OMRON

MEMS Flow Rate Sensor

D6F-W/D6F-V

User's Manual

MEMS Flow Rate Sensor

A300-E1-02

Contents

1. Overview

This User's Manual describes usage of and interface with OMRON's MEMS flow rate sensor (D6F-W/D6F-V). It should be noted that this document is intended to supplement the datasheet, which should be referenced when using the sensor.

2. Product Lineup

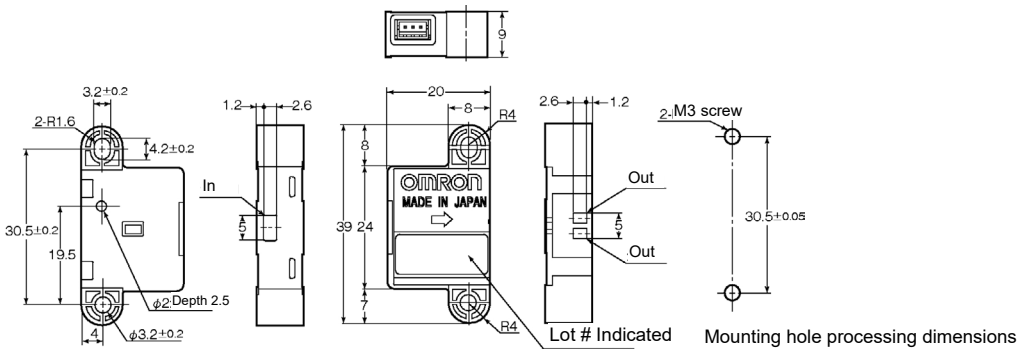
Table 1 shows the MEMS flow rate sensor (D6F-W/D6F-V) lineup and Table 2 accessories (optional).

Table 1 Lineup

Flow range	Model	Applicable cable
0 to 1 m/s	D6F-W01A1	D6F-W CABLE D6F-W CABLE-L
0 to 4 m/s	D6F-W04A1	
0 to 10 m/s	D6F-W10A1	
0 to 3 m/s	D6F-V03A1	D6F-CABLE2 D6F-CABLE2-L

3. Dimensions

3.1 D6F-W (D6F-W01A1, D6F-W04A1, D6F-W10A1)



3.2 D6F-V03A1

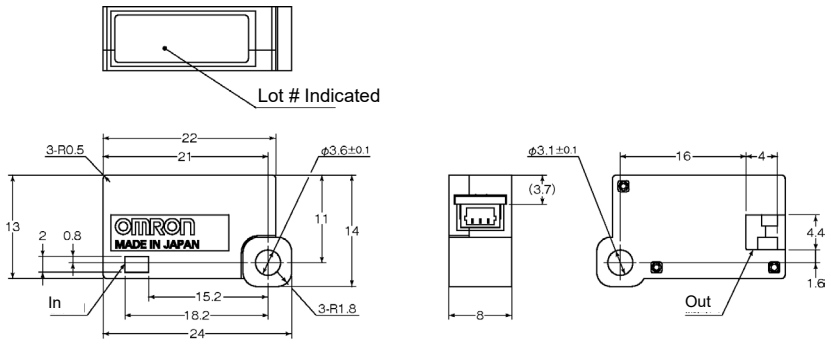
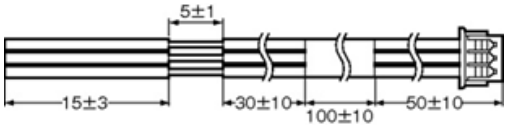


Table 2 Connector Specifications

	D6F-W		D6F-V
Press-fit connector			
Socket	_		03SR-3S
Wire	_		AWG#30
Crimping connector			
Housing	ZHR-3		SHR-03V-S
Contact	SZH-002T-P0.5	SZH-003T-P0.5	SSH-003T-P0.2
Wire	AWG#28 to 26	AWG#32 to 28	AWG#32 to 28

3.3 Accessories (optional)

D6F-W CABLE

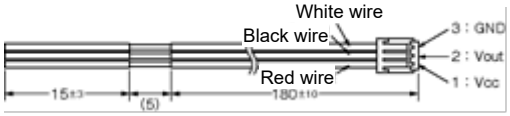


D6F-W CABLE-L

A model with the total length of D6F-W CABLE as 2000 (mm).

