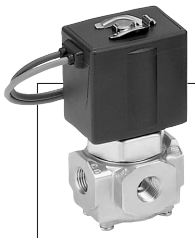
Direct Operated 3 Port Solenoid Valve

Series VX31/32/33

For Air, Water, Oil, Steam



Single Unit

■ Valve

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

■ 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

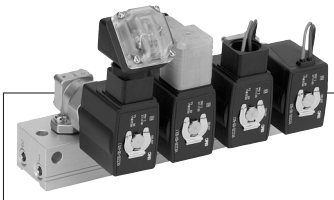
Body — C37, Stainless steel
Seal — NBR, FKM, EPDM, PTFE, FFKM

■ Electrical Entry

- Grommet
- Conduit
- DIN terminal
- Conduit terminal

Normally Closed (N.C.) / Normally Open (N.O.) / Common (COM.)

Model		VX31	VX32	VX33
Orifice dia.	1.5 mmø	●	—	—
	2.2 mmø	●	●	●
	3 mmø	●	●	●
	4 mmø	—	●	●
Port size		1/8 1/4	1/4 3/8	1/4 3/8



Manifold

■ Valve

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

■ Base

Common SUP/EXH type

■ 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 — C37
Base — Aluminum
Seal — NBR, FKM, EPDM

■ Electrical Entry

- Grommet
- Conduit
- DIN terminal
- Conduit terminal

Normally Closed (N.C.) / Normally Open (N.O.) / Common (COM.)

Model			VX31	VX32	VX33
Orifice dia.	1.5 mmø		●	—	—
	2.2 mmø		●	●	●
	3 mmø		●	●	●
	4 mmø		—	●	●
(Common SUP/EXH type) Port size		IN port	1/4		
		OUT port	1/8, 1/4		
		EXH port	1/4		

Common Specifications

Standard Specifications

Valve specifications	**Valve construction**		Direct operated poppet
	Withstand pressure (MPa)		3.0
	Body material		C37, Stainless steel
	Seal material		NBR, FKM, EPDM, PTFE, FFKM
	Enclosure		Dusttight, Low jetproof (equivalent to IP65)*
	Environment		Location without corrosive or explosive gases
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	24 VDC, 12 VDC
	Allowable voltage fluctuation		±10% of rated voltage
	Allowable leakage voltage	AC (Class B coil, Built-in full-wave rectifier type)	5% or less of rated voltage
		AC (Class H coil)	20% or less of rated voltage
		DC	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

Model	Power consumption (W)	Temperature rise (C) Note)
VX31	4.5	45
VX32	7	45
VX33	10.5	60

Note) The values are for an ambient temperature of 20ºC and at the rated voltage.

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

Model	Apparent power (VA)∗	Temperature rise (C) Note)
VX31	7	55
VX32	9.5	60
VX33	12	65

∗ 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).
Note) The values are for an ambient temperature of 20ºC and at the rated voltage.

AC Specification (Class H coil)

Model		Apparent power (VA)		Temperature rise (C) Note)
	Frequency (Hz)	Inrush	Energized	
VX31	50	33	14	65
	60	28	12	60
VX32	50	65	33	100
	60	55	27	95
VX33	50	94	50	120
	60	79	41	115

Note) The values are for an ambient temperature of 20ºC and at the rated voltage.

Applicable Fluid Check List

All Options (Single Unit)

VX3 □ 0 2 4 □□ – □□ – □□□ 1 – □

Option symbol

Fluid and application	Option symbol	Seal material		Body material/ Shading coil material Note 6)	Guide pin material	Coil insulation type Note 4)	Note
		Main valve poppet	Fixed sealant				
Air	**Nil**	NBR	NBR	C37	PPS	B	—
	G			Stainless steel			
Medium vacuum, Non-leak, Oil-free	**M** Note 1, 2)	FKM	FKM	Stainless steel	PPS	B	
	V Note 1, 2)			C37			
Water	**Nil**	NBR	NBR	C37	PPS	B	
	G			Stainless steel			
Heated water	**E**	EPDM	EPDM	C37/Cu	Stainless steel	H	
	P			Stainless steel/Ag			
Oil Note 3)	**A**	FKM	FKM	C37	PPS	B	
	H			Stainless steel			
	D			C37/Cu	Stainless steel	H	
	N			Stainless steel/Ag			
Steam (Max.183°C)	**S**	FFKM	PTFE	C37/Cu	Stainless steel	H	COM. only
	Q			Stainless steel/Ag			
Copper-free, Fluoro-free Note 5)	**J**	EPDM	EPDM	Stainless steel	PPS	B	—
	P			Stainless steel/Ag	Stainless steel	H	
Others	**B**	EPDM	EPDM	C37	PPS	B	
	C	FFKM	PTFE		Stainless steel		COM. only
	K Note 1, 2)			Stainless steel			COM. only, Oil-free

∗ If using for other fluids, please consult with SMC.

All Options (Manifold)∗

VX3 □□ 1 3 5 □□ – 00 – □□□ 1

Option symbol

Fluid and application	Option symbol	Seal material		Body material/ Shading coil material Note 6)	Guide pin material	Coil insulation type Note 4)
		Main valve poppet	Fixed sealant			
Air	**Nil**	NBR	NBR	C37	PPS	B
Medium vacuum, Non-leak, Oil-free	**V** Note 1, 2)	FKM	FKM	C37	PPS	B
Oil Note 3)	**A**	FKM	FKM	C37	PPS	B
	D			C37/Cu	Stainless steel	H
Others	**B**	EPDM	EPDM	C37	PPS	B
	E			C37/Cu	Stainless steel	H

∗ Aluminum is only available with the material for a manifold base.
∗ If using for other fluids, please consult with SMC.

Note 1) The leakage amount (10^{-6} Pa·m³/s) of "V", "M" options are values when differential pressure is 0.1 MPa.
Note 2) "V", "M" and "K" options are for oil-free treatment.
Note 3) The dynamic viscosity of the fluid must not exceed 50 mm²/s or less.
Note 4) Coil insulation type Class H: AC spec. only, Class B/AC spec.: built-in full-wave rectifier type only
Note 5) The nuts (non-welded parts) are nickel plated on the C37 material.
Note 6) There is no shading coil attached to DC spec. or Class B/AC spec.

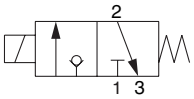
For Air /Single Unit

(Inert gas, Non-leak, Medium vacuum)

Model / Valve Specifications

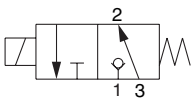
N.C.

Passage symbol



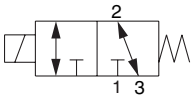
N.O.

Passage symbol



COM.

Passage symbol



Port size	Orifice diameter (mmø)	Model	Max. operating pressure differential (MPa)			Flow characteristics			Max. system pressure (MPa)	Weight Note) (g)
			N.C.	N.O.	COM.	C[dm³/(s·bar)]	b	Cv		
1/8 (6A)	1.5	**VX311□-01**	1	1	0.7	0.29	0.32	0.08	2.0	380
	2.2	**VX312□-01**	0.7	0.5	0.4	0.60	0.25	0.15		
	3	**VX313□-01**	0.3	0.3	0.2	0.82	0.20	0.20		
1/4 (8A)	1.5	**VX311□-02**	1	1	0.7	0.29	0.32	0.08		
	2.2	**VX312□-02**	0.7	0.5	0.4	0.60	0.25	0.15		
		VX322□-02	1.2	1	0.7	0.64	0.40	0.17		530
		VX332□-02	1.6	1.6	1					730
	3	**VX313□-02**	0.3	0.3	0.2	0.82	0.20	0.20		380
		VX323□-02	0.6	0.5	0.3	1.1	0.25	0.27		530
		VX333□-02	1	0.9	0.6					730
	4	**VX324□-02**	0.3	0.25	0.2	1.6	0.20	0.38		530
		VX334□-02	0.5	0.4	0.3					730
3/8 (10A)	2.2	**VX322□-03**	1.2	1	0.7	0.64	0.40	0.17		530
		VX332□-03	1.6	1.6	1					730
	3	**VX323□-03**	0.6	0.5	0.3	1.1	0.25	0.27		530
		VX333□-03	1	0.9	0.6					730
	4	**VX324□-03**	0.3	0.25	0.2	1.6	0.20	0.38		530
		VX334□-03	0.5	0.4	0.3					730

Note) Weight of grommet type. Add 10 g for conduit, 30 g for DIN terminal, and 60 g for conduit terminal type respectively.
Also, add 60 g for VX31□□, 80 g for VX32□□ and VX33□□ respectively for bracket option.

