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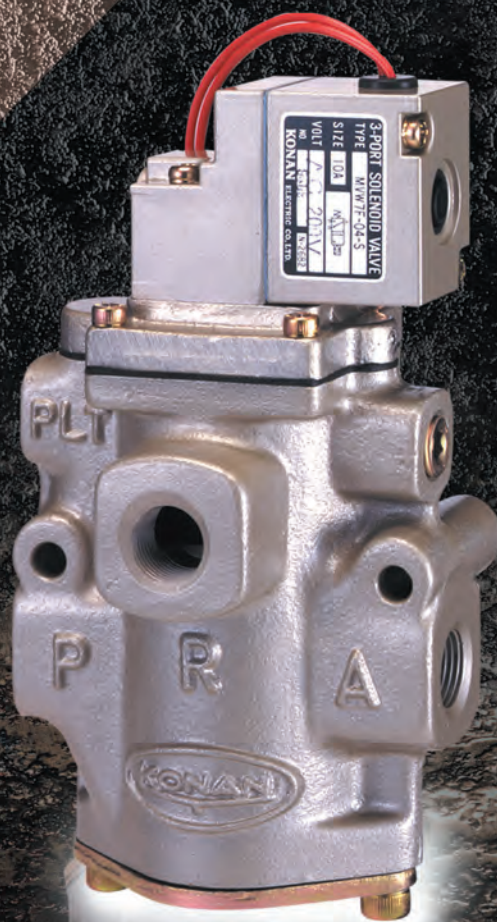
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Large-Capacity Poppet-type Pneumatic Solenoid Valves



4 Port Series

MVW344F&N



4 Port Series

MVW7F&N

Large-Capacity Poppet-type Pneumatic Solenoid Valves

HEAVY-DUTY

Spacer A

The back-pressure regulating mechanism is employed, which enables operation under any piping conditions.

Pilot Valve

A molded urethane rubber part is used for a poppet-type pilot valve, which provides very high durability. In addition, since the separate type which prevents fluid from entering the solenoid part is used, operation less affected by drain and oil mist can be ensured.

Main Valve

Since the main valve is lightweight and has no connection part, durability has increased greatly and the response speed has increased. Furthermore, the poppet-type structure displays remarkable strength against drain and dust.

Spacer B

The valve mechanism less affected by a transient phenomenon when switching is employed to reduce air loss.

MVW344N-14-S

HEAVY DUTY HD

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Features

I

Small and compact.

2

Employment of the back-pressure regulating mechanism enables operation under any piping conditions.

3

Employment of the valve structure less affected by a transient phenomenon when switching reduces air loss.

4

The main valve can be replaced without removal of piping.

5

Elimination of connection parts in addition to valve weight reduction has increased durability drastically.

6

Employment of the poppet structure both for the main and pilot valves displays remarkable strength against drain and dust.

7

The effective cross section area has increased greatly.

8

Operation without lubrication is possible.

9

Operation at high response speed is possible.

10

When the pilot pressure separate supply type is used, these valves can be used optimally for low-pressure application.

II

A terminal box can be attached optionally.

Solenoid Valves for Fluid Control and Valve Systems

General Handling Instructions and Precautions


Please read the following general handling precautions carefully before ordering solenoid valves for fluid control.

Following information is based on a risk assessment for Konan general purpose solenoid valves used for fluid systems (hereafter referred to as Agvalve(s)Ah). Each section provides information essential for safe operation of valve systems and prevention of risk and damage that may affect operators. Please read carefully.

Safety Precautions

References:

JIS B9702:
Safety of machinery principles of risk assessment
JIS B8370:
Pneumatic fluid power general rules relating to systems

 **Warning** A valve is operated by switching electric signals to increase / decrease or stop/supply fluid. It is widely used for fluid control systems in general. For safe operation of the valve, care should be taken especially for the following points.

① Selection of solenoid valves

1.1 Applicable fluid

A valve should be used with compressed air only, except for cases where nitrogen gas tank¹⁾ is used for system inspection, emergency measure, or portable pressure source. If highly dry air with dew point of no more than -40°C is to be used, make sure to use the valve with lubrication taking into consideration the dryness measure.

For a general purpose solenoid valve (for liquid and gas fluid) for which air is not specified as one of applicable fluids, do not employ compressed air as a flow media. For anything unclear regarding applicable fluids, feel free to ask our sales personnel in the planning stage.

Note1) Be careful to avoid suffocation of operators and others around the valve system. For a system that uses portable air or nitrogen tank, the High Pressure Gas Safety Law will be applied where fluid pressure exceeds 1 MPa.

1.2 Safety of a valve

A pneumatic system may be exposed to various hazardous environment, including those derived from the system components as well as the condition for use and the system structure. In selecting a valve make sure to take into consideration the valve function as well as safety in installation, adjustment, actual operation, system failure, and disposal of the valve.

1.3 Electrical safety

A solenoid valve is activated by magnetic force (solenoid). Take into consideration the following matters when selecting a valve and electric options.

- 1) Dust-proof/water-proof specification Water-proof indication should follow JIS C0920.
- 2) Sudden shut down of power source (power failure, emergency shutdown, etc.)
- 3) Voltage fluctuation in power source and electrical surge
- 4) Leakage current at PLC (sequencer) power off Konan solenoid valves are not equipped with functions that meet the following conditions. Do not use the valves in these conditions or employ a safe electric distribution.
 - 1) External magnetic field effect
 - 2) Electric current from the relevant control circuit
 - 3) Lightning-induced voltage

1.4 Pilot valve

A compact size pilot valve is widely used in general, as it switches large main valve with a small output. However, a certain inlet pressure is essential for the valve operation. For control of minimal pressure, select a direct-acting type valve. With optional pilot supply (separate pilot piping needed), a pilot valve can be used even when the main valve pressure is zero.

1.5 Back pressure from exhaust port

In some poppet valves, back pressure from the exhaust port may affect the valve operation. There is no problem with the back pressure generated in the silencer set at the exhaust port, but do not force to narrow the exhaust port diameter or connect a long pipe to the port. Details of the effect of back pressure are described in a separate operation manual. For anything unclear feel free to contact our sales personnel.

1.6 Reverse flow

Use a valve complying with the flow direction indicated with arrow mark in the JIS figure of the catalogue and operation manual. Safe operation cannot be guaranteed if the valve is used with reverse pressure or reverse flow. There is no problem with the slow reverse flow exhaustion during maintenance or compressor power off. If valve operation is stopped abnormally, a failure may occur when restarting operation due to the stop position of the valve. If reverse flow is detected at abnormal stop or any trouble at the restart of the valve is concerned, feel free to ask our sales personnel.

1.7 Manual operation

- 1) If there is a possibility that manual operation button of a valve may be pushed unexpectedly, select a valve equipped with protection cover.
- 2) If failure to unlock manual operation of a valve may cause serious danger, select a valve without locking function.

② Solenoid valve installation

Solenoid valves have precise operational functions and are used for applications with versatile conditions and environment. It is therefore sometimes difficult to assume all concerned risks or risk factors when designing a valve. In such cases the valve function and performance may be deteriorated in a period shorter than the maintenance period set by the manufacturer. In order to avoid the risks, install the valve as instructed below.

2.1 Installation site

Install a valve in a place where setting and maintenance is easy. As a valve is often incorporated into an existing main system, consideration for maintenance is sometimes insufficient. Secure enough space for safety of the valve operation.

2.2 Operating procedure

When operating a valve to activate a pneumatic cylinder and other actuators, install the components and complete piping, and then start operation of the actuators with small load and slow speed, gradually adjusting them to rated conditions while confirming no abnormalities or air leakage in the valve and actuators.

2.3 Bursting out of a cylinder

After installation or maintenance, supply air after confirming that a cylinder is in a targeted valve control position. If not in

the position, the cylinder may rapidly shift to the control position. In order to avoid this risk, installation of a slow-start valve at the IN port of the valve is recommended.

Note) (See Section 2.4) When installing a slow-start valve at the IN port of a pilot valve, adjust a bypass valve of the slow-start valve in order to maintain minimal operational pressure of the pilot valve. If the bypass valve diameter is excessively narrowed, the pilot pressure will become less than the minimal operational pressure, which may cause valve malfunction.

Also, when restarting air supply, open a manual valve in a short period of time while checking manometer to secure minimal operational pressure of the pilot valve, and then supply air slowly.

2.4 Securing pilot pressure

Install a pilot valve taking care for the following matters.

- 1) Inlet pressure of a valve should be higher than the minimal operational pressure. Especially if air supply is not enough, pressure fluctuation may occur during the valve operation and pressure may be below the lower limit of the operational pressure.
- 2) If long piping is employed at the inlet of a valve or the pipe diameter is smaller than the port diameter, pressure drop may occur, resulting in the inlet pressure decrease.

Note: One countermeasure is to install a supplementary air tank in front of the inlet port. In order to confirm no decrease in inlet pressure, install a manometer around the port.

- 3) For a manifold type solenoid valve, make sure to connect allowable number of valves only. Simultaneous operation with excess number of valves (more than 3 units in standard) may cause centralized pressure drop at the manifold, decreasing the valve inlet pressure.

Note: For a manifold with two inlet ports, the number of valves can be increased by supplying air from both ports.

2.5 Indication

If a valve nameplate cannot be seen due to installation environment, place an alternative indication near the valve.

2.6 Residual pressure

Compressed air in a pneumatic valve system may not be completely exhausted after the valve power shut down. Residual pressure may cause unintended cylinder operation in the system. A valve should be installed taking into consideration the risks including sudden blowout of residual air.

2.7 Air exhaustion

At an exhaust port of a valve, sonic jet flow may occur, causing noise as well as damage to operator due to the fragments and dusts spread by the jet flow. If any personnel may come closer to the exhaust port, install a silencer to avoid noise and adjust air flow.

2.8 Training

A sufficiently trained person should be responsible for installation and maintenance of a pneumatic system. (Konan provides training for operation and maintenance of pneumatic components. Feel free to contact our sales personnel for details.)

③ Maintenance of solenoid valves

Maintenance should be performed in accordance with the following steps. Feel free to contact our sales personnel for separate maintenance manual.

3.1 Daily inspection

- 1) Drains contained in compressed air may inhibit the valve lubrication. Set an air filter in front of the valve and routinely exhaust drains.actuators.

- 2) During the valve system operation, check the valve visually and acoustically for external abnormalities or noise. Check also the loosening of screws and air leakage from exhaust port and piping joint without exhausting air from the system, and perform periodical inspection as necessary to recover any abnormalities.

3.2 Periodical inspection

Following periodical inspection should be conducted by-annually or annually.

- 1) Overhaul should be performed after pneumatic/electric shut-down and abnormalities recorded and repair conducted as necessary.
- 2) In the 2nd periodical inspection, perform an overhaul of the product, repair or exchange solenoid assAfy, coil, packings, and other components as necessary. However, even before 2 years has passed, the valve that reached the specified durable operation cycle²⁾ should be over hauled and parts exchanged if necessary.

Note2) [Laboratory durable operation cycle]: New Magstar 414 series and heavy duty series solenoid valves: 5 million cycles

Durable operation cycle for each valve is specified in the operation manual or drawing. This cycle is determined based on the Konan standard test results. Inspection interval should be determined referring to the actual installation environment or storage records.

- 3) If a valve is not used for a long time, the valve function may be deteriorated when restarting operation, due to precipitation or effusion of lubricant film. According to the JIS standard, minimal operation frequency of a valve is specified as once in 30 days. Before reaching that date perform periodical test operation or take other measures for preventing the valve deterioration.

3.3 Residual energy

Maintenance requiring actual operation of a system should be performed after pneumatic/electric shut-down and exhaustion of all residual electrical charge and compressed air from the system. Make sure the movable components do not move during the maintenance, and mechanically fix them if necessary for safety. Care should also be taken for components that may drop out during the maintenance operation and components with sharp edges to ensure safety.

3.4 Communication

If multiple persons are involved in the maintenance operation, keep all the personnel informed about the conditions including power-off, completion of residual pressure exhaustion, power-on, and resumption of air supply.

④ Solenoid valve installation site

Use of a valve at the following sites requires compliances with special functional specifications and regulations. Consult our sales personnel in the planning process for anything unclear. thing unclear.

- 1) Operating conditions not within the specified range
- 2) Significant risk for users, properties, or environment is anticipated

Eg: Use in explosive environment³⁾, use for nuclear power plants, vehicles, medical components, components related to the Occupational Health and Safety Law and/or the High Pressure Gas Safety Law, etc.

Note3) : Select Konan explosion-proof solenoid valves for use in general gas explosive environment.

Users Instructions

Followings are comprehensive precautions for operation of a solenoid valve and a system incorporating a valve. Make sure to keep in mind these matters for maintaining safety.

Caution ① **Transport of solenoid valves**

1.1 Weight

For safety of operators, heavy-weight valves and valve units should be transported with the aid of conveyer equipment. Valve weight can be confirmed by referring to Konan Pneumatic Solenoid Valve Catalogue and product drawings. Mini-size valves should be handled with care, as they may collapse by excessive force. Especially make sure not to hold the lead wire when transporting the valves.

1.2 Dropping

During lifting or horizontal transportation of a valve, handle the valve carefully not to drop or damage.

1.3 Dust prevention

Plastic plug is attached to the valve connection ports to prevent dusts and rusts from entering the valve. Do not remove the plug until immediately before piping. If the plug is lost, take a protection measure with alternative cover.

Caution ② **Storage**

2.1 Storage during transport

If a valve is to be installed where it is exposed to wind and rain or other adverse environment, transport the valve to the specified site just before installation. If the valve is to be stored at the installation site by necessity, keep it packed and protect with a sheet cover.

2.2 Storage

A valve should be stored as follows to prevent contamination and material deterioration.

- 1) Avoid high temperature and humidity as well as places with dusts.
- 2) If a valve is to be stored for more than 1 year, keep it packed or provide equivalent protection.
- 3) Long-term storage may result in sticking of packings or other components due to shortage of lubrication. In such cases, conduct pre-conditioning operation of the valve before regular use.
- 4) After a long period of storage, permanent deformation, change of size, or deterioration of packings and other components would be a concern. After such storage period, conduct a valve operation test. If any abnormalities are found, perform an overhaul or exchange deformed/deteriorated components as appropriate

Warning ③ **Surrounding environment**

3.1 Vibration/shock

- 1) Install a valve using hose connection to avoid the place where the valve is exposed to excessive shock or vibration. Care should be taken not to make outlet piping longer, which may affect system response.
- 2) If a valve is to be installed in a place where it is exposed to excessive shock or vibration, set the valve with a vibration isolation table. Ensure the valve is firmly fixed at the setting and connection portions fastened tightly. After start of operation, inspect the connections in a periodical manner to check any loose parts or deformation and re-fasten screws.

3.2 Handling during installation

For safety of operators

Do not ride on a valve and pipes or hang wires on the operational equipment during installation.

3.3 Surrounding environment

Environment surrounding a valve should be considered carefully. Avoid places where the valve is exposed to rain and wind, direct sunlight, salt, corrosive gas, chemical fluids, organic solvents, steam, etc. Corrosion resistance measure can be taken depending on the environment. Feel free to contact our sales personnel for details.

3.4 Working temperature

Use a valve with specified range of ambient temperature and fluid temperature. Care should be taken especially for the following cases.

- 1) Temperature of compressed air around an air compressor may become high, which may cause deterioration of packings or malfunction of the valve.
- 2) Coil life depends on thermal degradation of insulation material. Avoid high temperature environment or continuous energization as much as possible.
- 3) In a place where temperature is close to 0°C, remove moisture in the compressed air with an air dryer. If the dehumidification is not performed, significant amount of moisture may freeze inside the valve to cause malfunction.

Warning ④ **Modification**

Do not modify a solenoid valve. Unexpected risk may arise.

Caution ⑤ **Intermediate stop of a cylinder by control of a solenoid valve**

- 1) A pneumatic cylinder can be stopped intermediately by controlling with a 3-position closed-center type solenoid valve. Due to compressible nature of air, however, precise stop position or retention rigidity of the stop position cannot be secured.
- 2) If the piping area between the speed control valve and the closed-center solenoid valve is large, air shifts from inside the cylinder to the valve pipings even after the valve is closed, thus the stop position shifts. In order to avoid this, install a speed control valve in front of the closed-center valve to minimize piping length.
- 3) As sealing portions inside a valve or cylinder system allow minimal leakage, it is difficult to maintain the intermediate stop position for a long time. If long-term retention of the stop position is necessary, install mechanical retention equipment such as brake, lock, or latching system.

Caution ⑥ **Spray lubrication using a lubricator**

See Konan Solenoid Valve Catalogue if a valve needs lubrication. For valves that need lubrication, set a lubricator at the inlet of the valve and perform spray lubrication.

6.1 Type of lubricating oil

- 1) Use JIS K 2213 (ISO VG32 or VG46) type turbine oil for lubrication using a lubricator.
- 2) Spray volume of a lubricator is determined by the number of oil drops (typically 0.03cm³ per drop or 1.5 to 2.5 drops per 1m³ of air).

6.2 Centralized lubrication

In principle 1 lubricator should be used for 1 valve. Lubricating multiple valves may result in uneven oil supply to each valve or actuator, particularly if there are differences in the operation

frequency, pipe length, size, and installation height of the actuators. By grouping the valves and actuators with similar conditions, centralized lubrication can be achieved.

