run through" as sonic conductance ***C***.

(3) Formula for flow rate

When

$\frac{P_2 + 0.1}{P_1 + 0.1} \leq 0.5$, **choked flow**

$$Q = 120 \times S (P_1 + 0.1) \sqrt{\frac{293}{273 + t}} \quad \cdots\cdots(3)$$

When

$\frac{P_2 + 0.1}{P_1 + 0.1} > 0.5$, **subsonic flow**

$$Q = 240 \times S \sqrt{(P_2 + 0.1)(P_1 - P_2)} \sqrt{\frac{293}{273 + t}} \quad \cdots\cdots(4)$$

Conversion with sonic conductance ***C***:

$$S = 5.0 \times C \quad \cdots\cdots(5)$$

Q : Air flow rate[dm³/min(ANR)], dm³ (cubic decimeter) of SI unit are also allowed to be described by ℓ (liter) 1 dm³ = 1 ℓ
S : Effective area [mm²]
P_1 : Upstream pressure [MPa]
P_2 : Downstream pressure [MPa]
t : Temperature [C]

Note) Formula for subsonic flow (4) is only applicable when the critical pressure ratio ***b*** is the unknown equipment. In the formula (2) by the sonic conductance ***C***, it is the same formula as when ***b*** = 0.5.

(4) Test method

Attach a test equipment with the test circuit shown in Fig. (2) in order to discharge air into the atmosphere until the pressure inside the air tank goes down to 0.25 MPa (0.2 MPa) from an air tank filled with the compressed air at a certain pressure level (0.5 MPa) which does not go below 0.6 MPa. At this time, measure the discharging time and the residual pressure inside the air tank which had been left until it turned to be the normal values to determine the effective area ***S***, using the following formula. The volume of an air tank should be selected within the specified range by corresponding to the effective area of an equipment for test. In the case of JIS B 8373, 8374, 8375, 8379, 8381, the pressure values are in parentheses and the coefficient of the formula is 12.9.

$$S = 12.1 \frac{V}{t} \log_{10} \left(\frac{P_s + 0.1}{P + 0.1}\right) \frac{293}{T} \quad \cdots\cdots(6)$$

S : Effective area [mm²]
V : Air tank capacity [dm³]
t : Discharging time [s]
P_s : Pressure inside air tank before discharging [MPa]
P : Residual pressure inside air tank after discharging [MPa]
T : Temperature inside air tank before discharging [K]

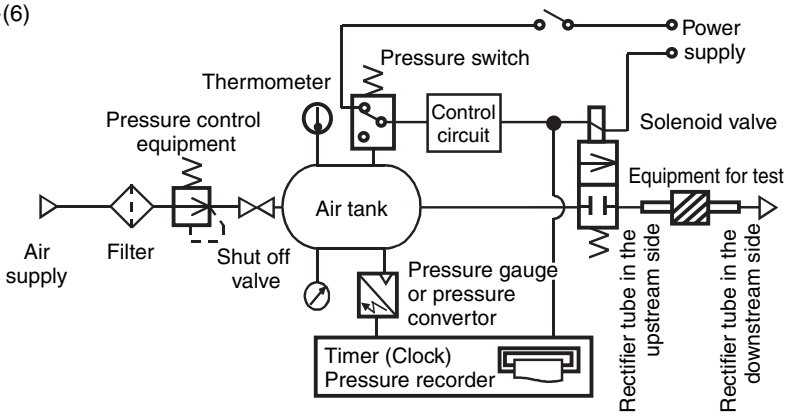


Fig. (2) Test circuit based on JIS B 8390

2.3 Flow coefficient *Cv* factor

The United States Standard ANSI/(NFPA)T3.21.3:1990: Pneumatic fluid power—Flow rating test procedure and reporting method for fixed orifice components

Defines the Cv factor of flow coefficient by the following formula which is based on the test conducted by the test circuit analogous to ISO 6358.

$$Cv = \frac{Q}{114.5\sqrt{\frac{P(P_2 + P_a)}{T_1}}} \quad \cdots\cdots(7)$$

P : Pressure drop between the static pressure tapping ports [bar]
P_1 : Pressure of the upstream tapping port [bar gauge]
P_2 : Pressure of the downstream tapping port [bar gauge]: $P_2 = P_1 - P$
Q : Flow rate [dm³/s standard condition]
Pa : Atmospheric pressure [bar absolute]
T_1 : Test conditions of the upstream absolute temperature [K]
is < $P_1 + P_a =$ 6.5 0.2 bar absolute, T_1 = 297 5K, 0.07 bar ***P*** 0.14 bar.
This is the same concept as effective area ***A*** which ISO6358 stipulates as being applicable only when the pressure drop is smaller than the upstream pressure and the compression of air does not become a problem.