• Refer to “Glossary” on page 31, for details on the max. operating pressure differential and the max. system pressure.

Fluid and Ambient Temperature

Power source	Fluid temperature (°C)		Ambient temperature (°C)
	Solenoid valve option (symbol)		
	Nil, G	**V, M**	
AC	–10 Note) to 60	–10 Note) to 40	–20 to 60
DC	–10 Note) to 60	–10 Note) to 40	–20 to 40

Note) Dew point temperature: –10°C or less

Valve Leakage

Internal Leakage / External Leakage

Seal material	Max. operating pressure differential	Leakage rate	
		Air	Non-leak, Medium vacuum Note)
NBR, FKM	From 0 to less than 1 MPa	1 cm³/min or less	10^{-6} Pa·m³/sec or less
	1 MPa or more	2 cm³/min or less	

Note) The leakage amount (10^{-6} Pa·m³/sec) for the “V” and “M” option are values when the differential pressure is 0.1 MPa.

How to Order (Single Unit)

DC

VX 31 1 4 □ □ – 01 □ – 5 G 1 – □

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

VX 31 1 4 □ □ – 01 □ – 1 G R1 – □

Model
Refer to Table (1) shown below for availability.

Orifice diameter
Refer to Table (1) shown below for availability.

Valve / Body type

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

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

Bracket

Nil	None
B	With bracket

∗ Bracket is neither mountable nor removable.

Built-in full-wave rectifier type

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

Suffix

Nil	—
Z	Oil-free spec.

Thread type

Nil	Rc
T	NPTF
F	G
N	NPT

Rated voltage

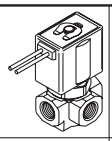
1	100 VAC 50/60 Hz	**6**	12 VDC
2	200 VAC 50/60 Hz	**7**	240 VAC 50/60 Hz
3	110 VAC 50/60 Hz	**8**	48 VAC 50/60 Hz
4	220 VAC 50/60 Hz	**J**	230 VAC 50/60 Hz
5	24 VDC		

∗ Refer to Table (3) shown below for availability.

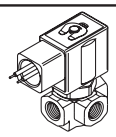
Refer to page 23 for ordering coil only.

Electrical entry (AC/DC)

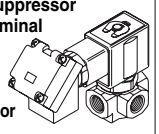
G -Grommet
GS-With grommet surge voltage suppressor



C -Conduit

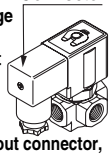


T -With conduit terminal
TS -With conduit terminal and surge voltage suppressor
TL -With conduit terminal and light
TZ -With conduit terminal, surge voltage suppressor and light



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

Table (1) Model – Orifice Diameter – Port Size

Solenoid valve model				Orifice symbol (diameter)			
Model	**VX31**	**VX32**	**VX33**	**1** (1.5 mmø)	**2** (2.2 mmø)	**3** (3 mmø)	**4** (4 mmø)
Port symbol (Port size)	**01** (1/8)	—	—	●	●	●	—
	02 (1/4)	—	—	●	●	●	—
	—	**02** (1/4)	**02** (1/4)	—	●	●	●
	—	**03** (3/8)	**03** (3/8)	—	●	●	●

Table (2) Solenoid Valve Option

Option symbol	Seal material		Body material/ Shading coil material	Guide pin material	Coil insulation type	Note Note)
	Main valve poppet	Fixed sealant				
Nil	NBR	NBR	C37	PPS	B	—
G			Stainless steel			
M	FKM	FKM	Stainless steel			Non-leak (10^{-6} Pa·m³/sec), Medium vacuum (0.1 Pa.abs), Oil-free
V			C37			

Note) The leakage amount (10^{-6} Pa·m³/sec) for the "V" and "M" option are values when the differential pressure is 0.1 MPa.

Table (3) Rated Voltage – Electrical Option

Rated voltage			Class B		
			S	**L**	**Z**
AC/ DC	Voltage symbol	Voltage	With surge voltage suppressor	With light	With light and surge voltage suppressor
AC	**1**	100 V	— Note)	●	— Note)
	2	200 V		●	
	3	110 V		●	
	4	220 V		●	
	7	240 V		—	
	8	48 V		—	
	J	230 V		—	
DC	**5**	24 V	●	●	●
	6	12 V	●	—	—

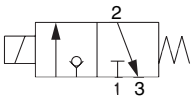
Note 1) Option S, Z are not available as surge voltage suppressor is integrated into the AC/Class B coil, as a standard.
∗ Class H coil is not available.

For Water/Single Unit

Model / Valve Specifications

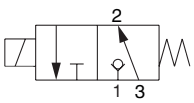
N.C.

Passage symbol



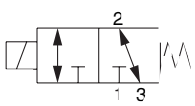
N.O.

Passage symbol



COM.

Passage symbol



Port size	Orifice diameter (mmø)	Model	Max. operating pressure differential (MPa)			Flow characteristics		Max. system pressure (MPa)	Weight Note) (g)
			N.C.	N.O.	COM.	Av x $10^{-6}m^2$	Cv converted		
1/8 (6A)	1.5	**VX311□-01**	1	1	0.7	1.9	0.08	2.0	380
	2.2	**VX312□-01**	0.7	0.5	0.4	3.8	0.16		
	3	**VX313□-01**	0.3	0.3	0.2	5.8	0.24		
1/4 (8A)	1.5	**VX311□-02**	1	1	0.7	1.9	0.08		
	2.2	**VX312□-02**	0.7	0.5	0.4	3.8	0.16		
		VX322□-02	1.2	1	0.7	4.6	0.19		530
		VX332□-02	1.6	1.6	1				730
	3	**VX313□-02**	0.3	0.3	0.2	5.8	0.24		380
		VX323□-02	0.6	0.5	0.3	7.9	0.33		530
		VX333□-02	1	0.9	0.6				730
	4	**VX324□-02**	0.3	0.25	0.2	12	0.50		530
		VX334□-02	0.5	0.4	0.3				730
3/8 (10A)	2.2	**VX322□-03**	1.2	1	0.7	4.6	0.19		530
		VX332□-03	1.6	1.6	1				730
	3	**VX323□-03**	0.6	0.5	0.3	7.9	0.33		530
		VX333□-03	1	0.9	0.6				730
	4	**VX324□-03**	0.3	0.25	0.2	12	0.50		530
		VX334□-03	0.5	0.4	0.3				730

Note) Weight of grommet type. Add 10 g for conduit, 30 g for DIN terminal, and 60 g for conduit terminal type respectively.
Also, add 60 g for VX31□□, 80 g for VX32□□ and VX33□□ respectively for bracket option.

• Refer to "Glossary" on page 31 for details on the max. operating pressure differential and the max. system pressure.

