Digital Flow Control System

Product Configuration/Handling Instructions ⋅ VM2

Digital Flow Switches ⋅ VM12

Digital Flow Sensors ⋅ VM20

Digital Flow Meters ⋅ VM24

Leak Detectors ⋅ VM28

Flow Sensors EFS2 ⋅ VM32

Flow Switches EFS3 ⋅ VM36

Discontinued
**Digital Flow Switch**

<table>
<thead>
<tr>
<th>Flow rate level</th>
<th>Low</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Plastic body</td>
<td>Plastic body</td>
<td>Metallic body</td>
</tr>
<tr>
<td>Plastic body (standard type)</td>
<td>DFS3-1002/500</td>
<td>DFS3-1000/5000</td>
<td>DFS3-1000</td>
</tr>
<tr>
<td>Stainless body</td>
<td>DFS3-1500</td>
<td>DFS3-2000</td>
<td>DFS3-2500</td>
</tr>
<tr>
<td>Material of body</td>
<td>Polyacetal (glass-filled)</td>
<td>Ni (nickel-plated)</td>
<td>SC14</td>
</tr>
</tbody>
</table>

**Digital Flow Switch + Digital Flow Meter**

Combination for reading flow rate and transmitting interlock signal when flow rate is insufficient.

- DFS3-1002
- DFS3-5002
- DFS3-1000
- DFS3-2000
- DFS3-2500
- DFS3-1500
- DFS3-5000

+(DFM2-1000)

**Digital Flow Sensor + Digital Flow Meter**

Combination only for reading flow rate.

- DFT-1000
- DFM2-1000

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**Explanation of Operation**

The rotor rotates at a speed in proportion to the liquid flow rate. The rotations of the rotor are detected by the sensor on the body side and converted to electric pulse signals. Unlike electromotive sensors using coils, the digital type sensor constantly gives rectangular waves with a uniform crest value irrespective of the rotor speed. The pulse period is compared with the period preset with the trimmer, and, when the period exceeds the setting (the flow rate becomes lower than the setting), an alarm is output, and the output lamp (red) lights. To prevent output of unnecessary alarms caused by flow rate ripple and instantaneous interruption, the delay circuit shown in the figure is used to output an alarm only when the period is kept more than the setting for 500 ms.

**Application Examples**

- Various vacuum machines, such as vacuum deposition units
- Semiconductor manufacturing machines
- Spot welding machines (including chip drop detectors)
- Laser beam machines
- Electronic microscopes
- X-ray
- Water treatment plants
- Atomic power plants
- Others

**Note:** When a Digital Flow Switch is used as a sensor.
**DFS3 Series Digital Flow Switches**

### Notes on use

- Use the flow switch within the specified ambient temperature range and keep the working fluid within the specified temperature range. If it is used in an improper temperature, the rotor magnet may decrease in magnetic force, output switching failure may occur, and the switch life may be reduced.
- Use the flow switch within the specified flow rate range. The flow rate range varies depending on the fluid viscosity and temperature. Therefore, it is recommended to cause an abnormal flow rate on the actual equipment to set the trimmer.
- If there are air bubbles in the flow switch or the fluid, the rotor speed will be higher than usual, and the flow rate at which an alarm is output will change. Please flow the switch appropriately to keep the inside of the switch filled with water by, for example, raising the piping on the downstream side of the switch. If the piping in advance to remove dust and foreign particles from the inside.
- If the working fluid contains rust, metallic particles, dust or other polishing substances, it is recommended to filter the upstream side of the flow switch. When a magnetic proximity type flow switch is used, iron particles in the fluid will adhere to the rotor magnet, and the switch may malfunction.
- Check the supply voltage of the flow switch to be used and the load voltage and current specifications. If the voltage or current is improper, the Digital Flow Switch may malfunction or be damaged.
- When a plastic body type flow switch is used in a place where the switch may be exposed to heat cycles or heat shock, use piping adapters. When connecting pipes directly on the plastic body, keep the tightening torque in a range from 5 to 10 Nm.

### Wiring procedures

#### Relay output type

**DC**

- **DFS3**
  - RED: +24 V DC
  - BLACK: 0 V DC
  - GREEN: Relay contacts

**AC**

- **DFS3**
  - White: 100 V AC
  - Black: 100 V AC
  - Green: Relay contacts

#### Open collector output type

**DC**

- **DFS3**
  - RED: +24 V DC
  - BLACK: 0 V DC
  - GREEN: Relay contacts

**AC**

- **DFS3**
  - White: 100 V AC
  - Black: 100 V AC
  - Green: Relay contacts

### Notes on use of output relay

- When using the flow switch, disconnect the power from the equipment on the electric circuit to be connected. Failure to do so may expose the worker to shock hazard or damage the Digital Flow Switch or load during wiring work.
- Connect a load to each output contact. If a power supply is directly connected without a load, the contact may be melted down or burnt out.
- Avoid using the switch with the alarm output relay kept outputting for a long time (e.g. to detect abnormal increase in flow rate). If it is used in such a manner, the temperature rise of the output relay coil may accelerate corrosion of the contact. In such a case, it is recommended to select an open collector output type switch.
- Use the output contacts within the contact capacity range. If the maximum contact capacity is exceeded during use, nonconformities, such as contact abnormal wear, breaking failure, meltdown and burnout, may be caused.
- When the output contacts are used on a minute current circuit, conducting failure is easily caused due to adsorption of oxides and carbides to the contacts. For a minute current circuit, it is recommended to select an open collector output type switch.
- Never configure a circuit on which overrun or contact burnout may occur when the three output contacts, NC, NO and COM, are short-circuited.

### Notes on contact protection

As standard for capacitor: 0.5 to 1 (μF) for current of 1 mA As standard for inductors: 0.5 to 2 (μH) for current of 1 V

### Notes on contact protection

When connecting an induction load, such as a DC relay, using an output contact, take surge absorption measures, such as a diode. When the induction load circuit is opened, back-rotation voltage of several hundred to several thousand volts is generated, and electricity is discharged from the contact.

**Digital Flow Control System**

**Handling Instructions**

**Relay output type**

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**Handling Instructions**

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**Digital Flow Control System**

**Handling Instructions**
Open collector output type

Connection with PLC (programmable controller)
- When the PLC has a built-in power supply
  ![Diagram of PLC connection]
- When the PLC does not have a built-in power supply
  ![Diagram of PLC connection without power supply]

Notes on protection of output circuit
- When an induction load, such as a DC relay, is connected, take surge absorption measures, such as a diode. The back-excitation voltage generated on the load when the output is turned off may damage the output element of the Digital Flow Switch.

Notes on use of open collector output type switch
- When wiring the flow switch, disconnect the power from the equipment on the electric circuit to be connected. Failure to do so may expose the worker to shock hazard or damage the Digital Flow Switch or load during wiring work.
- Do not use the Digital Flow Switch out of the working voltage range (max. allowable voltage is 50 V DC). If voltage higher than the working voltage range is applied or AC power is applied to the switch, internal elements may be damaged or burnt out.

Notes on use of open collector output type switch
- Take care not to wire the power supply in reverse polarity. Internal elements may be damaged or burnt out.
- Do not short-circuit the load. Internal elements may be damaged or burnt out.