Contacts : SSH-002T-P0.5 (J.S.T. Mfg. Co., Ltd.)
Housing : ZHR-3 (J.S.T. Mfg. Co., Ltd.)
Wire : AWG#26

D6F-CABLE2



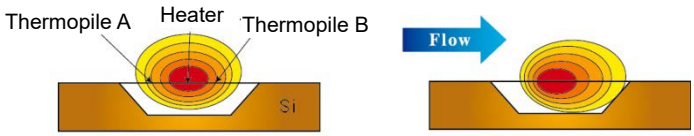
D6F-CABLE2-L

A model with the total length of D6F-CABLE2 as 2000 (mm).

Contacts : SSH-003T-P0.2 (J.S.T. Mfg. Co., Ltd.)
Housing : SHR-03V-S (J.S.T. Mfg. Co., Ltd.)
Wire : AWG#30

4. Operating Principle

MEMS air flow sensor (D6F-W/D6F-V) is a thermal mass flow sensor.
A silicon substrate has a heater and thermopiles on both sides of it on the thin film formed on the substrate, which detects heat transfer as changes of air flow on it to measure the flow rate.



[No flow condition] [Flow condition]

5. Features of Product

Minute changes in air flow can be measured

By using a thermal mass flow method, OMRON's MEMS air flow sensor (D6F-W/D6F-V) can measure very small changes of air flow rate. Note that it does not measure flow rate stipulated by Measurement Act.

High dust resistance

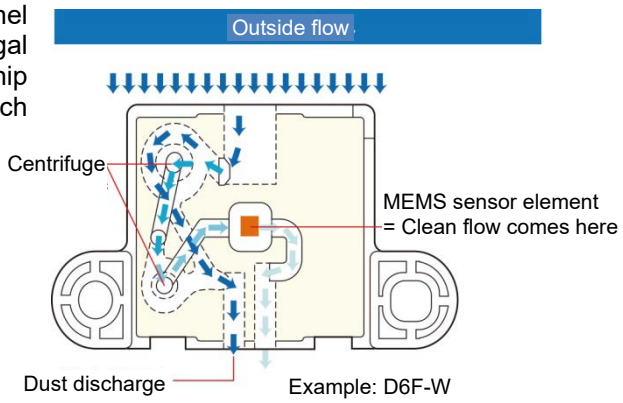
Can be used in dusty environment by its structure (DSS[*1]) that helps prevent dust in fluid from adhering to the sensor.
(Avoid dust around the air inlet)

Installable inside a duct

MEMS air flow sensor (D6F-W/D6F-V) is small enough to install in a duct.

*1 DSS (Dust Segregation Structure)

Air coming from outside is divided into a spiral channel and a core channel. Dust is separated by the centrifugal force caused by the helical structure, and the sensor chip is supplied with a gas that contains almost no dust, which can reduce contamination.