3. Process fluid control equipment

(1) Conformed standard

IEC60534-2-3: 1997: Industrial process control valves. Part 2: Flow capacity, Section Three-Test procedures
JIS B 2005: 1995: Test method for the flow coefficient of a valve
Equipment standards: JIS B 8471: Solenoid valve for water
JIS B 8472: Solenoid valve for steam
JIS B 8473: Solenoid valve for fuel oil

(2) Definition of flow characteristics

Av factor: Value of the clean water flow rate represented by m³/s which runs through a valve (equipment for test) when the pressure difference is 1 Pa. It is calculated using the following formula.

$$Av = Q\sqrt{\frac{\rho}{P}} \quad \cdots\cdots(8)$$

Av : Flow coefficient [m²]
Q : Flow rate [m³/s]
P : Pressure difference [Pa]
ρ : Density of fluid [kg/m³]

(3) Formula of flow rate

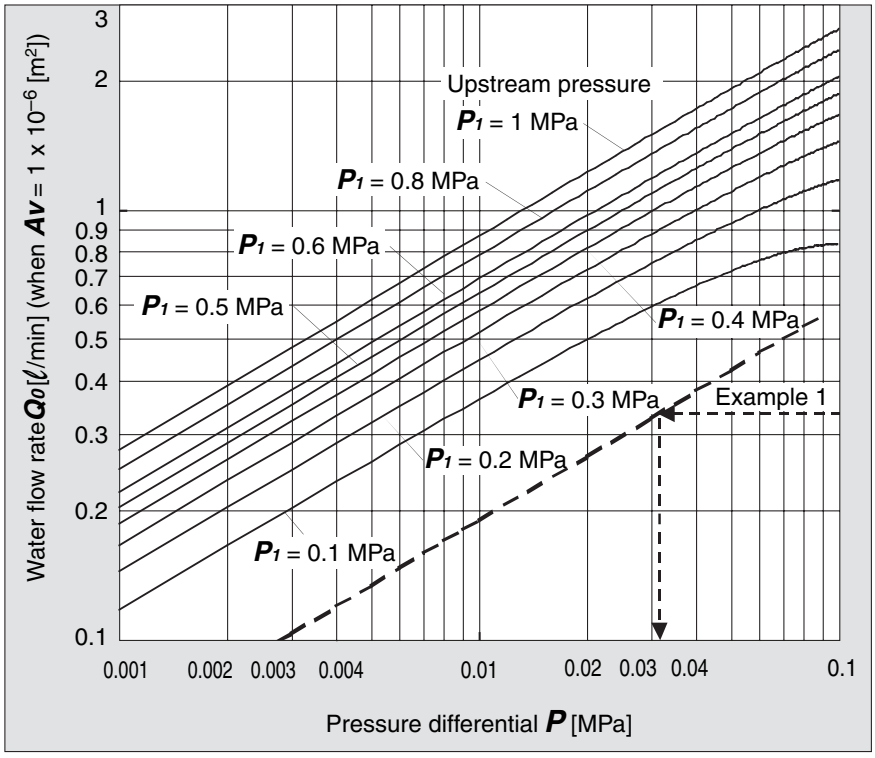
It is described by the practical units. Also, the flow characteristics are shown in Graph (2).
In the case of liquid:

$$Q = 1.9 \times 10^6 Av\sqrt{\frac{P}{G}} \quad \cdots\cdots(9)$$

Q : Flow rate [ℓ/min]
Av : Flow coefficient [m²]
P : Pressure difference [MPa]
G : Relative density [water = 1]

Solenoid Valve Flow Characteristics

Conversion of flow coefficient:
$Av = 28 \times 10^{-6}\ Kv = 24 \times 10^{-6}\ Cv$ ·····(10)
Here,
Kv factor: Value of the clean water flow rate represented by m^3/h which runs through a valve at 5 to 40C, when the pressure difference is 1 bar.
Cv factor (Reference values): Figures representing the flow rate of clean water by US gal/min which runs through a valve at 60F, when the pressure difference is 1 lbf/in^2 (psi).
Value is different from ***Kv*** and ***Cv*** factors for pneumatic purpose due to different test method.



Graph (2) Flow characteristics

Example 1)
Obtain the pressure difference when water 15 [ℓ/min] runs through a solenoid valve with an $Av = 45 \times 10^{-6}$ [m^2].
Since $Q_0 = 15/45 = 0.33$ [ℓ/min], according to Graph (2), if reading ***P*** when Q_0 is 0.33, it will be 0.031 [MPa].

(4) Test method
Attach a test equipment with the test circuit shown in Fig. (3). Next, pour water at 5 to 40C, then measure the flow rate with a pressure difference of 0.075 MPa. However, the pressure difference needs to be set with a large enough difference so that the Reynolds number does not go below a range of 4×10^4.
By substituting the measurement results for formula (8) to figure out ***Av***.