Fluid and Ambient Temperature

Power source	Fluid temperature (°C)		Ambient temperature (°C)
	Solenoid valve option (symbol)		
	Nil, G, H	**E, P**	
AC	1 to 60	1 to 99	–20 to 60
DC	1 to 40	—	–20 to 40

Note) With no freezing

Valve Leakage

Internal Leakage / External Leakage

Seal material	Max. operating pressure differential	Leakage rate (Water)
NBR, FKM, EPDM	From 0 to less than 1 MPa	0.1 cm^3/min or less
	1 MPa or more	0.2 cm^3/min or less

How to Order (Single Unit)

DC, AC/Class H coil VX 31 1 4 ☐ ☐ – 01 ☐ – 1 G 1 – ☐

AC/Class B coil (Built-in full-wave rectifier type) VX 31 1 4 ☐ ☐ – 01 ☐ – 1 G R1 – ☐

Model
Refer to Table (1) shown below for availability.

Orifice diameter
Refer to Table (1) shown below for availability.

Valve / Body type

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

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

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

Thread type

Nil	Rc
T	NPTF
F	G
N	NPT

Suffix

Nil	—
Z	Oil-free spec.

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 Table (3) shown below for availability.

Refer to page 23 for ordering coil only.

Built-in full-wave rectifier type

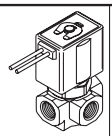
Bracket

Nil	None
B	With bracket

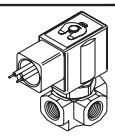
∗ Bracket is neither mountable nor removable.

Electrical entry

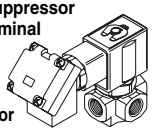
G -Grommet
GS-With grommet surge voltage suppressor



C -Conduit

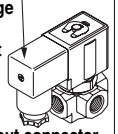


T -With conduit terminal
TS -With conduit terminal and surge voltage suppressor
TL -With conduit terminal and light
TZ -With conduit terminal, surge voltage suppressor and light



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

Table (1) Model Orifice Diameter Port Size

Solenoid valve model				Orifice symbol (diameter)			
Model	VX31	VX32	VX33	1 (1.5 mmø)	2 (2.2 mmø)	3 (3 mmø)	4 (4 mmø)
Port symbol (Port size)	**01** (1/8)	—	—	●	●	●	—
	02 (1/4)	—	—	●	●	●	—
	—	**02** (1/4)	**02** (1/4)	—	●	●	●
	—	**03** (3/8)	**03** (3/8)	—	●	●	●

Table (2) Solenoid Valve Option

Option symbol	Seal material		Body material/ Shading coil material	Guide pin material	Coil insulation type	Note
	Main valve poppet	Fixed sealant				
Nil	NBR	NBR	C37	PPS	B	—
G			Stainless steel			
E	EPDM	EPDM	C37/Cu	Stainless steel	H	Heated water
P			Stainless steel/Ag			
H	FKM	FKM	Stainless steel	PPS	B	—

Table (3) Rated Voltage Electrical Option

Rated voltage			Class B		
			S	L	Z
AC/ DC	Voltage symbol	Voltage	With surge voltage suppressor	With light	With light and surge voltage suppressor
AC	**1**	100 V	— Note)	●	— Note)
	2	200 V		●	
	3	110 V		●	
	4	220 V		●	
	7	240 V		—	
	8	48 V		—	
	J	230 V		—	
DC	**5**	24 V	●	●	●
	6	12 V	●	—	—

Note) Option S, Z are not available as surge voltage suppressor is integrated into the AC/Class B coil, as a standard.

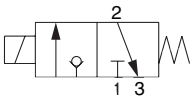
Rated voltage			Class H		
			S	L	Z
AC/ DC	Voltage symbol	Voltage	With surge voltage suppressor	With light	With light and surge voltage suppressor
AC	**1**	100 V	●	●	●
	2	200 V	●	●	●
	3	110 V	●	●	●
	4	220 V	●	●	●
	7	240 V	●	—	—
	8	48 V	●	—	—
	J	230 V	●	—	—
DC	**5**	24 V	DC specification is not available.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

For Oil/Single Unit

Model / Valve Specifications

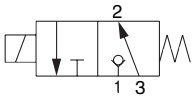
N.C.

Passage symbol



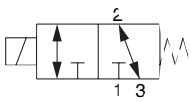
N.O.

Passage symbol



COM.

Passage symbo



Port size	Orifice diameter (mmø)	Model	Max. operating pressure differential (MPa)			Flow characteristics		Max. system pressure (MPa)	Weight Note) (g)
			N.C.	N.O.	COM.	Av x $10^{-6}m^2$	Cv converted		
1/8 (6A)	1.5	**VX311□-01**	1	1	0.7	1.9	0.08	2.0	380
	2.2	**VX312□-01**	0.7	0.5	0.4	3.8	0.16		
	3	**VX313□-01**	0.3	0.3	0.2	5.8	0.24		
1/4 (8A)	1.5	**VX311□-02**	1	1	0.7	1.9	0.08		
	2.2	**VX312□-02**	0.7	0.5	0.4	3.8	0.16		
		VX322□-02	1.2	1	0.7	4.6	0.19		530
		VX332□-02	1.6	1.6	1				730
	3	**VX313□-02**	0.3	0.3	0.2	5.8	0.24		380
		VX323□-02	0.6	0.5	0.3	7.9	0.33		530
		VX333□-02	1	0.9	0.6				730
	4	**VX324□-02**	0.3	0.25	0.2	12	0.50		530
		VX334□-02	0.5	0.4	0.3				730
3/8 (10A)	2.2	**VX322□-03**	1.2	1	0.7	4.6	0.19		530
		VX332□-03	1.6	1.6	1				730
	3	**VX323□-03**	0.6	0.5	0.3	7.9	0.33		530
		VX333□-03	1	0.9	0.6				730
	4	**VX324□-03**	0.3	0.25	0.2	12	0.50		530
		VX334□-03	0.5	0.4	0.3				730

Note) Weight of grommet type. Add 10 g for conduit, 30 g for DIN terminal, and 60 g for conduit terminal type respectively.
Also, add 60 g for VX31□□, 80 g for VX32□□ and VX33□□ respectively for bracket option.

• Refer to "Glossary" on page 31 for details on the max. operating pressure differential and the max. system pressure.

Fluid and Ambient Temperature

Power source	Fluid temperature (°C) Solenoid valve option (symbol)		Ambient temperature (°C)
	A, H	**D, N**	
AC	–5 Note) to 60	–5 Note) to 120	–20 to 60
DC	–5 Note) to 40	—	–20 to 40

Note) Dynamic viscosity: 50 mm^2/s or less

Valve Leakage

Internal Leakage / External Leakage

Seal material	Max. operating pressure differential	Leakage rate (Oil)
FKM	From 0 to less than 1 MPa	0.1 cm^3/min or less
	1 MPa or more	0.2 cm^3/min or less

How to Order (Single Unit)

DC, AC/Class H coil VX 31 1 4 A □ – 01 □ – 1 G 1 – □

AC/Class B coil (Built-in full-wave rectifier type) VX 31 1 4 A □ – 01 □ – 1 G R1 – □

Model
Refer to Table (1) shown below for availability.

Orifice diameter
Refer to Table (1) shown below for availability.

Valve / Body type

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

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

Bracket

Nil	None
B	With bracket

* Bracket is neither mountable nor removable

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

Built-in full-wave rectifier type

Suffix

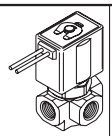
Nil	—
Z	Oil-free spec.

Thread type

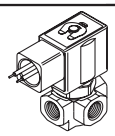
Nil	Rc
T	NPTF
F	G
N	NPT

Electrical entry

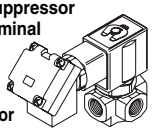
G -Grommet
GS-With grommet surge voltage suppressor



C -Conduit

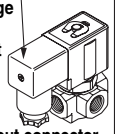


T -With conduit terminal
TS -With conduit terminal and surge voltage suppressor
TL -With conduit terminal and light
TZ -With conduit terminal, surge voltage suppressor and light



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 Table (3) shown below for availability.