6. Main Specifications

6.1 Feature & Rating

Table 3 Main Specifications of D6F-W/D6F-V

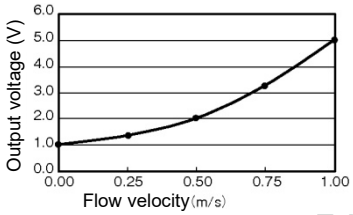
Model	D6F-W01A1	D6F-W04A1	D6F-W10A1	D6F-V03A1
Flow Range[*2]	0 to 1 m/s	0 to 4 m/s	0 to 10 m/s	0 to 3 m/s
Calibration Gas[*3]	Air			
Electrical Connection	Three-pin connector			
Power Supply	10.8 to 26.4 VDC			3.15 to 3.45 VDC
Current Consumption	15 mA max.[*4]			15 mA max.[*5]
Output Voltage	1 to 5 VDC[*6]			0.5 to 2 VDC[*6]
Accuracy (25°C characteristic)	±5%FS		±6%FS	±10%FS
Repeatability[*7]	±0.4%FS			±1.5%FS
Output voltage (Max.)	5.7 VDC [*8]			2.7 VDC[*8]
Output voltage (Min.)	0 VDC [*8]			
Rated Power Supply Voltage	26.4 VDC			12 VDC
Rated Output Voltage	6 VDC			3 VDC
Case	PPS			PBT
Degree of Protection	IEC IP40 (except for flow inlet and outlet)			
Operating Temperature[*9]	−10 to 60°C			
Operating Humidity[*9]	35% to 85%			
Storage Temperature[*9]	−40°C to 80°C			
Storage Humidity[*9]	35% to 85%			
Temperature Characteristics	±5%FS[*10]			±20%FS[*10]
Insulation Resistance	Between Sensor outer cover and lead terminals: 20 MΩ min (at 500 VDC)			
Dielectric Strength	Between Sensor outer cover and lead terminals: 500 VAC, 50/60 Hz min. for 1 min (leakage current: 1 mA max.)			
Weight	6.3 g			5.3 g

*2. Volumetric flow rate at 25°C, 101.3 kPa.
*3. Dry gas. (must not contain oil or mist.)
*4. With no load, with a Vcc of 12 to 24 VDC, and at 25°C
*5. With no load, with a Vcc of 3.3 VDC, and at 25°C
*6. Non-linear output, load resistance of 10kΩ
*7. Reference (typical)
*8. Load resistance: 10 kΩ
*9. With no condensation or icing
*10. For 25°C characteristic at an ambient temperature of −10 to 60°C

Flammability UL94 standard: V-0

6.2 Output Voltage Characteristics

D6F-W01A1



D6F-W04A1

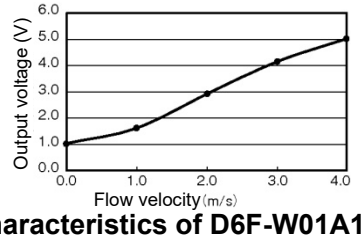


Table 4 Output Characteristics of D6F-W01A1

Flow velocity (m/s)	0	0.25	0.50	0.75	1.00
Output voltage (V)	1.00±0.20	1.35±0.20	2.01±0.20	3.27±0.20	5.00±0.20

Table 5 Output Characteristics of D6F-W04A1

Flow velocity (m/s)	0	1.0	2.0	3.0	4.0
Output voltage (V)	1.00±0.20	1.58±0.20	2.88±0.20	4.11±0.20	5.00±0.20

D6F-W10A1

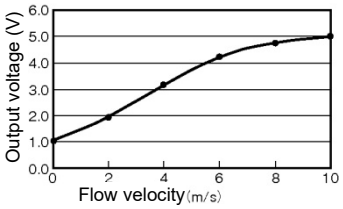


Table 6 Output Characteristics of D6F-W10A1

Flow rate (m/s)	0	2.0	4.0	6.0	8.0	10.0
Output voltage (V)	1.00±0.24	1.94±0.24	3.23±0.24	4.25±0.24	4.73±0.24	5.00±0.24

D6F-V03A1

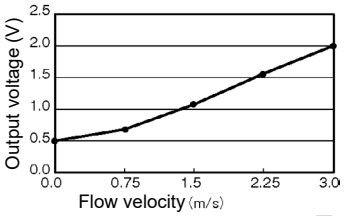


Table 7 Output Characteristics of D6F-V03A1

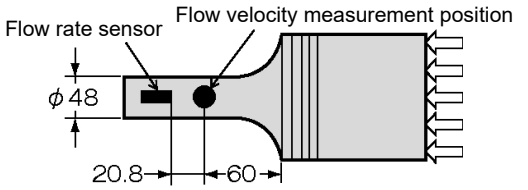
Flow velocity (m/s)	0	0.75	1.50	2.25	3.00
Output voltage (V)	0.50±0.15	0.70±0.15	1.11±0.15	1.58±0.15	2.00±0.15

(Note) The flow velocity is converted from measured value of mass flow rate using OMRON's standard wind tunnel and does not specify the flow velocity stipulated by Measurement Act.