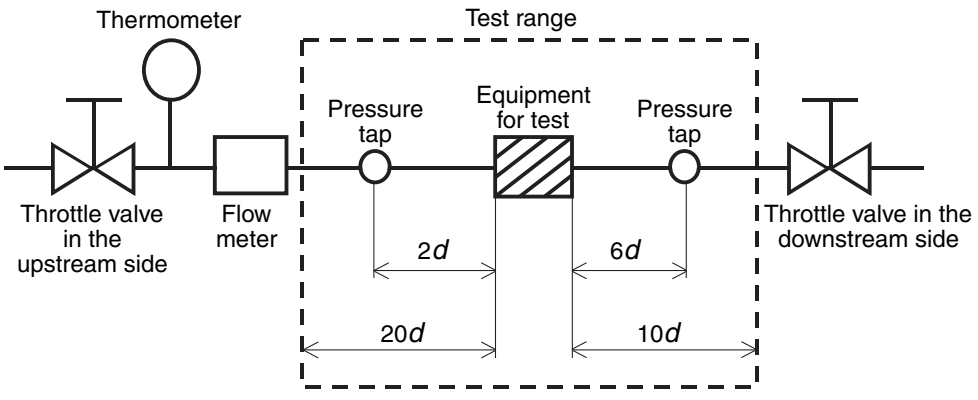
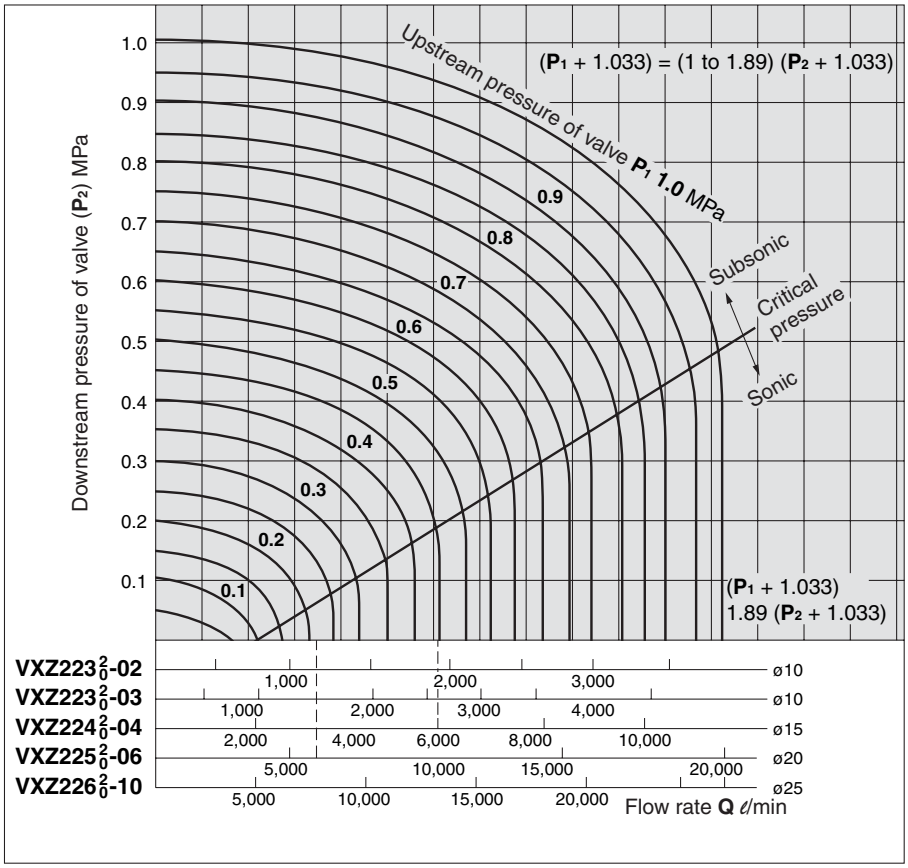


Fig. (3) Test circuit based on IEC60534-2-3, JIS B 2005

Flow Characteristics

Note) Use this graph as a guide. In the case of obtaining an accurate flow rate, refer to pages 14 through to 18.

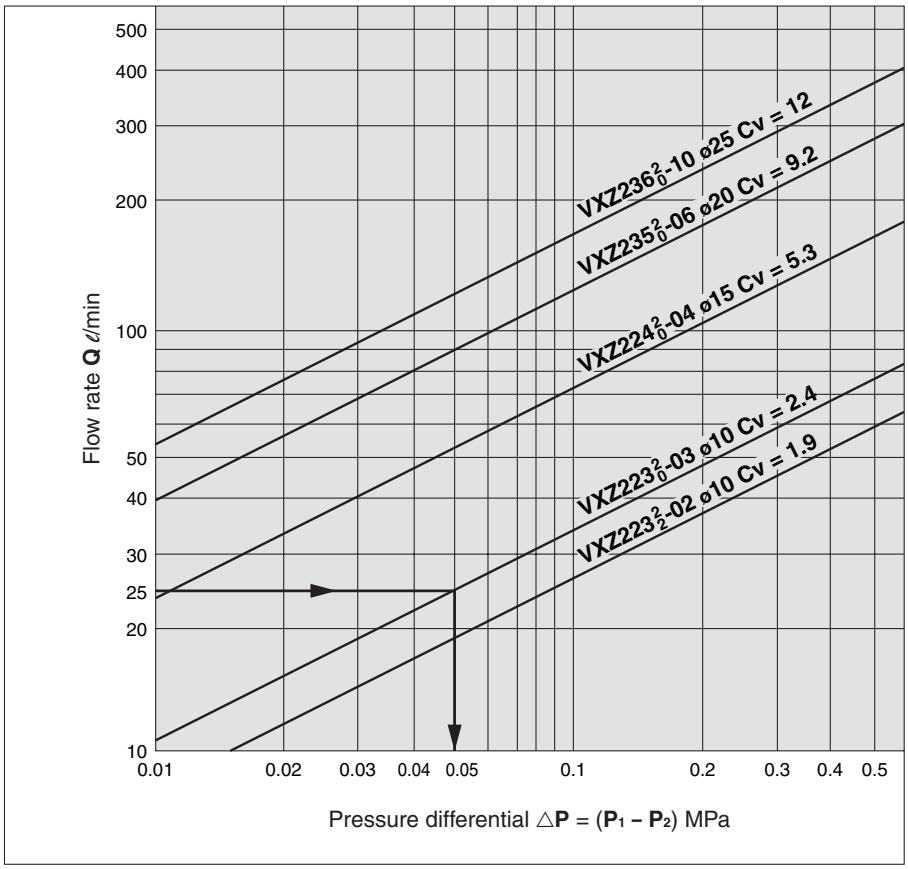
For Air



How to read the graph

The sonic range pressure to generate a flow rate of 6,000 ℓ/min (ANR) is P_1 0.47 MPa for a ø15 orifice (VXZ224[20]-04) and P_1 0.23 MPa for a ø20 orifice (VXZ235[20]-06).