6.3 Selection of oilless solenoid valve

For control of an oilless actuator, select an oilless solenoid valve. If the valve is not frequently used, lubricated oil may not reach the valve or actuator due to little spray volume.

- 1) Use specified grease for overhaul of an oilless solenoid valve. Reconfirm the type of grease with our sales personnel.
- 2) A greased oilless valve or oilless actuator can be lubricated, but once lubricated, the grease will be exhausted. Although durability is enhanced after the lubrication, continual lubrication will be required.



Reference ⑦ Pneumatic system control

7.1 Sequence control

Follow the below steps for sequence control of an actuator incorporating a pneumatic valve.

- 1) Detect the position.
- 2) Interlock the circuit of the valve that controls other actuators in the system.

7.2 Power failure and pneumatic pressure failure

- 1) In case of power failure or emergency stop during a sequence operation, select normal stop position of the valve so that the cylinder at operation stops or shifts to a safe position. Depending on the type of valve following action may be seen at emergency stop.
 - a) Single-acting return type: Shifts to the start position.
 - b) Double-acting detent (retention) type: Shifts to the final stop position.
 - c) Closed-center type: Stops at the current position.
- 2) If operation is stopped in the middle of sequence and restarting operation from the stopped position may cause any trouble, manually control each actuator to return to the start position. Indicate procedure to recover operation.
- 3) If operation is stopped in the middle of sequence and air inside the system exhausted, a cylinder piston may drop due to gravity or it may rapidly shift at the next air supply to damage operator or surrounding equipment. Make sure to return the piston to the start position before exhausting air from the system.
- 4) In order to complete a cycle operation even in case of pressure failure, reserve sufficient amount of pneumatic pressure in an air tank.



Warning ⑧ Residual pressure exhaustion

In a system circuit using a check valve (non-return valve), a pilot check valve, and/or a closed center solenoid valve, exhaust residual pressure separately or indicate warnings for residual pressure, as air may be contained even the system is not in operation.

Indicate the manual type valve for residual pressure exhaustion in the system circuit drawing.



Reference ⑨ Circuit and piping

9.1 Pressure drop

In a pneumatic control system employing long pipes at the end or entrance of the system, sufficient pressure may not be supplied due to pressure drop. Piping thus should be designed properly, or supplementary air tank should be installed to secure supply pressure if a valve is operated intermittently.

9.2 Air filtration

Air supplied to a valve should be filtrated by a filter with nominal filtration rating of no more than 40 mm to remove solid contaminants. Exhaust liquid drain or oil through the filter or drain separator after sufficient cooling of the air.

Exposure to contaminated, high temperature compressed air may deteriorate packings or other components, making the valve life shorter.

9.3 Piping

- 1) Use galvanized pipe for steel tube piping and remove dusts after screwing.
- 2) Before connection, clean the pipes by air flushing or washing to remove internal dusts, moisture, and oil.
- 3) If a seal tape is used for screwing, wrap the tape around twice or three times in a direction opposite to the screwing direction, leaving 1.5 to 2 threads from the screw edge.
- 4) When screwing pipes and joints into a valve, use an appropriate size of wrench and fasten the pipes and joints to the extent not causing air leakage. Forceful screwing may result in cracking of the valve connection port or leakage/malfunction due to contamination with fragments of sealing materials.
- 5) In case of 6A to 25A (Rc1/8 to 1) size pipes or joints, 4 to 5 threads should be screwed. An exercise for seal tape wrapping and screwing before actual work is recommended.
- 6) A valve (especially large-size valve) should be fixed not only with the piping but also with supporting components. For some mini-size solenoid valves with steel tube piping, supporting components may be used for the piping portion. In this case sufficiently support around the valve with piping clamp and other components.



Caution ⑩ Electrical circuit and piping

- 1) Reconfirm that the voltage and current (AC or DC) of power source and the valve to be used are identical.
- 2) For DC solenoid, check the polarity of the connection terminal to avoid improper connection.
- 3) For a double solenoid valve with common terminal, make sure not to perform improper common connection.
- 4) If TRIAC is used for the AC output of the PLC (sequencer), leakage current at power shut down may affect action of solenoid or indicator lamp. In such case submit the PLC output specification to the PLC manufacturer or Konan sales personnel to discuss about a method to decrease leakage current.
- 5) Power surge due to electromagnetic induction at solenoid power off may significantly shorten the operating life of junction on the electrical circuit. For Konan solenoid valves without surge absorber, consult our sales personnel for a method to connect surge absorber.
- 6) For lead wire connection, wiring should be conducted using appropriate connecting terminal while keeping the wire loose.



Caution ⑪ Special valves

For valves with special specifications like below, consult our sales personnel before ordering regarding the conditions for use.

- 1) Use with carbon gas or nitrogen gas
- 2) Use under conditions with high/low temperature or high radiant heat
- 3) Use at a place with ozone or salt
- 4) Use in explosive environment



Warning ⑫ Disposal

- 1) Do not incinerate a valve for disposal. It may explode or emit poisonous gas.
- 2) Check the material of each component of a valve with catalogue or operation manual for segregation disposal. Konan solenoid valves do not include materials indisposable as general industrial waste.

INFORMATION

Type

3-port solenoid valve

3-port solenoid valve has 3 ports: fluid inlet (P-port), outlet (A-port), and exhaust port (R-port). This is mainly used for operation of single-acting actuators or diaphragm valves.

The valve structure is as follows:

Normally closed : Air flow stops when solenoid is de-energized.

Normally open : Air flows when solenoid is de-energized.

5-port solenoid valve

5-port solenoid valve has 5 ports: a fluid inlet (P-port), 2 load connection ports (A- and B-ports), and 2 exhaust ports (R1- and R2-ports).

This valve is mainly used for operation of double-acting actuators.

Two types (return, hold) are available, and three positioning (closed center, exhaust center, pressure center) can be selected.

The exhaust port can be used as connection to flow control valve (exhaust valve).

Air-operated valve

This valve controls direction of air flow using air pressure signals, unlike solenoid valves that utilize solenoid. The valve performance is comparable to that of solenoid valves, except slightly longer response time.

JIS symbols

Solenoid valves are expressed by JIS-specified graphic symbols and characters based on JIS B0125 "Fluid power systems and components." Each symbol is shown in the Model code section.

Model code

Model code specifies each product by the specified code numbers or alphabets. Please indicate model codes when ordering valves.

Specifications

All specifications described in the catalogue are based on the results of varied tests performed in accordance with JIS B8374

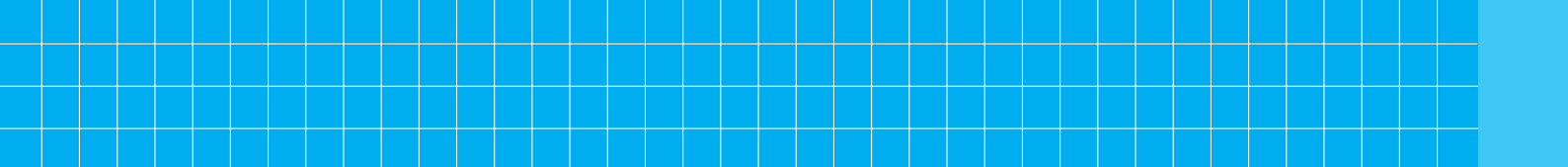
"Pneumatic system -- 3-port solenoid operated valves"

and JIS B8375 "Pneumatic fluid power -- Five-port directional control valves." The other parameters below are common to all solenoid valves.

Internal leakage	Less than the value specified in JIS B8374/8375
Ambient relative humidity	Not more than 95%
Insulation resistance	Not less than 10 M Ω (Measured by 500 V Megger test)
Withstand voltage	Commercial frequency, 1500 V, 1 min

Connection

DC solenoid valves have no polarity.



3 Port Solenoid Valves

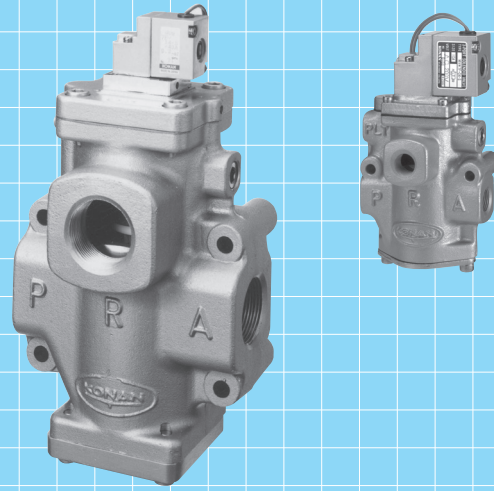
Large-Capacity Poppet-type(Return)

Normally closed
MVW7F – S

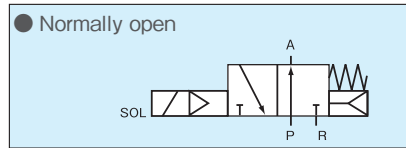
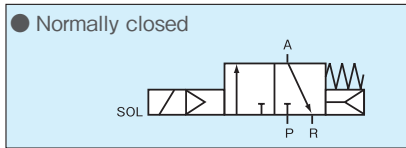
Port size Rc 3/8 ~ 2

Normally open
MVW7FR – S

Port size Rc 3/8 ~ 2



JIS symbol



Specifications

Model code	Normally closed	MVW7F-04-S		MVW7F-08-S		MVW7F-14-S		
	Normally open	MVW7FR-04-S		MVW7FR-08-S		MVW7FR-14-S		
Port size		Rc 3/8	Rc 1/2	Rc 3/4	Rc1	Rc1 1/4	Rc1 1/2	Rc2
Effective area of valve		70mm ²	80mm ²	200mm ²	220mm ²	700mm ²	750mm ²	800mm ²
Fluid	Compressed air (Dry air filter passage less than 40 μm.)							
Working pressure range	0.2 ~ 0.7MPa							
Proof pressure	1.05MPa							
Ambient temperature	- 20 ~ 50°C (remove moisture perfectly from the fluid to prevent freezing when used at 5°C or lower.)							
Solenoid	Allowable voltage fluctuation	± 10% of the rated voltage						
	Temperature rise	Max.80°C						
	Insulation class	JIS C 4003 Class B						
	Power consumption	See coil data						
Response time		less than 0.05s		less than 0.05s		less than 0.18s		
Operating frequency	Max.2time/s							
Installation position	As desired							
Mass ※		1.1kg		1.7kg		6.1kg		

Note) The mass marked with "※" does not include options.

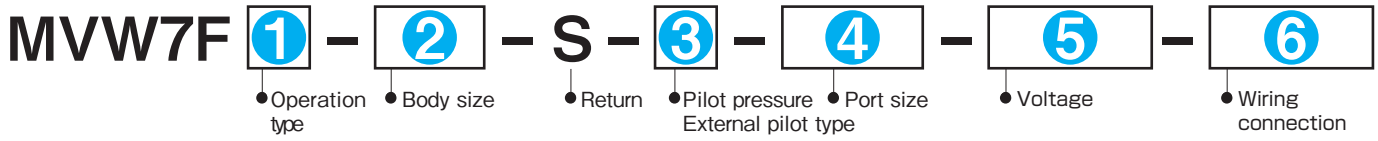
● Consult factory for non-standard applications which are not covered by above specifications.

Coil data

Rated voltage [V]	AC										Rated voltage [V]	DC			
	100		110		125		200		220			24	48	100	110
Frequency [Hz]	50	60	50	60	50	60	50	60	50	60					
Issuance current [mA]	199	177	164	144	165	143	115	100	83	72					
Retention current [mA]	93	75	86	60	79	62	57	42	43	30	250	129	60	49	

Model Code

When ordering, specify the model as follows.



1 Operation type

Normally closed	No entry
Normally open	R

2 Body size

Rc 3/8	04
Rc 1/2	
Rc 3/4	08
Rc 1	
Rc 1 1/4	14
Rc 1 1/2	
Rc 2	

3 Pilot pressure · External pilot type

Internal (Standard) pilot type	No entry
External pilot type	P

● In the case of external pilot type, working pressure is as follows. Please be careful.

Working pressure ≤ Pilot pressure ≥ 0.2MPa

4 Port size

04	Rc 3/8	10A
	Rc 1/2	15A
08	Rc 3/4	20A
	Rc 1	25A
14	Rc 1 1/4	32A
	Rc 1 1/2	40A
	Rc 2	50A

5 Voltage

AC100V (50/60Hz)	AC100
AC110V (50/60Hz)	AC110
AC125V (50/60Hz)	AC125
AC200V (50/60Hz)	AC200
AC220V (50/60Hz)	AC220
DC 24V	DC 24
DC 48V	DC 48
DC100V	DC100
DC110V	DC110

6 Wiring connection

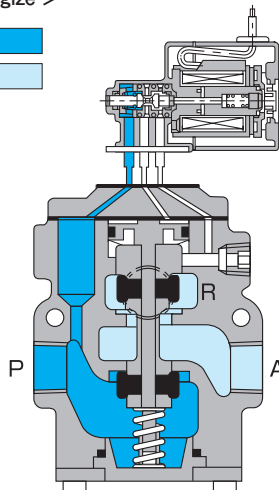
Lead wire	No entry
DIN connector	DT
DIN connector (With Indicate Lamp)	DN
DIN connector (With Indicate Lamp · Surge absorber)	DNZ
TBF1 Type Terminal box	TBF1
TBF1 Type Terminal box (With Indicate Lamp)	TBF1N
TBF1 Type Terminal box (With Surge absorber)	TBF1Z
TBF1 Type Terminal box (With Indicate Lamp · Surge absorber)	TBF1ZN