6.3 Wind Tunnel for Evaluation

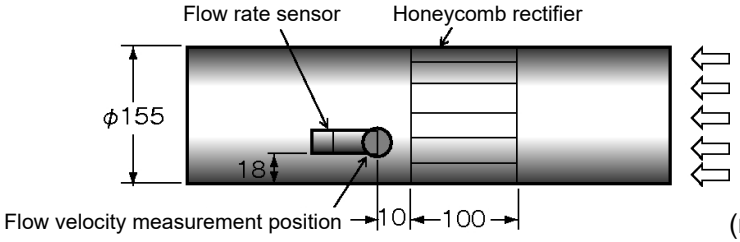
Characteristics of D6F-W/D6F-V may change due to difference of wind tunnel aperture size and installation position. Shown below are standard test environments of OMRON.

D6F-W01A1, D6F-W04A1



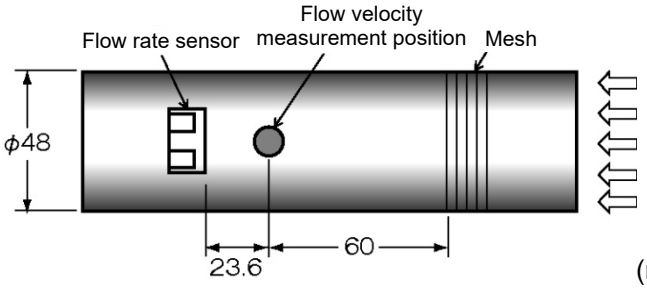
(mm)

D6F-W10A1



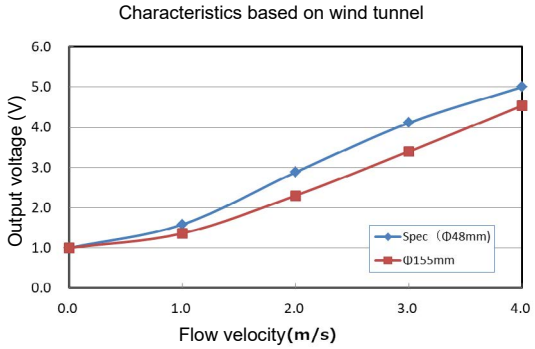
(mm)

D6F-V03A1



(mm)

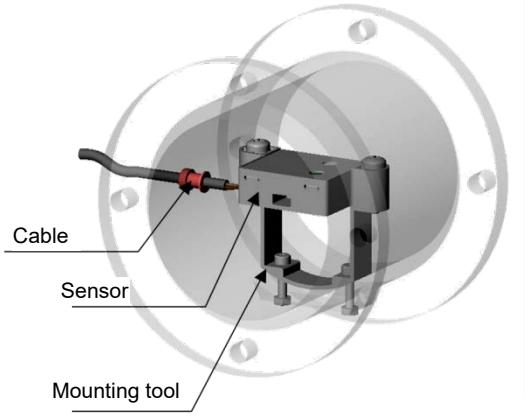
Shown below is a result of measurement done by D6F-W04A1 adjusted for its standard wind tunnel and measured in the standard wind tunnel of D6F-W10A1. The larger the aperture size is, the smaller the influx to and output from the sensor become. This is because MEMS air flow rate sensor has pressure loss.



7. Installation Method

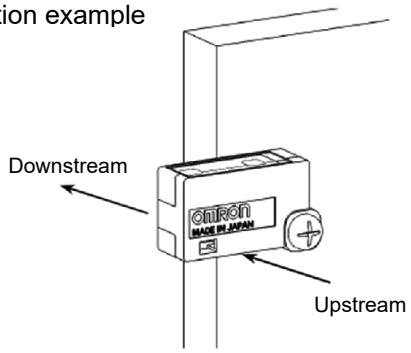
D6F-W
The sensor should be placed so that the label side should be facing up.
Use M3 pan-head screw and tighten with torque of 0.59(N•m) or less. (Refer to installation examples)

Installation example



D6F-V
The sensor should be placed so that the label side should be vertical to the upwind.
Use M3 pan-head screw and tighten with torque of 0.59(N•m) or less.
(Refer to installation examples)