Notes on use of open collector output type switch
- Do not short-circuit the load. Internal elements may be damaged or burnt out.
- Take care not to wire the power supply in reverse polarity. Internal elements may be damaged or burnt out.

Notes on use of open collector output type switch
- Wire the power supply with a load. If the power supply is directly connected without a load, internal elements may be damaged or burnt out.

Digital Flow Control System

Handling Instructions

Plug fitting procedures
- Select a required flow rate range from the flow ranges A and B, and screw the supplied plug into the unnecessary range port.

Example)
- When the set flow rate is 1 l/min (steady flow rate is 0.6 l/min) and the primary pressure is 0.2 MPa, select the range A, and fit the plug to the range B port.
- When the set flow rate is 3 l/min (steady flow rate is 6 l/min) and the primary pressure is 0.1 MPa, select the range B, and fit the plug to the range A port.

Notes)
- When fitting the plug to DFS3-1000 or 5000, use the supplied sealing O-ring. The plug is made of plastic. Tighten it to a torque of 3 to 4 N·m.
- When fitting the plug to DFS3-1200 or 1500, use a sealing tape.

Caution: Do not use any plug other than the supplied one.

Piping adapter fitting procedures
- Fitting the piping adapter set (DF-AP)
  - Screw the piping adapter completely until the adapter contact surface gets into close contact with the body side face.
  - Tightening torque: 15 to 20 N·m (DFS3-1000-5000)

Notes)
- This figure shows how to fit the adapters for feeding water in the arrow direction.
  - Fit the plug in accordance with the plug fitting procedures.

Notes)
- If the low-flow nozzle has not been fully inserted, the low-flow piping adapter cannot be screwed in completely. Insert the low-flow nozzle surely.
  - Screw the adapter completely until the adapter contact surface gets into close contact with the body side surface.

- Before connecting the pipes, flush them. Take care that sealing tape cuttings, dust and rust do not enter the pipes.
  - When piping the low-flow piping adapter and piping adapter, use a sealing tape, and tighten the pipes to a torque of 5 to 10 N·m. (Wrap two layers or less of the sealing tape.)

Tightening Torque Table

<table>
<thead>
<tr>
<th>Part to be tightened</th>
<th>Tightening torque range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct piping to plastic body</td>
<td>5 to 10 N·m</td>
</tr>
<tr>
<td>Fitting of plastic plug</td>
<td>3 to 4 N·m</td>
</tr>
<tr>
<td>Fitting of piping adapter</td>
<td>5 to 10 N·m</td>
</tr>
<tr>
<td>Fitting of low-flow piping adapter</td>
<td>5 to 10 N·m</td>
</tr>
<tr>
<td>Piping to piping adapter</td>
<td>1.2 to 1.8 N·m</td>
</tr>
</tbody>
</table>

Note 1) For the plastic body type switch, it is recommended to use the piping adapters. (Wrap two layers or less of the sealing tape.)
**Digital Flow Control System**

**Handling Instructions**

### Body installation procedures

- **The body can be installed in any direction.** When installing, observe the following instructions.
  1. **To suspend the Digital Flow Switch with steel piping**
  2. **To screw one side onto steel piping and connect a plastic tube to the other side**
  3. **To secure the body on a plate and connect plastic tubes**

**Note:** If DFS3-100+ or 500+ having a plastic body is installed in this manner, the ports may be damaged. It is recommended to fit the piping adapter DF-AP (accessory).

### Disassembling procedures

- **Never remove the cover.** (If the cover is removed by the user and the switch is disabled, the repair is not covered by warranty.)
- **Insert the supplied rotor cap opener into the rotor cap groove, and turn it counterclockwise.** Then, the rotor cap, rotor, and rotor pin can be easily disassembled.
- **When reassembling, apply a thin layer of grease to the rotor cap O-ring zone except DFS3-1500 and 2500.** Silicone grease or Teflon grease is recommended. When applying grease to DFS3-1500 or 2500, use grease suitable for the fluid used.
- **If the rotor magnet is covered with iron particles when the switch is disassembled, use a cleaner suitable for the fluid used.** If the magnet is left covered with the particles, the sensor may not detect the magnet.

**Note:** Strap the rotor cap opener near the flow switch so that it can be readily used.

### List of Parts in Contact with Liquid

<table>
<thead>
<tr>
<th>Name</th>
<th>Rotor cap</th>
<th>Rotor</th>
<th>Rotor pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Polytetrafluoroethylene</td>
<td>SUS316</td>
<td>Polyacetal</td>
</tr>
<tr>
<td>Model</td>
<td>DF-RCP</td>
<td>DF-RCS</td>
<td>DF-RP</td>
</tr>
<tr>
<td>DFS3-100</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>DFS3-100</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>DFS3-1500</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>DFS3-2500</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>DFS3-5000</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>DFS3-2500</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>DFS3-5000</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

**Note:** Tighten the mounting screws to a torque of 1.2 to 1.8 N·m. (DFS3-100+/500+)

### DFT Series Digital Flow Sensors

**Wiring procedures**

- **Red:** +10.8 to 26.4 V
- **Black:** –0 V

*Connect to DC power supply.*

**Procedures for wiring with Digital Flow Meter**

(Digital Flow Sensor DFT1000) (Digital Flow Meter DFM1000)

**For the wiring procedures, see the Handling instructions for the Digital Flow Meters.**

**Procedures for connecting with a device other than Digital Flow Meters**

- **Connection with PLC (programmable controller)**
  - When the PLC has a built-in power supply
  - When the PLC does not have a built-in power supply

**Note:** For details, carefully read the instruction manual for the PLC to be used.

**Notes on wiring**

- **When wiring the flow sensor, disconnect the power from the equipment on the electric circuit to be connected.** Failure to do so may expose the worker to shock hazard or damage the Digital Flow Sensor during wiring work.

**Tightening Torque Table**

<table>
<thead>
<tr>
<th>Part to be tightened</th>
<th>Torque range (N·m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct piping to plastic body</td>
<td>5 to 10</td>
</tr>
<tr>
<td>Fitting of plastic plug</td>
<td>3 to 4</td>
</tr>
<tr>
<td>Fitting of piping adapter</td>
<td>5 to 10</td>
</tr>
<tr>
<td>Fitting of low-flow piping adapter</td>
<td>5 to 10</td>
</tr>
<tr>
<td>Piping to piping adapter</td>
<td>5 to 10</td>
</tr>
<tr>
<td>Fitting of plastic body, M6×0.8</td>
<td>1.2 to 1.8</td>
</tr>
</tbody>
</table>

**Note 1:** For the plastic body type switch, it is recommended to use the piping adapters. (Wrap two layers or less of the sealing tape.)
Handling Instructions

**Installing method**

1. When the flow sensor is suspended with steel pipes

   ![Diagram](image1)

   Note 1: If the steel pipe is excessively long, a moment is applied to the flow sensor body, and the parts may be damaged. In such a case, it is recommended to fit the piping adapter OF-AP (accessory).