Structure / Operation

MVW7F

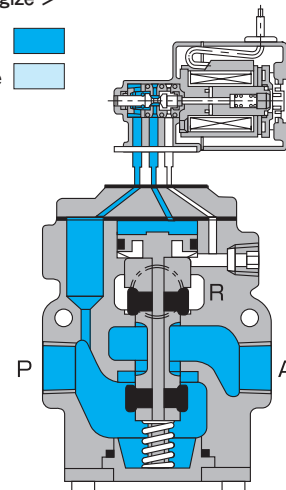
< SOL.Deenergize >

P → Close
 A → R



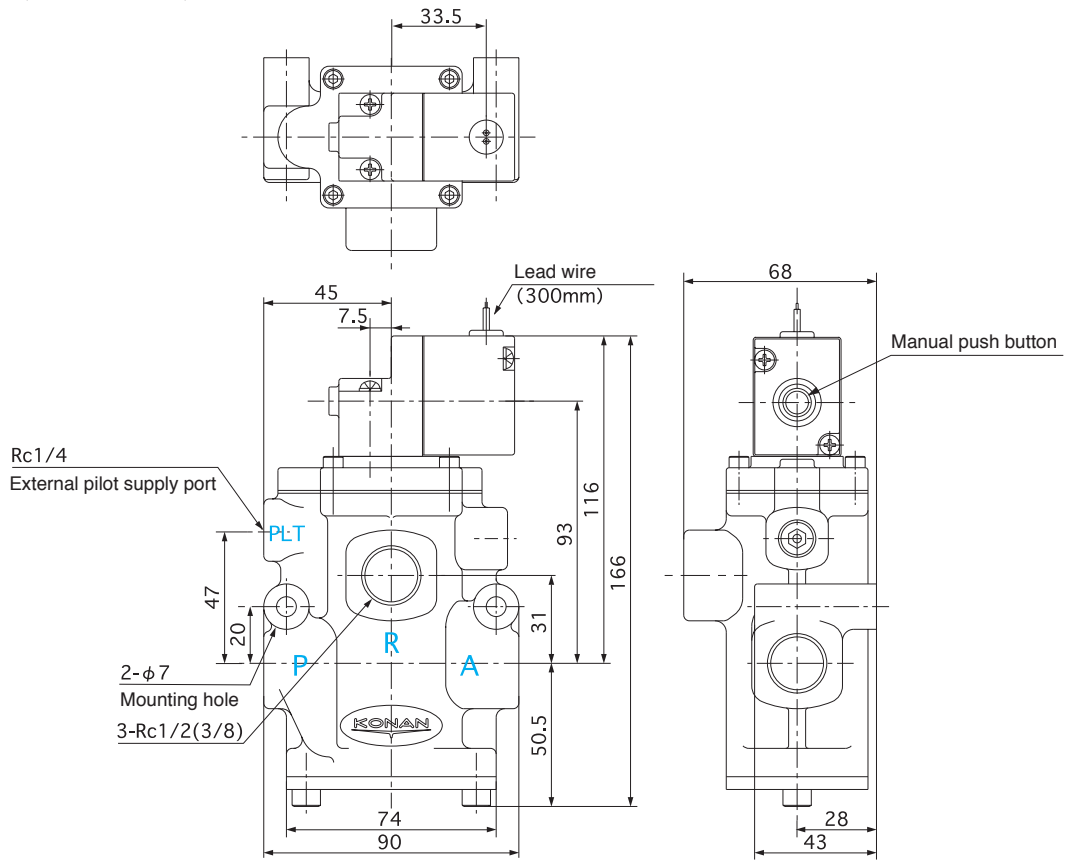
< SOL.Energize >

P → A
 R → Close

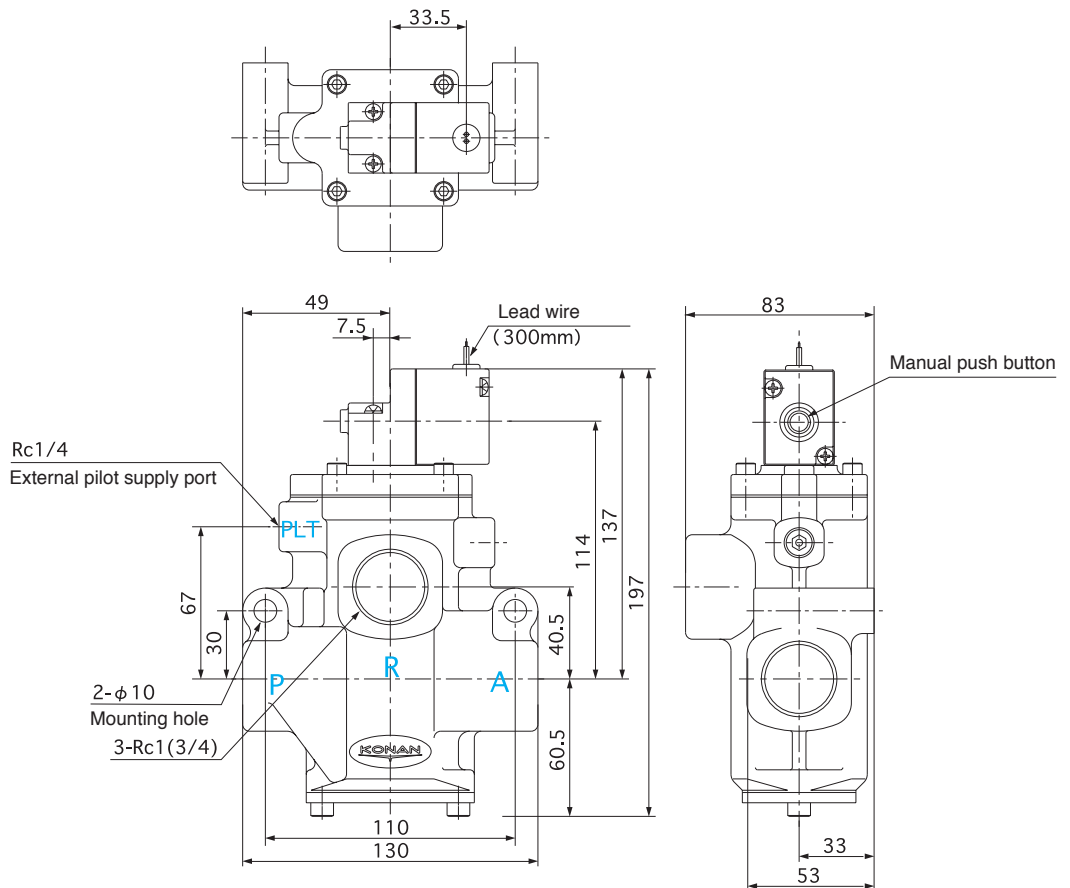


External Dimensions

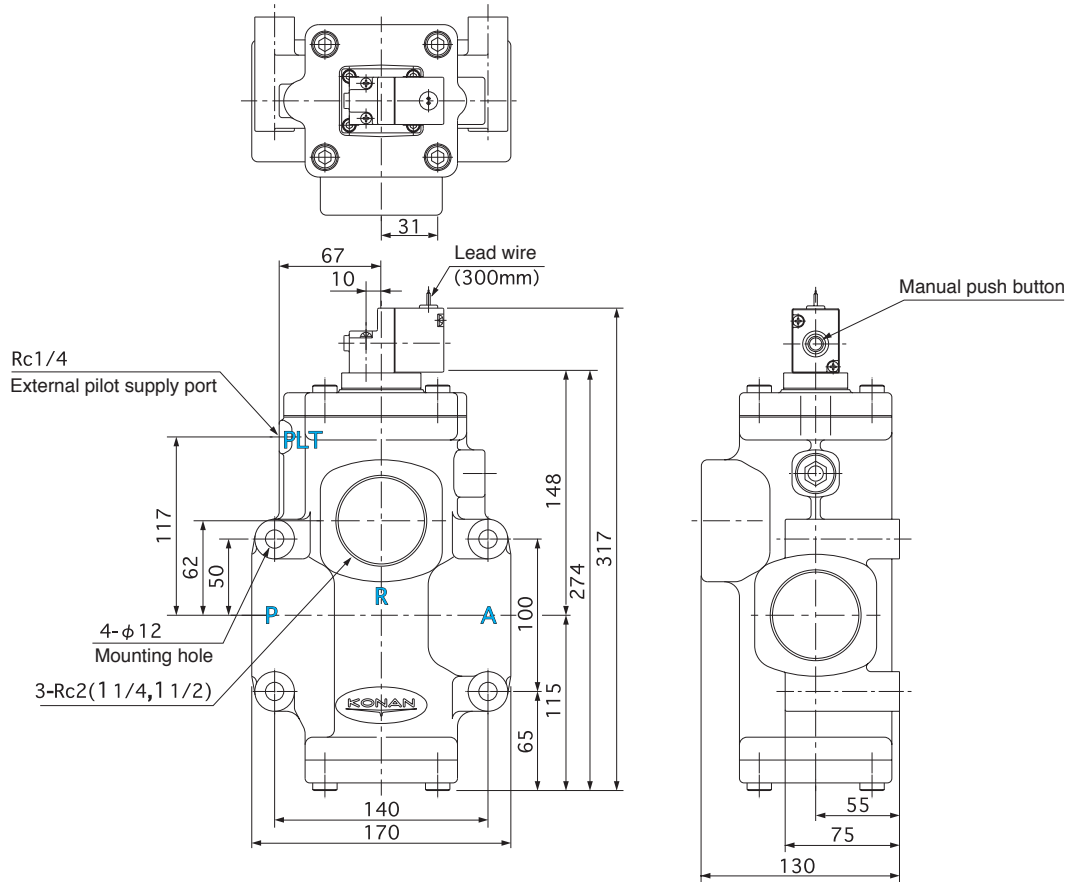
MVW7F (R) -04-S (Lead wire)



MVW7F (R) -08-S (Lead wire)

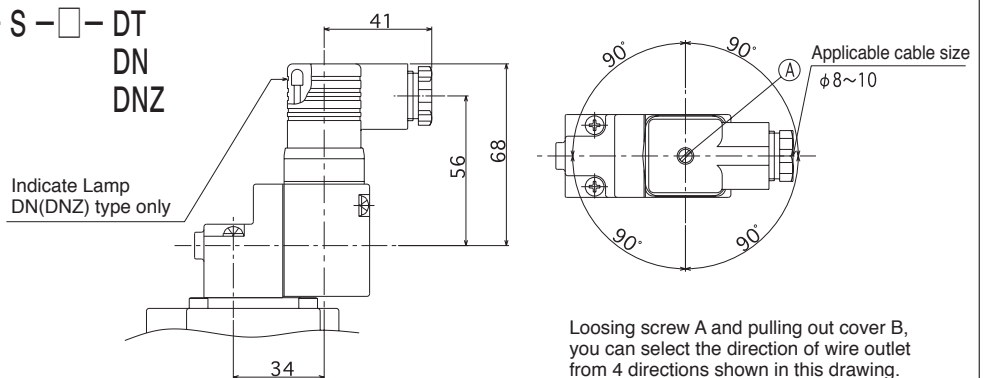


MVW7F (R) -14-S (Lead wire)



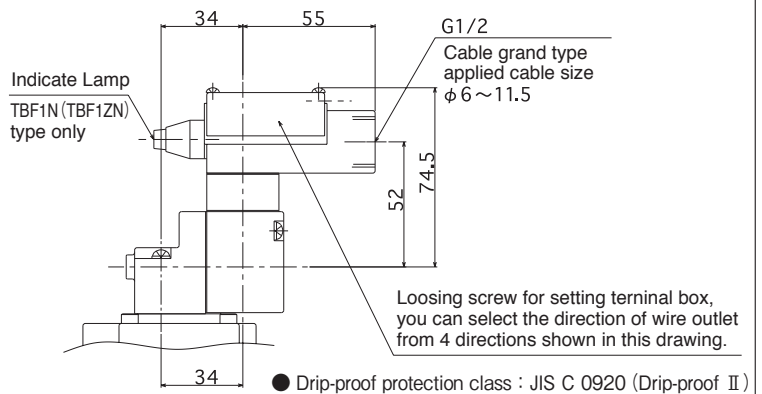
■ DIN connector (Option) Installation

MVW7F (R) - 04 · 08 · 14 - S - □ - DT
 DN
 DNZ



■ TBF1 type Terminal box (Option) Installation

MVW7F (R) - 04 · 08 · 14 - S - □ - TBF1
 TBF1N
 TBF1Z
 TBF1ZN



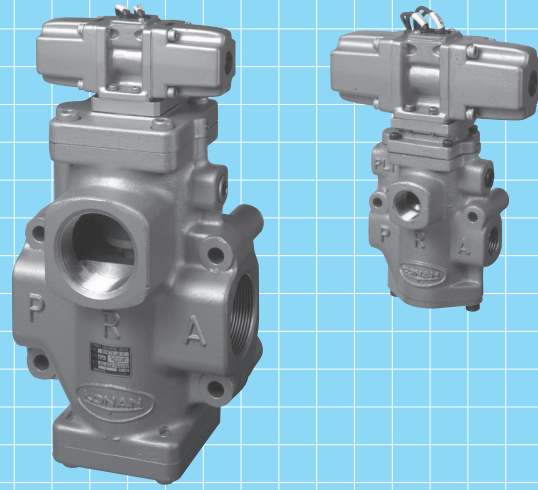
● Drip-proof protection class : JIS C 0920 (Drip-proof II)

3 Port Solenoid Valves

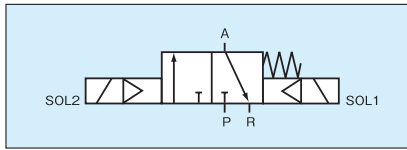
Large-Capacity Poppet-type(Hold)

Normally closed
MVW7N – D

Port size Rc 3/8 ~ 2



JIS symbol



Note) When the pneumatic pressure of P becomes "0" at the SOL.2 position, the valve will be returned to the SOL.1 position by the spring force.

Specifications

Model code		MVW7N-04-D		MVW7N-08-D		MVW7N-14-D		
Port size		Rc 3/8	Rc 1/2	Rc 3/4	Rc1	Rc1 1/4	Rc1 1/2	Rc2
Effective area of valve		70mm ²	80mm ²	200mm ²	220mm ²	700mm ²	750mm ²	800mm ²
Fluid		Compressed air (Dry air filter passage less than 40 μm.)						
Working pressure range		0.2 ~ 0.7MPa						
Proof pressure		1.05MPa						
Ambient temperature		- 20 ~ 50°C (remove moisture perfectly from the fluid to prevent freezing when used at 5°C or lower.)						
Solenoid	Allowable voltage fluctuation	- 15%~ 0% of rated voltage (Continuous) , 0%~ +10% of rated voltage (Short time)						
	Temperature rise	Max.80°C						
	Insulation class	JIS C 4003 Class B						
	Power consumption	See coil data						
Response time		less than 0.03s		less than 0.05s		less than 0.3s		
Operating frequency		Max.2time/s						
Installation position		Installation of the pilot valve with its horizontal.						
Mass ※		1.8kg		2.4kg		6.4k		

Note) The mass marked with "※" does not include options.

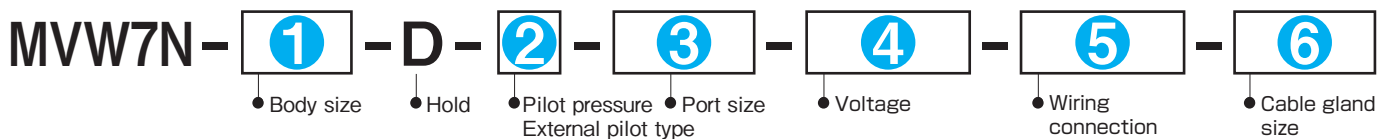
● Consult factory for non-standard applications which are not covered by above specifications.

Coil data

Rated voltage [V]	AC							Rated voltage [V]	DC		
	100		110		200		220		24	48	100
Frequency [Hz]	50	60	50	60	50	60	60				
Issuance current [mA]	1415	995	1441	1200	733	500	639	Retention current [mA]	583	292	140
Retention current [mA]	283	199	288	240	147	100	128				

Model Code

When ordering, specify the model as follows.



1 Body size

Rc 3/8	04
Rc 1/2	
Rc 3/4	08
Rc 1	
Rc 1 1/4	14
Rc 1 1/2	
Rc 2	

2 Pilot pressure · External pilot type

Internal (Standard) pilot type	No entry
External pilot type	P

● In the case of external pilot type, working pressure is as follows. Please be careful.

Working pressure ≤ Pilot p-ressure ≥ 0.2MPa

3 Port size

04	Rc 3/8	10A
	Rc 1/2	15A
08	Rc 3/4	20A
	Rc 1	25A
14	Rc 1 1/4	32A
	Rc 1 1/2	40A
	Rc 2	50A

4 Voltage

AC100V (50/60Hz)	AC100
AC110V (50/60Hz)	AC110
AC200V (50/60Hz)	AC200
AC220V (60Hz)	AC220
DC 24V	DC 24
DC 48V	DC 48
DC100V	DC100
DC110V	DC110

5 Wiring connection

Lead wire	No entry
DIN connector	DT
DIN connector (With Indicate Lamp)	DN
TBF1 Type Terminal box	TBF1
TBN2 Type Terminal box	TBN2
TBN2 Type Terminal box (With Indicate Lamp)	TBN2N
TBN2 Type Terminal box (With Surge absorber)	TBN2Z
TBN2 Type Terminal box (With Indicate Lamp · Surge absorber)	TBN2ZN

6 Cable gland size

A	φ B	φ C	Code
G 1/2	10	9	15A
	11	10	15B
	12	11	15C
G 3/4	13	12	20A
	15	13	20B
	17	15	20C

* In the case of 6 TBN2 type please enter the applicable gland size.

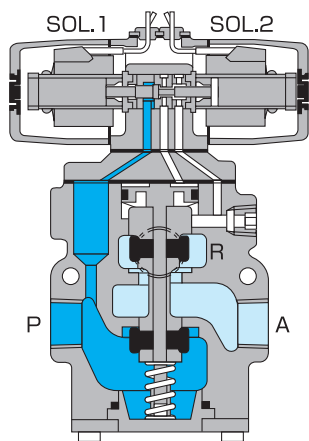
* In the case of TBN2 type please enter the applicable 6 gland size.