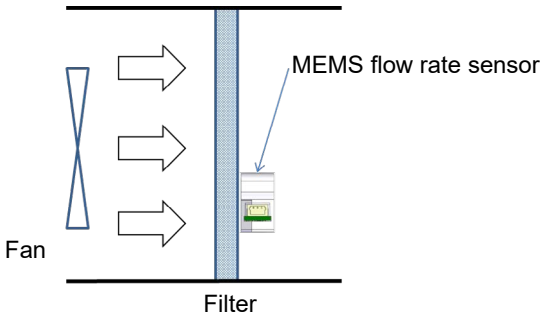
Installation example

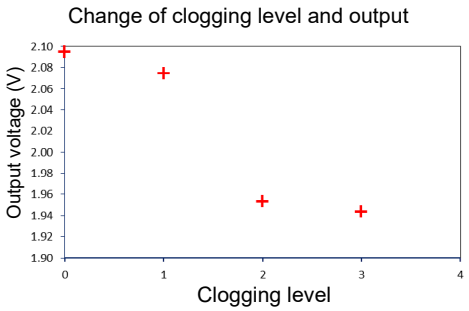


8. Usage Example of Sensor

8.1 Clogged Filter Detection

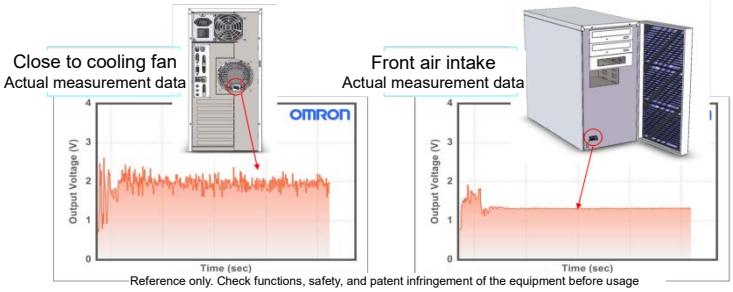
For a device that has filters on its air inlet and outlet, measuring changes of air flow rate through the filters allows detection of a clogged filter. For example, installing a MEMS sensor behind the filter and monitoring its output voltage allows detection of a clogged filter. Shown below is an experiment result tested with an actual device. It shows clogging causes output changes.





8.2 Clogged Server Detection

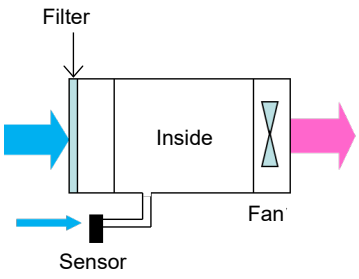
For a device that requires cooling, such as a server, air flow rate can be monitored by installing a sensor at the cooling air inlet (right), as exhaust from the air outlet (left) is not stable, as shown below.



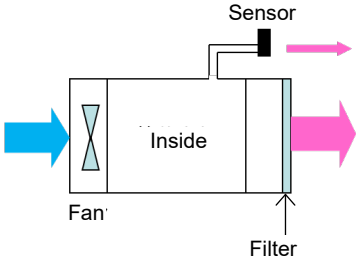
8.3 Installation in Turbulent Atmosphere

If an occurrence of turbulence is evident, you can install the sensor using a bypass instead of installing inside the casing.

When a filter is clogged, flow rate at the air inlet (main flow path) decreases. This causes pressure fluctuation in a certain space. In addition, the flow rate at the bypass (2nd flow path) increases.



