# Specifications／Operation Manual

## Flow Controller (for water)

## *FC2W504 - 03 - 3 - X110*
## *FC2W520 - 04 - 3 - X110*

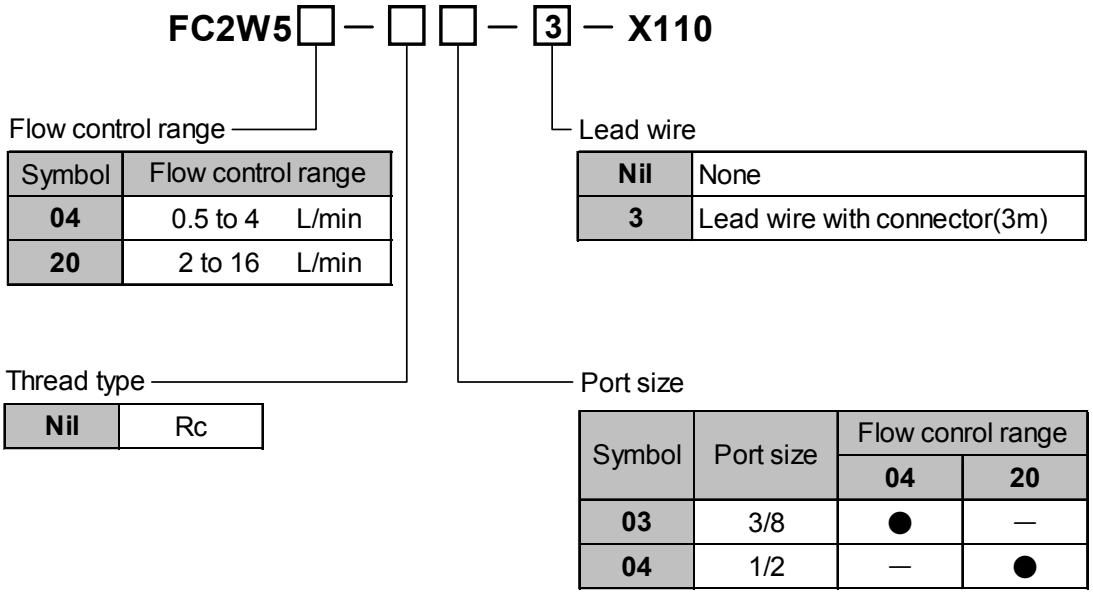
SMC Corporation

Contents

## 1. Scope

Product Name : Flow Controller ( for water )
Product Model : FC2W504 - 03 - 3 - X110 A
FC2W520 - 04 - 3 - X110 A

Model number indication A




| Symbol | Flow control range |
|---|---|
| **04** | 0.5 to 4 L/min |
| **20** | 2 to 16 L/min |

| | |
|---|---|
| **Nil** | None |
| **3** | Lead wire with connector(3m) |

| | |
|---|---|
| **Nil** | Rc |

| Symbol | Port size | Flow conrol range | |
|---|---|---|---|
| | | **04** | **20** |
| **03** | 3/8 | ● | — |
| **04** | 1/2 | — | ● |

## 2. Dimensions

Refer to this product dimensions.

- C - FC2W504 - 03 - 3 - X110 A
- C - FC2W520 - 04 - 3 - X110 A

## 3. Specifications

The operating life for this product is 1 million times under the following condition.

【Operation pattern】: Full stroke open and close（1 time count is one way operation）
【Operating pressure】: 0.3 MPa constant（range of the specification）
【Operating temperature】: 20 to 25 ℃
【Flow temperature】: 20 to 25 ℃
【Quality of fluid 】: Clean water

Other detailed specification is according to Table 1 on next page.

Table 1: Specification

| Model | FC2W504 | FC2W520 | |
|---|---|---|---|
| Applicable fluid | Water | | |
| Flow detection method | Karman vortex | | |
| Flow measuring range | 0.4 to 5.1 L/min | 1.7 to 22.0 L/min | |
| Flow control range | 0.5 to 4.0 L/min | 2.0 to 16.0 L/min | |
| Operating pressure range | 0.2 to 0.4 MPa | | |
| Proof pressure | 0.6 MPa | | |
| Operating temperature range | 0 to 50 °C<br>（with no condensation） | | |
| Flow temperature range | 0 to 50 °C<br>（with no condensation） | | |
| Control accuracy | ±5%F.S. | | With operating pressure range |
| Temperature characteristics | ±5%F.S.<br>（0 to 50 °C,25 °C reference） | | |
| Leakage when fully closed[Note1)] | 0.4 L/min or less | 1 L/min or less | |
| Response time[Note2] | 10 sec or less | | |
| Input signal[Note3)] | Analog voltage input：DC 1 to 5 V<br>Input impedance：1 MΩ | | With flow measuring range |
| Output signal[Note3)] | Flow pulse output | | |
| LED indicator[Note4)] | When power is ON：PWR LED turns on green<br>When error is detected：ERR LED turns on red or blinks | | |
| Power supply voltage | DC24V±10%以下 | | |
| Current consumption | 0.5 A | | |
| Piping port size | IN/OUT<br>Rc3/8 | IN/OUT<br>Rc3/8,Rc1/2 | Refer to this product dimension |
| Product size | Refer to this product dimension | | |