Refer to page 23 for ordering coil only.

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

Table (1) Model Orifice Diameter Port Size

Solenoid valve model				Orifice symbol (diameter)			
Model	VX31	VX32	VX33	1 (1.5 mmø)	2 (2.2 mmø)	3 (3 mmø)	4 (4 mmø)
Port symbol (Port size)	**01** (1/8)	—	—	●	●	●	—
	02 (1/4)	—	—	●	●	●	—
	—	**02** (1/4)	**02** (1/4)	—	●	●	●
	—	**03** (3/8)	**03** (3/8)	—	●	●	●

Table (2) Solenoid Valve Option

Option symbol	Seal material		Body material/ Shading coil material	Guide pin material	Coil insulation type
	Main valve poppet	Fixed sealant			
A	FKM	FKM	C37	PPS	B
H			Stainless steel		
D			C37/Cu	Stainless steel	H
N			Stainless steel/Ag		

* The additives contained in oil are different depending on the type and manufacturers, so the durability of the seal materials will vary. For details, please consult with SMC.

Table (3) Rated Voltage Electrical Option

Rated voltage			Class B		
			S	L	Z
AC/ DC	Voltage symbol	Voltage	With surge voltage suppressor	With light	With light and surge voltage suppressor
AC	1	100 V	— Note)	●	— Note)
	2	200 V		●	
	3	110 V		●	
	4	220 V		●	
	7	240 V		—	
	8	48 V		—	
	J	230 V		—	
DC	5	24 V	●	●	●
	6	12 V	●	—	—

Note) Option S, Z are not available as surge voltage suppressor is integrated into the AC/Class B coil, as a standard.

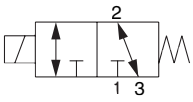
Rated voltage			Class H		
			S	L	Z
AC/ DC	Voltage symbol	Voltage	With surge voltage suppressor	With light	With light and surge voltage suppressor
AC	1	100 V	●	●	●
	2	200 V	●	●	●
	3	110 V	●	●	●
	4	220 V	●	●	●
	7	240 V	●	—	—
	8	48 V	●	—	—
	J	230 V	●	—	—
DC	5	24 V	DC specification is not available.		
	6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

For Steam /Single Unit

Model / Valve Specifications

COM.

Passage symbol



Port size	Orifice diameter (mmø)	Model	Max. operating pressure differential (MPa)	Flow characteristics		Max. system pressure (MPa)	Weight Note) (g)
			COM.	Av x $10^{-6}m^2$	Cv converted		
1/8 (6A)	1.5	**VX3114-01**	0.7	1.9	0.08	1.0	380
	2.2	**VX3124-01**	0.4	3.8	0.16		
	3	**VX3134-01**	0.2	5.8	0.24		
1/4 (8A)	1.5	**VX3114-02**	0.7	1.9	0.08		
	2.2	**VX3124-02**	0.4	3.8	0.16		
		VX3224-02	0.7	4.6	0.19		530
		VX3324-02	1				730
	3	**VX3134-02**	0.2	5.8	0.24		380
		VX3234-02	0.3	7.9	0.33		530
		VX3334-02	0.6				730
	4	**VX3244-02**	0.2	12	0.50		530
		VX3344-02	0.3				730
3/8 (10A)	2.2	**VX3224-03**	0.7	4.6	0.19		530
		VX3324-03	1				730
	3	**VX3234-03**	0.3	7.9	0.33		530
		VX3334-03	0.6				730
	4	**VX3244-03**	0.2	12	0.50		530
		VX3344-03	0.3				730

Note) Weight of grommet type. Add 10 g for conduit, 30 g for DIN terminal, and 60 g for conduit terminal type respectively.
Also, add 60 g for VX31□□, 80 g for VX32□□ and VX33□□ respectively for bracket option.

• Refer to "Glossary" on page 31 for details on the max. operating pressure differential and the max. system pressure.

Fluid and Ambient Temperature

Power source	Fluid temperature (°C)	Ambient temperature (°C)
	Solenoid valve option (symbol)	
	S, Q	
AC	183	–20 to 60

Valve Leakage

Internal Leakage

Seal material	Leakage rate (Air)
FFKM	150 cm^3/min or less

External Leakage

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

How to Order (Single Unit)

VX [31] [1] [4] [S] [ ] [01] [ ] [1] [G] [1] [ ]

Model
Refer to Table (1) shown below for availability.

Orifice diameter
Refer to Table (1) shown below for availability.

Valve / Body type

4	COM. / Single unit

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

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

Thread type

Nil	Rc
T	NPTF
F	G
N	NPT

Suffix

Nil	—
Z	Oil-free spec.

Rated voltage

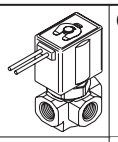
1	100 VAC 50/60 Hz	**7**	240 VAC 50/60 Hz
2	200 VAC 50/60 Hz	**8**	48 VAC 50/60 Hz
3	110 VAC 50/60 Hz	**J**	230 VAC 50/60 Hz
4	220 VAC 50/60 Hz		

∗ Refer to Table (3) shown below for availability.

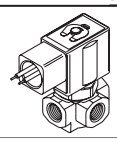
Refer to page 23 for ordering coil only.

Electrical entry

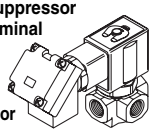
G -Grommet
GS-With grommet surge voltage suppressor



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 Table (3) for available combinations between each electrical option (S, L, Z) and rated voltage.

Bracket

Nil	None
B	With bracket

∗ Bracket is neither mountable nor removable.

Table (1) Model Orifice Diameter Port Size

Solenoid valve model				Orifice symbol (diameter)			
Model	VX31	VX32	VX33	**1** (1.5 mmø)	**2** (2.2 mmø)	**3** (3 mmø)	**4** (4 mmø)
Port symbol (Port size)	**01** (1/8)	—	—	●	●	●	—
	02 (1/4)	—	—	●	●	●	—
	—	**02** (1/4)	**02** (1/4)	—	●	●	●
	—	**03** (3/8)	**03** (3/8)	—	●	●	●

Table (2) Solenoid Valve Option

Option symbol	Seal material		Body material/ Shading coil material	Guide pin material	Coil insulation type
	Main valve poppet	Fixed sealant			
S	FFKM	PTFE	C37/Cu	Stainless steel	H
Q			Stainless steel/Ag		

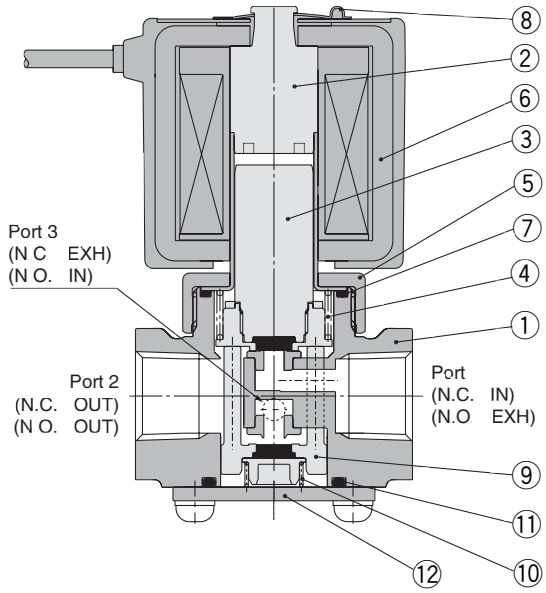
Solenoid coil AC/Class H only

Table (3) Rated Voltage Electrical Option

Rated voltage			Class H		
			S	**L**	**Z**
AC/ DC	Voltage symbol	Voltage	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 specification is not available.		
	6	12 V			