For Water



How to read the graph

When a water flow of 25 ℓ/min is generated, △P 0.05 MPa for a valve with ø10 orifice (VXZ223[20]-03).

Glossary of Terms

Pressure Terminology

1. Maximum operating pressure differential

The maximum pressure differential (the difference between the inlet and outlet pressure) which is allowed for operation, with the valve closed or open. When the outlet pressure is 0 MPa, this becomes the maximum operating pressure.

2. Minimum operating pressure differential

The minimum pressure differential (the difference between the inlet pressure and outlet pressure) required to keep the main valve fully opened.

3. Maximum system pressure

The maximum pressure that can be applied inside the pipelines (line pressure).
(The pressure differential of the solenoid valve portion must be less than the maximum operating pressure differential.)

4. Proof pressure

The pressure in which the valve must be withstood without a drop in performance after holding for one minute under prescribed pressure and returning to the operating pressure range. (value under the prescribed conditions)

Electrical Terminology

1. Apparent power (VA)

Volt-ampere is the product of voltage (V) and current (A). Power consumption (W): For AC , $W = V \cdot A \cdot \cos\theta$. For DC, $W = V \cdot A$.
(Note) $\cos\theta$ shows power factor. $\cos\theta = 0.6$

2. Surge voltage

A high voltage which is momentarily generated by shutting off the power in the shut-off area.

3. Enclosure

A degree of protection defined in the “JIS C 0920: Waterproof test of electric machinery/appliance and the degree of protection against the intrusion of solid foreign objects”.

IP65: Dusttight, Low jetproof type

“Low jetproof type” means that no water intrudes inside an equipment that could hinder from operating normally by means of applying water for 3 minutes in the prescribed manner. Take appropriate protection measures, since a device is not usable in an environment where a droplet of water is splashed.

Others

1. Material

NBR: Nitrile rubber

FKM: Fluoro rubber – Trade names: Viton®, Dai-el®, etc.

EPDM: Ethylene propylene rubber

2. Oil-free treatment

The degreasing and washing of wetted parts.

3. Passage symbol

In the JIS symbol ( ) IN and OUT are in a blocked condition ( ), but actually in the case of reverse pressure (O U T > IN), there is a limit to the blocking.
( ) is used to indicate that blocking of reverse pressure is not possible.

Series VXZ22/23
Safety Instructions

The following safety instructions are intended to prevent a hazardous situation and/or equipment damage. These instructions indicate the level of potential hazard by all safety practices, including labels of **"Caution", "Warning"** or **"Danger"**. To ensure safety, please observe ISO 4414 Note 1), JIS B 8370 Note 2).

⚠ Caution: Operator error could result in injury or equipment damage.

⚠ Warning: Operator error could result in serious injury or loss of life.

⚠ Danger : In extreme conditions, there is a possible result of serious injury or loss of life.

Note 1) ISO 4414: Pneumatic fluid power – General rules relating to systems
Note 2) JIS B 8370: General Rules for Pneumatic Equipment

⚠ Warning

1. The compatibility of equipment is the responsibility of the person who designs the system or decides its specifications.

Since the products specified here are used in various operating conditions, their compatibility with a specific system must be based on specifications, post analysis and/or tests to meet a specific requirement. The expected performance and safety assurance will be the responsibility of the person who has determined the compatibility of the system. This person should continuously review the suitability of all items specified, referring to the latest catalog information and taking into consideration the possibility of equipment failure when configuring a system. Be particularly careful in determining the compatibility with the fluid to be used.

2. Only trained personnel should operate machinery and equipment.

The fluid can be dangerous if handled incorrectly. Assembly, handling or maintenance of the system should be performed by trained and experienced operators.

3. Do not service machinery/equipment or attempt to remove components until the safety is confirmed.

1. Inspection and maintenance of machinery/equipment should only be performed once measures to prevent falling or runaway of the driven object have been confirmed. Measures to prevent danger from a fluid should also be confirmed.
2. When equipment is to be removed, confirm the safety processes mentioned above, release the fluid pressure and be certain there is no danger from fluid leakage or fluid remaining in the system.
3. Carefully restart the machinery, confirming that safety measures are being implemented.

4. Contact SMC if the product is to be used in any of the following conditions:

1. Conditions and environments beyond the given specifications, or if product is used outdoors.
2. With fluids whose application causes concern due to the type of fluid or additives, etc.
3. An application which has the possibility of having a negative effect on people, property, and therefore requires special safety analysis.

2 Port Solenoid Valve for Fluid Control Precautions 1

Be sure to read this before handling.
For detailed precautions on each series, refer to the main text.

Design

⚠ Warning

1. Cannot be used as an emergency shutoff valve, etc.

The valves presented in this catalog are not designed for safety applications such as an emergency shutoff valve. If the valves are used in this type of system, other reliable safety assurance measures should also be adopted.

2. Extended periods of continuous energization

The solenoid coil will generate heat when continuously energized. Avoid using in a tightly shut container. Install it in a well-ventilated area. Furthermore, do not touch it while it is being energized or right after it is energized.