Note1. For emergency stop of the flow, use an external shut valve.
Note2. Time required for the flow rate to reach the valve that is equivalent to 90% of the commanded flow rate (input signal).
Note3. See Graph 1 on 14 page for the relationship between the flow rate and the input/output signals.
Note4. LED display when an error is detected is according to Table 5 and Table 6 on 13 page.

## 4. Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage. These instructions indicate the level of potential hazard with the labels of "Caution", "Warning" or "Danger". They are all important notes for safety and must be followed in addition to International standards (ISO/IEC)[*1)] and other safety regulations.

∗1) ISO 4414: Pneumatic fluid power -- General rules relating to systems.

ISO 4413: Hydraulic fluid power -- General rules relating to systems.

IEC 60204-1: Safety of machinery -- Electrical equipment of machines. (Part 1: General requirements)

ISO 10218-1992: Manipulating industrial robots -Safety.

etc.

| | |
|---|---|
| ⚠ **Caution :** | CAUTION indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury. |
| ⚠ **Warning:** | WARNING indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury. |
| ⚠ **Danger :** | DANGER indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury. |

### ⚠ Warning

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

Since the product specified here is used under various operating conditions, its compatibility with specific equipment must be decided by the person who designs the equipment or decides its specifications based on necessary analysis and test results. The expected performance and safety assurance of the equipment will be the responsibility of the person who has determined its compatibility with the product. This person should also continuously review all specifications of the product referring to its latest catalog information, with a view to giving due consideration to any possibility of equipment failure when configuring the equipment.

**2. Only personnel with appropriate training should operate machinery and equipment.**

The product specified here may become unsafe if handled incorrectly. The assembly, operation and maintenance of machines or equipment including our products must be performed by an operator who is appropriately trained and experienced.

**3. Do not service or attempt to remove product and machinery/equipment until safety is confirmed.**

1. The inspection and maintenance of machinery/equipment should only be performed after measures to prevent falling or runaway of the driven objects have been confirmed.
2. When the product is to be removed, confirm that the safety measures as mentioned above are implemented and the power from any appropriate source is cut, and read and understand the specific product precautions of all relevant products carefully.
3. Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.

**4. Contact SMC beforehand and take special consideration of safety measures if the product is to be used in any of the following conditions.**

1. Conditions and environments outside of the given specifications, or use outdoors or in a place exposed to direct sunlight.
2. Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion and recreation, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or other applications unsuitable for the standard specifications described in the product catalog.
3. An application which could have negative effects on people, property, or animals requiring special safety analysis.
4. Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation.

## ⚠ Caution

**The product is provided for use in manufacturing industries.**
The product herein described is basically provided for peaceful use in manufacturing industries.
If considering using the product in other industries, consult SMC beforehand and exchange specifications or a contract if necessary.
If anything is unclear, contact your nearest sales branch.

## ■Compliance Requirements

The product used is subject to the following "Limited warranty and Disclaimer" and "Compliance Requirements".
Read and accept them before using the product.

**Compliance Requirements**

1. The use of SMC products with production equipment for the manufacture of weapons of mass destruction (WMD) or any other weapon is strictly prohibited.
2. The exports of SMC products or technology from one country to another are governed by the relevant security laws and regulation of the countries involved in the transaction. Prior to the shipment of a SMC product to another country, assure that all local rules governing that export are known and followed.

## ⚠ Caution

**SMC products are not intended for use as instruments for legal metrology.**
Measurement insutruments that SMC manufactures or sells have not been qualified by type approval tests relevant to the metrology (measurement) laws of each country. Therefore , SMC products cannot be used for business or certification ordained by the metrology (measurement) laws of each country.