2. To screw one side onto steel piping and connect a plastic tube to the other side

   ![Diagram](image2)

   Note 1: If the steel pipe is excessively long, a moment is applied to the flow sensor body, and the parts may be damaged. In such a case, it is recommended to fit the piping adapter OF-AP (accessory).

3. To secure the body on a plate and connect plastic tubes

   1) ![Diagram](image3)

   2) ![Diagram](image4)

   Note 1: Tighten the mounting screws to a torque of 1.2 to 1.8 N·m.

**Disassembling procedures**

- Never remove the cover. (If the cover is removed by the user and the sensor is disabled, the repair is not covered by warranty.)
- Insert the supplied rotor cap opener into the rotor cap groove, and turn it counterclockwise.
- Then, the rotor cap, rotor and rotor pin can be easily disassembled.
- When reassembling, apply a thin layer of grease to the rotor cap O-ring zone. Silicone grease or Teflon grease is recommended.

**Notes on use**

- Use the flow sensor within the specified ambient temperature range keeping the working fluid within the specified temperature range. If it is used at an improper temperature, the rotor magnet may decrease in magnetic force, and the sensor life may be reduced.
- Use the flow sensor within the working flow rate range.
- If there are air bubbles in the flow sensor or the fluid, the rotor speed will be higher than usual. Pipe the flow sensor appropriately to keep the inside of the sensor filled with water by, for example, raising the piping on the downstream side of the sensor.
- Flush the piping in advance to remove dust and foreign particles from the inside. If the working fluid contains rust, metallic particles, dust or other polishing substances, fit a filter on the upstream side of the flow sensor. Iron particles in the fluid will adhere to the rotor magnet, and the sensor may malfunction.
- When a plastic body type flow switch is used in a place where the switch may be exposed to heat cycles or heat shock, use piping adapters. When connecting pipes directly on the plastic body, keep the tightening torque in a range from 5 to 10 N·m.

**Tightening Torque Table**

<table>
<thead>
<tr>
<th>Part to be tightened</th>
<th>Unit: N·m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct piping to plastic body</td>
<td>5 to 10</td>
</tr>
<tr>
<td>(Note 1)</td>
<td></td>
</tr>
<tr>
<td>Fitting of plastic plug</td>
<td>3 to 4</td>
</tr>
<tr>
<td>Fitting of piping adapter</td>
<td>5 to 10</td>
</tr>
<tr>
<td>Fitting of low-flow piping adapter</td>
<td>1.2 to 1.8</td>
</tr>
<tr>
<td>Fitting of plastic body, M5=0.8</td>
<td></td>
</tr>
</tbody>
</table>

Note 1: For the plastic body type switch, it is recommended to use the piping adapters. (Wrap two layers or less of the sealing tape.)

**DFM2 Series Digital Flow Meters**

- Before actually using the flow meter, thoroughly read the instruction manual supplied with the product and the instruction manual for the device (DFT3 or DFT) to be used in combination with the flow meter.
- For the procedures for calibrating the meter indication, see the instruction manual supplied with the product.

**Place of installation**

- Use the flow meter in an indoor environment.
- Avoid using it in a place where combustible gas is generated, in an atmosphere with organic solvents (methyl alcohol, thinner, benzene, etc.) or chemicals, such as strong alkaline and strong acid substances, or in a place subject to splashes of water or oil, much dust or severe vibration or impact.
- If it is used in an environment where a large amount of static electricity is generated, install the static electricity source as far from the meter body as possible. Failure to do so may cause operation failure.
- Use a rigid panel in consideration of the meter body weight and the cable weight.
- To install the meter, use the supplied fitting. Secure the body putting the panel between the body flange and the fitting. (Tighten the fitting screws to a torque of approx. 0.5 N·m.)
- For the external dimensions of the flow meter installed on the panel and the panel cut size, see the "Outline Drawing."

**Notes on wiring**

- Wire the meter correctly in accordance with the <Connection Diagram>.
- To connect the terminals, it is recommended to use crimp-style terminals. Use crimp-style terminals equivalent to those shown below.

![Crimp-style terminal](image5)

- Before wiring, disconnect the power from the equipment. Failure to do so may expose the worker to electric shock. Also, other electric devices or the Digital Flow Meter may be damaged.
Various models of rotor type Digital Flow Switches are newly launched.

- In addition to the conventional models, stainless body models for high flow rates are added.
- Power relay output models with increased contact capacity and open collector output models are added.
- Improved noise resistance.

Note: The predictive function used in DFS2 is not provided for this DFS3 Series.

### Specifications

<table>
<thead>
<tr>
<th>Flow rate level</th>
<th>Low</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Plastic body</td>
<td>Magnetic proximity type</td>
<td>Stainless steel body</td>
</tr>
<tr>
<td></td>
<td>Metal body</td>
<td>Magnetic proximity type</td>
<td>Stainless steel body</td>
</tr>
<tr>
<td>Detection method</td>
<td>Magnetic proximity type</td>
<td>Magnetic proximity type</td>
<td>Magnetic proximity type</td>
</tr>
<tr>
<td>Model</td>
<td>DFS3-1000/5000</td>
<td>DFS3-100</td>
<td>DFS3-1500</td>
</tr>
<tr>
<td>Material of body</td>
<td>Polyacetal (glass-filled)</td>
<td>BOC (Nickel-plated)</td>
<td>SCS14</td>
</tr>
<tr>
<td>Working fluid</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
</tr>
</tbody>
</table>

- **Flow rate range**:
  - 0.2 to 2.5 L/min
  - Flow rate range 0.5 to 5 L/min for DFS3-2000

#### Electric Specifications (Common)

- **Voltage range**: 24 V DC or 100 V AC
- **Power consumption**: 700 mW or less
- **Cable**: VCTF 8-core, 0.3 mm², 1 m

### Output Specifications (Relay output)

- **Contact structure**: Relay is driven when flow rate becomes lower than setting.
- **Rated control capacity** (at resistive load):
  - 30 V DC 5A/250 V AC 5A
- **Max. allowable voltage** (at resistive load):
  - 150 V (DC)/1250 VA (AC)
- **Max. allowable current**:
  - 125 V DC/300 V AC
- **Max. applicable load**:
  - 5 A
- **Min. allowable load**:
  - 5 V DC 10 mA
- **Insulation resistance between contacts**:
  - 1 MΩ or more at 35 °C insulation resistance tester
- **Withstand voltage between contacts**:
  - 1000 V AC for 1 min
- **Electrical life**:
  - 10,000 times or more of rated load, switching frequency of 30 times/min

### How to order

- **Flow rate range**:
  - 0 to 1.0 MPa
  - Ambient temperature:
    - 0 to +70°C (No condensing)
  - Fluid temperature:
    - 0 to 120°C (No freezing)
- **Reading accuracy**:
  - ±20% fs
- **Hysteresis**:
  - 5% or less
  - 7% or less
- **Alarm output response time**:
  - Approx. 500 ms
- **Installing direction**:
  - Free
- **Flowing direction**:
  - Both directions
- **Number of output points**:
  - 1 contact, Relay output: 1 point or open collector: 2 points (1 point for each of OUT-HIGH and OUT-LOW)
- **Rated power supply**:
  - 24 V DC or 100 V AC

### Accessories

- **Piping adapter set** (For prevention of breakage of ports of DFS3-1000 and 5000)
  - Part number: DF-AP
  - Contents: Piping adapter (material: copper alloy/C3604B): 2 pcs
  - Sealing O-ring (P-10A): 2 pcs
- **Low flow piping adapter set** (Set for converting medium flow rate DFS3-1000 or 5000 to low flow type)
  - Part number: DF-PW2
  - Contents: Piping adapter (material: copper alloy): 1 pc
  - Low flow piping adapter (material: copper alloy/C3604B): 1 pc
  - Low flow nozzle (material: copper alloy/BG6): 1 pc
  - Sealing O-ring (P-10A): 2 pcs
  - O-ring for nozzle (1A5-6): 1 pc

Note: Only plastic bodies are provided with piping adapters.