Construction

Single unit
Body material C37 Stainless steel

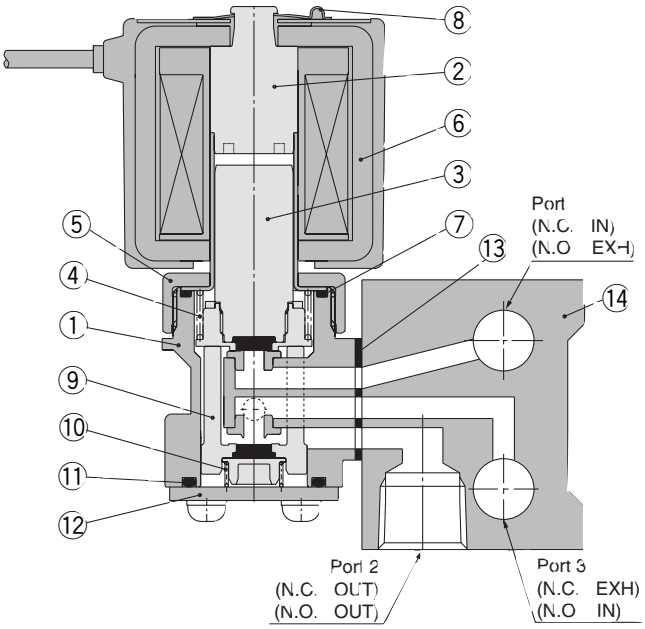


Component Parts

No.	Description	Material	
		Standard	Option
1	**Body**	C37	Stainless steel
2	**Tube assembly** Note)	Stainless steel, Cu	Stainless steel, Ag
3	**Armature assembly**	Stainless steel, C36, PTFE (NBR)	Stainless steel, PTFE (FKM, EPDM, FFKM)
4	**Return spring**	Stainless steel	
5	**Nut**	C37	C37/Ni plated
6	**Solenoid coil**	Class B molded	Class H molded
7	**O-ring**	(NBR)	(FKM, EPDM, PTFE)
8	**Clip**	SK	
9	**Guide pin assembly**	PPS, C36 (NBR)	Stainless steel (FKM, EPDM, FFKM)
10	**Support spring**	Stainless steel	
11	**O-ring**	(NBR)	(FKM, EPDM, PTFE)
12	**Plate**	Stainless steel	

The materials in parentheses are the seal materials.
Note) Cu and Ag are not applicable to the DC spec and to the AC spec with built-in full-wave rectifier.

Manifold
Base material: Aluminum
Manifold body material: C37



Component Parts

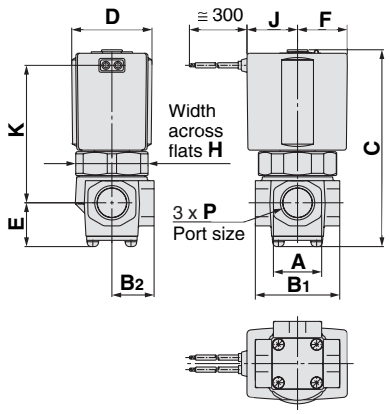
No.	Description	Material	
		Standard	Option
	Manifold body	C37	
2	**Tube assembly** Note)	Stainless steel, Cu	
3	**Armature assembly**	Stainless steel, C36, PTFE (NBR)	Stainless steel, PTFE (FKM, EPDM, FFKM)
4	**Return spring**	Stainless steel	
5	**Nut**	C37	C37/Ni plated
6	**Solenoid coil**	Class B molded	Class H molded
7	**O-ring**	(NBR)	(FKM, EPDM)
8	**Clip**	SK	
9	**Guide pin assembly**	PPS, C36 (NBR)	Stainless steel (FKM, EPDM)
10	**Support spring**	Stainless steel	
11	**O-ring**	(NBR)	(FKM, EPDM)
12	**Plate**	Stainless steel	
13	**Gasket**	(NBR)	(FKM, EPDM)
14	**Base**	Aluminum	

The materials in parentheses are the seal materials.
Note) Cu is not applicable to the DC spec and to the AC spec with built-in full-wave rectifier.

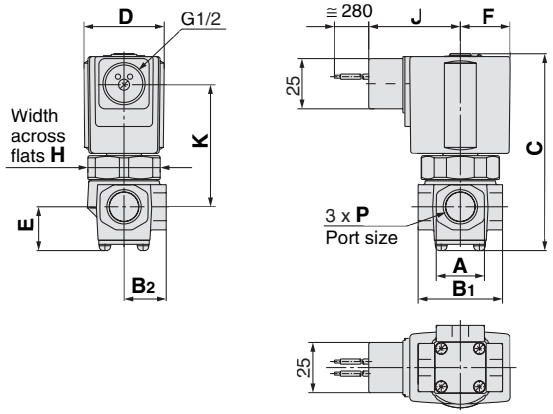
Dimensions Single Unit / Body Material C37, Stainless Stee

Normally closed (N.C.) VX31□0/VX32□0/VX33□0
Normally open (N.O.) VX31□2/VX32□2/VX33□2
Common (COM.) VX31□4/VX32□4/VX33□4

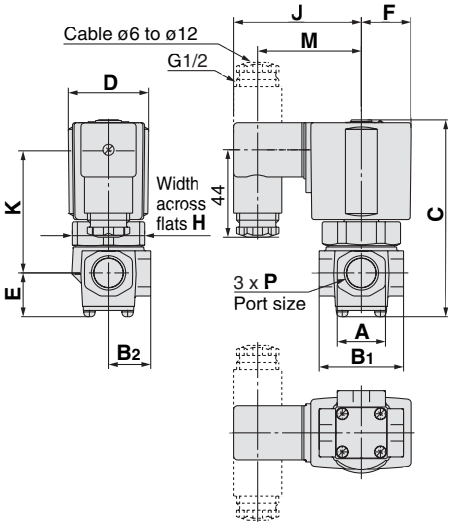
Grommet: G



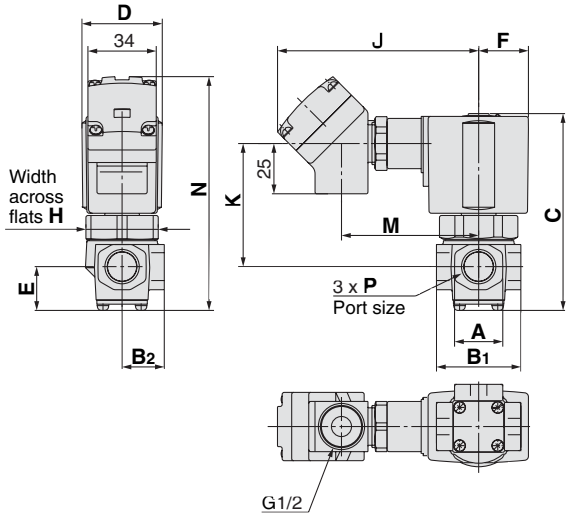
Conduit: C



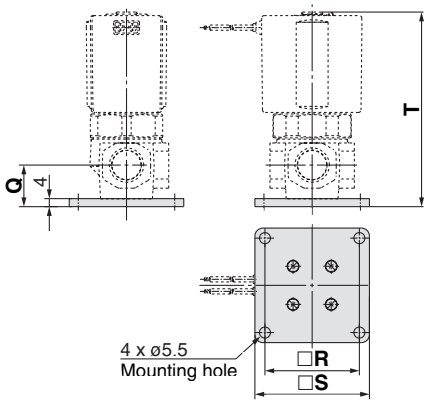
DIN terminal: D



Conduit terminal T



With bracket



(mm)