## Operator

- ♦This operation manual is intended for those who have knowledge of machinery using pneumatic equipment, and have sufficient knowledge of assembly, operation and maintenance of such equipment. Only those persons are allowed to perform assembly, operation and maintenance.
- ♦Read and understand this operation manual carefully before assembling, operating or providing maintenance to the product.

## ■Safety Instructions

### ⚠Warning

■Do not disassemble, modify (including changing the printed circuit board) or repair.
An injury or failure can result.

■Do not operate the product outside of the specifications.
Do not use for flammable or harmful fluids.
Fire, malfunction, or damage to the product can result.
Verify the specifications before use.

■Do not operate in an atmosphere containing flammable, explosive or corrosive gas.
Fire or an explosion can result.
This product is not designed to be explosion proof.

■Do not use the product for flammable fluid.
A fire or explosion can result.
Only air and $N_2$ are applicable.

■Do not use the product in a place where static electricity is a problem.
Otherwise it can cause failure or malfunction of the system.

■If using the product in an interlocking circuit:
- Provide a double interlocking system, for example a mechanical system
- Check the product regularly for proper operation

Otherwise malfunction can result, causing an accident.

■The following instructions must be followed during maintenance :
- Turn off the power supply
- Stop the air supply, exhaust the residual pressure and verify that the air is released before performing maintenance work

Otherwise an injury can result.

### ⚠Caution

■Do not touch the terminals and connectors while the power is on.
Otherwise electric shock, malfunction or damage to the product can result.

■After maintenance is complete, perform appropriate functional inspections and leak tests.
Stop operation if the equipment does not function properly or there is a leakage of fluid.
When leakage occurs from parts other than the piping, the product might be faulty.
Disconnect the power supply and stop the fluid supply.
Do not apply fluid under leaking conditions.
Safety cannot be assured in the case of unexpected malfunction.

## ■NOTE

○Follow the instructions given below when designing, selecting and handling the product.

●The instructions on design and selection (installation, wiring, environment, adjustment, operation, maintenance, etc.) described below must also be followed.

∗Product specifications

•For emergency stop of the flow, use an external shut valve absolutely.
The purpose of this product is flow control within the range of specification.

•The direct current power supply used should be UL approved as follows.
Circuit (class 2) of maximum 30 Vrms (42.4 V peak) or less, with UL 1310 class 2 power supply unit or UL 1585 class 2 transformer.

•The product is a c𝐑us approved product only if it has a c𝐑us mark on the body.

•Use the specified voltage.
Otherwise failure or malfunction can result.
Insufficient supply voltage may not drive a load due to a voltage drop inside the product.
Verify the operating voltage of the load before use.

•Do not exceed the specified maximum allowable load.
Otherwise it can cause damage or shorten the lifetime of the product.

•Applicable fluid is water (0 to 50 °C).
Otherwise it can cause damage or shorten the lifetime of the product.
Do not use fluids containing chemicals, synthetic oils, organic solvents, salt or corrosive gases.
Using such fluids can result in malfunction and damage to the product.
Check the details of the specifications before use.

•Consider measures to prevent over pressure due to water hammer.
<Measures to reduce water hammer>
1. Install a water hammer relieving valve.
2. Use a flexible material for piping (such as a rubber hose) and an accumulator that can absorb impact pressure.
3. Keep piping as short as possible.

•Use the product within the specified operating pressure and temperature range.

•Reserve a space for maintenance.
Allow sufficient space for maintenance when designing the system.

●Product handling

∗Installation

•Tighten to the specified tightening torque.
If the tightening torque is exceeded the mounting screws, brackets and the product can be broken. Insufficient torque can cause displacement of the product from its proper position and the looseness of the mounting screws.

Table 2: Tightening torque

| Nominal thread size | Tightening torque |
|---|---|
| Rc(NPT)3/8 | 22 to 24 Nm |
| Rc(NPT)1/2 | 28 to 30 Nm |
| Rc(NPT)3/4 | 28 to 30 Nm |
| Rc(NPT)1 | 36 to 38 Nm |
| Rc(NPT)1 1/4 | 40 to 42 Nm |
| Rc(NPT)1 1/2 | 48 to 50 Nm |

•Be sure to ground terminal FG when using a commercially available switch-mode power supply.

•Do not use in a place subject to heavy vibration and/or shock.
Otherwise damage to the internal parts can result, causing malfunction.