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DFS3 Series

DFS3-1200 and 1500 contact us.
Flow setting procedures

- When setting with a flow meter
  1. Reduce the flow rate in the piping to the set flow rate.
  2. Then, turn the flow rate setting trimmer on the front panel of the flow switch with a slotted screwdriver to switch the LED from green to red.

- When setting without a flow meter
  Use the following graphs when determining an approximate flow rate without using a flow meter.

Example: To output an alarm using DFS3-1000 when the flow rate is about 10 l/min or less

The intersection of the line of the set flow rate of 10 l/min and the line of flow rate range B is A. Read the percentage specified for the point A, 35%.

Set the flow switch trimmer to 35%, and an alarm will be output when the flow rate is approx. 10 l/min or less.

Trimmer Setting Scale-Flow Characteristic Graphs (fluid: tap water at 20°C)

DFS3-1002, 5002(low flow rate type)

DFS3-1000, 1200, 1500, 5000(medium flow rate type)

DFS3-2000, 2500(large flow rate type)

How to read the graph

The flow rate-pressure loss characteristic curves shown left are used to determine the pressure loss of DFS3 Series Digital Flow Switches.

DFS3-1002, 5002(low flow rate type) Primary pressure 0.2 MPa

DFS3-1000, 1200, 1500, 5000(medium flow rate type) Primary pressure 0.3 MPa

DFS3-2000, 2500(large flow rate type) Primary pressure 0.15 MPa

Answer: The intersection of the line of the flow rate of 20 l/min and the flow curve is A. Read the value of the secondary pressure at the point A.

Where,
(Pressure loss)=(primary pressure)−(secondary pressure)
Therefore, =0.3 MPa−0.25 MPa=0.05 MPa

Accordingly, to feed water at a flow rate of 20 l/min, the pressure difference between the upstream and downstream sides of the flow switch is 0.05 MPa. This indicates that the primary pressure (pump discharge pressure) must be 0.05 MPa or more. However, actually, determine the pump discharge pressure based on the pressure loss on the whole piping. Note: The characteristics vary depending on the viscosity and temperature of the fluid used.
Digital Flow Switch

**DFS3—1000-1200-1500-5000—24 V DC**

Dimensions when piping adapter set (DF-AP) is attached
DFS3—1000-5000—24 V DC

Note: The appearance is different, but the outer dimensions are the same as shown above.

DFS3—1500—24 V DC

Note: The appearance is different, but the outer dimensions are the same as shown above.

DFS3—1000-1200-1500-5000—100 V AC

Note: The appearance is different, but the outer dimensions are the same as shown above.

**DFS3—2000-2500—24 V DC**

Dimensions when low flow piping adapter set (DF-FW2) is attached
DFS3—1002-5002—24 V DC

Note: For the low flow type, use the flow rate range A.

DFS3—2500—24 V DC

DFS3—2000-2500—100 V AC

Piping adapter (accessory)

Low flow piping adapter (accessory)
Flow sensors for converting instantaneous flow rate of liquid to electric pulse signal

- When combined with a Digital Flow Meter, the sensor enables to directly read the instantaneous flow rate as a digital value and facilitates measurement from a distance.
- The flow state can be visually checked.
- The working flow rate range can be switched to two ranges, 0.5 to 5 l/min and 2.5 to 25 l/min.
- The sensors can be disassembled without disconnection of pipes.

### Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>DFT-1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working fluid</td>
<td>Water</td>
</tr>
<tr>
<td>Working pressure range</td>
<td>0 to 1.0 MPa</td>
</tr>
<tr>
<td>Proof test pressure</td>
<td>1.5 MPa</td>
</tr>
<tr>
<td>Flow rate range A</td>
<td>0.5 to 5 l/min</td>
</tr>
<tr>
<td>Flow rate range B</td>
<td>2.5 to 25 l/min</td>
</tr>
<tr>
<td>Reading accuracy</td>
<td>±5% (0 to +70°C)</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>0 to +50°C (No condensing)</td>
</tr>
<tr>
<td>Fluid temperature</td>
<td>0 to +70°C (No freezing)</td>
</tr>
<tr>
<td>Installing direction</td>
<td>Free</td>
</tr>
<tr>
<td>Flowing direction</td>
<td>Both directions</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 280 g</td>
</tr>
</tbody>
</table>

**Note:** These ranges apply to tap water of 20°C. The working temperature range varies depending on the viscosity and temperature of the fluid used.

### Electrical Specifications

- **Supply voltage:** 10.8 to 26.4 V DC
- **Consumption current:** 15 mA
- **Output Type:** Photocoupler output
- **Voltage:** 0 V to 30 V
- **Current:** 4 mA or less
- **Cable:** VCTF 5-core, 0.5 mm², 1 m long

### Accessories

- **Piping adapter set**
  (Prevention of cracking of plastic body parts)
  Part number: DF-AP
  Contents: Piping adapter (material: copper alloy/C36048): 2 pcs
  Sealing O-ring (P-10A): 2 pcs

### Flow Characteristic Curves (fluid tap water)

- Primary pressure: 0.3 MPa
- Flow rate range A: 0.5 to 5 l/min
- Flow rate range B: 2.5 to 25 l/min

### Parts List

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Material</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rotor pin</td>
<td>Alumina ceramic</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Rotor cap gasket</td>
<td>Nitrile rubber</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Rotor cap</td>
<td>Polyether sulfone (bearing: alumina ceramic)</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Body</td>
<td>Polyacetal</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Rotor</td>
<td>Polyacetal (bearing: alumina ceramic)</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Hall IC</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Magnet</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Cover gasket</td>
<td>Nitrile rubber</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Cover</td>
<td>Cold rolled steel</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Cable gland</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Cable</td>
<td>—</td>
<td>1 m</td>
</tr>
<tr>
<td>12</td>
<td>Screw gasket</td>
<td>—</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>Screw</td>
<td>—</td>
<td>4</td>
</tr>
</tbody>
</table>

### How to read the graph

Use the flow characteristic curves to determine the pressure loss of DFT Series Digital Flow Sensors. Example: Determine the pressure loss caused when water is fed at 20 l/min using the flow rate range B.