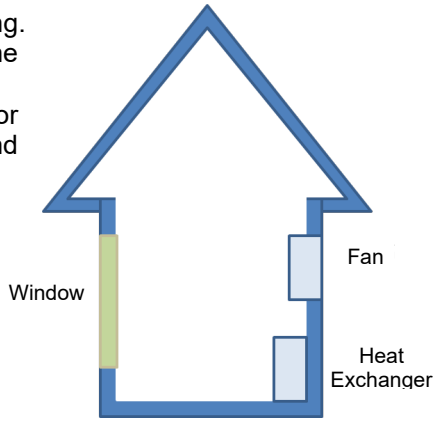
Case: Negative pressure



Case: Positive pressure

8.4 Ventilation Detection at Fan

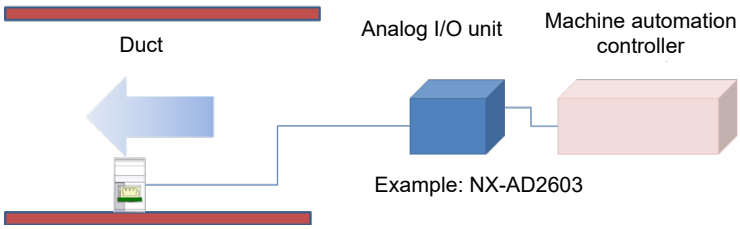
In an airtight house, ventilation may not be done while the fan is working. It occurs when ventilation pressure by the fan and air pressure from the outside air are equalized.
To confirm whether ventilation is actually done or not, you must monitor air flow rate using MEMS air flow sensor in addition to fan voltage and differential pressure monitoring.

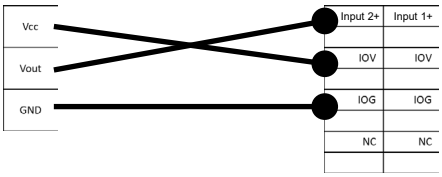


8.5 Connection to Control Using Sensor Output

Shown below is an example of configuration for control when output of a MEMS air flow sensor becomes less or more than the certain value.
Connect the sensor output to analog I/O unit or comparator for control with set voltage as a threshold.

The sensor can be connected to a controller via OMRON's analog I/O unit. To use D6F-V, you must provide 3.3VDC power supply.
(Refer to installation examples)





9. Troubleshooting

Q: The sensor output is nonlinear. It there an approximate expression of output characteristics?
A: Table 8 shows the approximate expression. Note that this expression is a polynomial approximation of the representative curve.

Approximation: Flow velocity $= Ax^6 + Bx^5 + Cx^4 + Dx^3 + Ex^2 + Fx + G$ (x: Voltage)

Table 8 Approximation Coefficients

	Model			
Coefficient	D6F-W01A1	D6F-W04A1	D6F-W10A1	D6F-V03A1
A:	0	0.0055	0	−2.62534
B:	−0.0004	−0.1112	0.0716	20.87142
C:	0.0032	0.8566	−0.9973	−68.14970
D:	0.0301	−3.0791	5.4446	117.16178
E:	−0.3648	4.9736	−14.4591	−111.95726
F:	1.3442	−1.6458	20.0874	58.03388
G:	−1.0007	−0.9999	−10.1473	−12.00028

Q: What happens if the flow exceeds the maximum flow velocity of the sensor?
A: Output becomes maximum rating output. The output stays at this value even if the flow rate exceeds the maximum value.
The sensor will not be broken.

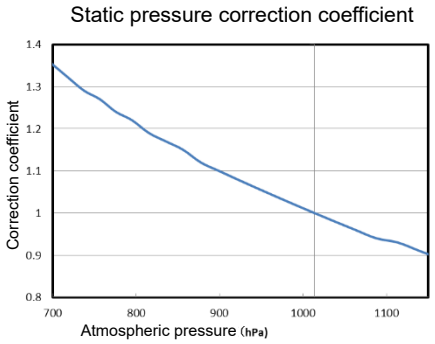
Q: What happens if the flow is reversed on the sensor?
A: Output voltage becomes 1.0 V (D6F-W) or 0.5V (D6F-V) or less, and no output at 0V.

Q: How is the sensor affected by atmospheric pressure?
A: MEMS air flow sensor is adjusted based on 1 (atm) and its output characteristics can change due to a change of atmospheric pressure (static pressure). For stable measurement, it is recommended to use static pressure correction.

Corrected air flow = Measured value x Static pressure correction coefficient

The static pressure correction can be calculated from Boyle-Charles Law for density:

$\frac{p}{\rho T} = Constant$ (p: Static pressure, ρ: Density, T: Absolute temperature)



Warranty and Limited Warranty

Thank you for using Omron Corporation (“Omron”) products. The Terms and Conditions hereunder are applied to Omron products regardless of where they are purchased. When you place an order, you are expected to agree to the Terms and Conditions described below.