Structure / Operation

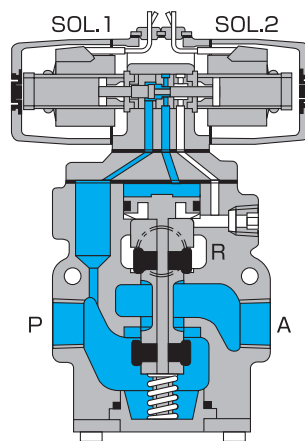
MVW7N - 04 - D

< SOL.1 Energized / SOL.2 De-energized >

< SOL.1 De-energized / SOL.2 Energized >



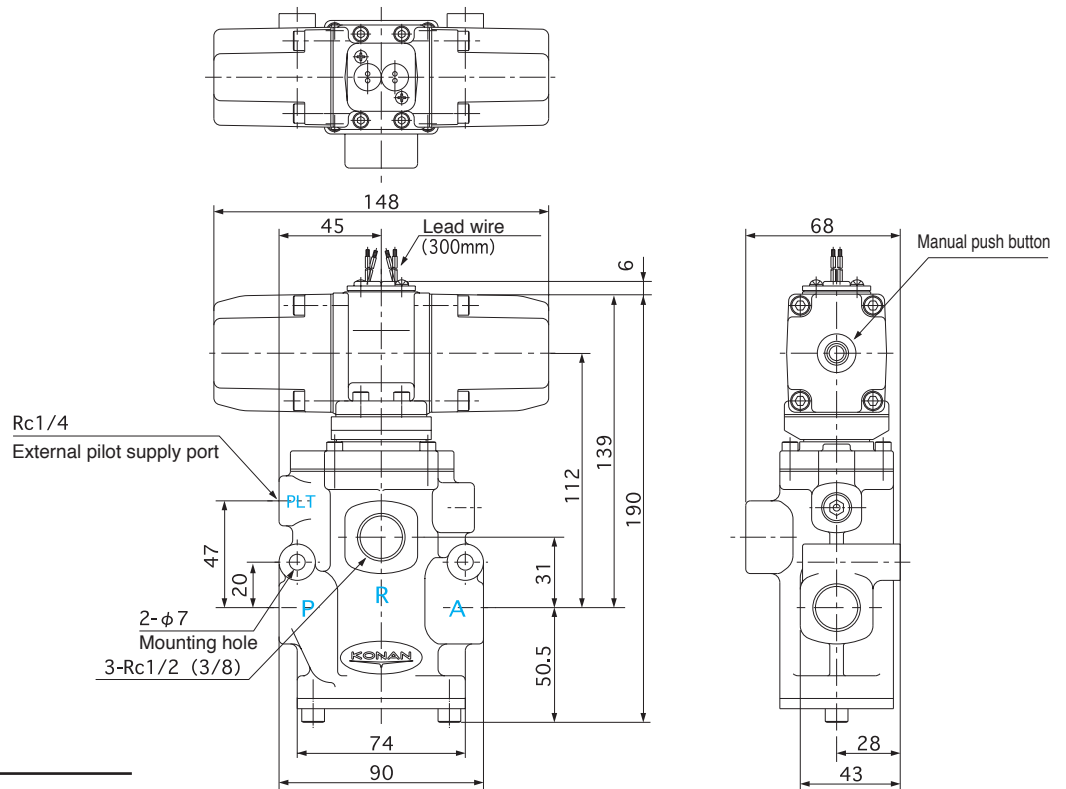
P → Close
A → R



P → A
R → Close

External Dimensions

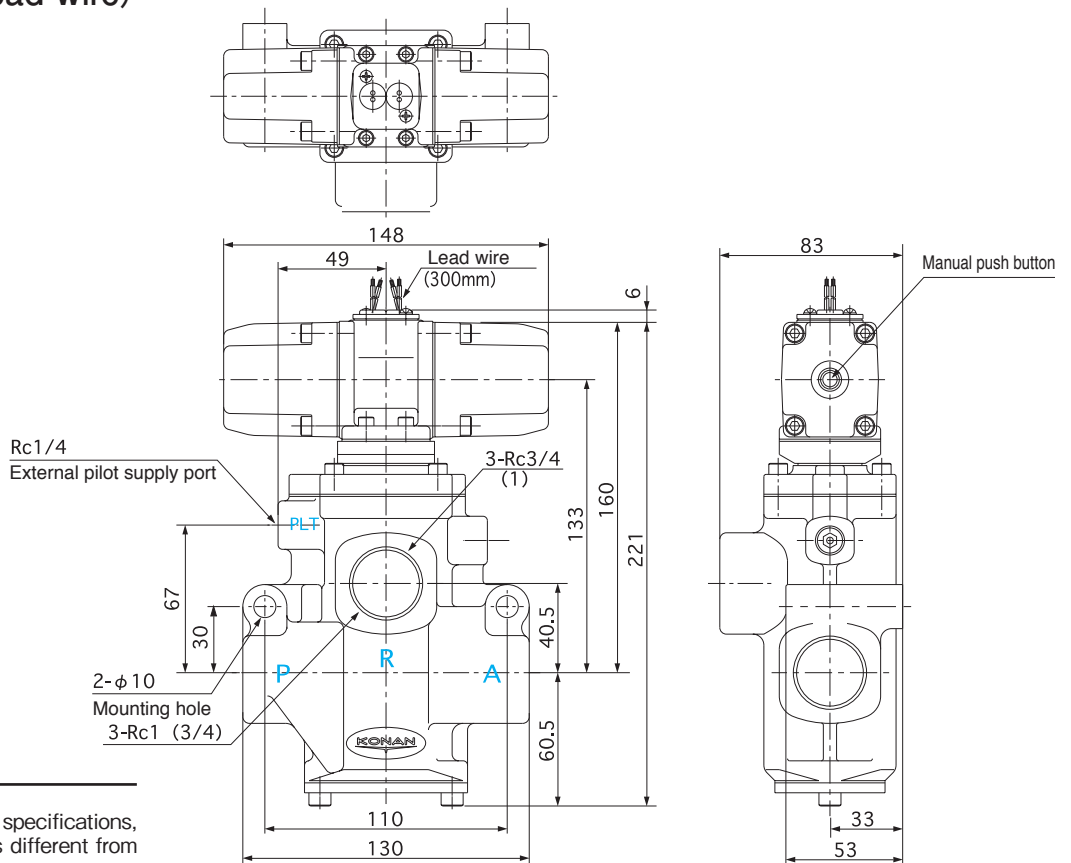
MVW7N-04-D (Lead wire)



Note

In the case of direct current specifications, the shape of the solenoid is different from this figure. Please refer for the details separately.

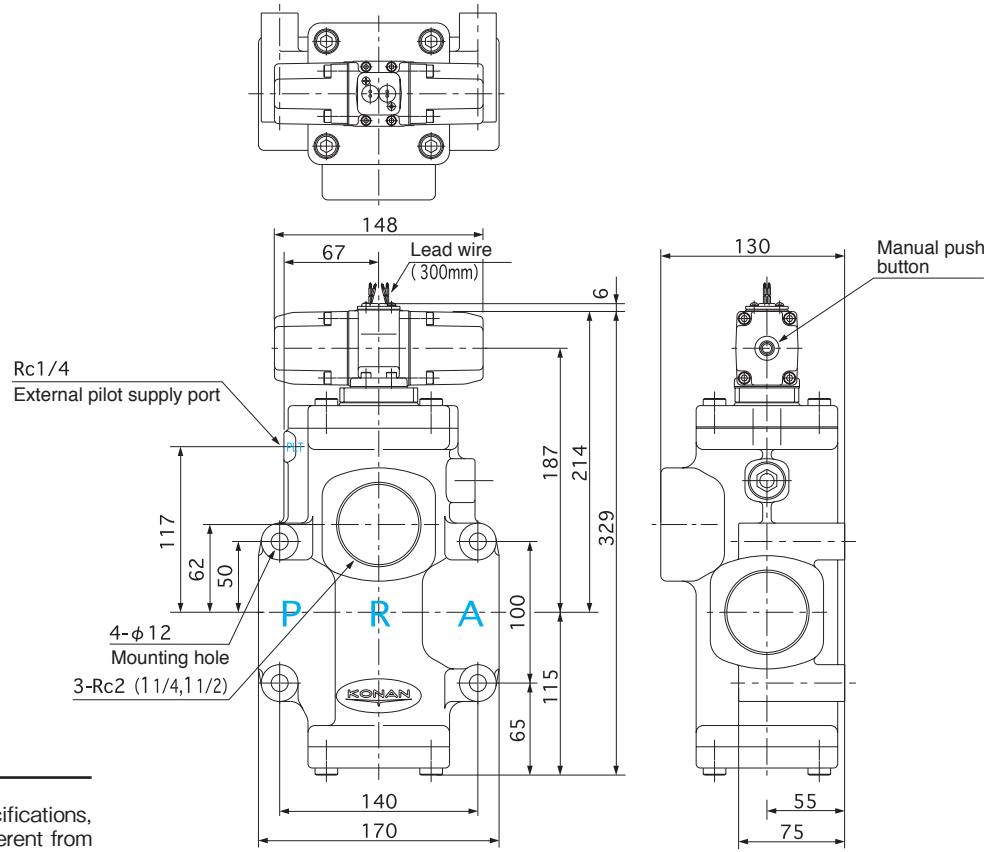
MVW7N-08-D (Lead wire)



Note

In the case of direct current specifications, the shape of the solenoid is different from this figure. Please refer for the details separately.

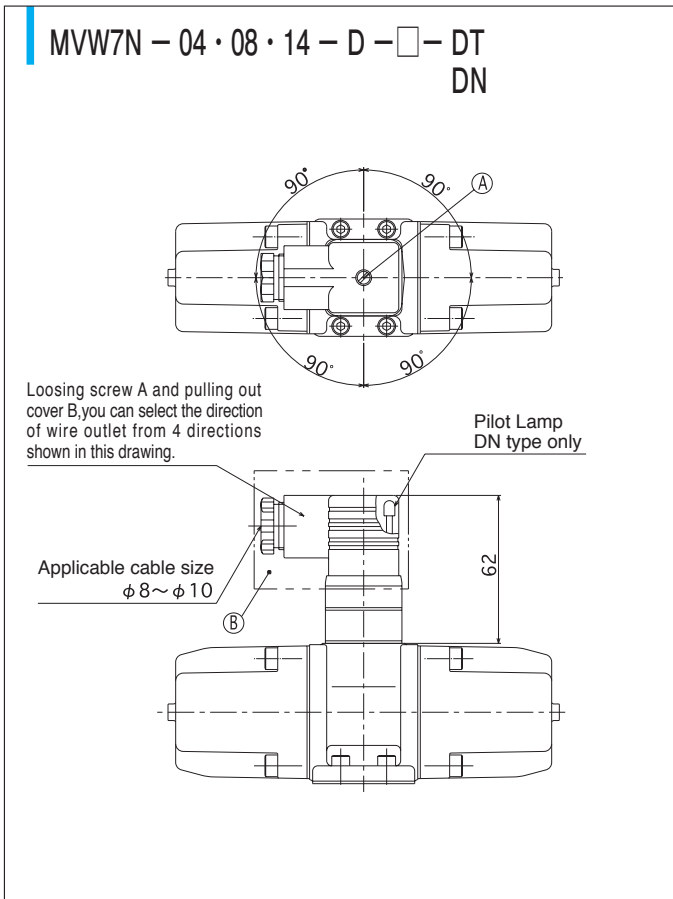
MVW7N-14-D (Lead wire)



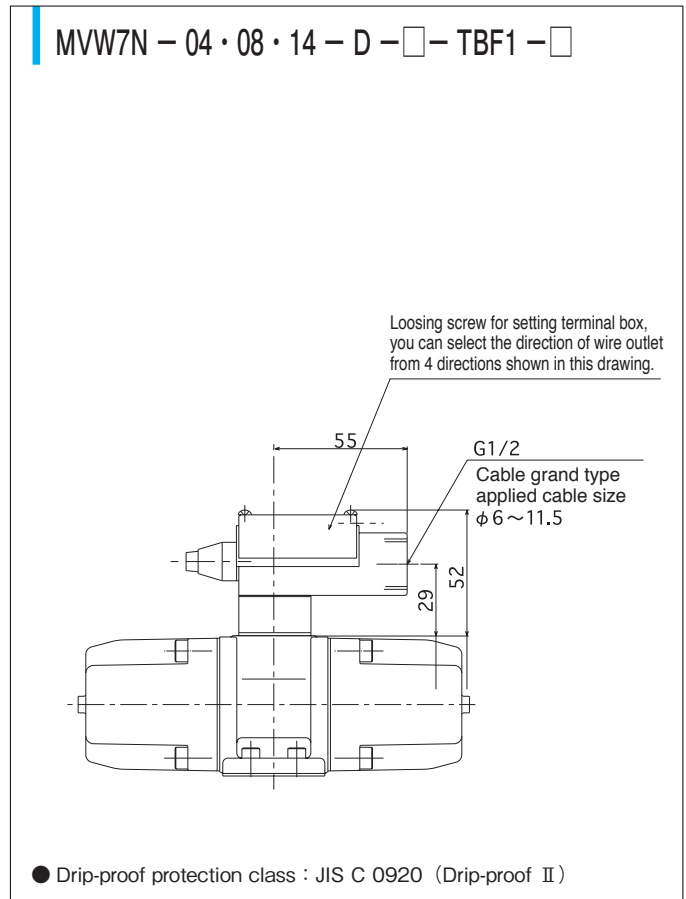
Note

In the case of direct current specifications, the shape of the solenoid is different from this figure. Please refer for the details separately.

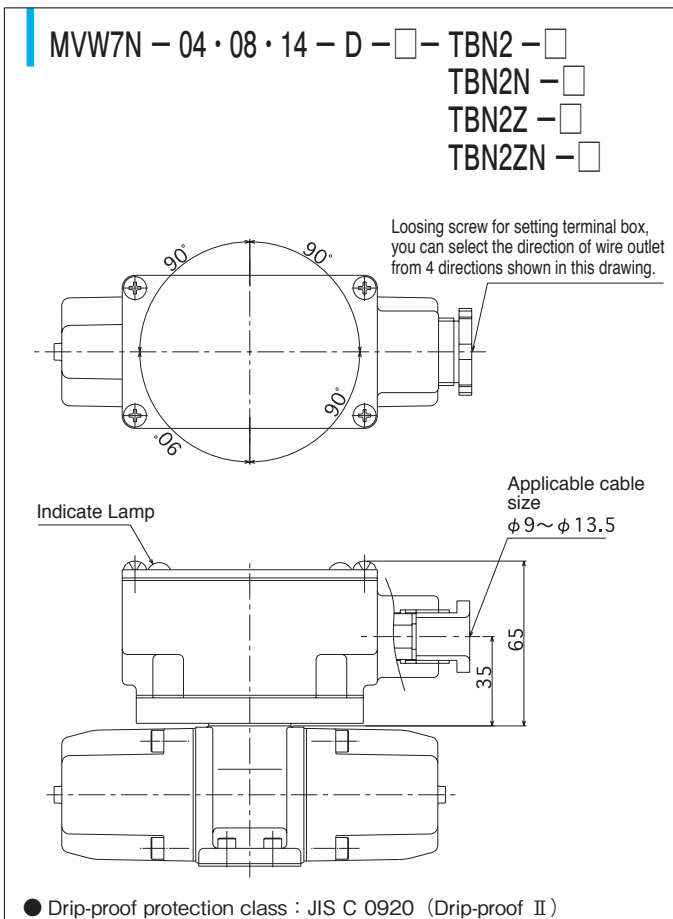
■ DIN connector (Option) Installation



■ TBF1 type Terminal box (Option) Installation



■ TBF2 type Terminal box (Option) Installation

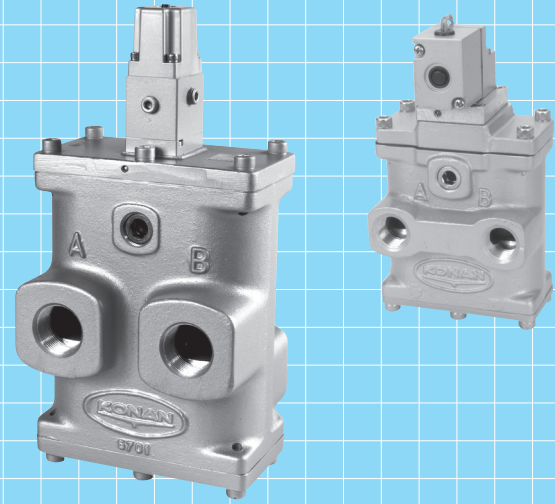


4 Port Solenoid Valves

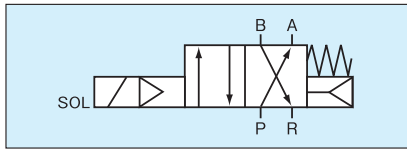
Large-Capacity Poppet-type(Return)

MVW344F – S

口径 Rc 3/8 ~ 2



JIS symbol



Specifications

Model code	MVW344F – 04 – S	MVW344F – 08 – S	MVW344F – 14 – S				
Port size	Rc 3/8	Rc 1/2	Rc 3/4	Rc1	Rc1 1/4	Rc1 1/2	Rc2
Effective area of valve	70mm ²	80mm ²	200mm ²	220mm ²	700mm ²	750mm ²	800mm ²
Fluid	Compressed air (Dry air filter passage less than 40 μm.)						
Working pressure range	0.2 ~ 0.7MPa						
Proof pressure	1.05MPa						
Ambient temperature	- 20 ~ 50°C (remove moisture perfectly from the fluid to prevent freezing when used at 5°C or lower.)						
Solenoid	Allowable voltage fluctuation	- 15%~ 0% of rated voltage (Continuous) , 0%~ +10% of rated voltage (Short time)					
	Temperature rise	Max.80°C					
	Insulation class	JIS C 4003 Class B					
	Power consumption	See coil data					
Response time	less than 0.05s	less than 0.07s		less than 0.15s			
Operating frequency	Max.2time/s						
Installation position	As desired						
Mass ※	2.1kg	3.0kg		10.6kg			

Note) The mass marked with “※” does not include options.

● Consult factory for non-standard applications which are not covered by above specifications.

Coil data

[Model : MVW344F – 04 – S/MVW344F – 08 – S]

Rated voltage [V]	AC										Rated voltage [V]	DC			
	100		110		125		200		220			24	48	100	110
Frequency [Hz]	50	60	50	60	50	60	50	60	50	60					
Issuance current [mA]	199	177	164	144	165	143	115	100	83	72					
Retention current [mA]	93	75	86	60	79	62	57	42	43	30					
												247	123	58	49

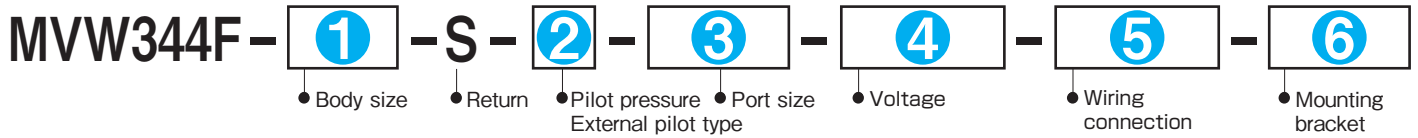
Coil data

[Model : MVW344F – 14 – S]

Rated voltage [V]	AC							Rated voltage [V]	DC						
	100		110		200		220		24	48	100	110			
Frequency [Hz]	50	60	50	60	50	60	60								
Issuance current [mA]	1415	995	1441	1200	733	500	639								
Retention current [mA]	283	199	288	240	147	100	128								
												583	292	140	186

Model Code

When ordering, specify the model as follows.



1 Body size

Rc 3/8	04
Rc 1/2	
Rc 3/4	08
Rc 1	
Rc 1 1/4	14
Rc 1 1/2	
Rc 2	

2 Pilot pressure · External pilot type

Internal (Standard) pilot type	No entry
External pilot type	P

● In the case of external pilot type, working pressure is as follows. Please be careful.