Model	Orifice diameter	Port size P	Electrical entry (AC/Class B)										
			Grommet		Conduit		DIN terminal			Conduit terminal			
N.C., N.O., COM.			J	K	J	K	J	K	M	J	K	M	N
VX31□□	ø1.5, ø2.2, ø3	1/8	30	46	48.5	41	65.5	42	53.5	100.5	41	69.5	91.5
VX31□□	ø1.5, ø2.2, ø3	1/4											
VX32□□	ø2.2, ø3, ø4	1/4, 3/8	33	56	51.5	51	68.5	52	56.5	103.5	51	72.5	105
VX33□□	ø2.2, ø3, ø4	1/4, 3/8	36	64.5	54	59.5	71	60.5	59	106	59.5	75	113

(mm)

Model	Orifice diameter	Port size P	A	B		C	D	E	F	H	Electrical entry (DC, AC/Class H)										Bracket mounting			
											Grommet		Conduit		DIN terminal			Conduit terminal						
N.C., N.O., COM.				B_1	B_2						J	K	J	K	J	K	M	J	K	M	N	Q	R	S	T
VX31□□	ø1.5, ø2.2, ø3	1/8	22	36	18	76.5	30	19	19.5	27	19.5	50	40	42.5	58.5	42	46.5	92	42.5	61	93	17.5	40	50	75.5
VX31□□	ø1.5, ø2.2, ø3	1/4		41	20.5																			
VX32□□	ø2.2, ø3, ø4	1/4, 3/8	24	42	21	90	35	22	22.5	32	22.5	60	43	52.5	61.5	52	49.5	95	52.5	64	106.5	21	47	57	89
VX33□□	ø2.2, ø3, ø4	1/4, 3/8	24	42	21	98	40	22	25	36	25.5	68.5	46	61	64	60.5	52	98	61	66.5	114.5	21	47	57	97

Replacement Parts

• Solenoid coil assembly part no.

DC

VX02 1 N − 5 G

Series

1	VX31□□
2	VX32□□
3	VX33□□

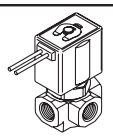
Rated voltage Note)

5	24 VDC
6	12 VDC

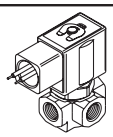
Note 1) Refer to Table (1) for available combinations.

Electrical entry

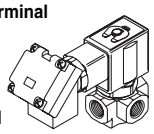
G -Grommet
GS-With grommet surge voltage suppressor



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



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 Table (1) for available combinations between each electrical option and rated voltage.

AC/Class H coil

VX02 1 N − 1 G H 2 Z

Series

1	VX31□□
2	VX32□□
3	VX33□□

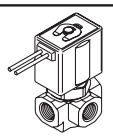
Rated voltage Note)

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

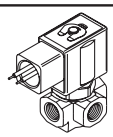
Note 1) Refer to Table (1) for available combinations.

Electrical entry

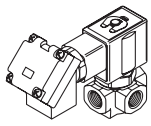
G -Grommet
GS-With grommet surge voltage suppressor



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 Table (1) for available combinations between each electrical option and rated voltage.

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

VX02 1 N 1 G R

Series

1	VX31□□
2	VX32□□
3	VX33□□

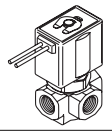
Rated voltage Note)

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

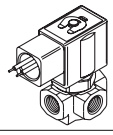
Note 1) Refer to Table (1) for available combinations.

Electrical entry

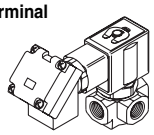
G -Grommet



C -Conduit

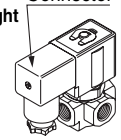


T -With conduit terminal
TL-With conduit terminal and light



D -DIN terminal
DL-DIN terminal with light
DO-For DIN terminal (without connector)

Connector



∗ Refer to Table (1) for available combinations between each electrical option and rated voltage.
∗ Surge voltage suppressor is integrated into the AC/Class B coil, as a standard.

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	— Note)	●	— Note)	●	●	●
	2	200 V		●		●	●	●
	3	110 V		●		●	●	●
	4	220 V		●		●	●	●
	7	240 V		—		●	—	—
	8	48 V		—		●	—	—
	J	230 V		—		●	—	—
DC	5	24 V	●	●	●	DC specification is not available.		
	6	12 V	●	—	—			

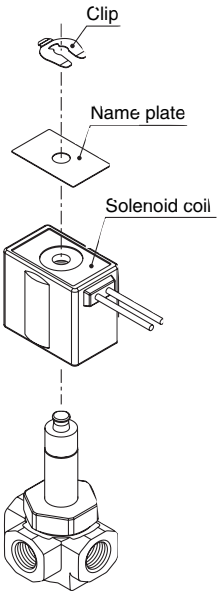
Note) Option S, Z are not available since a surge voltage suppressor is integrated into the AC/Class B coil, as a standard
∗ When changing coils, AC/DC are not interchangeable with each other, and Class B and H coils are also not interchangeable with each other.

Replacement Parts

• **Name plate part no.**

AZ-T-VX **Valve model**

↑ Enter by referring to "How to Order"



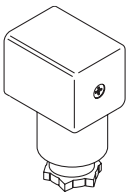
• **Clip part no.**

For VX31 **VX021N-10**
For VX32: **VX022N-10**
For VX33: **VX023N-10**

• **DIN connector part no.**

Without electrical option **GDM2A**

With electrical option **GDM2A** □□



Electrical option

S	With surge voltage suppressor
L	With light
Z	With light and surge voltage suppressor

∗ Refer to Table (1) for 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

Solenoid Valve Flow Characteristics
(How to indicate flow characteristics)

1. Indication of flow characteristics

Indication of the flow characteristics in specifications for equipment such as solenoid valve, etc. is depending on “Table (1)”.

Table (1) Indication of Flow Characteristics

Corresponding equipment	Indication by international standard	Other indications	Standards conforming to
Equipment for pneumatics	*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**
Equipment for controlling process fluids	*Av*	—	**IEC60534-2-3: 1997** **JIS B 2005: 1995** **Equipment: JIS B 8471, 8472, 8473**
	—	*Cv*	

2. Equipment for pneumatics

2.1 Indication according to the international standards

(1) Standards conforming to

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

Flow rate characteristics are indicated as a result of a comparison between sonic conductance C and critical pressure ratio b.

Sonic conductance C : Values which divide 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 the standard condition.

Critical pressure ratio b : It is the pressure ratio which will turn to the choke flow (downstream pressure/upstream pressure) when it is smaller than this values. (critical pressure ratio)

Choked flow : It is 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. (choked flow)

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 abbreviation (ANR) after the unit depicting air volume.
(standard reference atmosphere)
Standard conforming to: ISO 8778: 1990 Pneumatic fluid power—Standard reference atmosphere, JIS B 8393: 2000: Pneumatic fluid power—Standard reference atmosphere

(3) Formula of flow rate

It can be indicated by the practical unit as following.

When $\frac{P_2 + 0.1}{P_1 + 0.1}$ 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 described by ℓ (liter). 1 dm³ = 1 ℓ.