- Do not pull the lead wire forcefully, not lift the product by pulling the lead wire. (Tensile force 49 N or less)
  Hold the body when handling to avoid the damage of the product.
  The product will be damaged, leading to failure and malfunction.
- For piping of the product, hold the piping with a spanner on the metal part of the piping (Piping attachment).
  Applying the spanner to other parts may lead to damage to the product.
  In particular, do not let the spanner come into contact with the M8 connector.
  The connector can be easily damaged.

Table 3: Width across flats of attachment

| | |
|---|---|
| 3/8 | 24 mm |
| 1/2 | 27 mm |
| 3/4 | 32 mm |
| 1 | 41 mm |
| 1 1/4 | 54 mm |
| 1 1/2 | 54 mm |

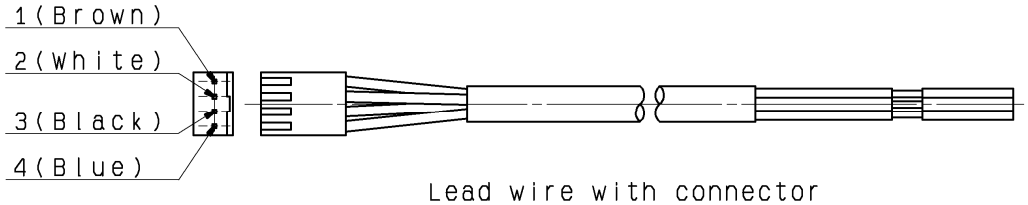
- Use a nominal 3 tapping screw for mounting the product body.
  The correct tightening torque is 0.5 to 0.55 Nm.
- The manifold piping on the IN side must have a straight section of piping whose length is 20 mm or more.
- Eliminate any dust left in the piping by air blow before connecting the piping to the product.
  Otherwise it can cause damage or malfunction.
- Refer to the flow direction of the fluid indicated on the model number plate or the body for installation and piping.
  Residual air can cause errors in measurement accuracy.
- Avoid piping in which the piping size of the IN side of the switch changes suddenly.
  If the piping size is reduced sharply or there is a restrictor such as a valve on the IN side, fluid velocity distribution in the piping will be disturbed, leading to improper flow control.
  If the OUT side is opened, or flow rate is excessive, cavitations may be generated, which may result in improper measurement.
  As a measure against this, it is possible to reduce the cavitations by increasing the fluid pressure.
  If the inside flow control valve is fully closed to operate the pump, the operation may unstable flow control due to the effect of pulsation (pressure fluctuation). Ensure that there is stable flow control before usage.
- Do not insert metal wires or other foreign objects into the flow path.
  Such actions can damage the sensor causing failure or malfunction.
- Never mount the product in a location that will be used as a scaffold.
  The product may be damaged if excessive force is applied by stepping or climbing onto it.
- If the fluid may contain foreign matter, install and connect a filter or mist separator to the inlet.
  The adherence of foreign matter to the vortex generator or detector can cause errors in measurement accuracy.
  A filter of approx. 150 mesh (100 $\mu$m) or more is recommended.
- Design and install the application so that the fluid detection path is always full.
- If the product is mounted vertically, let the liquid flow from bottom to top.
  Trapped air bubbles can cause errors in measurement accuracy.
  (If the fluid detection path is always filled with liquid, there will be no problem.)
  Please be aware that water droplets may cause early deterioration/damage, particularly if the product is installed vertically or upside-down.
- The product body is made of resin. Do not apply load directly to the product when piping.
  This may cause damage, breakage and/or water leakage of the product.

∗Wiring(The connector pulling out opening is contained.)