3. This solenoid valve cannot be used for explosion proof applications.

4. Maintenance space

The installation should allow sufficient space for maintenance activities.

5. Liquid rings

In cases with a flowing liquid, provide a by-pass valve in the system to prevent the liquid from entering the liquid seal circuit.

6. Actuator drive

When an actuator, such as a cylinder, is to be driven using a valve, take appropriate measures to prevent potential danger caused by actuator operation.

7. Pressure (including vacuum) holding

It is not usable for an application such as holding the pressure (including vacuum) inside of a pressure vessel because air leakage is entailed in a valve.

8. When the conduit type is used as equivalent to an IP65 enclosure, install a wiring conduit, etc.

9. When an impact, such as water hammer, etc., caused by the rapid pressure fluctuation is applied, the solenoid valve may be damaged. Give an attention to it.

Selection

⚠ Warning

1. Confirm the specifications.

Give careful consideration to the operating conditions such as the application, fluid and environment, and use within the operating ranges specified in this catalog.

2. Fluid

1. Type of fluid

   Before using a fluid, confirm whether it is compatible with the materials from each model by referring to the fluids listed in this catalog. Use a fluid with a dynamic viscosity of 50 mm^2/s or less. If there is something you do not know, please contact us.

2. Flammable oil, Gas,

   Confirm the specification for leakage in the interior and/or exterior area.

Selection

⚠ Warning

3. Corrosive gas

   Cannot be used since it will lead to cracks by stress corrosion or result in other incidents.

4. Use an oil-free specification when any oily particle must not enter the passage.

5. Applicable fluid on the list may not be used depending on the operating condition. Give adequate confirmation, and then determine a model, just because the compatibility list shows the general case.

3. Fluid quality

The use of a fluid which contains foreign matter can cause problems such as malfunction and seal failure by promoting wear of the valve seat and armature, and by sticking to the sliding parts of the armature, etc. Install a suitable filter (strainer) immediately upstream from the valve. As a general rule, use 80 to 100 mesh.
When used to supply water to boilers, substances such as calcium and magnesium which generate hard scale and sludge are included. Since this scale and sludge can cause the valve to malfunction, install water softening equipment, and a filter (strainer) directly upstream from the valve to remove these substances.

4. Air quality

1. Use clean air.

   Do not use compressed air which includes chemicals, synthetic oils containing organic solvents, salt or corrosive gases, etc., as it can cause damage or malfunction.

2. Install air filters.

   Install air filters close to valves at their upstream side. A filtration degree of 5 m or less should be selected.

3. Install an air dryer or after cooler, etc.

   Compressed air that includes excessive drainage may cause malfunction of valves and other pneumatic equipment. To prevent this, install an air dryer or after cooler, etc.

4. If excessive carbon powder is generated, eliminate it by installing mist separators at the upstream side of valves.

   If excessive carbon powder is generated by the compressor, it may adhere to the inside of the valves and cause a malfunction.

Refer to SMC's Best Pneumatics 2004 Vol. 14 catalog for further details on compressed air quality.

5. Ambient environment

Use within the operable ambient temperature range. Confirm the compatibility between the product's composition materials and the ambient atmosphere. Be sure that the fluid used does not touch the external surface of the product.

6. Countermeasures against static electricity

Take measures to prevent static electricity since some fluids can cause static electricity.

7. For the low particle generation specification, confirm us separately.

8. Minimum differential operating pressure

Even if the differential pressure is greater than the minimum differential operating pressure when the valve is closed, it may become lower than the minimum differential operating pressure when the valve is open due to restrictors in the piping of the supply source (such as a pump, compressor, etc.). Please exercise caution.

Back page 2

2 Port Solenoid Valve for Fluid Control Precautions 2

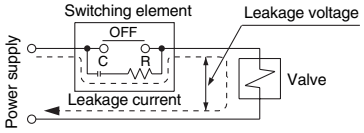
Be sure to read this before handling.
For detailed precautions on each series, refer to the main text.

Selection

⚠ Caution

1. Leakage voltage

Particularly when using a resistor in parallel with a switching element and using a C-R element (surge voltage suppressor) to protect the switching element, take note that leakage current will flow through the resistor, C-R element, etc., creating a possible danger that the valve may not turn off.



AC coil: 20% or less of rated voltage
DC coil: 2% or less of rated voltage

2. Low temperature operation

1. The valve can be used in an ambient temperature of between –10 to –20C. However, take measures to prevent freezing or solidification of impurities, etc.
2. When using valves for water application in cold climates, take appropriate countermeasures to prevent the water from freezing in tubing after cutting the water supply from the pump, by draining the water, etc. When warming by a heater, etc., be careful not to expose the coil portion to a heater. Installation of a dryer, heat retaining of the body is recommended to prevent a freezing condition in which the dew point temperature is high and the ambient temperature is low, and the high flow runs.

Mounting

⚠ Warning

1. If air leakage increases or equipment does not operate properly, stop operation.

After mounting is completed, confirm that it has been done correctly by performing a suitable function test.

2. Do not apply external force to the coil section.

When tightening is performed, apply a wrench or other tool to the outside of the piping connection parts.

3. Be sure not to position the coil downwards.

When mounting a valve with its coil positioned downwards, foreign objects in the fluid will adhere to the iron core leading to a malfunction.

4. Do not warm the coil assembly with a heat insulator, etc.

Use tape, heaters, etc., for freeze prevention on the piping and body only. They can cause the coil to burn out.

