CKD

SM-6997-A

# INSTRUCTION MANUAL

## FLAT CYLINDER

## FC※

- Please read this instruction manual carefully before using this product, particularly the section describing safety.
- Retain this instruction manual with the product for further consultation whenever necessary.

CKD Corporation

# For Safety Use

To use this product safely, basic knowledge of pneumatic equipment, including materials, piping, electrical system and mechanism, is required (to the level pursuant to JIS B 8370 Pneumatic System Rules).

We do not bear any responsibility for accidents caused by any person without such knowledge or arising from improper operation.

Our customers use this product for a very wide range of applications, and we cannot keep track of all of them. Depending on operating conditions, the product may fail to operate to maximum performance, or cause an accident. Thus, before placing an order, examine whether the product meets your application, requirements, and how to use it.

This product incorporates many functions and mechanisms to ensure safety. However, improper operation could result in an accident. To prevent such accidents, read this instruction manual carefully for proper operation.

Observe the cautions on handling described in this manual, as well as the following instructions:

## ⚠ Precautions

- Before performing an overhaul inspection on the actuator, deactivate residual pressure completely.
- While the actuator is operating, do not step into or place hands in the driving mechanism.
- To prevent an electric shock, do not touch the electric wiring connections (exposed live parts) of the actuator equipped with a solenoid valve or switch.
  Perform an overhaul inspection with the power off. Also, do not touch these live parts with wet hands.

# INDEX

FC※

Flat Cylinders

Manual No. SM 6997-A



NOTE : Letters & figures enclosed within Gothic style bracket (examples such as [C2-4PP07] · [V2-503-B] etc. ) are editorial symbols being unrelated with contents of the book.


Jan.22.1988

Revision : Jun.7.1998

# 1. PRODUCTS

## 1.1 Specifications

### 1) Specifications < > Specifies the item is with switch (es).

| Model no. / item | | FCS-<L> Single-acting, push out type | FCH-<L> Single-acting, retract type | FCD-<L> Double-acting | FCD-D<L> Double-acting, dual rod tyoe | FCD-K<L> Double-acting with cushion |
|---|---|---|---|---|---|---|
| Media | | Compressed air | | | | |
| <Applicable switches> | | <Solid stat type switches: M2V, M2WV, M3V & M3WV<br>Reed switch type switches: M0V & M5V > | | | | |
| Max. working pressure MPa | | 0.7 | | | | |
| Min. working pressure MPa | Equiv. to ϕ25, ϕ32, ϕ40 & ϕ50 | 0.12 | | 0.07 | 0.1 | 0.07 |
| Withstanding pressure MPa | | 1.05 | | | | |
| Tube bore mm | | Equiv. to ϕ25 | Equiv. to ϕ32 | Equiv. to ϕ40 | Equiv. to ϕ50 | Equiv. to ϕ50 |
| (Connecting bore dia.) | | (M5×0.8) | (M5×0.8) | (RC1/8) | (RC1/8) | (RC1/8) |
| Ambient temperature °C | | −10~60 | | | | |
| Piston speed mm/s | | 50~500 | | | | |
| Cushion | | No cushion | | | | Rubber cushion |
| Lubrication | | Not required (Turbine oil class 1, ISO VG32 or equiv. if lubrication is preferred.) | | | | |

### 2) Revolvable angle tolerance and Allowable rotary torque

| Tube bore (mm) / Item | Equiv. to ϕ25 | Equiv. to ϕ32 | Equiv. to ϕ40 | Equiv. to ϕ50 | Equiv. to ϕ63 |
|---|---|---|---|---|---|
| Non-rotating accuracy (Note) deg. | ±1 | ±0.8 | ±0.5 | ±0.5 | ±0.5 |
| Allowable rotary torque N·m | 1 | 1.6 | 2.5 | 3.9 | 5.9 |

Note : Above-mentioned valves are at the pull end. (except piston rod bend)

1 N·m =10.2 kgf·cm

### 3) Stroke

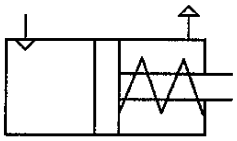
| Model No. | Tube bore | Stroke (mm) ※ | Max. stroke (mm) (mm) |
|---|---|---|---|
| FCS (Single-acting, Push-out type)<br>FCH (Single-acting, Retract type) | Equiv. to ϕ25 & ϕ32 | 5, 10 | 10 |
| | Equiv. to ϕ40 & ϕ50 | 10,20 | 20 |
| FCD-D (Double-acting)<br>FCD-D (Double-acting, Dual rod type) | Equivalent to ϕ25, ϕ32, ϕ40, ϕ50 and ϕ63 | 5, 10, 15, 20, 25, 30, (35), 40, (45), 50 | 50 |
| FCD-K (With cushion) | | | 150 |

※ (Stroke) is optional stroke. Intermediate stroke length is by every 1 mm on order.

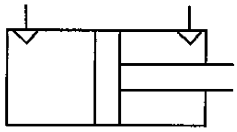
Note : There is a limitation of the minimum stroke requirement to mount switch (es). Refer to 7-1. 2) page 11 regarding with this matter.