Working pressure ≤ Pilot p-ressure ≥ 0.2MPa

3 Port size

04	Rc 3/8	10A
	Rc 1/2	15A
08	Rc 3/4	20A
	Rc 1	25A
14	Rc 1 1/4	32A
	Rc 1 1/2	40A
	Rc 2	50A

4 Voltage

AC100V (50/60Hz)	AC100
AC110V (50/60Hz)	AC110
AC125V (50/60Hz) ※	AC125
AC200V (50/60Hz)	AC200
AC220V (50/60Hz) ※	AC220
DC 24V	DC 24
DC 48V	DC 48
DC100V	DC100
DC110V	DC110

※ 1 Body size 14 is not manufactured for "AC125 (50/60Hz)" and "AC220 (50Hz)".

5 Wiring connection

Lead wire	No entry
DIN connector	DT
DIN connector (With Indicate Lamp)	DN
DIN connector (With Indicate Lamp · Surge absorber)	DNZ
TBF1 Type Terminal box	TBF1
TBF1 Type Terminal box (With Indicate Lamp)	TBF1N
TBF1 Type Terminal box (With Surge absorber)	TBF1Z
TBF1 Type Terminal box (With Indicate Lamp · Surge absorber)	TBF1ZN

6 Mounting bracket

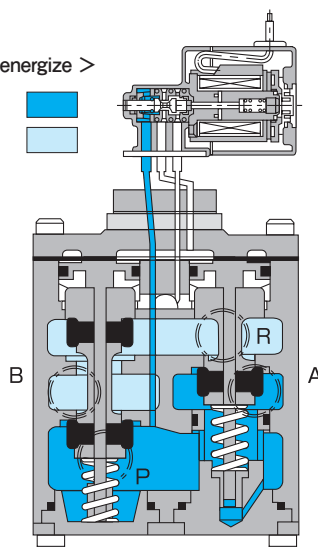
Not needed	No entry
Required	BR

Structure / Operation

MVW344F - 04 - S

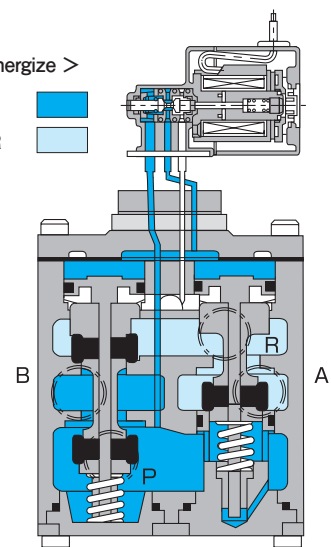
< SOL.Deenergize >

P → A ■
B → R ■



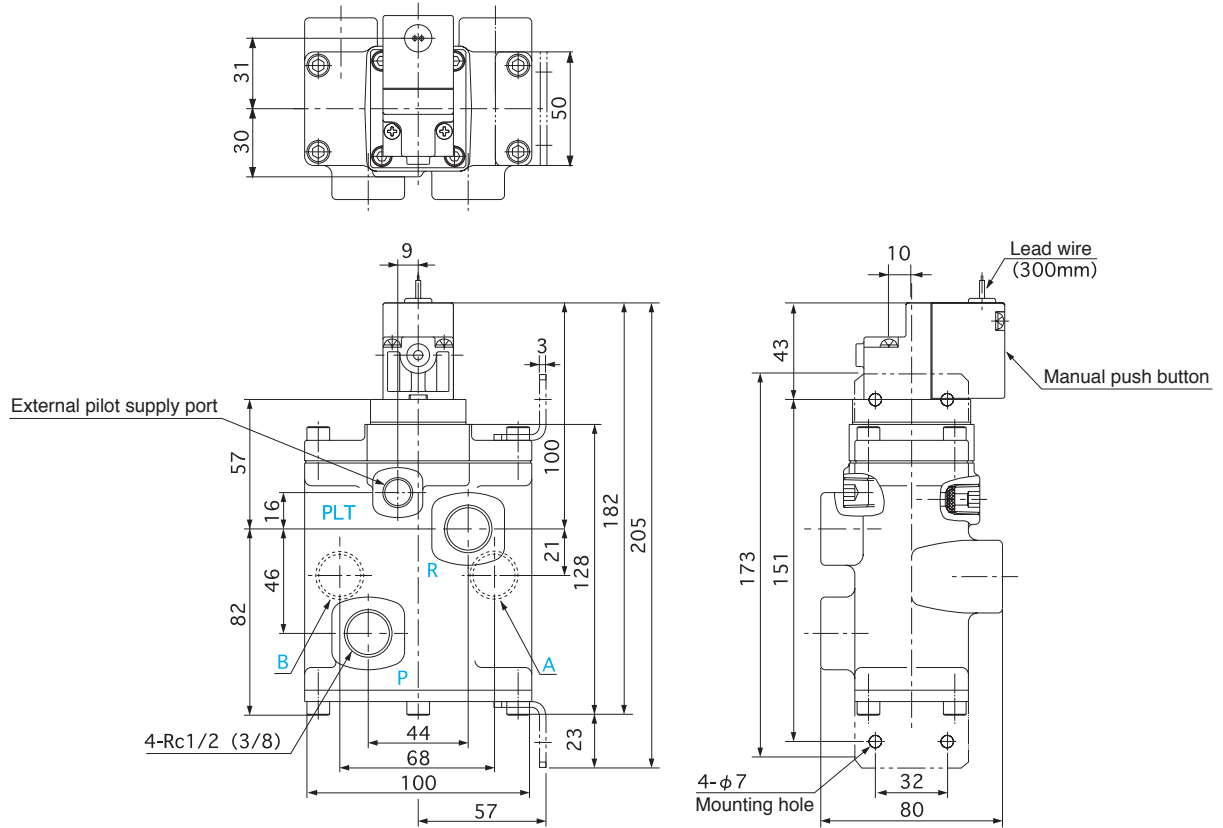
< SOL.Energize >

P → B ■
A → R ■

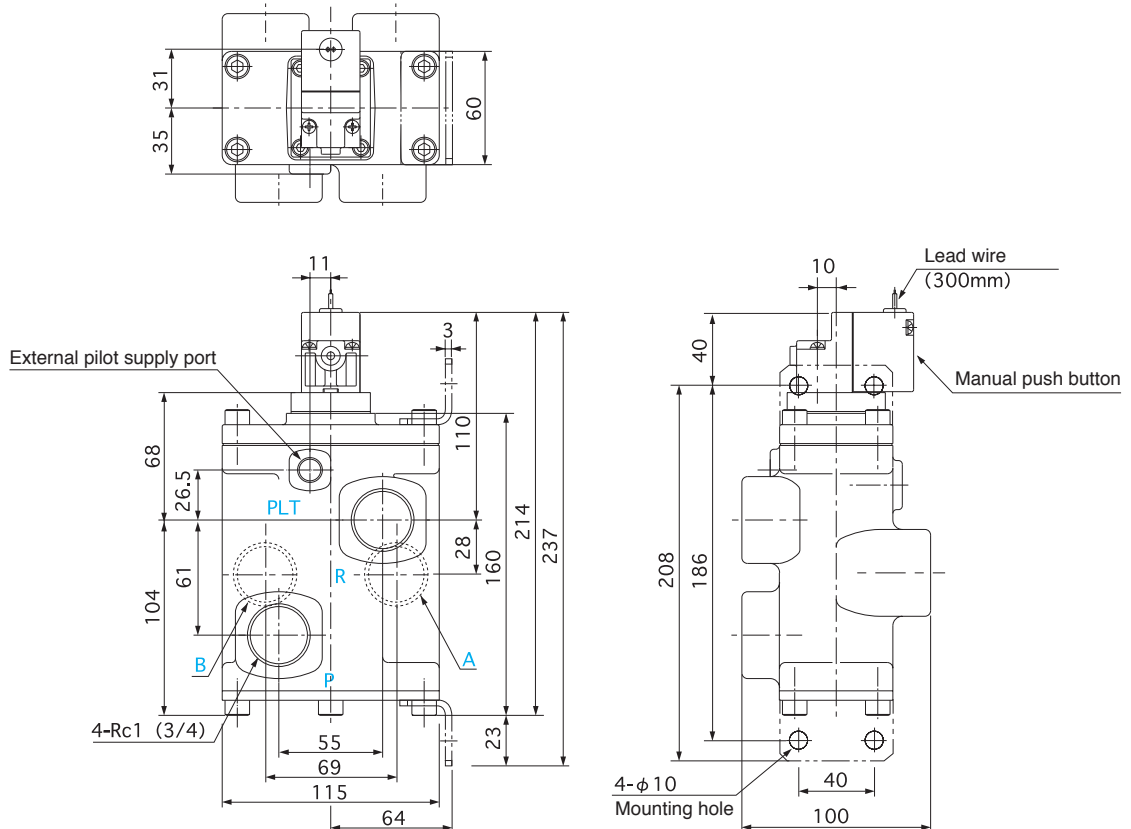


External Dimensions

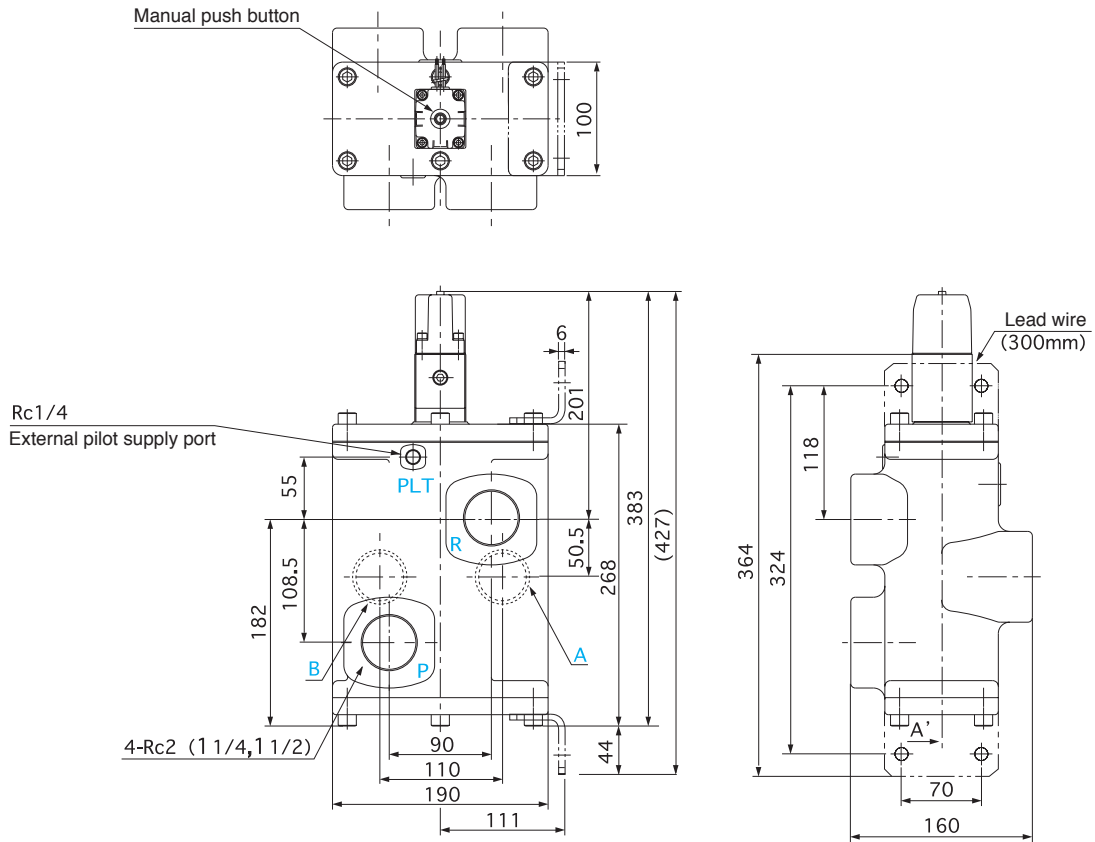
MVW344F-04-S (Lead wire)



MVW344F-08-S (Lead wire)

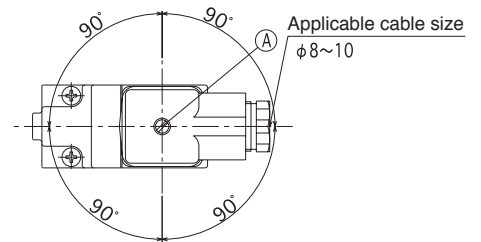
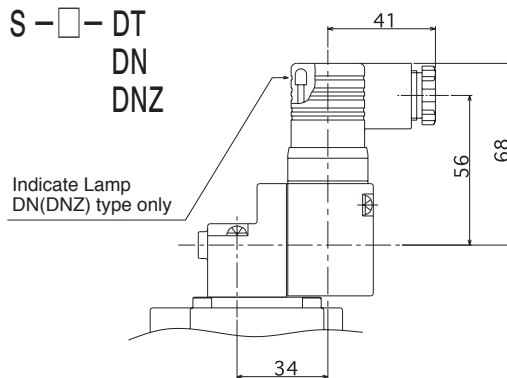


MVW344F-14-S (Lead wire)



■ DIN connector (Option) Installation

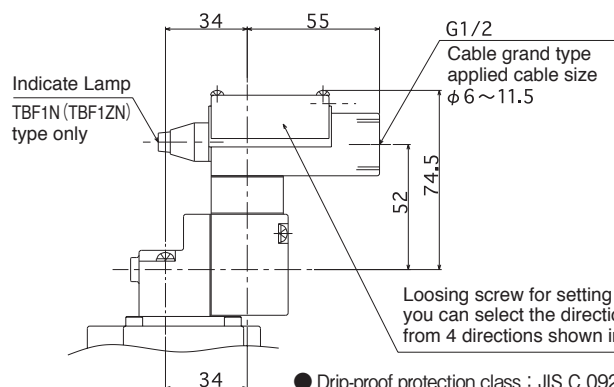
MVW344F - 04 · 08 · 14 - S - □ - DT
DN
DNZ



Loosening screw A and pulling out cover B, you can select the direction of wire outlet from 4 directions shown in this drawing.

■ TBF1 type Terminal box (Option) Installation

MVW344F - 04 · 08 · 14 - S - □ - TBF1
TBF1N
TBF1Z
TBF1ZN



Loosening screw for setting terminal box, you can select the direction of wire outlet from 4 directions shown in this drawing.

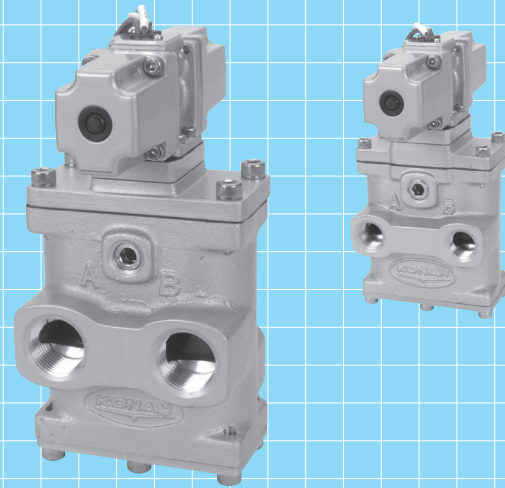
● Drip-proof protection class : JIS C 0920 (Drip-proof II)

4 Port Solenoid Valves

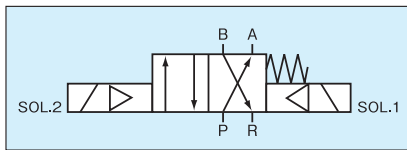
Large-Capacity Poppet-type(Hold)

MVW344N – D

口径 Rc 3/8 ~ 1



JIS symbol



Note) When the pneumatic pressure of P becomes "0" at the SOL.2 position, the valve will be returned to the SOL.1 position by the spring force.

Specifications

Model code		MVW344N – 04 – D	MVW344N – 08 – D	MVW344N – 14 – D				
Port size		Rc 3/8	Rc 1/2	Rc 3/4	Rc1	Rc1 1/4	Rc1 1/2	Rc2
Effective area of valve		70mm ²	80mm ²	200mm ²	220mm ²	700mm ²	750mm ²	800mm ²
Fluid		Compressed air (Dry air filter passage less than 40 μm.)						
Working pressure range		0.2 ~ 0.7MPa						
Proof pressure		1.05MPa						
Ambient temperature		- 20 ~ 50°C (remove moisture perfectly from the fluid to prevent freezing when used at 5°C or lower.)						
Solenoid	Allowable voltage fluctuation	± 10% of the rated voltage						
	Temperature rise	Max.80°C						
	Insulation class	JIS C 4003 Class B						
	Power consumption	See coil data						
Response time		less than 0.03s	less than 0.05s		less than 0.3s			
Operating frequency		Max.2time/s						
Installation position		Installation of the pilot valve with its horizontal.						
Mass ※		2.4kg	3.3kg		11.2kg			

Note) The mass marked with "※" does not include options.