5. Secure with brackets, except in the case of steel piping and copper fittings.

6. Avoid sources of vibration, or adjust the arm from the body to the minimum length so that resonance will not occur.

7. Painting and coating

Warnings or specifications printed or labeled on the product should not be erased, removed or covered up.

Piping

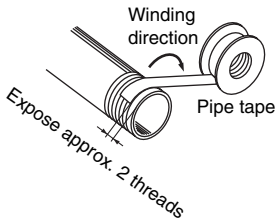
⚠ Caution

1. Preparation before piping

Before piping is connected, it should be thoroughly blown out with air (flushing) or washed to remove chips, cutting oil and other debris from inside the pipe.
Install piping so that it does not apply pulling, pressing, bending or other forces on the valve body.

2. Wrapping of pipe tape

When connecting pipes, fittings, etc., be sure that chips from the pipe threads and sealing material do not enter the valve.
Furthermore, when pipe tape is used, leave 1.5 to 2 thread ridges exposed at the end of the threads.



3. Avoid connecting ground lines to piping, as this may cause electric corrosion of the system.

4.Always tighten threads with the proper tightening torque.

When attaching fittings to valves, tighten with the proper tightening torque shown below.

Tightening Torque for Piping

Connection threads	Proper tightening torque N·m
Rc 1/8	7 to 9
Rc 1/4	12 to 14
Rc 3/8	22 to 24
Rc 1/2	28 to 30

5. Connection of piping to products

When connecting piping to a product, refer to its instruction manual to avoid mistakes regarding the supply port, etc.

6. Steam generated in a boiler contains a large amount of drainage.
Be sure to operate it with a drain trap installed.

7. In applications such as vacuum and non-leak specifications, use caution specifically against the contamination of foreign matters or airtightness of the fittings.

8. If a regulator is directly connected to a solenoid valve, their interaction will cause them to enter a state of resonance. In some cases, this will result in chattering.

2 Port Solenoid Valve for Fluid Control Precautions 3

Be sure to read this before handling.
For detailed precautions on each series, refer to the main text.

Wiring

⚠ Caution

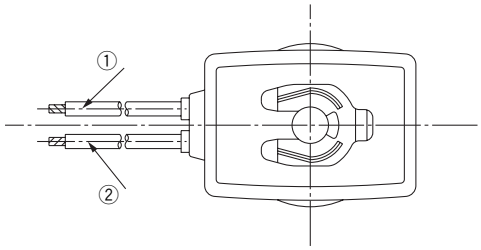
1. **As a rule, use electrical wire with a cross sectional area of 0.5 to 1.25 mm^2 for wiring. Furthermore, do not allow excessive force to be applied to the lines.**
2. **Use electrical circuits which do not generate chattering in their contacts.**
3. **Use voltage which is within 10% of the rated voltage. In cases with a DC power supply where importance is placed on responsiveness, stay within 5% of the rated value. The voltage drop is the value in the lead wire section connecting the coil.**
4. **When a surge from the solenoid affects the electrical circuitry, install a surge absorber, etc., in parallel with the solenoid.**
   Or, adopt an option that comes with the surge voltage protection circuit. (However, a surge voltage occurs even if the surge voltage protection circuit is used. For details, please consult with us.)

Electrical Connections

⚠ Caution

Grommet

Class H coil: AWG18 Insulator O.D. 2.2 mm
Class B coil: AWG20 Insulator O.D. 2.5 mm

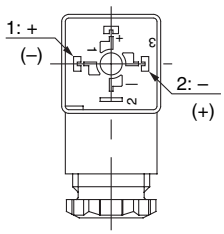


Rated voltage	Lead wire color	
	①	②
DC (Class B only)	Black	Red
100 VAC	Blue	Blue
200 VAC	Red	Red
Other AC	Gray	Gray

∗ There is no polarity.

DIN terminal (Class B only)

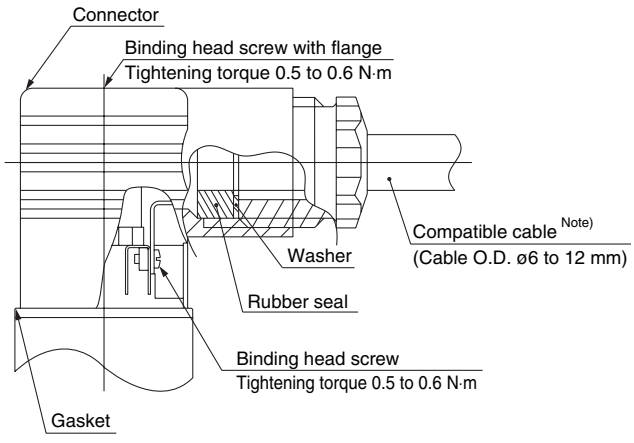
Since internal connections are as shown below for the DIN terminal, make connections to the power supply accordingly.



Terminal no.	1	2
DIN terminal	+ (–)	– (+)

∗ There is no polarity.

- Use compatible heavy duty cords with cable O.D. of ø6 to 12 mm.
- Use the tightening torques below for each section.



Note) For an outside cable diameter of ø9 to 12 mm, remove the internal parts of the rubber seal before using.

Back page 4

2 Port Solenoid Valve for Fluid Control Precautions 4

Be sure to read this before handling.
For detailed precautions on each series, refer to the main text.