## 1.2 JIS symbols

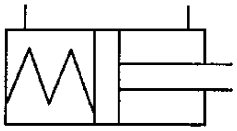
• FCS



• FCD
• FCD-K

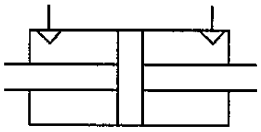


• FCH



[C3-111-A]

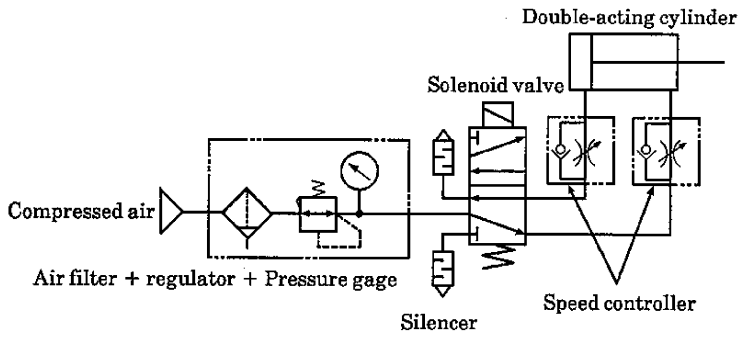
• FCD-D



[C3-111-B]

## 1.3 Fundamental circuit diagram

1) Fundamental circuit diagram for double-acting cylinder (No lubrication)
It is as per illustrated below.

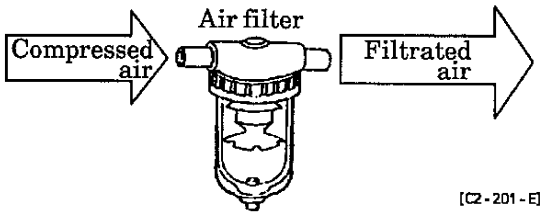



[C2-102-A]

# 2. CAUTION

## 2.1 Media

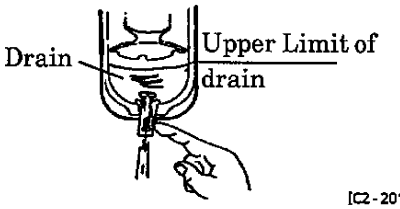
Use the compressed air, filtrated and dehumidified. Carefully select a filter of an adequate filtration rate (5$\mu$m or lower preferred), flow rate and its mounting location (as closest to directional control valve as possible).



[C2-201-E]

## 2.2 Draining of sludge

Be sure to drain out the accumulation in filter periodically.



[C2-201-F]

## 2.3 Inspection of air compressor

Note that the intrusion of carbide of compressor oil (such as carbon or tarry substance) into the circuit causes malfunction of solenoid valve and cylinder. Be sure to carry out thorough inspection and maintenance of compressor.

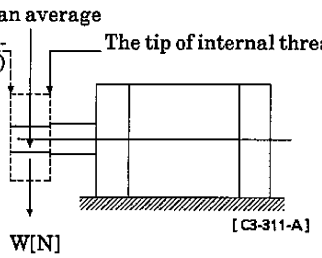
# 3. OPERATION

## 3.1 Lateral load

Refer the following chart, Fig. 1, as for guide line of load when intending to install the cylinder horizontally.

[Unit for st. : mm ]
[Unit :N]

| | | |
|---|---|---|
| ϕ25 | Standard | W = 383 / (33 + st.) |
| | K type | W = 638 / (40.5 + st.) |
| ϕ32 | Standard | W = 672 / (35.5 + st.) |
| | K type | W = 1090 / (43 + st.) |
| ϕ40 | Standard | W = 1120 / (39.5 + st.) |
| | K type | W = 1780 / (47 + st.) |
| ϕ50 | Standard | W = 2060 / (40 + st.) |
| | K type | W = 3090 / (53 + st.) |
| ϕ63 | Standard | W = 4410 / (51 + st.) |
| | K type | W = 6040 / (58.5 + st.) |




Note : This indicates the diagram when the load is attached at the above-mentioned position.

Fig. 1

## 3.2 Allowable energy absorption

| Size | Allowable energy absorption (J) Without cushion (FCD-□) (FCD-L-□) | With cushion (FCD-K-□) (FCD-KL-□) |
|---|---|---|
| Equiv. to ϕ25 | 0.015 | 0.34 |
| 〃 ϕ32 | 0.02 | 0.54 |
| 〃 ϕ40 | 0.026 | 0.67 |
| 〃 ϕ50 | 0.04 | 1.02 |
| 〃 ϕ63 | 0.05 | 1.56 |

Refer the following charts, Fig. 2 and 3, as for guide line of load limit. (page 5)