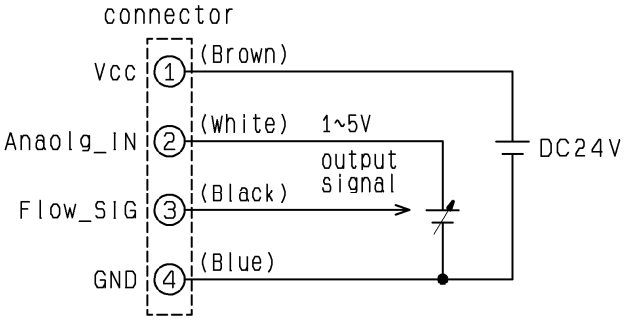
- Use a dedicated attached lead wire with connector.
- Do not pull the lead wires. In particular, never lift a product equipped with fitting and piping by holding the lead wires.
  Otherwise damage to the internal parts can result, causing malfunction or disconnection from the connector.
- Avoid repeatedly bending, stretching or applying a heavy object or force to the lead wire.
  Repetitive bending or tensile stress can cause the sheath of the wire to peel off, or break the wire.
  If the lead wire can move, fix it near the body of the product.
  The recommended bend radius of the lead wire is 6 times the outside diameter of the sheath, or 33 times the outside diameter of the insulation material, whichever is larger.
  Replace a damaged lead wire with a new one.
- Wire correctly.
  Incorrect wiring can break the product.
- Do not perform wiring while the power is on.
  Otherwise damage to the internal parts can result, causing malfunction.
- Do not route wires and cables together with power or high voltage cables.
  Otherwise the product can malfunction due to interference of noise and surge voltage from power and high voltage cables to the signal line. Route the wires (piping) of the product separately from power or high voltage cables.
- Confirm proper insulation of wiring.
  Poor insulation (interference from another circuit, poor insulation between terminals, etc.) can lead to excess voltage or current being applied to the product, causing damage.
- Keep wiring as short as possible to prevent interference from electromagnetic noise and surge voltage.
  Do not use a cable longer than 10 m.
  Wire the DC(-) line (blue) as close as possible to the power supply.
- When the analogue output is used, install a noise filter (line noise filter, ferrite element, etc.) between the switch-mode power supply and this product.
- Power supply & signal input／output connector(CN1)
  The functions of this connector are connection with power supply and analog signal input and flow sensor signal output

Table 4: Functions of connector terminal

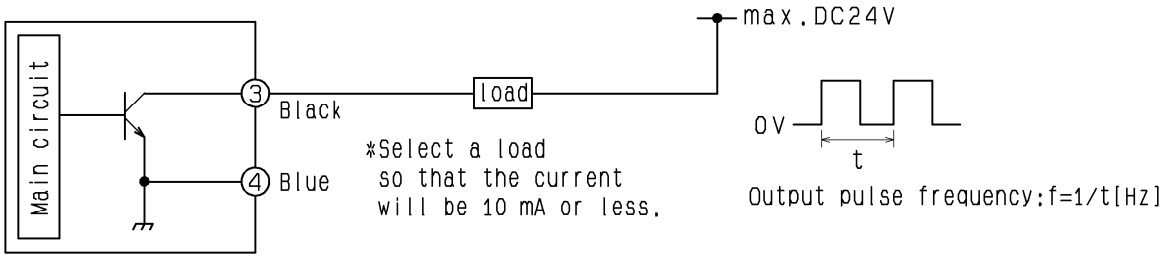
| Terminal Number | Color | Sign | Description |
|---|---|---|---|
| 1 | Brown | Vcc | DC24V±10% |
| 2 | White | Analog_IN | Analog voltage input：DC1 to 5V |
| 3 | Black | FLOW_SIG | Flow pulse output |
| 4 | Blue | GND | |




Lead wire with connector




Wiring




Wiring example of the output signal

∗Environment

- Do not use the product in an environment that is constantly exposed to the splash of water.
  Otherwise failure or malfunction can result. Take measures such as using a cover.
- Do not use the product in an environment where corrosive gases or fluids could be splashed.
  Otherwise damage to the product and malfunction can result.
- Do not use in a place where the product could be splashed by oil or chemicals.
  If the product is used in an environment containing oils or chemicals such as coolant or cleaning solvent, even for a short time, it may be adversely affected (damage, malfunction, or hardening of the lead wires).
- Do not use in an area where surges are generated.
  When a machine or equipment generating large surge near the product (magnetic type lifter, high frequency inductive furnace, motor, etc.), this can result in malfunction (display of incorrect value), deterioration and damage of internal elements. Take measures against the surge sources, and prevent the lines from coming into close contact.
- Do not use a load which generates surge voltage.
  When a surge-generating load such as a relay or solenoid is driven directly, use a Flow switch with a built-in surge absorbing element.
- The product is not CE marked. Take measures against lightning strikes in the system.
- Mount the product in a location that is not affected by vibration or impact.
  Otherwise failure or malfunction can result.
- Do not use the product in the presence of a magnetic field.
  Such use can result in malfunction of the product.
- Do not let foreign matter, such as wire debris, get inside the product.
  The adherence of foreign matter to the vortex generator or detector can cause errors in measurement accuracy.
  A filter of approx. 150 mesh (100 $\mu$m) or more is recommended to the inlet.
- Do not use this product in places where there are cyclic temperature changes.
  Heat cycles other than ordinary changes in temperature can adversely affect the inside of the product.

•Do not expose the product to direct sunlight.
If using in a location directly exposed to sunlight, shade the product from the sunlight.
Otherwise failure or malfunction can result.