**Answer:** The intersection of the line of flow rate of 20 l/min and the flow curve is A. Read the secondary pressure value at the point A. Where, (pressure loss) = (primary pressure) − (secondary pressure)

Therefore, 

\[ \text{Pressure loss} = 0.3 \text{ MPa} - 0.25 \text{ MPa} = 0.05 \text{ MPa} \]

Accordingly, when water is fed at 20 l/min, the pressure difference between the upstream and downstream sides of the flow sensor is 0.05 MPa. This indicates that the primary pressure (pump discharge pressure) must be 0.05 MPa or more. However, actually, determine the pump discharge pressure based on the pressure loss on the whole piping.

### Drawing of Principle

The rotor rotates at a speed in proportion to the liquid flow rate. A permanent magnet is molded in the rotor. The hall IC on the body side detects the magnetism and converts the rotor rotation to an electric pulse signal.

Unlike electromotive sensors using coils, the digital type hall IC constantly gives rectangular waves with a uniform crest value irrespective of the rotor speed. This pulse is insulated by the photocoupler and output to the outside.

### Explanation of Operation
DFT-1000

Note) For the dimensions of the sensor provided with the piping adapters, see the dimensional drawing of DFS3 Series.

Frequency-Flow Characteristic Graph (fluid: tap water at 20°C)
The flow meter receives an output pulse from a Digital Flow Switch or a Digital Flow Sensor and digitally displays the instantaneous flow rate of liquid.

- The flow rate can be easily read on the LED display with a character height of 10 mm.
- A compact front panel in DIN standard size of 72x72 is used. (The mounting dimensions are the same as those of DFM series.)
- The flow rate range can be changed by operating the switch.

### Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>DFM2-1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display</td>
<td>Red segment LED, 10x5.5 (height×width), mm</td>
</tr>
<tr>
<td>Display range</td>
<td>0 to 99999, display of up to 5 digits</td>
</tr>
<tr>
<td>Counting method</td>
<td>Period measurement operation method</td>
</tr>
<tr>
<td>Decimal point</td>
<td>Display of 0 to 4 digits after decimal point, arbitrarily settable</td>
</tr>
<tr>
<td>Display range (L/min)</td>
<td>0.2 to 2, 0.5 to 5, 2.5 to 25, 12 to 120</td>
</tr>
<tr>
<td>Setting of auto-zero time</td>
<td>Settable in range from 1 to 9 sec in 1 sec units</td>
</tr>
<tr>
<td>Pulse input (INI)</td>
<td>Input resistance: 10 kΩ (pull up to 24 V DC), negative logic operation</td>
</tr>
<tr>
<td></td>
<td>Input current: 2 mA or less</td>
</tr>
<tr>
<td></td>
<td>Operating voltage: ON voltage: 2 V or less</td>
</tr>
<tr>
<td></td>
<td>OFF voltage: 5 V or more</td>
</tr>
<tr>
<td></td>
<td>Pulse width: 50 μs or more for H and L</td>
</tr>
<tr>
<td>Set inhibit input (KPT)</td>
<td>Input resistance: 10 kΩ (pull up to 24 V DC), negative logic operation</td>
</tr>
<tr>
<td></td>
<td>Input current: 2 mA or less</td>
</tr>
<tr>
<td></td>
<td>Operating voltage: ON voltage: 2 V or less (Settings cannot be changed.)</td>
</tr>
<tr>
<td></td>
<td>OFF voltage: 5 V or more (Settings can be changed.)</td>
</tr>
<tr>
<td>Setting memory</td>
<td>Storing method: Storage by nonvolatile element (NV-RAM)</td>
</tr>
<tr>
<td></td>
<td>Storage period: Approx. 10 years</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>100 V/200 V AC, 90 to 120 % 50/60 Hz</td>
</tr>
<tr>
<td>External power supply</td>
<td>24 V DC±10% 80 mA</td>
</tr>
<tr>
<td>Power consumption</td>
<td>Approx. 8.5 W</td>
</tr>
<tr>
<td>Working ambient temperature</td>
<td>−10 to +50°C (No freezing)</td>
</tr>
<tr>
<td>Working ambient humidity</td>
<td>35 to 85%RH (No condensing)</td>
</tr>
<tr>
<td>Storage ambient temperature</td>
<td>−25 to +85°C (No freezing)</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 450 g (incl. accessories)</td>
</tr>
<tr>
<td>Accessories</td>
<td>Panel mounting bracket/screw</td>
</tr>
<tr>
<td>Applicable devices</td>
<td>All models of Digital Flow Switches, Digital Flow Sensors</td>
</tr>
</tbody>
</table>

**Note:** For the procedures for changing each setting, see the instruction manual supplied with the product.
Dimensional Drawings

Outline Circuit Diagram

Explanation of operation

When the output frequency of the Digital Flow Switch or Digital Flow Sensor is input into the DFM2, the frequency is calculated according to the frequency division ratio and the decimal point position set with the pre-scaler setting key switch (on the front panel), and the instantaneous flow rate is displayed on the digital display unit.

Connection Diagram

Combination to give interlock signal when flow rate is insufficient

Digital Flow Switch + Digital Flow Meter
DFS3-1000 - 1200 - 1500 - 2500 - 2500-24 V DC + DFM2-1000

- When the relay contact a is used, the contact is closed while the flow rate is lower than the set flow rate.

Digital Flow Sensor + Digital Flow Meter
DFT - 1000 + DFM2 - 1000

- When the relay contact a is used, the contact is closed while the flow rate is lower than the set flow rate.
Leak detectors evolved from DFS3 Series Digital Flow Switches

- Sensing of difference in flow rate between IN and OUT sides.
- Leak of approx. 3% can be detected by setting the min. leak detection level (at a flow rate of 25 l/min).
- Highly reliable switches resistant to noises from spot welding machines, etc.
- The detecting method can be selected from magnetic proximity and iron proximity types depending on the intended use.

### Specifications

<table>
<thead>
<tr>
<th>Type</th>
<th>Plastic body</th>
<th>Iron proximity type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detecting method</td>
<td>Magnetic proximity type</td>
<td>Iron proximity type</td>
</tr>
<tr>
<td>Model</td>
<td>LD1-1000-24 V DC</td>
<td>LD1-6000-24 V DC</td>
</tr>
<tr>
<td>Material of body</td>
<td>Polyacetal (glass-filled)</td>
<td>Water</td>
</tr>
<tr>
<td>Working fluid</td>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td>Port size</td>
<td>Rc3/8 (with piping adapter)</td>
<td>Water</td>
</tr>
<tr>
<td>Pressure range</td>
<td>0 to 1.0 MPa</td>
<td>No condensing</td>
</tr>
<tr>
<td>Proof test pressure</td>
<td>1.5 MPa</td>
<td>No freezing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>0 to +50°C (No condensing)</td>
<td>No freezing</td>
</tr>
<tr>
<td>Fluid temperature</td>
<td>0 to +70°C (No freezing)</td>
<td>No freezing</td>
</tr>
<tr>
<td>Flow rate range</td>
<td>2.5 to 25 ℓ/min</td>
<td>No freezing</td>
</tr>
<tr>
<td>Reading accuracy</td>
<td>±5% or less</td>
<td></td>
</tr>
<tr>
<td>Hysteresis</td>
<td>5% or less</td>
<td></td>
</tr>
<tr>
<td>Alarm output response time</td>
<td>Approx. 500 ms</td>
<td></td>
</tr>
<tr>
<td>Installing direction</td>
<td>Free</td>
<td></td>
</tr>
<tr>
<td>Flowing direction</td>
<td>Both directions (Upper: primary side Lower: secondary side)</td>
<td>No condensing</td>
</tr>
<tr>
<td>Number of output points</td>
<td>1c contact, relay output×1 point (common to insufficient flow rate and leak)</td>
<td>No condensing</td>
</tr>
<tr>
<td>Rated power supply</td>
<td>24 V DC</td>
<td>No condensing</td>
</tr>
<tr>
<td>Leak detecting current</td>
<td>Leak of approx. 3% or more can be detected by setting the min. leak detection level (at 25 ℓ/min).</td>
<td>No condensing</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 1300 g</td>
<td>No condensing</td>
</tr>
</tbody>
</table>