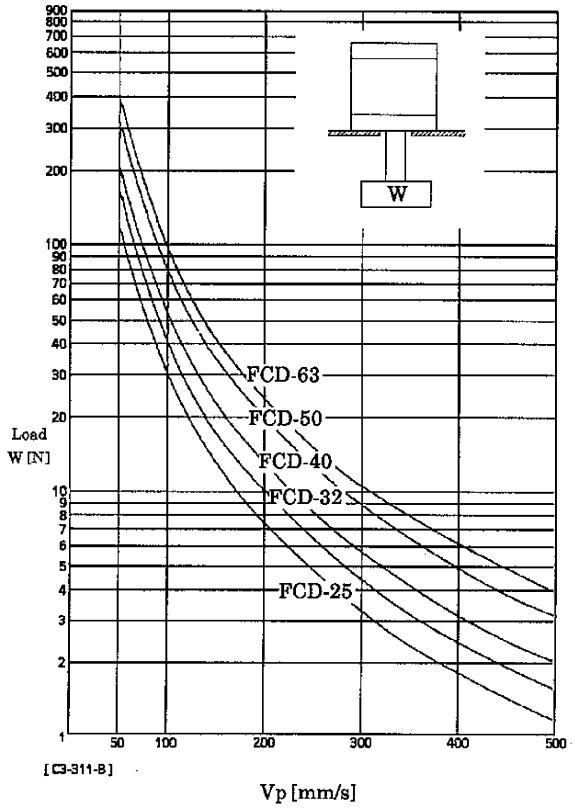



Fig. 2

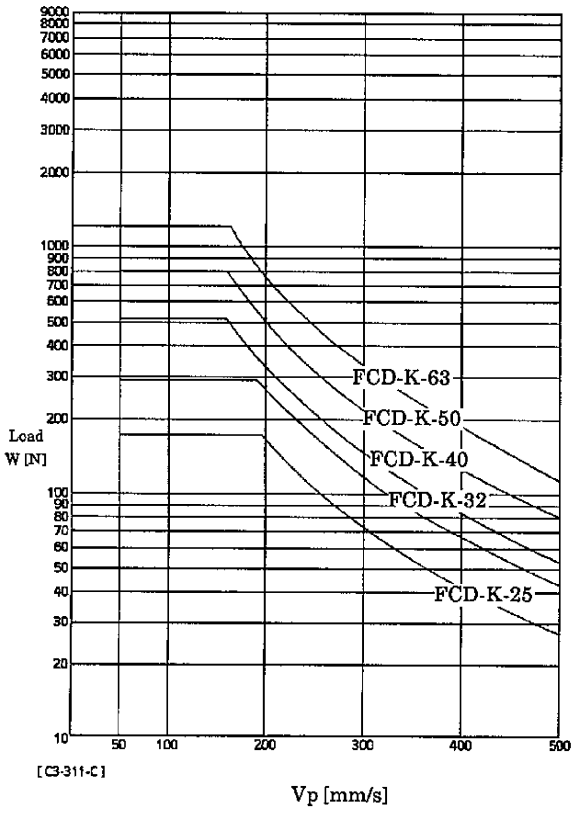



Fig. 3

- Install an external shock absorber to absorb the excessive energy when the load is to exceed the given condition.
- Cylinder speed is to be regulated by a set of speed controller. To set the speed, start setting it from lower speed than aimed then raise it up gradually.

## 3.3 Eccentric load (Torque load)

Refer the following table and keep the load within these limitation in the case of intending to attach an eccentric load at the tip of piston rod.

| | FCD-(L)-25 | FCD-(L)-32 | FCD-(L)-40 | FCD-(L)-50 | FCD-(L)-63 |
|---|---|---|---|---|---|
| Allowable rotary torque (N·m) | 10 | 1.6 | 2.5 | 3.9 | 5.9 |

Furthermore, avoid such usage of cylinder to receive turning torque with impact or direction of torque load altering.

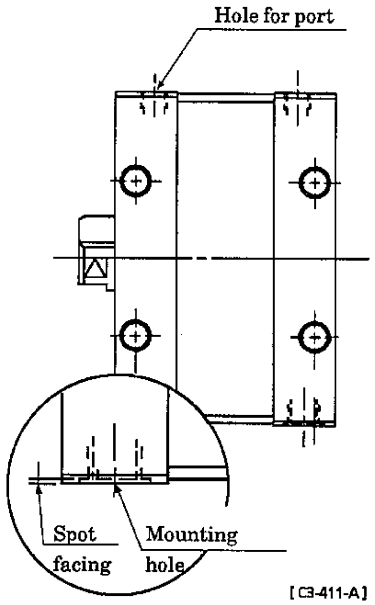
# 4. INSTALLATION

## 4.1 Ambient temperature range

The range of serviceable ambient temperature for these types of cylinders is −10 ~ 60°C.

## 4.2 Mounting direction

Except port side, every side can be made mounting surface. Carefully avoid, however, of being confused between internal thread for port connection and mounting holes with metric thread located opposite to the surface for port. (The mounting holes are provided with spot facing.)




## 4.3 Mounting load

Pay attention to the following articles when intending to attach the load to the tip of rod.

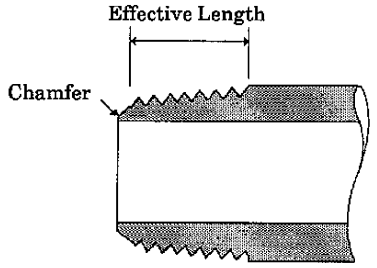
1) In case an internal thread is provided at the tip of rod.
   Use a standard hexagonal wrench to tighten the load. Attach the load to the tip while holding square shank of rod with a wrench.
2) In case an external thread is provided at the tip of rod.
   Attach the load to the tip while holding hexagonal shank of rod with a wrench. Carefully eliminate of giving an effect of turning torque to piston directly. (There is much potentiality of causing damage to the piston in this case as the turning torque is larger than what is generated by an internal thread joint because of being a larger diameter than that of internal thread.)

## 4.4 Load motion

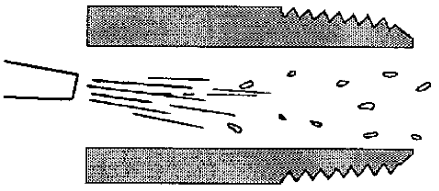
In case the axis of load motion is not parallel to the centerline of rod, there will be a possible twist of rod or bearing and tear of packing. There is, also, potentiality of cylinder damage depending upon a operating condition. Make use of the free joint, the product of CKD, installing it in between the tip of rod and load.