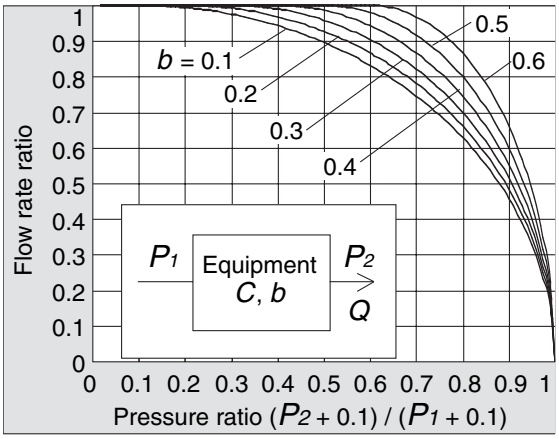
C Sonic conductance [dm³/(s·bar)]
b Critical pressure ratio [—]
P_1 Upstream pressure [MPa]
P_2 Downstream pressure [MPa]
t Temperature [C]
Note) Formula of subsonic flow is the elliptic analogous curve.
Flow characteristics curve is indicated in the Graph (1. For details, please use SMC's "Energy Saving 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 the 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 line

(4) Test method
By attaching a test equipment with the test circuit indicated in Fig. (1) while maintaining to a certain amount which does not let the upstream pressure go down below 0.3 MPa, measure the maximum flow to be saturated in the first place. Next, 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 formula of subsonic flow in order to find b, then obtain the critical pressure ratio b from that average.

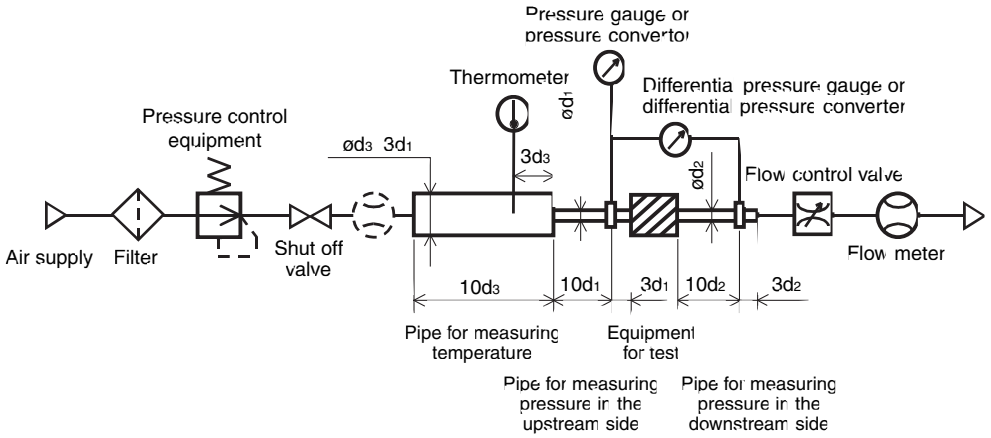


Fig. (1) Test circuit based on ISO 6358, JIS B 8390

2.2 Effective area *S*

(1) Standards conforming to

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*: is 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* (effective area).

(3) Formula of 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[dm^3/min(ANR)], dm^3 (cubic decimeter) of SI unit is good to be described by ℓ (liter), too. 1 dm^3 = 1 ℓ
S : Effective area [mm^2]
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 by sonic conductance *C* (2), it is the same formula when $b = 0.5$.

(4) Test method

By attaching the equipment for testing with the test circuit shown in Fig. (2), 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 compressed air of a certain pressure (0.5 MPa) which does not go down 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, and then determine the effective area *S* by using the following formula. The volume of air tank should be selected within the specified range by corresponding to the effective area of the equipment being tested. In the case of JIS B 8373, 8374, 8375, 8379, 8381, the pressure values are in parentheses and the coefficient of formula is 12.9.

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

S : Effective area [mm^2]
V : Air tank capacity [dm^3]
t : Discharging time [s]
Ps : Pressure inside air tank before discharging [MPa]
P : Residual pressure inside air tank after discharging [MPa]
T : Temperature inside air tank before discharging [K]

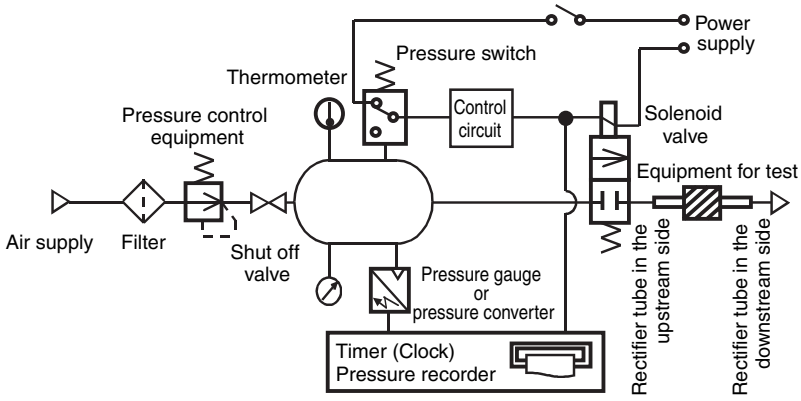


Fig. (2) Test circuit based on JIS B 8390

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. Equipment for process fluids

(1 Standards conforming to

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 Regulator 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 known unit. Also, the flow characteristics line shown in the 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]
In the case of saturated aqueous vapor:

$$Q = 8.3 \times 10^6 Av\sqrt{P(P_2 + 0.1)} \quad \cdots\cdots(10)$$

Q Flow rate [m³/s]
Av Flow coefficient [m²]
P Pressure difference [Pa]
P_1 Relative density [MPa]: $P = P_1 \quad P_2$
P_2 Relative density [MPa]

Conversion of flow coefficient

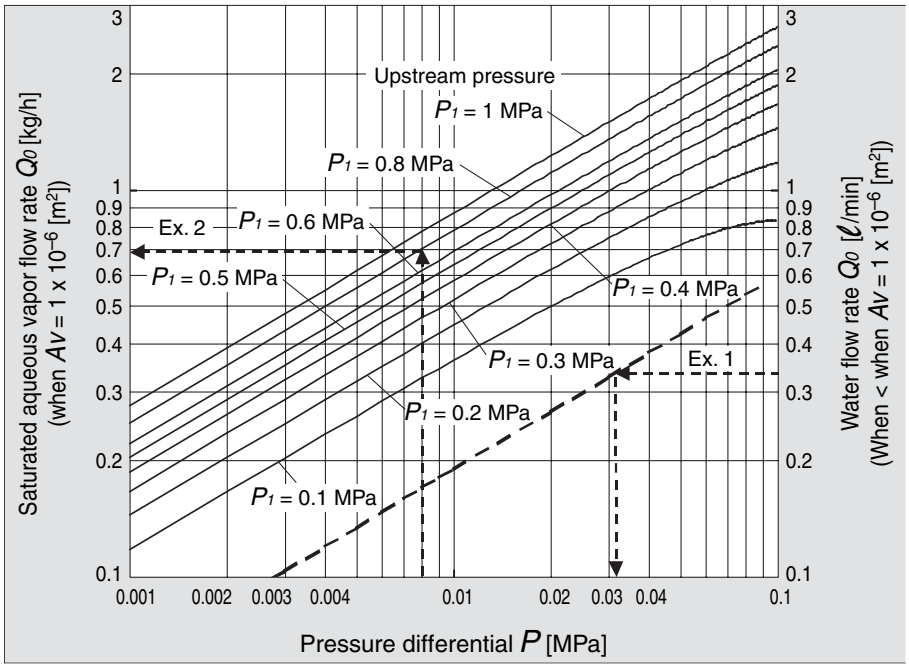
$Av = 28 \times 10^{-6} Kv = 24 \times 10^{-6} Cv$ .....(1

Here,

Kv factor: Value of the clean water flow rate represented by the m^3/h which runs through the valve at 5 to 40°C when the pressure difference is 1 bar

Cv factor (Reference values): It is the figures representing the flow rate of clean water by US gal/min which runs through the valve at 60°F, when the pressure difference is 1 lbf/in^2 (psi)

Values of pneumatic Kv are different from Cv because the testing method is different from each other.