Notes:
- Use the flow switch within the flow rate range.
- The values shown in the table apply to cases of measurement of flow rate of tap water (20°C).
- The flow rate range varies depending on the viscosity of the fluid to be measured.
Explantion of operation and application examples

When water is fed to LD1, the rotors rotate in proportion to the flow rate. The rotor speeds are detected by the upper and lower sensors. Theoretically, the rotor speeds detected by the upper and lower sensors are the same. If the speeds differ due to instrumental error, the speeds are corrected by the internal circuit, and the flow rate difference is monitored.

The flow rate difference between IN and OUT of the cooling unit is monitored through LD1 to detect leak between IN and OUT of LD1. It gives an alarm also when the flow rate is insufficient.

While the flow rate through the upper part of LD1 is used as the master flow rate, the flow rate through the lower part of LD1 is used to regular flow rate monitoring. Accordingly, the flow rate can be monitored irrespective of flow rate drop and cooling resistance due to contamination in the cooling unit and piping to be checked for leak. When the inside of the piping is cleaned, the upper part of LD1 can be used as a reserved line.

By the conventional method of detecting leak in a cooling unit, the flow switch on a normal line often outputs an alarm due to flow rate fluctuation on the primary side caused by leak from one point. To avoid this, it was required to reduce the alarm flow rate setting to an excessively lower value.

LD1 monitors the difference between the inlet flow rate and outlet flow rate of a cooling unit and outputs an alarm when a difference between the flow rates is detected. Therefore, it is not affected by flow rate fluctuation on the primary side and is able to stop only the line where leak has occurred. It outputs an alarm also when the primary flow rate is dropped by water pump trouble.

Unit: mm

Dimensional Drawings

Wiring Procedures

*For the handling procedures, see the instruction manual.
Small-size high-performance skeleton body flow sensors

- Compact type flow sensors
- Two detecting methods, magnetic proximity type and iron proximity type are available.
- The sensors can be maintained easily without disconnection of pipes.
- They can be installed in any posture. Straight run of pipe is not required.
- The skeleton body enhances the visibility of the LED.
- Applicable to low flow rates (semi-standard)

Product conforming to RoHS

Main Body Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Low flow rate type</th>
<th>Standard type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow rate level</td>
<td>Low flow rate type</td>
<td>Standard type</td>
</tr>
<tr>
<td>Detection method</td>
<td>Magnetic proximity</td>
<td>Iron proximity</td>
</tr>
<tr>
<td>Model</td>
<td>EFS2-M</td>
<td>EFS2-F</td>
</tr>
<tr>
<td>Material of body</td>
<td>Polyacetal</td>
<td></td>
</tr>
<tr>
<td>Working fluid</td>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>Port size</td>
<td>Rc3/8</td>
<td></td>
</tr>
<tr>
<td>Working pressure range</td>
<td>0 to 1.0 MPa</td>
<td></td>
</tr>
<tr>
<td>Proof test pressure</td>
<td>1.5 MPa</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>0 to +50°C (No condensing)</td>
<td></td>
</tr>
<tr>
<td>Fluid temperature</td>
<td>0 to +60°C (No freezing)</td>
<td></td>
</tr>
<tr>
<td>Flow rate range</td>
<td>0.5 to 3l/min</td>
<td>2.5 to 25l/min</td>
</tr>
<tr>
<td>Reading accuracy</td>
<td>±5%/FS</td>
<td></td>
</tr>
<tr>
<td>Repeatability</td>
<td>±2%</td>
<td></td>
</tr>
<tr>
<td>Alarm output response time</td>
<td>700 ms or less</td>
<td></td>
</tr>
<tr>
<td>Installing direction</td>
<td>Free</td>
<td></td>
</tr>
<tr>
<td>Flowing direction</td>
<td>One direction</td>
<td>Both directions</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 270 g</td>
<td>Approx. 250 g</td>
</tr>
</tbody>
</table>

Electrical Specifications

- Common electrical specifications
  - Power supply: 24 V DC ±10%
  - Power consumption: 1.5 W or less

Output Specifications

EFS2-PS (frequency, switch output)

<table>
<thead>
<tr>
<th>Frequency output</th>
<th>Photocoupler</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 V DC</td>
<td>Load current: 4 mA or less</td>
</tr>
</tbody>
</table>

Alarm output

- Max. allowable voltage: 30 V DC
- Load current: 10 mA

Alarm contact

- Higher than set flow rate: Signal ON
- Lower than set flow rate: Signal OFF

Dimensions

- EFS2-PS
- EFS2-A

Performance Curves

- EFS2-PS (frequency, switch output)
- EFS2-A (current output)
**Relationship with Pressure Loss**

![Graph showing relationship between pressure loss and flow rate]

**Setting procedures and fluid**

- Use EFS2 within the set flow rate range. The set flow rate range varies depending on the fluid viscosity and temperature. Therefore, it is recommended to cause an abnormal flow rate on the actual equipment to set the trimmer.
- EFS2 is designed to measure the flow rate of water. If it is used for measurement of another fluid, the accuracy cannot be guaranteed.
- Never use it for flammable fluids.
- If foreign particles enter the fluid, install a filter on the primary side. If foreign particles adhere to the rotor of EFS2, correct measurement cannot be made.
- Before feeding a fluid, check that the pressure reducing valve and flow rate adjusting valve. If pressure flow rate is less than the rated value is applied to EFS2, its body may be damaged.

**Wiring**

- **WARNING**
  - When wiring the flow sensor, disconnect the power from the equipment on the electric circuit to be connected. Failure to do so may expose the worker to shock hazard or damage the flow sensor or load during wiring work.
  - Check the supply voltage of the flow sensor to be used and the load voltage and current specifications. If the voltage or current is improper, the flow sensor may malfunction or be damaged.
  - Take care not to apply bending or torsional load to the cable. Doing so may break the cable.
  - If the distance of the cable to the destination is long, secure the cable at intervals of 20 cm to prevent looseness of the cable. If the cable is loose, someone may catch his foot on the cable, thereby breaking it.
  - When the cable is laid on the ground, it may be stepped on directly or put under equipment, and may be broken or short-circuited. Protect it with a metallic conduit or the like.
  - Do not lay the cable close to high-voltage wires of other electric devices or power sources. Do not bundle the cable together with power source cables. Noises from the high-voltage wires, power sources or power source cables will enter the flow sensor cable and cause the flow sensor and load to malfunction. It is recommended to protect the cable with a shield tube or the like.
  - When wiring, check the wire colors. Inconformity wiring results in breakage, fault and malfunction of the flow sensor. Check the wire colors on this instruction manual prior to wiring.