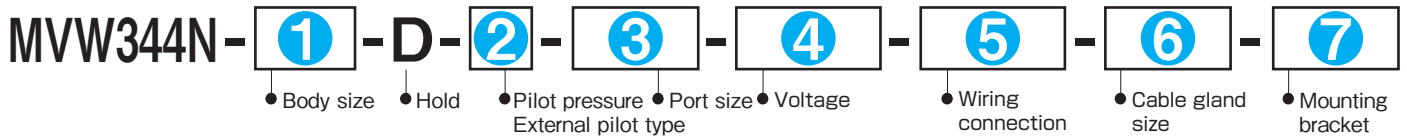
● Consult factory for non-standard applications which are not covered by above specifications.

Coil data

Rated voltage [V]	AC							Rated voltage [V]	DC		
	100		110		200		220		24	48	100
Frequency [Hz]	50	60	50	60	50	60	60				
Issuance current [mA]	1415	995	1441	1200	733	500	639	Retention current [mA]	583	292	140
Retention current [mA]	283	199	288	240	147	100	128				

Model Code

When ordering, specify the model as follows.



1 Body size

Rc 3/8	04
Rc 1/2	
Rc 3/4	08
Rc 1	
Rc 1 1/4	14
Rc 1 1/2	
Rc 2	

2 Pilot pressure · External pilot type

Internal (Standard) pilot type	No entry
External pilot type	P

● In the case of external pilot type, working pressure is as follows. Please be careful.

Working pressure ≤ Pilot p-ressure ≥ 0.2MPa

3 Port size

04	Rc 3/8	10A
	Rc 1/2	15A
08	Rc 3/4	20A
	Rc 1	25A
14	Rc 1 1/4	32A
	Rc 1 1/2	40A
	Rc 2	50A

4 Voltage

AC100V (50/60Hz)	AC100
AC110V (50/60Hz)	AC110
AC200V (50/60Hz)	AC200
AC220V (60Hz)	AC220
DC 24V	DC 24
DC 48V	DC 48
DC100V	DC100

5 Wiring connection

Lead wire	No entry
DIN connector	DT
DIN connector (With Indicate Lamp)	DN
TBF1 Type Terminal box	TBF1
TBN2 Type Terminal box	TBN2
TBN2 Type Terminal box (With Indicate Lamp)	TBN2N
TBN2 Type Terminal box (With Surge absorber)	TBN2Z
TBN2 Type Terminal box (With Indicate Lamp · Surge absorber)	TBN2ZN

6 Cable gland size

A	φ B	φ C	Code
G 1/2	10	9	15A
	11	10	15B
	12	11	15C
G 3/4	13	12	20A
	15	13	20B
	17	15	20C

* In the case of 5 TBN2 type please enter the applicable gland size.

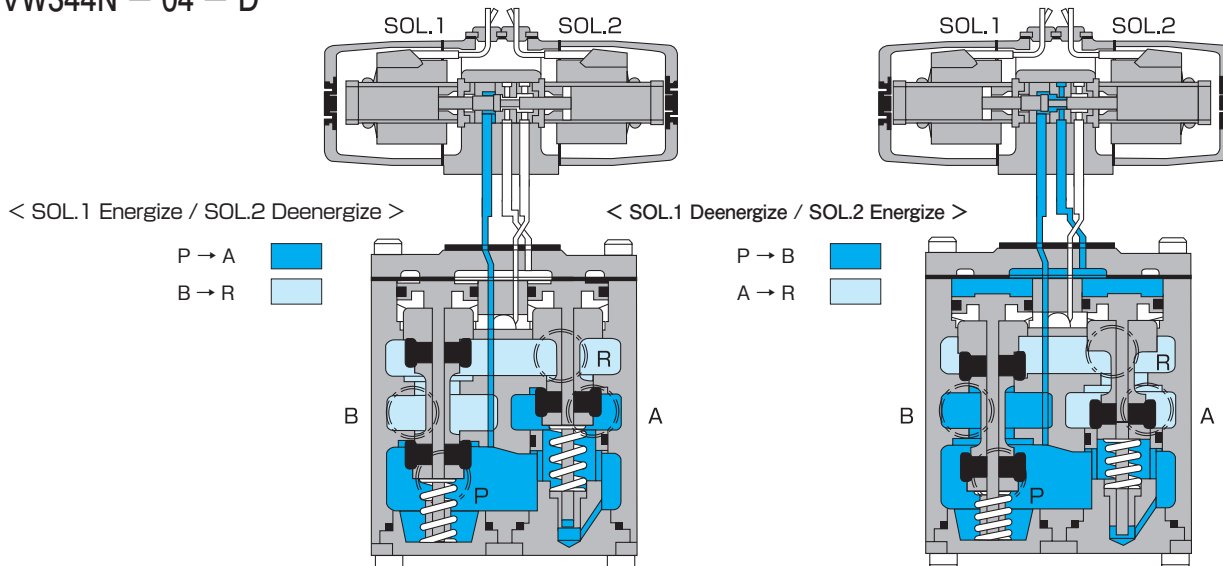
7 Mounting bracket

Without	No entry
With	BR

* In the case of TBN2 type please enter the applicable 6 gland size.

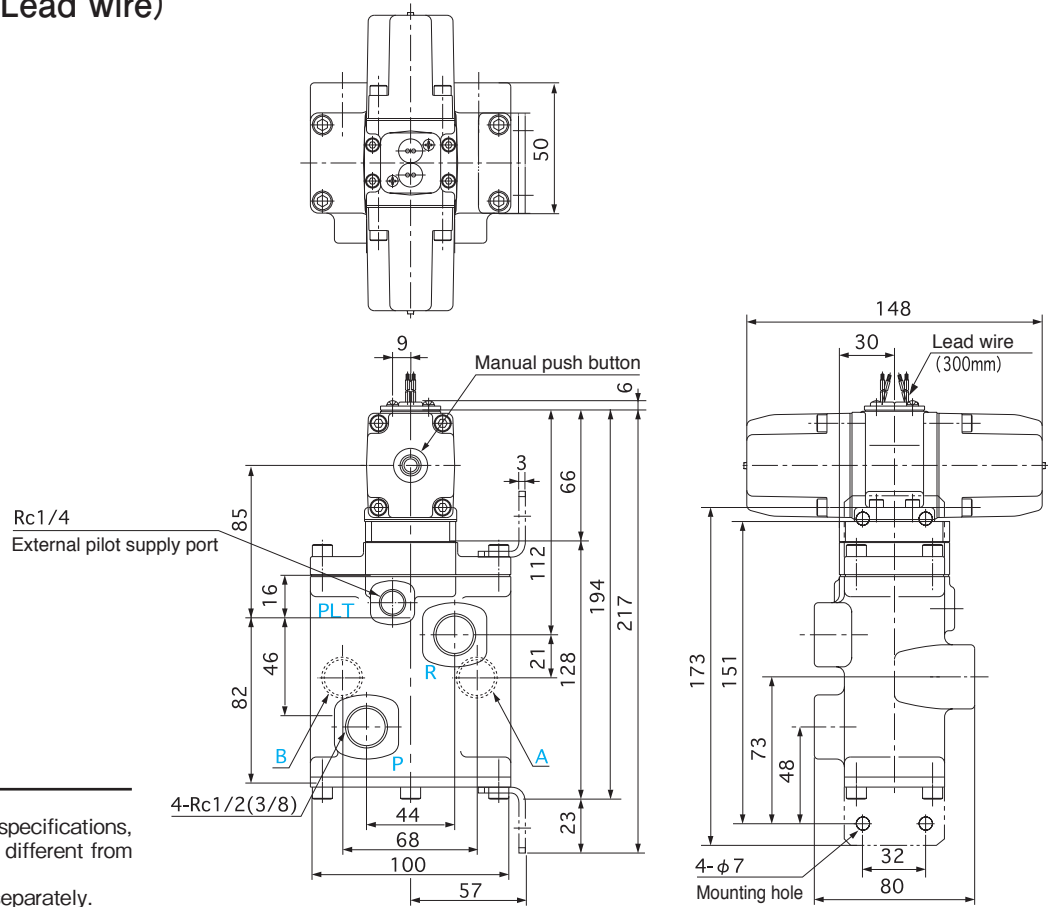
Structure / Operation

MVW344N - 04 - D



External Dimensions

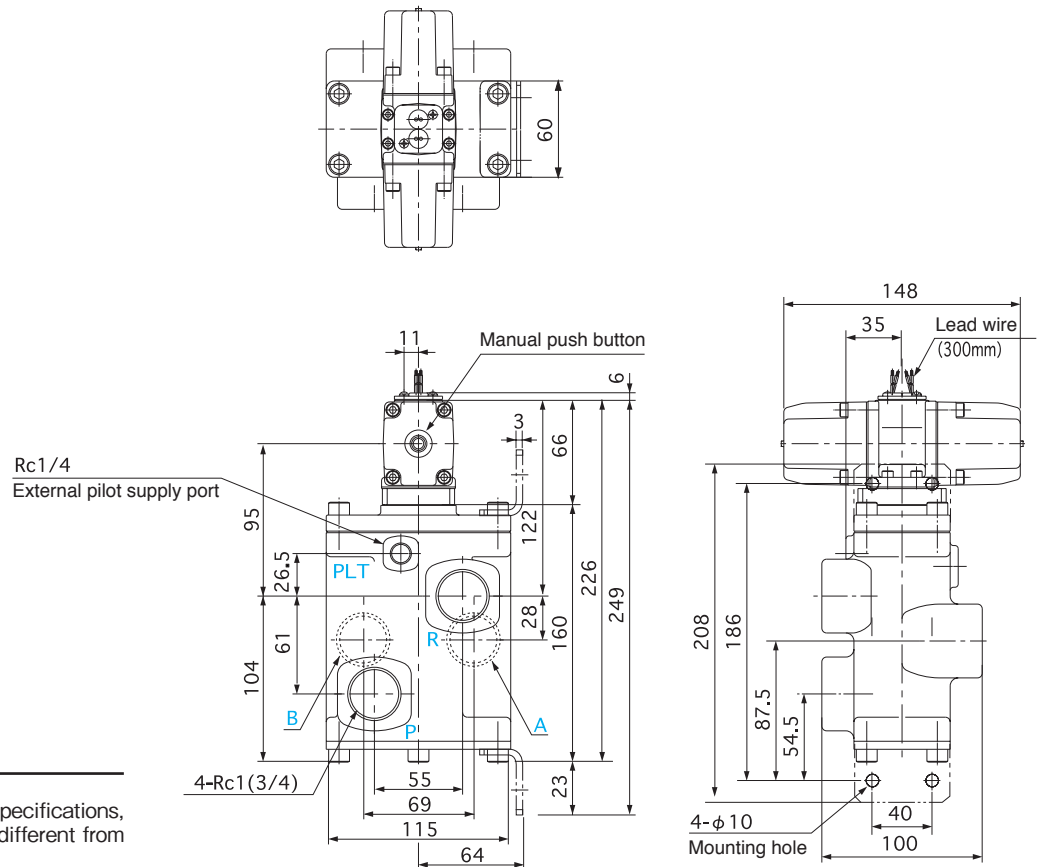
MVW344N-04-D (Lead wire)



Note

In the case of direct current specifications, the shape of the solenoid is different from this figure. Please refer for the details separately.

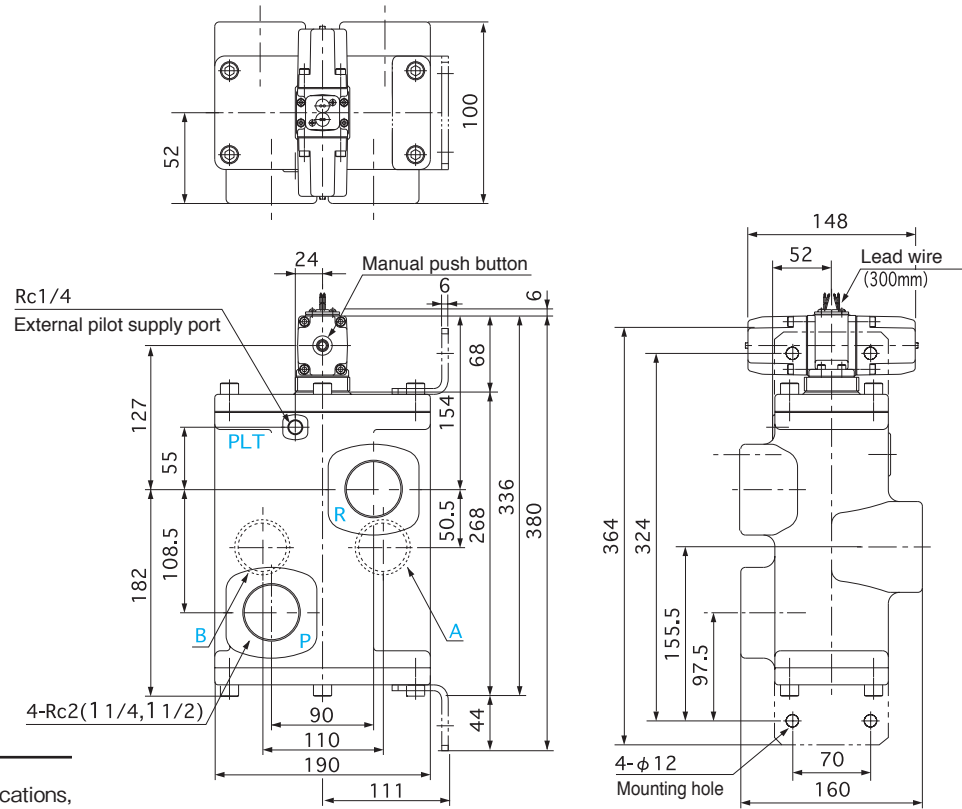
MVW344N-08-D (Lead wire)



Note

In the case of direct current specifications, the shape of the solenoid is different from this figure. Please refer for the details separately.

MVW344N-14-D (Lead wire)

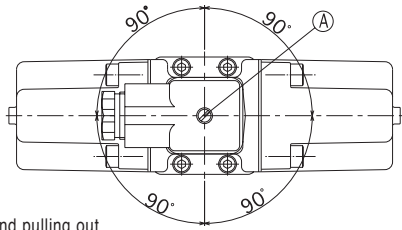


Note

In the case of direct current specifications, the shape of the solenoid is different from this figure. Please refer for the details separately.

■ DIN connector (Option) Installation

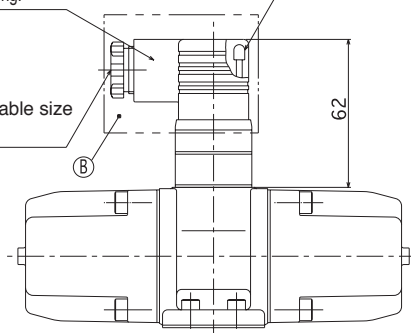
MVW344N - 04 · 08 · 14 - D - □ - DT
- DN



Loosing screw A and pulling out cover B, you can select the direction of wire outlet from 4 directions shown in this drawing.

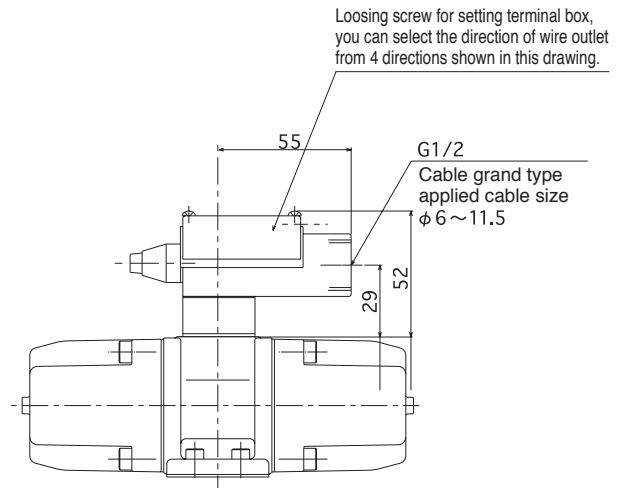
Indicate Lamp
DN type only

Applicable cable size
 $\phi 8 \sim \phi 10$



■ TBF1 type Terminal box (Option) Installation

MVW344N - 04 · 08 · 14 - D - □ - TBF1 - □



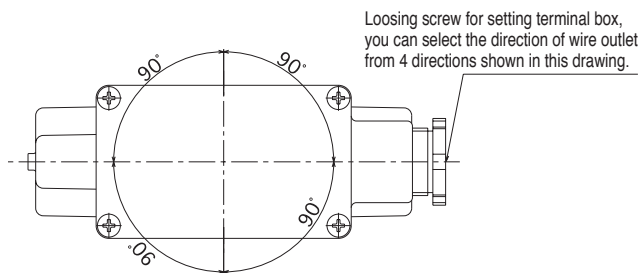
Loosing screw for setting terminal box, you can select the direction of wire outlet from 4 directions shown in this drawing.

G1/2
Cable grand type
applied cable size
 $\phi 6 \sim 11.5$

● Drip-proof protection class : JIS C 0920 (Drip-proof II)

■ TBF2 type Terminal box (Option) Installation

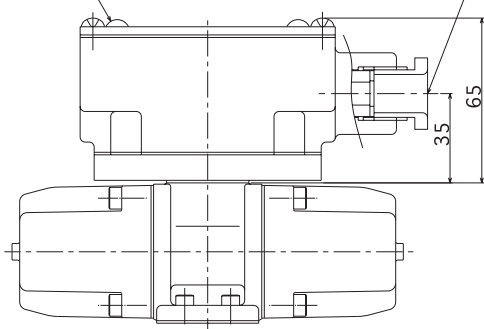
MVW344N - 04 · 08 · 14 - D - □ - TBN2 - □
TBN2N - □
TBN2Z - □
TBN2ZN - □



Loosing screw for setting terminal box, you can select the direction of wire outlet from 4 directions shown in this drawing.