## 4.5 Piping

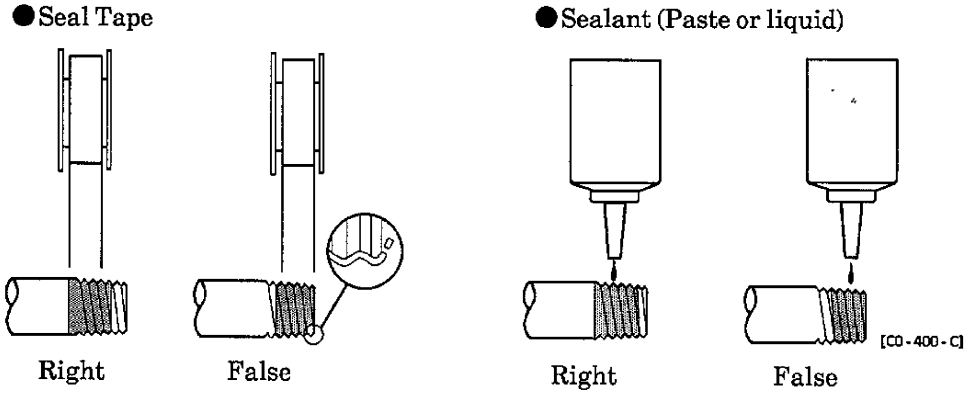
1) For piping beyond the filter, use pipes that hardly get corroded such as galvanized pipes, nylon tubes, rubber tubes, etc. (Refer to Selection Guide Table for Related Equipment.)
2) See to it that the pipe connecting cylinder and solenoid valve has effective sectional area needed for the cylinder to drive at specified speed. (Refer to Selection Guide Table for Related Equipment.)
3) Install filter preferably adjacent upper-stream to solenoid valve for eliminating rust, foreign substance and drain in the pipe.
4) Strictly observe the effective thread length of gas pipe and give a chamfer of approx. 1/2 pitch from the threaded end.
5) Flush air into the pipe to blow out foreign substances and chips before piping.



[C0-400-A]


[C0-400-B]

6) Refrain applying sealant or sealing tape approx. two pitches of thread off the tip of pipe to avoid residual substances from falling into piping system.



[C0-400-C]

# 5. MAINTENANCE

## 5.1 Periodic inspection

1) In order to upkeep the cylinder in optimum condition, carry out periodic inspection once or twice a year.
2) Inspection items
   ⓐ Check the mounting bolts and nuts to the piston rod end fittings and supporting fittings for slackening.
   ⓑ Check that the cylinder operates smoothly.
   ⓒ Check any change of the piston speed and cycle time.
   ⓓ Check for internal and/or external leakage.
   ⓔ Check the piston rod for flaw (scratch) and deformation.
   ⓕ Check the stroke for any abnormality.
   ⓖ Check for any change of turning play of piston rod.
   ⓗ Check for any slacking machine screws or off set position.
   ⓘ Check for any existence of crack or crazing on the lead cord or at the terminal to a switch.
   ⓙ Check for accumulation of any magnetizing particle such as cutting metal chips or any metal dust at the place where switch is mounted.

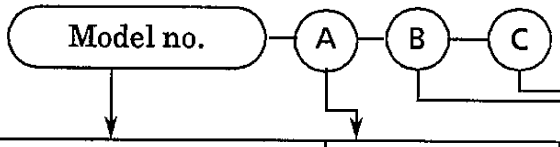
   Refer to the "Trouble shooting", 5.2, should there be any trouble found, also carry out additional tightening if bolts, nuts, etc.are slackened.

## 5.2 Trouble Shooting

| Trouble | Cause | Countermeasure |
|---|---|---|
| Does not operate | No pressure or inadequate pressure | Provide an adequate pressure source. |
| | Signal is not transmitted to direction control valve | Correct the control circuit. |
| | Improper or misalignment of installation | Correct the installation state and/or change the supporting system. |
| | Broken packing | Replace the packing. |
| Does not function smoothly | Lower speed than rated | Reduce the load. |
| | Improper or misalignment of installation | Correct the installation state and/or change the supporting system. |
| | Exertion of transverse (lateral) load or excessive swirel load | Install a guide.<br>Revise the installation state and/or change the spporting system. |
| | Excessive load | Increase the pressure itself and/or the tube bore. |
| | Speed control valve is built in the way of "Meter in" circui | Change the installation direction of the speed control valve. |
| Breakage and/or deformation | Impact force due to high speed operation | Turn the speed down.<br>Reduce the load.<br>Install a mechanism with more secured cushion effect (External cushion mechanism) |
| | Exertion of transverse (lateral) load | Install a guide.<br>Revise the installation state and/or change the supporting system. |
| | The torque to the rod is exceeding the tolerable limit. | Reduce the torque.<br>Install a larger size cylinder.<br>Install a guide. |
| Switch does not function right. | Mounting location of the switch is not appropriate. | Relocate the switches within the area of HD, RD, referring to the Section 7, "CAUTION FOR OPERATING CYLINDER SW". |
| | Switch is electrically damaged | Rectify the electric circuit so as to eliminate the excessive current or voltage to the coil. (Replace the switch.)<br>Inspect if there is an extremely sharp bend of lead wire causing a short circuit. (Replace the switch.) |
| | Switch is mechanically damaged | Replace the switch with a new one.<br>Remove any external obstacles causing the mechanical damage to the switch. |
| | Abnormal distribution of magetic flux of magnet to actuate the switch. | Clean and remove the accumulation of magnetizing material such as iron chips away from switch. |