**Installation**

- **WARNING**
  - Never install this sensor in a piping zone which may be used as a scaffold. If excessive load is applied to the sensor, it may be damaged.
  - Check that the device operates normally prior to use. After installation, repairing or maintaining it, conduct appropriate function inspection and leak check, and make sure that it has been correctly installed. If the user modifies it or removes the cover, the repair is not covered by warranty.
  - When installing, take care not to drop or hit it or apply excessive impact to it. Even if the flow sensor body is not damaged, internal components may be damaged, and the sensor may malfunction.
  - Install the flow sensor in a place where it will not be affected by vibration or impact.

**Piping**

- **WARNING**
  - When piping the flow sensor, observe the tightening torque. If any pipe is tightened to a torque exceeding the specified torque range, the flow sensor may be damaged. If any pipe is tightened to a torque less than the specified torque range, the connected threaded portion may be loosened.
  - (Tightening torque range: 15 to 20 N-m)
  - When piping the flow sensor, never put a spanner on the plastic part. Doing so can damage the flow sensor. Put a spanner to this piping adapter (brass part).
  - Design and pipe the system so that the detecting flow path is kept filled with the liquid for example, by raising the piping on the downstream side of the flow sensor. Particularly, when the sensor is installed vertically, feed the liquid in the upward direction. If there are air bubbles in the flow sensor or the fluid, the rotor speed will be higher than usual, the flow rate will change, and the output signal will be distorted.
  - Before connecting the pipes, flush them. Take care that welding or sheet metal cutting, dust and rust do not enter the pipes.
  - If the pipe size is sharply reduced in the piping zone or there is a throttle, such as a valve, on the primary side, cavitation occurs in the piping, and the flow rate cannot be measured correctly. Therefore, such measures shall be taken on the secondary side of the flow sensor.
  - Do not apply thrust load to the piping zone.
  - Do not remove the piping adapters. If they are removed, they cannot be reused.
Small-size high-performance skeleton body flow switches compactly integrated with digital display function

- Conforming to CE marking
- Changes in flow rate can be monitored for two points, the lower and upper limits.
- The display block consists of a display and LED lamps.
- Two detecting methods, magnetic proximity type and iron proximity type, are available.
- The switches can be installed in any position. Straight run of pipe is not required.
- Metallic adapters for piping are provided as standard accessories.
- Low flow rate type switches are standardized.

Main Body Specifications

<table>
<thead>
<tr>
<th>Flow rate level</th>
<th>Low flow rate type</th>
<th>Standard type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection method</td>
<td>Magnetic proximity</td>
<td>Iron proximity</td>
</tr>
<tr>
<td>Model</td>
<td>EFS3-M</td>
<td>EFS3-F</td>
</tr>
<tr>
<td>Material of body</td>
<td>Polyacetal</td>
<td>Polyacetal</td>
</tr>
<tr>
<td>Working fluid</td>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td>Port size</td>
<td>Rc3/8</td>
<td>Rc3/8</td>
</tr>
<tr>
<td>Working pressure</td>
<td>0 to 1.0 MPa</td>
<td>0 to 1.0 MPa</td>
</tr>
<tr>
<td>Proof test pressure</td>
<td>1.5 MPa</td>
<td>1.5 MPa</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>0 to +50°C (No condensing)</td>
<td>0 to +50°C (No condensing)</td>
</tr>
<tr>
<td>Fluid temperature</td>
<td>0 to +60°C (No freezing)</td>
<td>0 to +60°C (No freezing)</td>
</tr>
<tr>
<td>Flow rate range</td>
<td>0.5 to 3 l/min</td>
<td>2.5 to 25 l/min</td>
</tr>
<tr>
<td>Reading accuracy</td>
<td>±5.5% FS</td>
<td>±5.5% FS</td>
</tr>
<tr>
<td>Repeatability</td>
<td>±2%</td>
<td>±2%</td>
</tr>
<tr>
<td>Alarm output response time</td>
<td>500 ms or less</td>
<td>500 ms or less</td>
</tr>
</tbody>
</table>

Output Specifications

<table>
<thead>
<tr>
<th>Frequency output</th>
<th>Photocoupler</th>
<th>Load current: 30 V DC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max. allowable voltage: 30 V DC</td>
<td>4 mA or less</td>
</tr>
</tbody>
</table>

LEDs:

- **Green LED**: The lamp lights when the flow rate exceeds the upper limit setting. At this time, the upper limit setting contact turns on.
- **Yellow LED**: This lamp is on while the flow rate is higher than the lower limit setting and lower than the upper limit setting. At this time, all contacts are off.
- **Red LED**: This lamp lights when the flow rate becomes lower than the lower limit setting. At this time, the lower limit setting contact turns on.

How to order

- EFS3-M: Magnetic proximity type
- EFS3-F: Iron proximity type

Part Numbers of Accessories

- Rotor pin: DF-RP
- Rotor cap: DF-RCP
- Rotor pin: DF-PS
- Rotor cap: DF-RCP

Electrical Specifications

- Power supply: 24 V DC ± 10%
- Power consumption: 1 W or less

Dimensional Drawings

Cable

- Red: 24 V DC
- Black: 0 V
- Brown: OUT-HIGH (+)
- Yellow: OUT-LOW (-)
- Green: Frequency output (+)
- White: COM (-)

Unit: mm

Explanation of Operation

When water is fed to EFS3 Series flow switch, the rotor rotates. The rotor rotation is converted to an electrical signal to measure the flow rate.

**Wiring procedures**

- **Connection with PLC (programmable controller)**
  - When EFS3-# is used
    - When the PLC has a built-in power supply
  - When the PLC does not have a built-in power supply

- **When several flow switches outputs are connected in series to a load (e.g., to input to a PLC on an OR circuit), check for flow switch output leakage current. The load may operate due to the leakage current.**
  - Leakage current per output: I<sub>CE</sub> ≤ 0.1 mA (V<sub>DC</sub> ≤ 50 V, Ta=25°C)

- **When several flow switch outputs are connected in series to a load (e.g., to input to a PLC on an AND circuit), check for flow switch output residual voltage. The load may not operate due to the output residual voltage.**
  - Output residual voltage per output: VCE ≤ 0.8 V (l=10 mA, Ta=25°C)
**Performance Curves**

EFS3-#PS (Frequency, switch output)

**Relationship between flow rate and frequency**

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Flow rate (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>5</td>
<td>1.0</td>
</tr>
<tr>
<td>10</td>
<td>1.5</td>
</tr>
<tr>
<td>15</td>
<td>2.0</td>
</tr>
<tr>
<td>20</td>
<td>2.5</td>
</tr>
<tr>
<td>25</td>
<td>3.0</td>
</tr>
</tbody>
</table>