Indicate Lamp

Applicable cable size
 $\phi 9 \sim \phi 13.5$



● Drip-proof protection class : JIS C 0920 (Drip-proof II)

3 Port Air Operated Valves

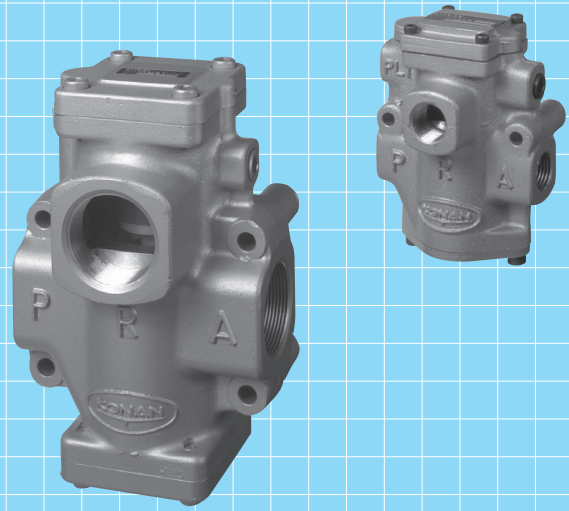
Large-Capacity Poppet-type

Normally closed
AVW7N

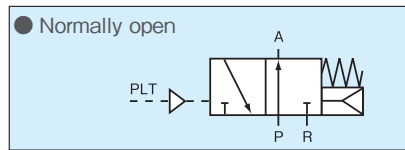
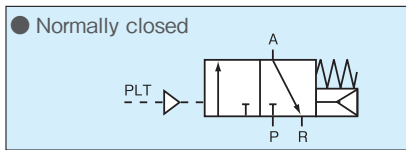
Port size Rc 3/8 ~ 2

Normally open
AVW7NR

Port size Rc 3/8 ~ 2



JIS symbol



Specifications

Model code	Normally closed	AVW7N-04		AVW7N-08		AVW7N-14		
	Normally open	AVW7NR-04		AVW7NR-08		AVW7NR-14		
Port size		Rc 3/8	Rc 1/2	Rc 3/4	Rc1	Rc1 1/4	Rc1 1/2	Rc2
Effective area of valve		70mm ²	80mm ²	200mm ²	220mm ²	700mm ²	750mm ²	800mm ²
Fluid	Compressed air (Dry air filter passage less than 40 μm.)							
Working pressure range	0.2 ~ 0.7MPa							
Pilot pressure	0.2 ~ 0.7MPa (Pilot pressure ≥ Working pressure)							
Proof pressure	1.05MPa							
Ambient temperature	- 20 ~ 60°C (remove moisture perfectly from the fluid to prevent freezing when used at 5°C or lower.)							
Operating frequency	Max.2time/s							
Installation position	As desired							
Mass		0.7kg		1.3kg		5.3kg		

● Consult factory for non-standard applications which are not covered by above specifications.

Model Code

When ordering, specify the model as follows.

AVW7N 1 - 2

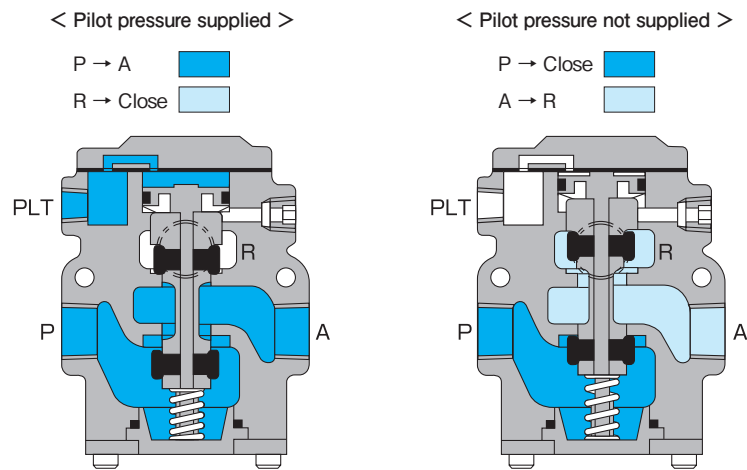
● Operation type ● Body size and Port size

1 Operation type	
Normally closed	No entry
Normally open	R

2 Body size and Port size		
04	Rc 3/8	04 - 10A
	Rc 1/2	04 - 15A
08	Rc 3/4	08 - 20A
	Rc 1	08 - 25A
14	Rc 1 1/4	14 - 32A
	Rc 1 1/2	14 - 40A
	Rc 2	14 - 50A

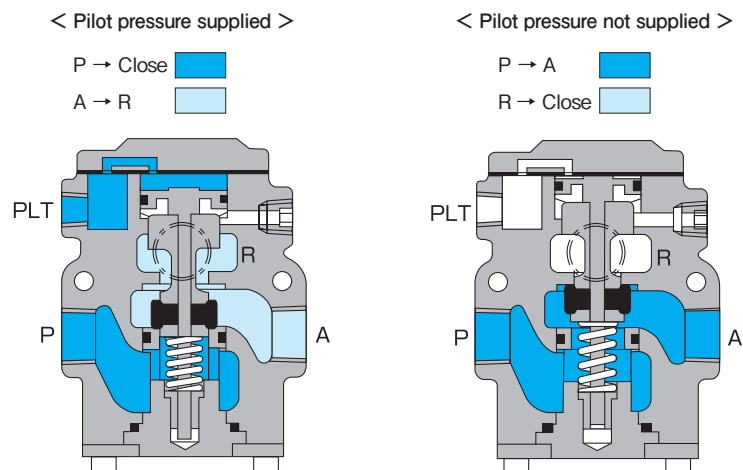
Structure / Operation

AVW7N - 04



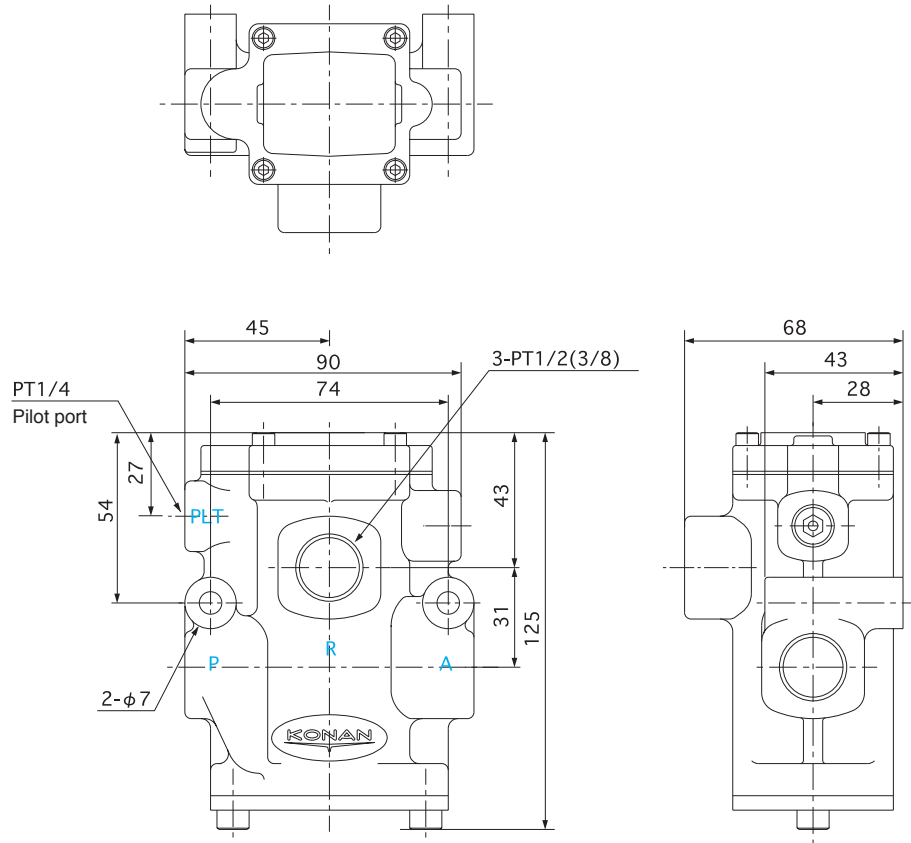
Structure / Operation

AVW7NR - 04

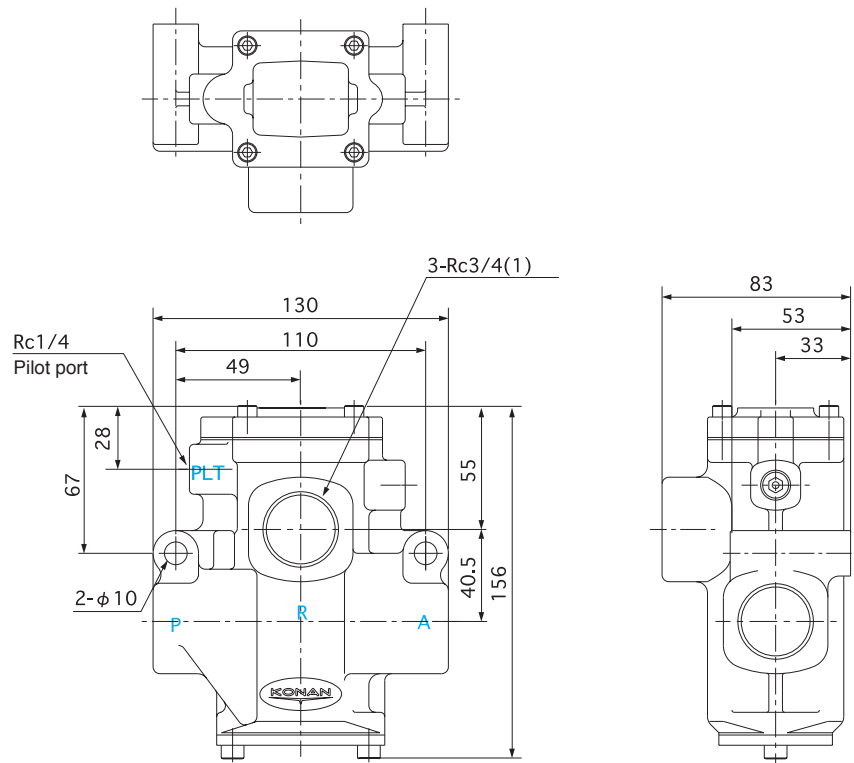


External Dimensions

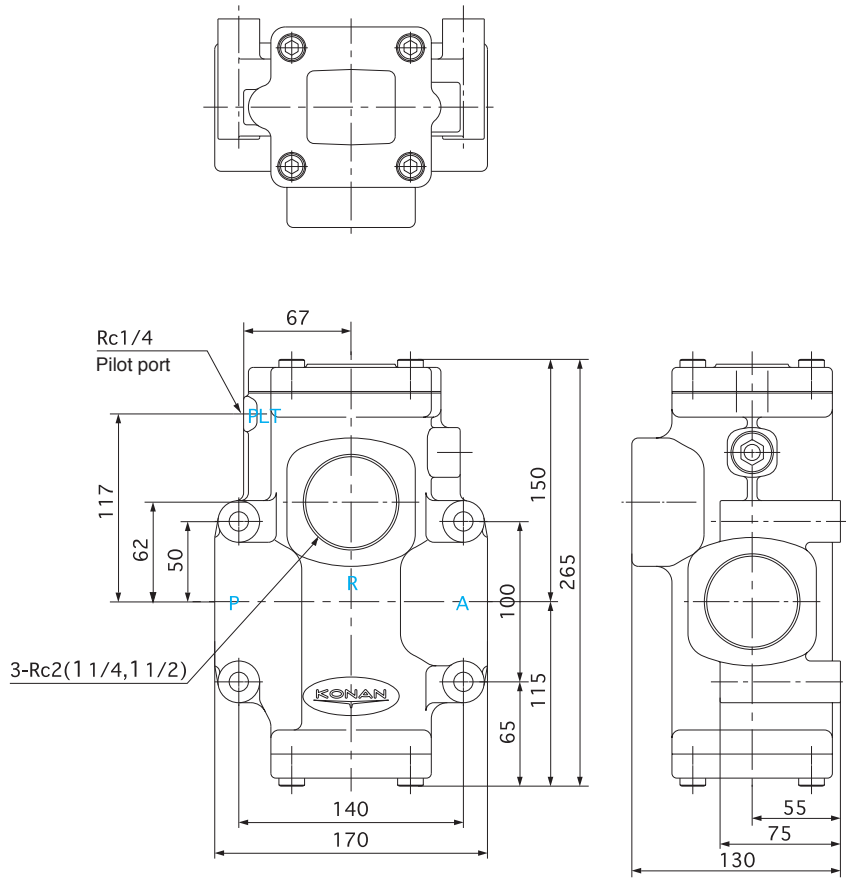
AVW7N (R) -04



AVW7N (R) -08



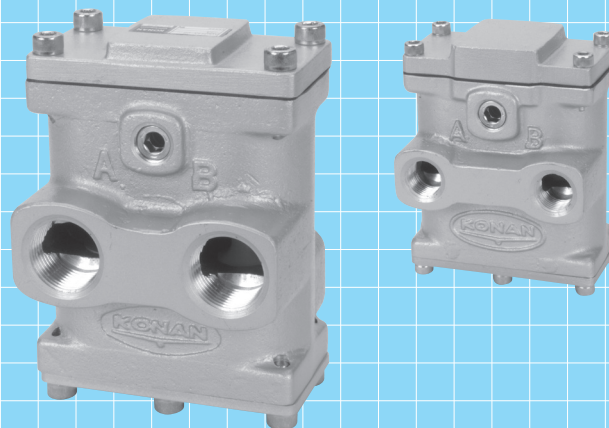
AVW7N (R) -14



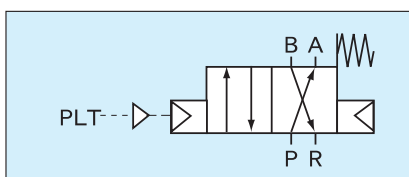
4 Port Air Operated Valves Large-Capacity Poppet-type

AVW344N

Port size Rc $\frac{3}{8}$ ~ 2



**JIS
symbol**



Specifications

Model code	AVW344N-04		AVW344N-08		AVW344N-14		
Port size	Rc $\frac{3}{8}$	Rc $\frac{1}{2}$	Rc $\frac{3}{4}$	Rc1	Rc1 $\frac{1}{4}$	Rc1 $\frac{1}{2}$	Rc2
Effective area of valve	70mm ²	80mm ²	200mm ²	220mm ²	700mm ²	750mm ²	800mm ²
Fluid	Compressed air (Dry air filter passage less than 40 μ m.)						
Working pressure range	0.2 ~ 0.7MPa						
Pilot pressure	0.2 ~ 0.7MPa (Pilot pressure \geq Working pressure)						
Proof pressure	1.05MPa						
Ambient temperature	- 20 ~ 60°C (remove moisture perfectly from the fluid to prevent freezing when used at 5°C or lower.)						
Operating frequency	Max.2time/s						
Installation position	As desired						
Mass	1.4kg		2.2kg		10.2kg		

● Consult factory for non-standard applications which are not covered by above specifications.

Model Code

When ordering, specify the model as follows.