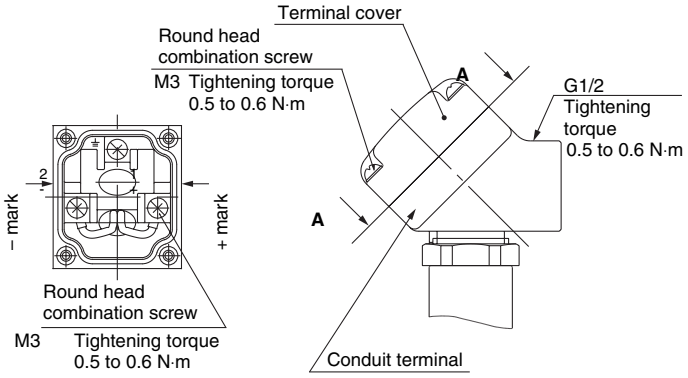
Electrical Connections

⚠ Caution

Conduit terminal

In the case of the conduit terminal, make connections according to the marks shown below.

- Use the tightening torques below for each section.
- Properly seal the terminal connection (G1/2) with the special wiring conduit, etc.

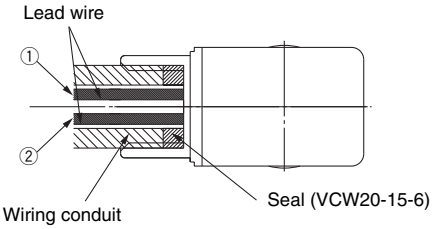


View A-A
(Internal connection diagram)

Conduit

When used as an IP65 equivalent, use seal (part no. VCW20-15-6) to install the wiring conduit. Also, use the tightening torque below for the conduit.

Class H coil: AWG18 Insulator O.D. 2.2 mm
Class B coil: AWG20 Insulator O.D. 2.5 mm



Rated voltage	Lead wire color	
	①	②
DC	Black	Red
100 VAC	Blue	Blue
200 VAC	Red	Red
Other AC	Gray	Gray

∗ There is no polarity for DC.

Description	Part no.
Seal	VCW20-15-6

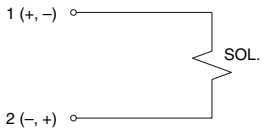
Note) Please order separately.

Electrical Circuits

⚠ Caution

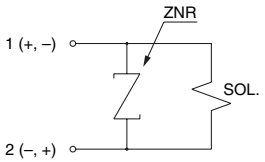
[DC circuit]

Grommet, Conduit, Conduit terminal, DIN type



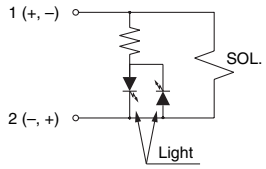
Without electrical option

Grommet, Conduit terminal, DIN type



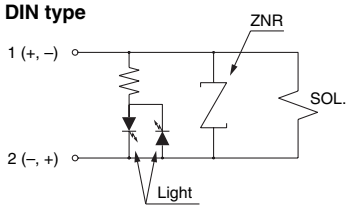
With surge voltage suppressor

Conduit terminal, DIN type



With light

Conduit terminal, DIN type

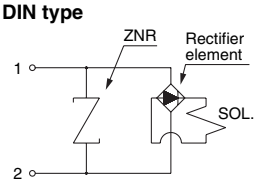


With light/surge voltage suppressor

[AC, Class B (Built-in full wave rectifier type) circuit]

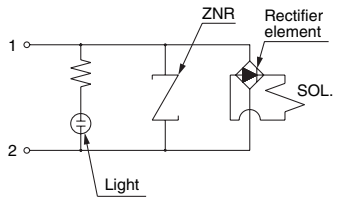
∗ For AC/Class B, the standard product is equipped with surge voltage suppressor.

Grommet, Conduit, Conduit terminal, DIN type



Without electrical option

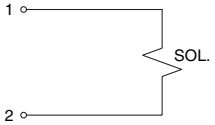
Conduit terminal, DIN type



With light

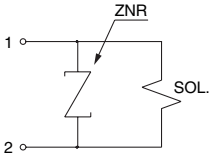
[AC, Class B/H circuit]

Grommet, Conduit, Conduit terminal



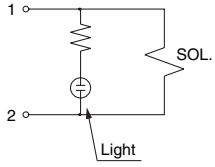
Without electrical option

Grommet, Conduit terminal



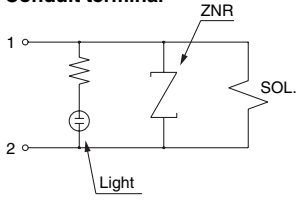
With surge voltage suppressor

Conduit terminal



With light

Conduit terminal



With light/surge voltage suppressor

Back page 5

2 Port Solenoid Valve for Fluid Control Precautions 5

Be sure to read this before handling.
For detailed precautions on each series, refer to the main text.

Operating Environment

⚠ Warning

1. Do not use the valves in an atmosphere having corrosive gases, chemicals, salt water, water steam, or where there is direct contact with any of these.

2. Do not use in explosive atmospheres.

3. Do not use in locations subject to vibration or impact.

4. Do not use in locations where radiated heat will be received from nearby heat sources.

5. Employ suitable protective measures in locations where there is contact with water droplets, oil or welding spatter, etc.

Lubrication

⚠ Caution

1. This solenoid valve can be operated without lubrication.

If a lubricant is used in the system, use turbine oil Class 1, ISO VG32 (with no additive). But do not lubricate a valve with EPDM seal.
Refer to the table of brand name of lubricants compliant with Class 1 turbine oil (with no additive), ISO VG32.