# 6. HOW TO ORDER

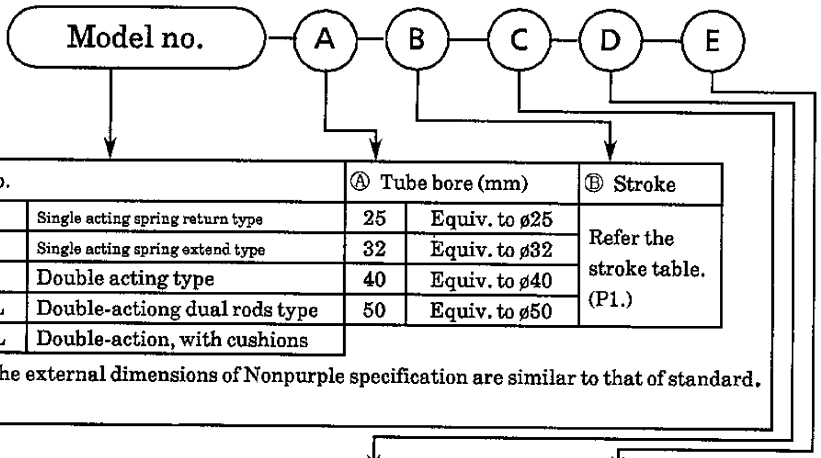
## 6.1 Flat cylinder without switches




| Model no. | | Ⓐ Tube bore (mm) | | Ⓑ Stroke | © Options | |
|---|---|---|---|---|---|---|
| FCS | Single acting spring return type | 25 | Equiv. to ø25 | Refer the stroke table. (P1.) | M | Piston rod different material |
| FCH | Single acting spring extend type | 32 | Equiv. to ø32 | | N | Externally threaded Rod tip |
| FCD | Double acting type | 40 | Equiv. to ø40 | | R | Internally threaded Rod tip with spigot joint |
| FCD-D | Double-actiong dual rods type | 50 | Equiv. to ø50 | | P6 | Nonpurple specification (Neither copper series nor Teflon series are used.) |
| FCD-K | Double-action, with cushions | | | | | |

Note) Nonpurple: Neither copper series nor Teflon series are used for prevention against gerating copper iron.
The external dimensions of Nonpurple specification are similar to that of standard.

## 6.2 Flat cylinder with switches




| Model no. | | Ⓐ Tube bore (mm) | | Ⓑ Stroke |
|---|---|---|---|---|
| FCS-L | Single acting spring return type | 25 | Equiv. to ø25 | Refer the stroke table. (P1.) |
| FCH-L | Single acting spring extend type | 32 | Equiv. to ø32 | |
| FCD-L | Double acting type | 40 | Equiv. to ø40 | |
| FCD-DL | Double-actiong dual rods type | 50 | Equiv. to ø50 | |
| FCD-KL | Double-action, with cushions | | | |

Note: The external dimensions of Nonpurple specification are similar to that of standard.

| © Model no. of switches (M□W is bi colors indicating switch) | | | Ⓓ Switch q'ty | | Ⓔ Options | |
|---|---|---|---|---|---|---|
| M2V※ | For PC | Solid state type | R | 1 ea.,Rod end | M | Piston rod different material |
| M2WV※ | | | H | 1 ea.,Head end | | |
| M3V※ | For relay, PC or IC circuit compact | | D | 2 ea. | N | Externally threaded Rod tip |
| M3WV※ | | | T | 3 ea. | R | Internally threaded Rod tip with spigot joint |
| M0V※ | For relay or PC | Reed switch type | | | P6 | Nonpurple specification (Neither copper series nor Teflon series are used.) |
| M5V※ | For relay or PC<br>For relay, PC or IC | | | | | |

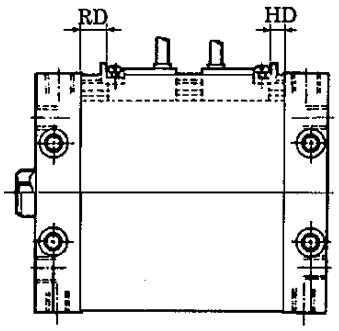
※ mark specifies the length of lead wire.

| ※ Lead wire length | |
|---|---|
| No code | 1 m (Standard) |
| 3 | 3 m (Option) |
| 5 | 5 m (Option) |

# 7. CAUTION FOR OPERATING CYLINDER SWITCHES

## 7.1 Common characteristics of reed switch type and solid state type cylinder switches

1) The cylinder switches were set at the position (for the best operating position) as indicated in the table below at the time of their shipment. Before operation, however, it is recommended to check the position of each switch. If the switch and the cylinder have been purchased separately, or if another switch has been added, check that the switch is properly positioned.