**Relationship with Pressure Loss**

**Relationship between flow rate and pressure loss (low flow rate)**

<table>
<thead>
<tr>
<th>Pressure loss (kPa)</th>
<th>Flow rate (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>0.5</td>
</tr>
<tr>
<td>0.02</td>
<td>1.0</td>
</tr>
<tr>
<td>0.03</td>
<td>1.5</td>
</tr>
<tr>
<td>0.04</td>
<td>2.0</td>
</tr>
<tr>
<td>0.05</td>
<td>2.5</td>
</tr>
<tr>
<td>0.06</td>
<td>3.0</td>
</tr>
</tbody>
</table>

**Relationship between flow rate and pressure loss (standard)**

<table>
<thead>
<tr>
<th>Pressure loss (kPa)</th>
<th>Flow rate (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.02</td>
<td>0.5</td>
</tr>
<tr>
<td>0.03</td>
<td>1.0</td>
</tr>
<tr>
<td>0.04</td>
<td>1.5</td>
</tr>
<tr>
<td>0.05</td>
<td>2.0</td>
</tr>
<tr>
<td>0.06</td>
<td>2.5</td>
</tr>
<tr>
<td>0.07</td>
<td>3.0</td>
</tr>
</tbody>
</table>

---

**Indicator specifications and setting procedures**

1. **Name**
   - SET key: Use to select a mode.
   - MODE confirmation lamp: Indicates the current mode.
   - MODE1: Alarm setting 1 (upper limit setting)
   - MODE2: Alarm setting 2 (lower limit setting)
   - MODE3: Output switching
     - (All MODE1 and MODE2 confirmation lamps turn on)
   - UP key: Use to increase the setting.
   - DOWN key: Use to decrease the setting.
     - In MODE3, it turns on the output.
     - In MODE3, it turns off the output.

2. **Defaults of parameters**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode 1</td>
<td>15.0</td>
</tr>
<tr>
<td>Mode 2</td>
<td>10.0</td>
</tr>
<tr>
<td>Mode 3</td>
<td>0 All LED lamps are on</td>
</tr>
</tbody>
</table>

3. **Explanation of parameters**

**Low flow rate type**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Function</th>
<th>Default</th>
<th>Setting range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode 1</td>
<td>Alarm setting 1</td>
<td>Upper limit</td>
<td>15.0</td>
</tr>
<tr>
<td>Mode 2</td>
<td>Alarm setting 2</td>
<td>Upper limit</td>
<td>10.0</td>
</tr>
<tr>
<td>Mode 3</td>
<td>Output forced switching</td>
<td>ON</td>
<td>-</td>
</tr>
</tbody>
</table>

**Procedures for changing parameter setting**

- **Upper limit setting procedures**
  - Press the SET button.
  - The mode will change to the upper limit setting mode (MODE1 lamp will turn on).
  - The upper limit setting will appear on the display. (The default is 15.0)
  - Every pressing the UP button increments the setting by 0.1. (Pressing the DOWN button decrements the setting by 0.1.)
  - Keep pressing the UP button, and the setting will continue to increase. (Keep pressing the DOWN button, and the setting will continue to decrease.)
  - To turn on the signal at 17.0, set the value on the display to 17.0.
  - After setting, press the SET button.
  - Then, the upper limit setting is complete.

- **Forced switching mode**
  - Forced switching mode
  - Press the SET button three times, or press the SET button after the completion of setting of the upper limit, and the mode will change to the forced switching mode. (The MODE1 and MODE2 lamps will turn on.)
  - Just after the mode is changed, the display is in the state shown in ①.
  - Press the SET button, and the mode will return to the instantaneous flow rate display mode.

- **Example of setting**

<table>
<thead>
<tr>
<th>Flow rate</th>
<th>Alarm setting 1 (Overflow 15 L/min)</th>
<th>Alarm setting 2 (Underflow 10 L/min)</th>
<th>LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 9</td>
<td>OFF</td>
<td>ON</td>
<td>Red</td>
</tr>
<tr>
<td>10 to 14</td>
<td>OFF</td>
<td>OFF</td>
<td>Yellow</td>
</tr>
<tr>
<td>15 to 25</td>
<td>ON</td>
<td>OFF</td>
<td>Green</td>
</tr>
</tbody>
</table>

*Note: The overflow setting key cannot be set to a value less than the underflow setting.
*The underflow setting key cannot be set to a value more than the overflow setting.*
Flow Switch

Wiring

**WARNING**
- When wiring the flow switch, disconnect the power from the equipment on the electric circuit to be connected.
- Failure to do so may expose the worker to shock hazard or damage the flow switch or load during wiring work.
- Check the supply voltage of the flow switch to be used and the load voltage and current specifications. If the voltage or current is improper, the flow switch may malfunction or be damaged.
- Take care not to apply bending, tensile or torsional load to the cable. Doing so may break the cable.
- If the distance of the cable to the destination is long, secure the cable at intervals of 20 cm to prevent looseness of the cable. If the cable is loose, someone may catch his foot on the cable, thereby breaking it.
- When the cable is laid on the ground, it may be stepped on directly or put under equipment and may be broken or short-circuited. Protect it with a metallic conduit or the like.
- Do not lay the cable close to high-voltage wires of other electric devices or power sources. Do not bundle the cable together with power source cables. Noises from the high-voltage wires, power sources or power source cables will enter the flow switch cable and cause the flow switch and load to malfunction. It is recommended to protect the cable with a shield tube or the like.
- When wiring, check the wire colors. Incorrect wiring results in breakage, fault and malfunction of the flow switch. Check the wire colors in this instruction manual prior to wiring.

**Notes on protection of output circuit**

**CAUTION**
- When EFS3+ is used
  - When an induction load, such as a DC relay, is connected, take surge absorption measures, such as a diode. The back excitation voltage generated on the load when the output is turned off may damage the output element of the flow switch.

The resistance shall be as high as the load resistance, and the capacitor value shall be determined by experiment.

Select a diode whose reverse breakdown voltage is 5 to 10 times higher than the circuit voltage and whose forward current is higher than the circuit current.

Determine the barrier cut-off voltage, Vo, under the following condition:
Supply voltage: Vo < 80 V

Piping

**WARNING**
- When piping the flow switch, observe the tightening torque. If any pipe is tightened to a torque exceeding the specified torque range, the flow switch may be damaged. If any pipe is tightened to a torque less than the specified torque range, the connected threaded portion may be loosened.

<Tightening torque range: 15 to 20 N·m>
- When piping the flow switch, never put a spanner on the plastic part. Doing so can damage the flow switch. Put a spanner to the piping adapter (brass part).
- Design and pipe the system so that the detecting flow path is kept filled with the liquid, for example, by raising the piping on the downstream side of the flow switch. Particularly, when the switch is installed vertically, feed the liquid in the upward direction. If there are air bubbles in the flow switch or the fluid, the rotor speed will be higher than usual, the flow rate will change, and the output signal will be disturbed.
- Before connecting the pipes, flush them. Take care that sealing tape cuttings, dust and rust do not enter the pipes.
- If the pipe size is sharply reduced in the piping zone or there is a throttle, such as a valve, on the primary side, cavitation occurs in the piping and the flow rate cannot be measured correctly. Therefore, such measures shall be taken on the secondary side of the flow switch.
- Do not apply thrust load to the piping zone.
- Do not remove the piping adapters. If they are removed, they cannot be reused.