•Keep within the specified fluid and ambient temperatures range.
Flow temperature range will become over 50 °C, proof pressure will decrease.
If the fluid freezes, it may cause damage and malfunction of the switch, so please take measures to prevent freezing.
When a fluid at a lower temperature than the ambient temperature is supplied, the product can break due to condensation and malfunction. Keep the product from having condensation.
Protection against freezing is necessary.
Avoid sudden temperature change even within specified temperature. Otherwise failure or malfunction can result.

•Do not operate close to a heat source, or in a location exposed to radiant heat.
This can cause operating failure.

∗Adjustment and Operation

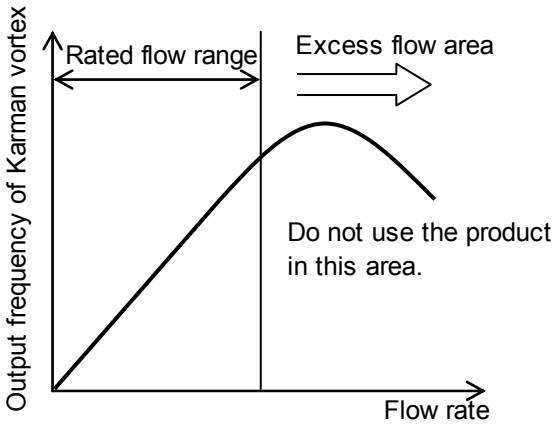
•Connect a load before turning the power supply on.

•Do not short-circuit the load.
Although error is displayed when the product load has a short circuit, generated over current lead to cause the damage of the product.

•Supply the power when there is no flow.

•This product moves automatically for valve opening degree 0 % (full close) after tuning the power supply on.
The method of opening the valve is input of properly analog signal.

•The product is a flow controller using Karman vortex. The flow controller using Karman vortex has lower output frequency at excess flow state. Do not use the product within the excess flow area in the chart below.




•Check the following states before flow control start (turning analog signal input on).
1. All valves that exists in the same piping are opening.
2. The pump is starting.
3. The channel of this product is filled with fluid.

If controls with no flow and stops flow under control, the valve is opening absolutely in every case.
Therefore, the operating life will decrease.

•Stop flow control absolutely before following
1. All valves that exists in the same piping are closed.
2. The pump is stopped.

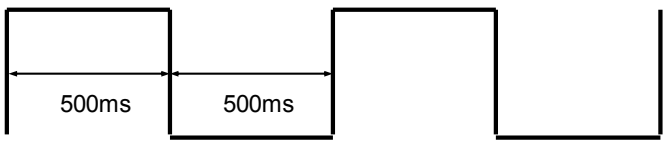
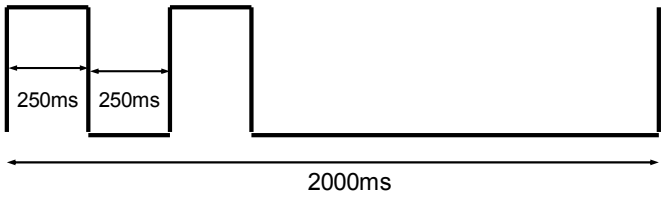
## ∗LED indicator

The following table 5 shows LED indicate function.
If LED of ERR was blinked with over current error, it cannot be reset and control.
(Refer to the following table 6.)
How to reset the product after ERR blinks is turn the power off and turn it on again.

Table 5: LED indicate function

| Name | Operation | Supplementation |
|---|---|---|
| PWR (LED1) | When power is on : Turn on<br>When power is off : Turn off | |
| ERR (LED2) | When error is detected : Blinking<br>When error is not detected : Turn off | When over current error and insufficient flow rate are detected, this led blinks. |