AVW344N – 1 – 2

● Body size and Port size ● Mounting bracket

1 Body size and Port size

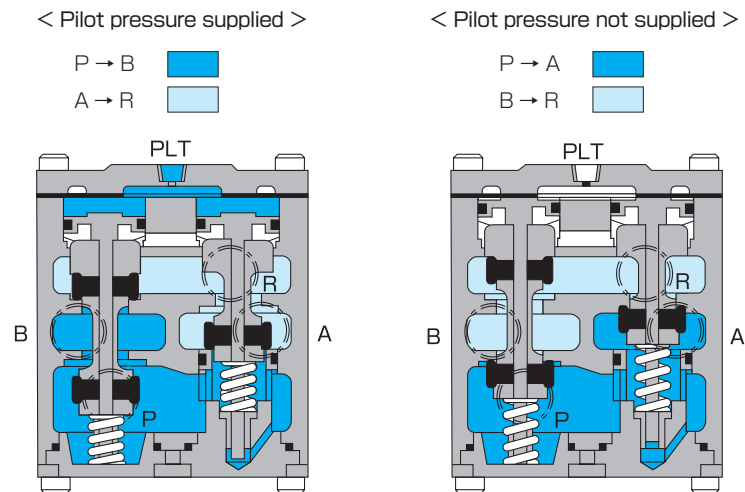
04	Rc $\frac{3}{8}$	04-10A
	Rc $\frac{1}{2}$	04-15A
08	Rc $\frac{3}{4}$	08-20A
	Rc 1	08-25A
14	Rc $1\frac{1}{4}$	14-32A
	Rc $1\frac{1}{2}$	14-40A
	Rc 2	14-50A

2 Mounting bracket

Not needed	No entry
Required	BR

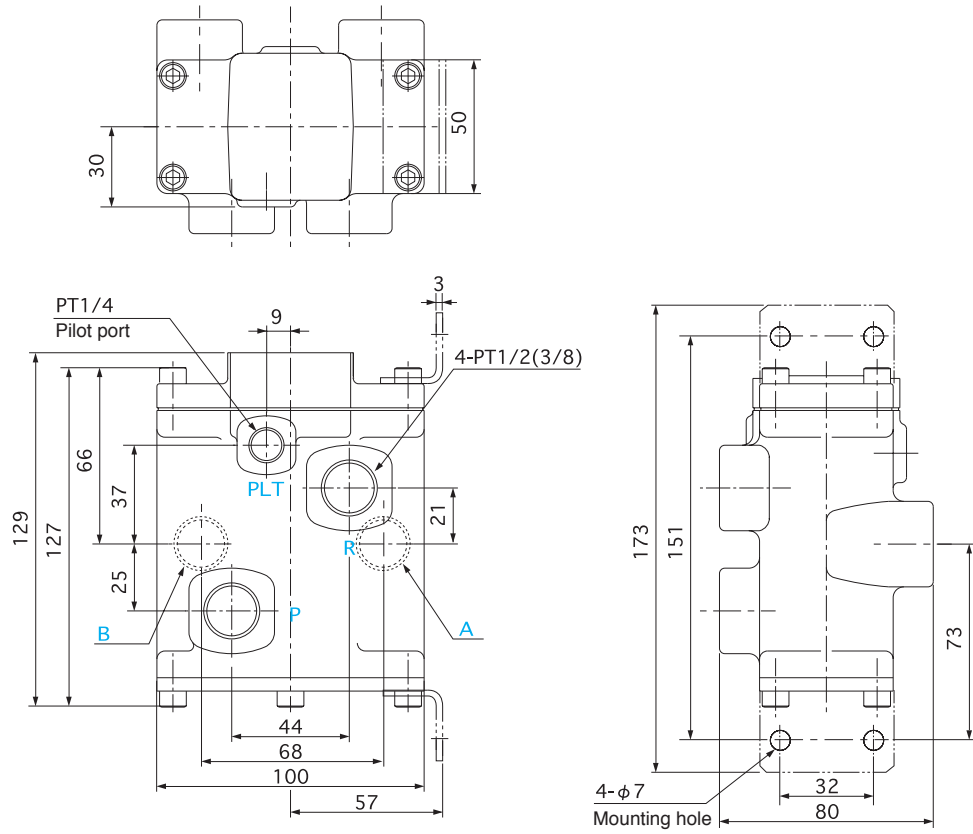
Structure / Operation

AVW344N – 04

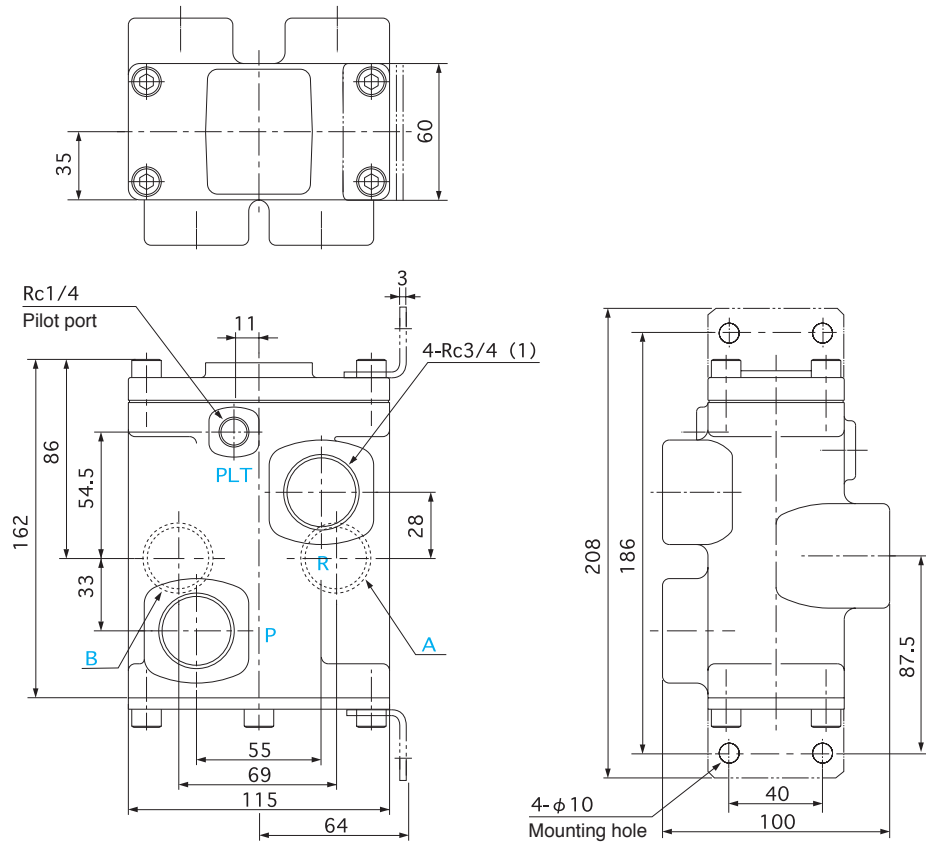


External Dimensions

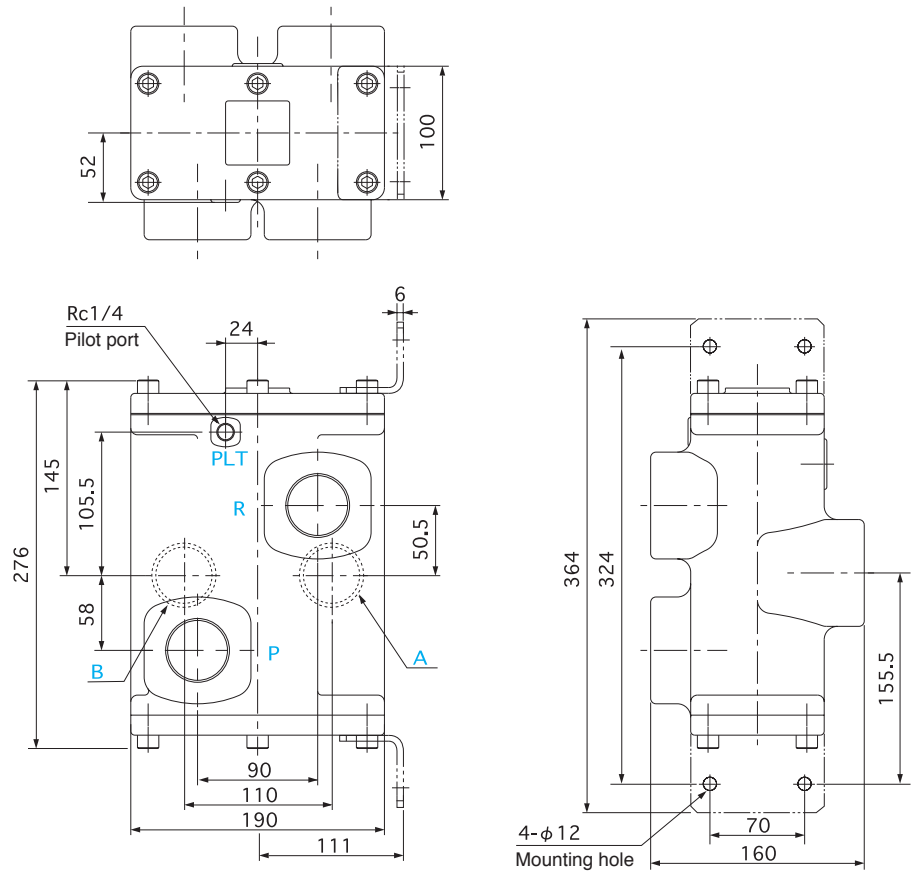
AVW344N-04



AVW344N-08



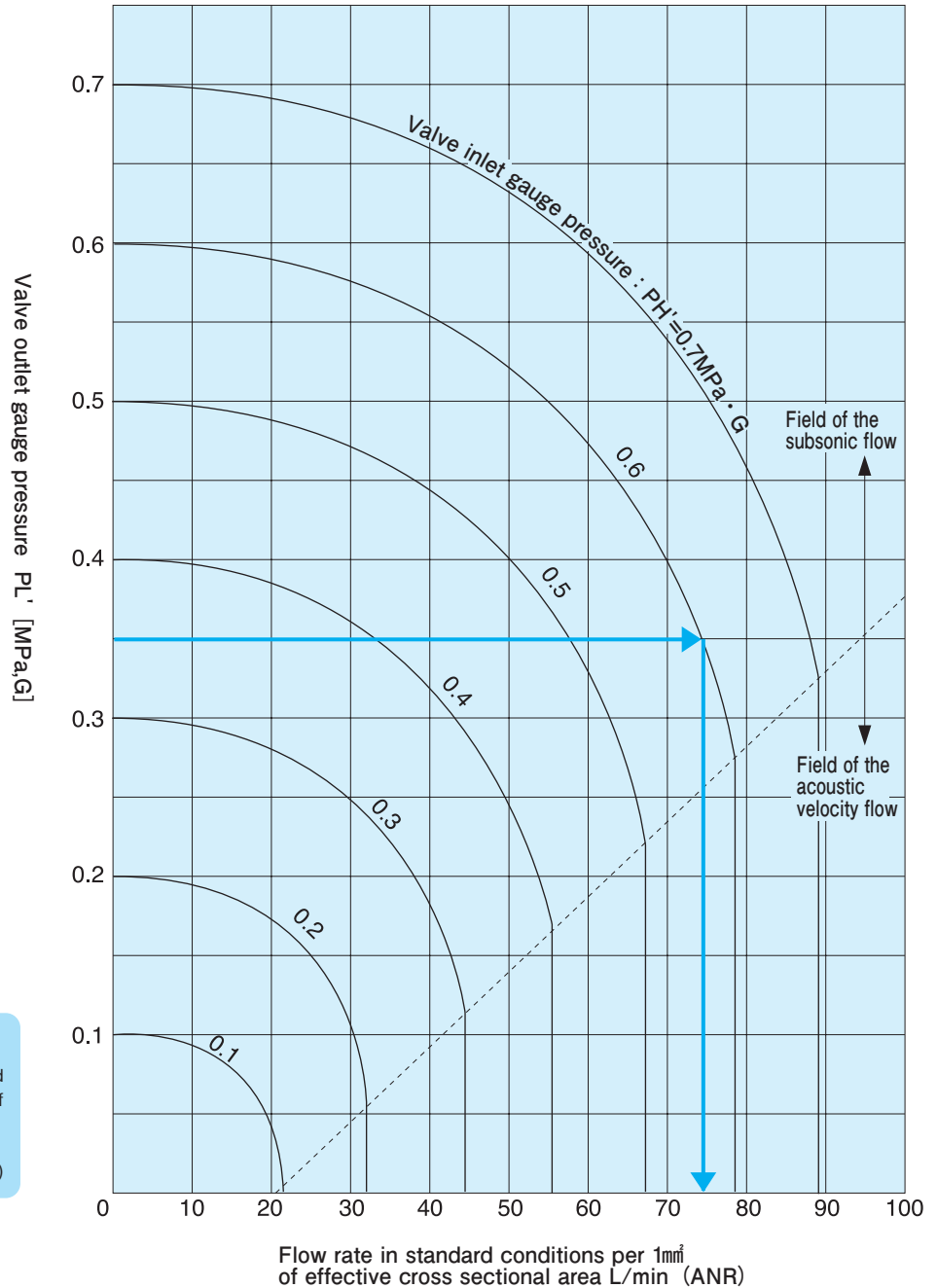
AVW344N-14



Determination of Flow-Rate [Reference]

■ To Determine Flow Rate · 1

(To calculate flow rate using effective cross sectional area of valve)



[Eg.]

When valve inlet pressure is 0.6 MPa and outlet pressure 0.35 MPa, the flow rate of the valve with effective cross sectional area 20mm^2 is calculated as follows:
 $75\text{L/min (ANR)} \times 20\text{mm}^2 = 1500\text{L/min (ANR)}$

◇ Flow Rate Calculation

- $P_H = (1 \sim 1.89) P_L$
 (In the case of subsonic flow) :

$$Q = 236S \sqrt{P_L (P_H - P_L)} \cdot \sqrt{\frac{293}{T}}$$

- $P_H = > 1.89P_L$
 (In the case of acoustic velocity flow) :

$$Q = 118SP_H \sqrt{\frac{293}{T}}$$

Q : Flow [L/min (ANR)]
 S : Effective sectional area [mm^2]
 P_H : Valve inlet absolute pressure [MPa,abs] = [Gauge pressure $P_H' + 0.101$] [MPa]
 P_L : Valve outlet absolute pressure [MPa,abs] = [Gauge pressure $P_L' + 0.101$] [MPa]
 T : Valve inlet absolute temperature [K]

Note

ANR shows standard condition of the air and shows 20 degrees Celsius, pressure of air in 1 atm.

■ To Determine Flow Rate · 2

(To calculate effective cross sectional area of valve using flow rate)

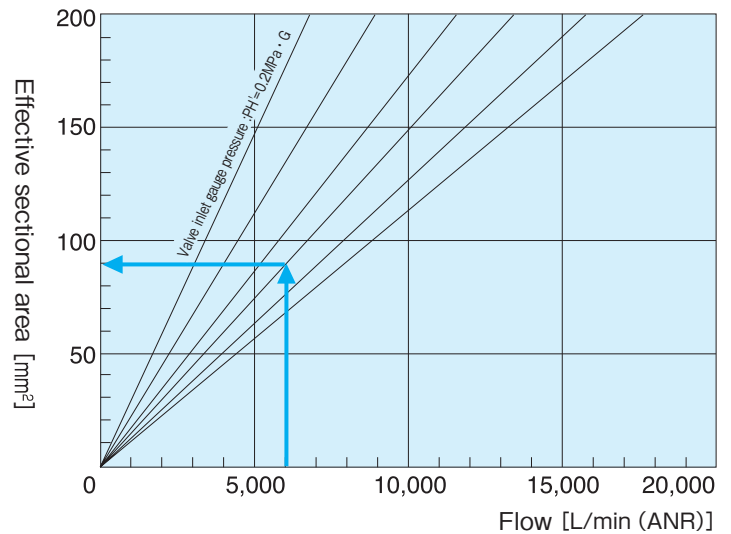
A

When ratio of valve inlet absolute pressure P_H (gauge pressure $P_H' + 0.101$) to valve outlet absolute pressure P_L (gauge pressure $P_L' + 0.101$) (P_H/P_L) is > 1.89
(In the case of acoustic velocity flow)

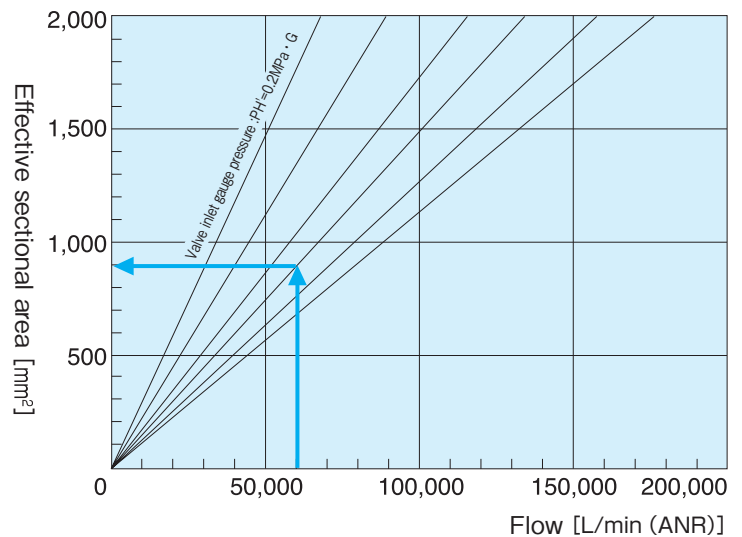
[Eg.]

When valve inlet pressure is 0.5 MPa,
the valve effective sectional area requiring
flow rate 6,000 L/min (ANR) is 90mm².

◆ When the flow rate is 20,000L/min (ANR) or less.



◆ When the flow rate is 200,000L/min (ANR) or less.



[Eg.]

When valve inlet pressure is 0.5 MPa,
the valve effective sectional area requiring
flow rate 60,000 L/min (ANR) is 900mm².

B

When P_H/P_L is > 1.89 :
Effective cross sectional area of the valve is determined
by the following formula :
(In the case of acoustic velocity flow)

$$\text{Effective sectional area [mm}^2\text{]} = \frac{\text{Flow [L/min]}}{236 \times (\text{The coefficient that found by a lower list})}$$

P_H' \ P_L'	0.65	0.6	0.55	0.5	0.45	0.4	0.35	0.3	0.25
0.7	0.194	0.265	0.313	0.347	0.372	—	—	—	—
0.6	—	—	0.181	0.246	0.288	0.317	—	—	—
0.5	—	—	—	—	0.660	0.224	0.261	—	—
0.4	—	—	—	—	—	—	0.151	0.201	—
0.3	—	—	—	—	—	—	—	—	0.133

Eg.

Effective cross sectional area when
 $P_H'=0.6$, $P_L'=0.45$, flow rate 3,000L/
min (ANR) :
$$\frac{3000}{236 \times 0.288} = 44.1\text{mm}^2$$

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