Class 1 Turbine Oil (with no additive), ISO VG32

Classification of viscosity (cst) (40C) / Viscosity according to ISO Grade	32
Idemitsu Kosan Co.,Ltd.	Turbine oil P-32
Nippon Oil Corp.	Turbine oil 32
Cosmo Oil Co.,Ltd.	Cosmo turbine 32
Japan Energy Corp.	Kyodo turbine 32
Kygnus Oil Co.	Turbine oil 32
Kyushu Oil Co.	Stork turbine 32
Nippon Oil Corp.	Mitsubishi turbine 32
Showa Shell Sekiyu K.K.	Turbine 32
Tonen General Sekiyu K.K.	General R turbine 32
Fuji Kosan Co.,Ltd.	Fucoal turbine 32

Please contact SMC regarding Class 2 turbine oil (with additives), ISO VG32.

Maintenance

⚠ Warning

1 Removing the product

The valve will reach a high temperature when used with high temperature fluids. Confirm that the valve temperature has dropped sufficiently before performing work. If touched inadvertently, there is a danger of being burned.

1. Shut off the fluid supply and release the fluid pressure in the system.
2. Shut off the power supply.
3. Dismount the product.

2. Low frequency operation

Switch valves at least once every 30 days to prevent malfunction. Also, in order to use it under the optimum state, conduct a regular inspection once a half year.

Maintenance

⚠ Caution

1. Filters and strainers

1. Be careful regarding clogging of filters and strainers.
2. Replace filter elements after one year of use, or earlier if the pressure drop reaches 0.1 MPa.
3. Clean strainers when the pressure drop reaches 0.1 MPa.

2. Lubrication

When using after lubricating, never forget to lubricate continuously.

3. Storage

In case of long term storage after use with heated water, thoroughly remove all moisture to prevent rust and deterioration of rubber materials, etc.

4. Exhaust the drain from an air filter periodically.

Operating Precautions

⚠ Warning

1. Valves will reach high temperatures from high temperature fluids. Use caution, as there is a danger of being burned if a valve is touched directly.

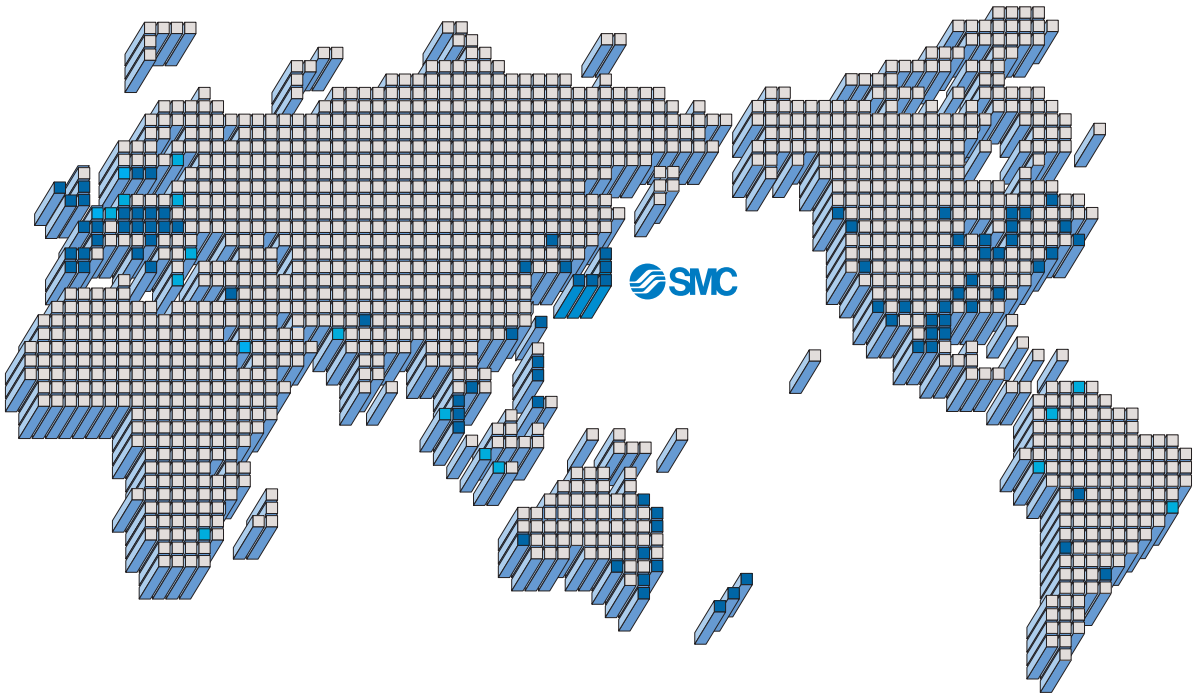
⚠ Caution

1. The valve of the pilot-operated 2-port solenoid valve may be opened momentarily and result in fluid leakage when pressure is applied to the valve suddenly (if the pump or compressor starts, for example) while the valve is closed. Please be cautious of this.

2.If a water hammer problem occurs, install either a water hammer attenuator (such as an accumulator) or use our water hammer resistant valve, the VXR series. For details, please contact us.

Back page 6

SMC'S GLOBAL MANUFACTURING, DISTRIBUTION AND SERVICE NETWORK



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