Table 6: LED of ERR indicate when abnormality is detected

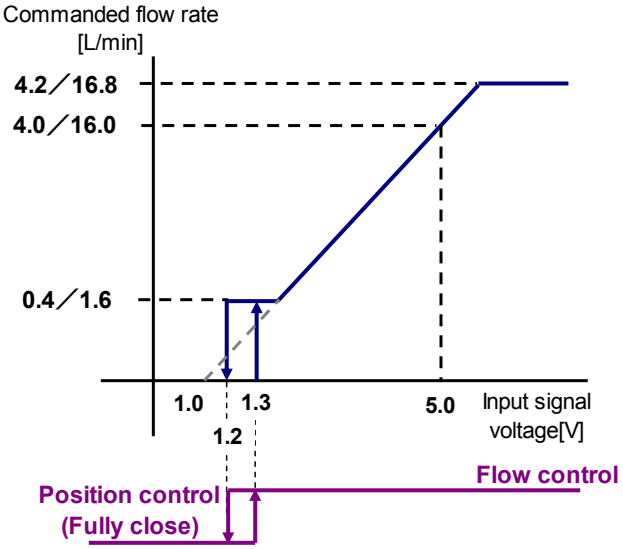
| Status | Lighting method | Action |
|---|---|---|
| **EEPROM error** | LED is kept turned on | Automatically restores operation if reading and writing are correctly executed. |
| **Over current error** Note) | The LED blinks with the blinking cycle of every 500 ms.<br>  | Operation will not be automatically restored. |
| **Insufficient flow rate** | The LED blinks every 2 seconds with the blinking cycle of every 250 ms x 2 times.<br>  | Error is automatically reset (LED turns off) after the supply flow rate is recovered. |

Note) When over current flows into the motor (with inner drive circuit), detected this error.
The causes of this error are serge noise and motor terminal short and etc.
If the error cannot be reset after turn the power off and turn it on again, then please contact SMC.

## ∗Input signal – Flow characteristics

See Graph1 for the relationship between the input signal and flow characteristics.

Note) Over 4 L/min for FC2W504, over 16 L/min for FC2W520 are not covered by the limited warranty of accuracy.

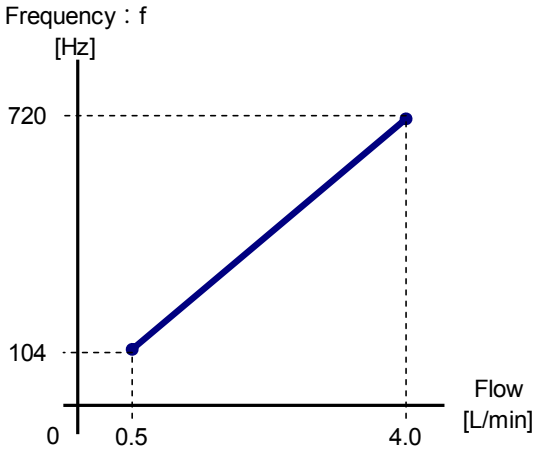



Graph 1: Input signal – Flow characteristics

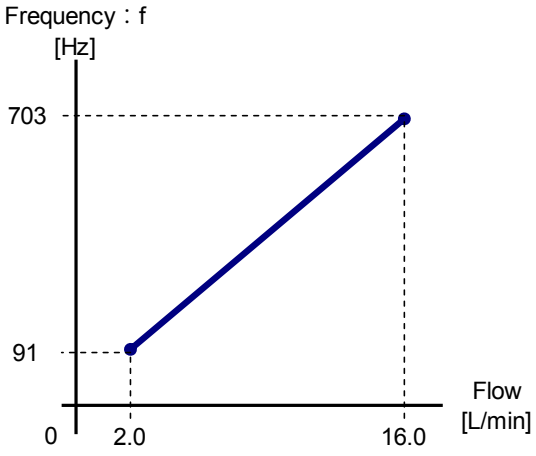
## ∗Pulse frequency of output signal – Flow characteristics

See Graph 2 and Graph 3 for the relationship between the pulse frequency of output signal and flow characteristics.

Note) Following frequency values are for reference.