Graph (2) Flow characteristics line

Example 1

Obtain the pressure difference when water 15 [ℓ/min] runs through the solenoid valve with an $Av = 45 \times 10^{-6}$ [m^2]

Since Q_0 = 15/45 = 0.33 [/min], according to the Graph (2), if reading P when Q_0 is 0.33, it will be 0.031 [MPa].

Example 2)

Obtain the flow rate of saturated aqueous vapor when P_1 = 0.8 [MPa], P = 0.008 [MPa] with a solenoid valve with an $Av = 1.5 \times 10^{-6}$ [m^2].

According to the Graph (2), if reading Q_0 when P_1 is 0.8 and P is 0.008, it is 0.7 [kg/h]. Hence, the flow rate Q = 0.7 x 1.5 = 1.05 [kg/h].

(4) Test method

By attaching the equipment for testing with the test circuit shown in Fig. (3) and running water at 5 to 40°C, 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.

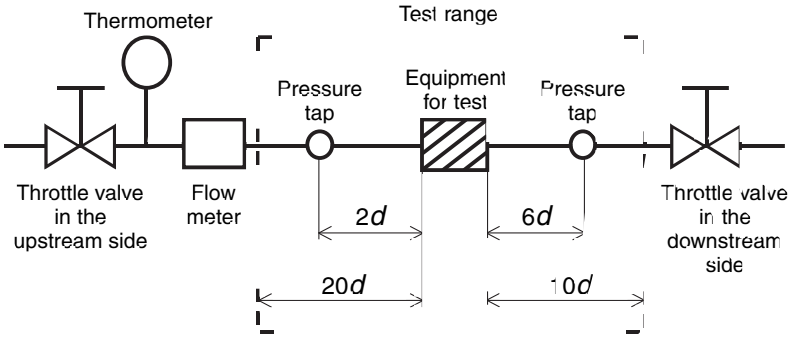
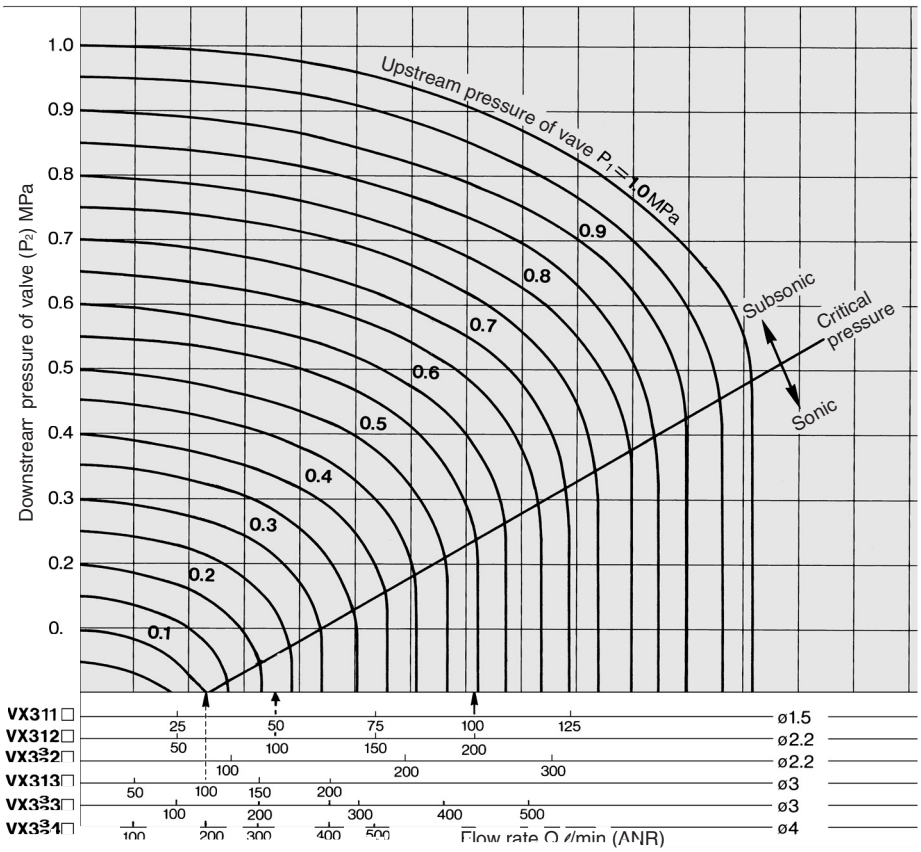


Fig. (3) Test circuit based on IEC60534-2-3, JIS B 2005

Flow Characteristics

Note) Use this graph as a guide. In the case of obtaining an accurate flow rate, refer to pages 25 through to 29.

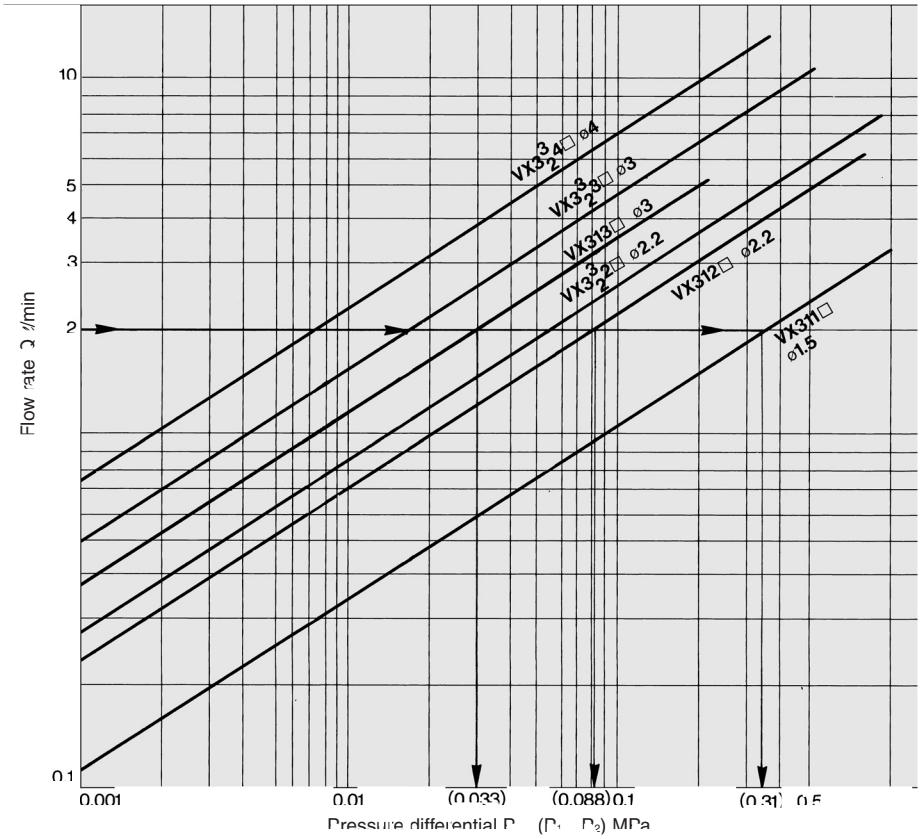
For Air



How to read the graph

The sonic range pressure to generate a flow rate of 100 ℓ/min (ANR) is
$P_1 \geq 0.$ MPa for a ø3 orifice (VX313□)
$P_1 \geq 0.23$ MPa for a ø2.2 orifice (VX312□), and
$P_1 \geq 0.55$ MPa for a ø1.5 orifice (VX31 □)

For Water



How to read the graph

When a water flow of 2 ℓ/min is generated,
$\Delta P \geq 0.033$ MPa for a ø3 orifice (VX313□),
$\Delta P \geq 0.088$ MPa for a ø2.2 orifice (VX312□), and
$\Delta P \geq 0.31$ MPa for a ø1.5 orifice (VX311□)