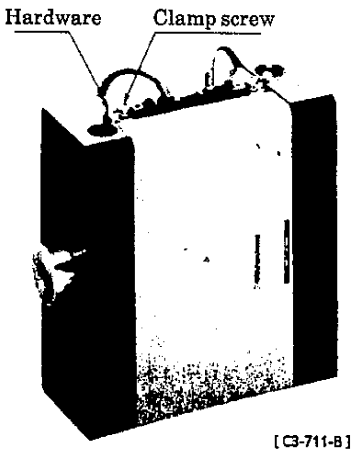
[C3-711-A]

Best operating position (RD and HD)

| Item / Tube bore (mm) / Series | | Best operating position (Solid state type / Reed switch type) RD | HD |
|---|---|---|---|
| FCS-L | Equiv. to ϕ25 | 5 | 2.5 |
| | Equiv. to ϕ32 | 6 | |
| | Equiv. to ϕ40 | | |
| | Equiv. to ϕ50 | | 3.5 |
| | Equiv. to ϕ63 | | 7.5 |
| FCH-L<br>FCD-L<br>FCD-DL | Equiv. to ϕ25 | 2.5 | 2.5 |
| | Equiv. to ϕ32 | | |
| | Equiv. to ϕ40 | | |
| | Equiv. to ϕ50 | | 3.5 |
| | Equiv. to ϕ63 | | 7.5 |
| FCD-KL | Equiv. to ϕ25 | 10 | 3 |
| | Equiv. to ϕ32 | | 4 |
| | Equiv. to ϕ40 | | 5 |
| | Equiv. to ϕ50 | | 6 |
| | Equiv. to ϕ63 | | 10 |

2) The minimum stroke to mount switch on the cylinder of this type is 10mm for one switch and is 15mm on different side for two switches. The minimum stroke apart each switch when intending to mount plural number of switches are; 35 mm for models FCD-25 or FCD-32 and 30 mm for models FCD-40, FCD-50, or FCD-63.

3) To adjust the position of the switch, loosen the clamp screw (the pan head screw) and slide the switch and the switch mount and fasten them at the proper position.



[C3-711-B]

4) To replace the switch, loosen the clamp screw (the pan head screw) and take it out from the mount. Leave the mount on the cylinder. Next, set a new switch in the mount, position them and fasten the screw (the tightening torque for the pan head screw: 0.5~0.7 N/m).

5) To set the switch at the middle of the stroke, proceed as follows.

① M0V, M2V, M3V, and M5V

Fix the piston at the stop position. Move the switch over the piston and find the position at which the switch first comes on. The midway point between the two positions is where the switch is the best operating position, and therefore the SW set position, given the piston position.

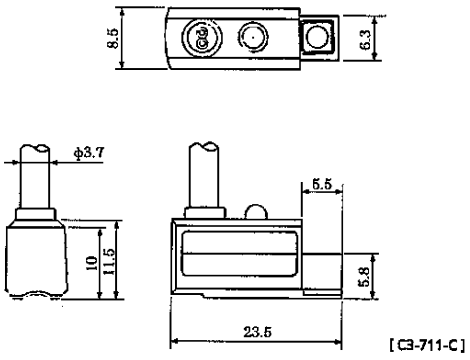
② The solid state type switches of bi colors indication, M2WV or M3WV .

Move the switch and fasten it where the green light comes on (the max. sensitivity position).

- The solid state type switches of bi colors indication shows the operating range by turning on a red light and the best operating range (the best mounting position) by a green light. This makes SW setting very easy.

  Electricity is on even while the red light is on, posing no problem to the operation of the switch.

6) External dimensions of the switch



## 7.2 Caution for operation
## (Solid state type switches : M2V, M2WV, M3V, and M3WV)

1) Connection of lead wire

Wire the switch correctly according to the wire colors. Be sure to turn off the power of the electric circuit before wiring.

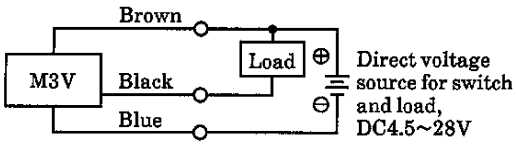



Fig. 1 An example (1) of basic circuit of M3 (M3WV) (When the switch and the load share the same electric power)

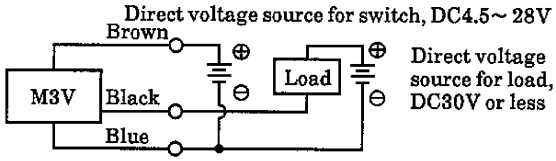



Fig. 2 An example (2) of basic circuit of M3 (M3WV) (When the switch and the load use separate e;ectroc power)

2) Output circuit protection

- With an inductive load (relay, solenoid valve), surge voltage occurs when the switch is turned off. To protect the circuit, be sure to install a protect circuit shown in Fig. 3.
- With a capacious load (capacitor), rush current occurs when the switch is turned on. Be sure to install a protect circuit shown in Fig. 4.
- If the total length of the lead wires exceeds 10 m, be sure to install a protect circuit as shown in Fig. 5 and 6 (for M2V) and Fig. 7 (for M3V).

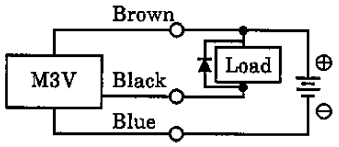



Fig. 3 An example of using an inductive load together with a surge absorbing element (diode). (Use Hitachi Ltd. made diode, V06C or the equivalent.)

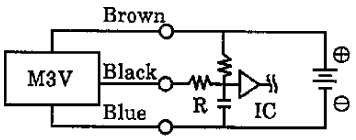



Fig. 4 An example of using capacious load together with current limiting resistance R. Comply with the following formula to figure out required R.

$$\frac{V}{0.15}=R\,(\Omega)$$

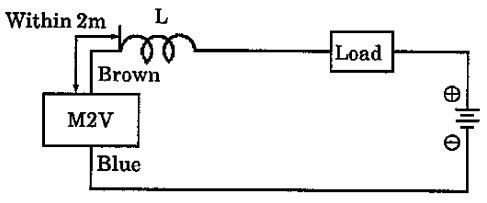



Fig. 5 • Choke coil
L = a couple hundred μH ~ a couple mH Surpassing high-frequency characteristic
• Connect the coil close to a switch (within 2 m).