Graph 2: For FC2W504

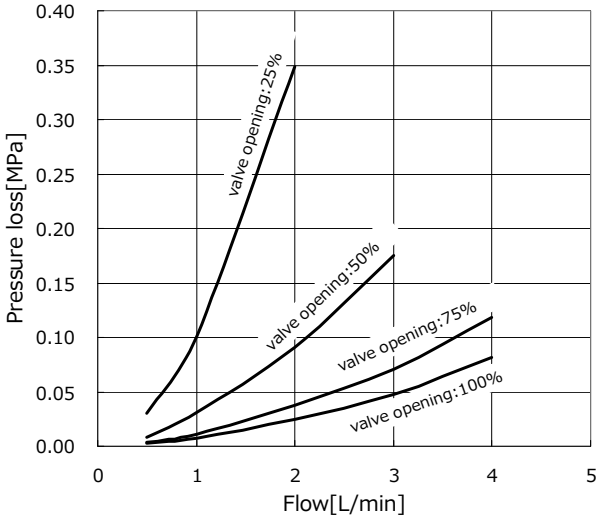



Graph 3: For FC2W520

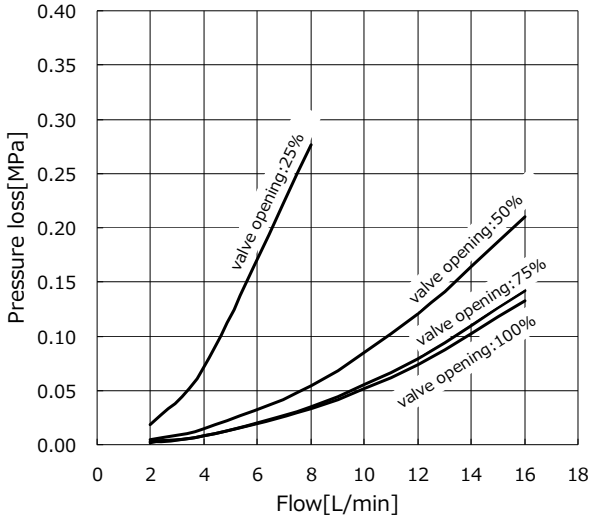
## ∗Pressure loss and Cv value

B

FC2W504-03-X110




FC2W520-04-X110




■ **FC2W504-03-X110**

| valve opening | Cv value |
|---|---|
| 100% | 0.31 |
| 75% | 0.26 |
| 50% | - |
| 25% | - |

■ **FC2W520-04-X110**

| valve opening | Cv value |
|---|---|
| 100% | 0.97 |
| 75% | 0.93 |
| 50% | 0.77 |
| 25% | - |

**Formula of Cv value**
**(General liguid)**

$$Cv = 1.17 \times Q_L \times \sqrt{\frac{G_L}{P_1 - P_2}}$$

$Cv$ : Flow factor
$Q_L$ : Flow [$m^3/h$]
$G_L$ : Specific gravity (water:1)
$P_1$ : Primary pressure[$kgf/cm^2$]
$P_2$ : Secondary pressure[$kgf/cm^2$]

Pressure loss $\Delta P$

$$\Delta P = P_1 - P_2$$

**∗Maintenance**

- Turn off the power supply, stop the supplied air, exhaust the residual pressure and verify the release of air before performing maintenance.
  There is a risk of unexpected malfunction
- Perform regular maintenance and inspections.
  There is a risk of unexpected malfunction of components due to the malfunction of equipment and machinery.
- Do not use solvents such as benzene, thinner etc. to clean the product.
  They could damage the surface of the body and erase the markings on the body.
  Use a soft cloth to remove stains.
  For heavy stains, use a cloth lightly dampened with diluted neutral detergent, then wipe up any residue with a dry cloth.
- Refer to the SMC website for the “Flow Switches Precautions (M-03-3)” for other safety instructions.

**∗Operating life**

The operating life for this product is 1 million times under the following condition.

【Operation pattern】: All open and close（1 time count is one way operation）
【Operating pressure】: 0.3 MPa constant（range of the specification）
【Operating temperature】: 20 to 25 ℃
【Flow temperature】: 20 to 25 ℃
【Quality of fluid 】: Clean water

## 5.Limited warranty

1. Period

The warranty period of the product is 1 year in service or 1.5 years after the product is delivered, whichever is first.*1)

*1) For this product, covered by the limited warranty is 1 year in service or operatin of 1 million times or less,whichever is first.
It is not covered by the limited warranty over that.

2. Scope

For any failure or damage reported within the warranty period which is clearly our responsibility, a replacement product or necessary parts will be provided.
This limited warranty applies only to our product independently, and not to any other damage incurred due to the failure of the product.

3. Contents

SMC warrants that:

a. The product operates normally as long as it is installed and maintained in the appropriate manner according to the operation manual and properly operated in the specifications shown in the catalog or under the operating conditions determined separately.
b. The component parts of the product have no defects in materials and assembly.
c. The dimensions of the product provided conform to those shown on the external dimensions drawing prepared by SMC.
d.This warranty will be nullified if:

1. The product has been improperly mounted or improperly connected to other machines.
2. Maintenance service has not been performed sufficiently and the product has been mishandled.
3. The product has been operated under conditions out of its specifications.
4. The product has been retrofitted or its construction has been changed by the owner and/or user.
5. A connected machine in your site has failed and caused subsequent failure to this product.
6. The product has failed because of an unavoidable cause such as an earthquake, fire or lightning.

4. Note

The final decision about whether the failure falls within the scope of warranty will be made by SMC. If the cause of failure is unclear, further pursuit of the matter will be discussed between the owner / user and SMC, and an appropriate further course of investigation determined.