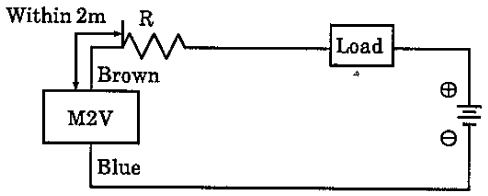



Fig. 6 • Rush current limiting ressistance
R = the maximum acceptable resistance by the load circuit
• Connect the coil close to a switch (within 2 m).

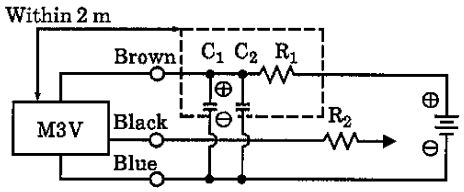



Fig. 7

- Source noise absorption circuit
  C1 = 20~50μF electrolytic capacitor (withstanding pressure 50V or more)
  C2 = 0.01~0.1μF ceramic capacitor
  R1 = 20~30Ω
- Rush current limiting resistance
  R2 = the maximum acceptable resistance by the load circuit
- Install it near by a switch (within 2 m).

### 3) Connection to a programmable controller (Sequencer)

Type of the connection varies depending upon the model of the programmable controller. Refer to the following Fig. 8~12 respectively.

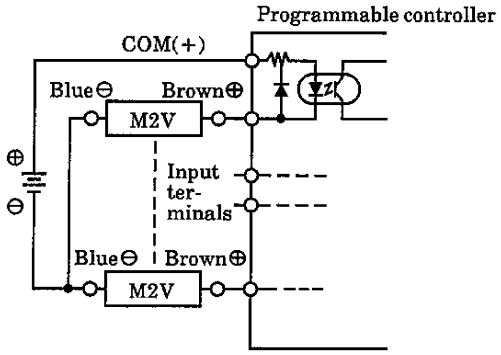



Fig. 8 An example of M2V (M2WV) model connection to sink load input type (with an external electric power)

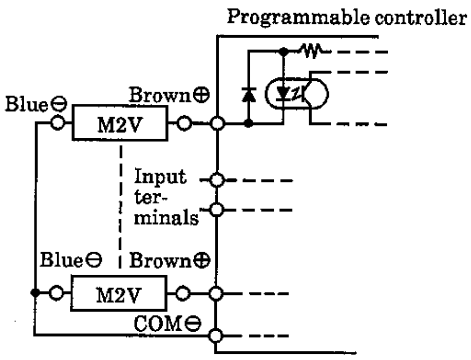



Fig. 9 An example of M2V (M2WV) model connection to sink load input type (with an internal electric power)

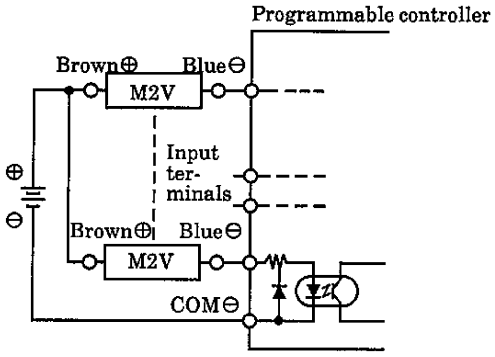



Fig. 10 An example of M2V model connection to sink load input type

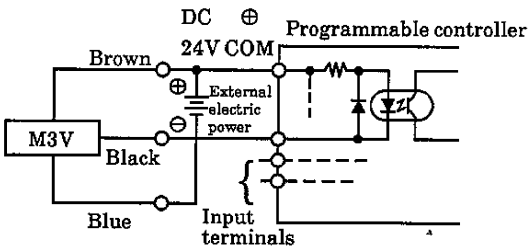



Fig. 11 An example of M3V (M3WV) model connection to sink load input type (with an external electric power)

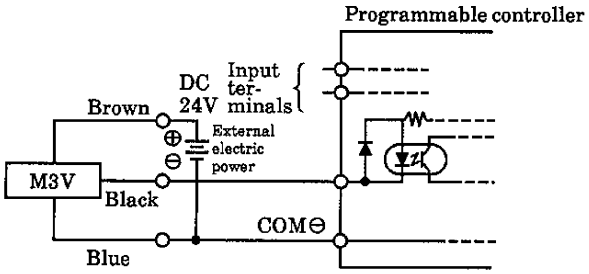



Fig. 12 An example of M3V (M3WV) model connection to sink load input type (with an internal electric power)
M3V switch is, however, unable to be connected to the source load input sequencer.

4) Series connection

When several M2V or M2WV swithces are connected in series, the total voltage drop by these switches is the sum of the voltage drop at each of all these switches. The voltage that applies to the load side equals the power supply voltage minus the total voltage drops by the switches. Check the input specifications of the programmable controller, which is a load, in determining the connection quantity. It is recommended of consulting us prior to have plural number of M3V switches connected.

5) Parallel connection

When M2V or M2WV switches are connected in parallel, the leak current multiplies by the number connected. Therefore, check the input specifications of the programmable controller, which is a load, in determining the connection quantity. In some occasions, either the lamps dim or distinguish at all.

M3V or M3WV on the contrary, connection of these switches creates very rare problem of multiplied the leak current due to almost negligible the leak current (10 $\mu$A or less) of individual switch. There will be no visible difference of luminance of lamps.

6) Magnetic environment

Avoid using these switches in a strong magnetic field or nearby large current(such as a large magnet or spot weldering machine). When two cylinders with switches are installed closely in parallel, or when a magnetic substance moves near the cylinder, the interference may affect the detection accuracy of the switch

7) Protection of lead wire

Pay consideration to eliminate repeating bending stress or stretching of lead cord while laying the cord. To the movable part, use such an electric wire of flexibility as for building a robot.

## 7.3 Caution for operation

### (Reed switch type switches : M0V, M5V)

1) Connection of lead wire

Do not connect the lead wire of switch directly to the power source;be sure to connect the load in series. For R0,take further care for the following items, Ⓐ and Ⓑ.

Ⓐ When using for DC connect the brown lead wire to ⊕ terminal and the blue lead wire to ⊖ terminal. If the lead wires are connected in reverse, the switch may activate but the light will not turn on.

Ⓑ When connecting to AC relay and programmable controller input ,the switch light may not turn on if their circuit has half-wave rectification. In such case, reverse the polarity of the switch lead wire. Bisides R4 and R5 have no polarity.

2) Capacity of contact points

Avoid using a load exceeding the max. capacity of contact points. On the other hand, in case of M0V model, switch lamp may not be lit sometimes when current is lower than rated current.

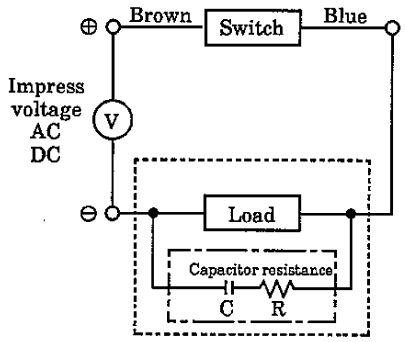
3) Protection of contact point

Whenever using inductive load such as relay, provide the contact protect circuits in either Fig. 1 or Fig. 2.

Furthermore, in case the overall wiring is to exceed the length shown in the table 1, provide the contact protect circuits in either Fig. 3 or Fig. 4.

Table 1

| Voltage | Wire length |
|---|---|
| DC | 100m |
| AC | 10m |




User wiring

Protect circuit (Spark quenching circuit)

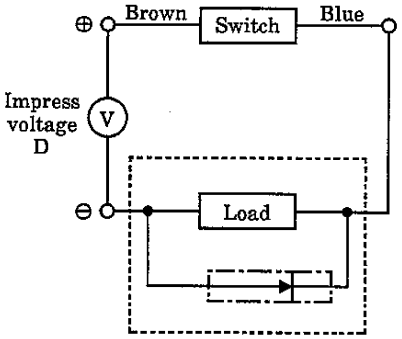
Recommended value

C (Capacitor) = 0.1μF

R (Resisteance) = 1 kΩ

OKAYA ELECTRIC INDUSTRIES CO., LTD. made XEB1K1 or the equivalent

Fig. 1 In case of using a resistance.



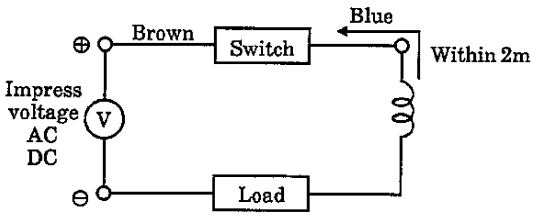

User wiring

Protect circuit

Rectifier diode for general use

Hitachi Ltd. made V06C or the equivalent

Fig.2 In case of using a diod.

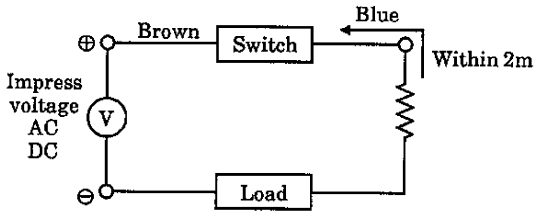



- Choke coil

  L= a couple hundred μH ~ a couple mH surpassing high frequency characteristic

- Connect the coil close to a switch (within 2 m).

Fig. 3




- Rush current limiting resistance

  R= the maximum acceptable resistance by the load circuit

- Connect the coil close to a switch (within 2 m).

Fig. 4

4) Relay

Use the following relays or the equivalent.

- OMRON Corporation ..... Model MY
- FUJI ELECTRIC CORP ..... Model HH5
- Matsushita Electric Works Ltd. ... Model HC

5) Series connection

When several M0V switches are connected in series, the total voltage drop by these switches is the sum of the voltage drop at each of all these switches. When a M0V switch is used and the others are M5V switches to check the function, the voltage drop is about the voltage drop of one piece of a M0V switch (approx. 2.4 V). The lamp turns on only when all the switches are turned on.

6) Parallel connection

When several switches are connected in parallel, there is no limitation for the number of switches that can be connected. However, it may sometimes happen the switch lamp turns dim or is not lit at all, in case of a M0V switch.

7) Magnetic environment

Avoid using these switches in a strong magnetic field or nearby large current(such as a large magnet or spot weldering machine). When two cylinders with switches are installed closely in parallel, or when a magnetic substance moves near the cylinder, the interference may affect the detection accuracy of the switch.

8) Protection of lead wire

Pay consideration to eliminate repeating bending stress or stretching of lead cord while laying the cord. To the movable part, use such an electric wire of flexibility as for building a robot.