1. Definition

The definition of terms used in these Terms and Conditions are as follows:

(1) Omron products: FA system equipment, general-purpose control devices, sensors, and electronic/mechanism components under Omron brand

(2) Catalogues: Omron general catalogue, FA system equipment general catalogue, safety component general catalogue, electronic/mechanism components general catalogue and other catalogues, specifications, instructions and manuals of Omron products, including electronically provided information available on the Omron electronic components information website, etc.

(3) Usage conditions: Usage conditions, rating, performance, operating environment, handling instructions, cautions, prohibited use, etc. of Omron products described in catalogues.

(4) Customer application: Application of Omron products by customers which include embedding and/or using Omron products in their parts/components, electronic substrates, devices, equipment or systems manufactured by customers.

(5) Fitness: (a) fitness, (b) performance, (c) non-infringement of third-party intellectual property, (d) compliance with laws and regulations and (e) conformity to standards.

2. Caution on Descriptions

Attention is required to the following points on descriptions in catalogues.

(1) Rated values and performance values are the product of tests performed for separate single conditions, including but not limited to temperature and humidity. It is not intended to warrant rated values and performance values for multiple combined conditions.

(2) Reference data are provided for reference only. Omron does NOT warrant that Omron products work properly at all time in the range of reference data.

(3) Application examples are provided for reference only. Omron does NOT warrant the fitness of Omron products under such application.

(4) Omron may discontinue the production of Omron products or change the specifications of them for the purpose of improving such products or other reasons entirely at its own discretion.

3. Precautions

Please be aware of and accept the following when you introduce or use Omron products:

(1) Please use Omron products in compliance with usage conditions including rating and performance.

(2) Please confirm fitness of Omron products in your application and use your own judgment to determine the appropriateness of using them in such application. Omron shall not warrant the fitness of Omron products in customer application.

(3) Please confirm that Omron products are properly wired and installed for their intended use in your overall system.

(4) When using Omron products, please make sure to (i) maintain a margin of safety vis-à-vis the published rated and performance values, (ii) design to minimize risks to customer application in case of failure of Omron products, such as introducing redundancy, (iii) introduce system-wide safety measures to notify risks to users, and (iv) conduct regular maintenance on Omron products and customer application.

(5) Omron products are designed and manufactured as general-purpose products for use in general industrial products. They are not intended to be used in the following applications. If you are using Omron products in the following applications, Omron shall not provide any warranty for such Omron products. Even in the case of the following applications to elevator/lift equipment and medical devices, etc, some case are likely applied to an usual guarantee prescribed on next article as general-purpose products used for general industrial products. So, please contact our sales person in charge.

(a) Applications with stringent safety requirements, including but not limited to nuclear power control equipment, combustion equipment, aerospace equipment, railway equipment, elevator/lift equipment, amusement park equipment, medical equipment, safety devices and other applications that could cause danger/harm to people’s body and life.

(b) Applications that require high reliability, including but not limited to supply systems for gas, water and electricity, etc., 24 hour continuous operating systems, financial settlement systems and other applications that handle rights and property.
(c) Applications under severe conditions or in severe environment, including but not limited to outdoor equipment, equipment exposed to chemical contamination, equipment exposed to electromagnetic interference and equipment exposed to vibration and shocks.
(d) Applications under conditions and environment not described in catalogues.

(6) In addition to the applications listed from (a) to (d) above, Omron products are not intended for use in automotive applications (including two wheel vehicles). Please do NOT use Omron products for automotive applications. Please contact Omron sales staff for products for automotive use.

4. Warranty Terms and Conditions

The terms and conditions for warranty of Omron products are as follows:

(1) Warranty period: One year after the purchase from Omron or Omron's agency.

(2) Coverage: Omron will provide either of the following two services for the malfunctioning Omron products at its own discretion:
(a) Free repair of malfunctioning Omron products at an Omron maintenance service location (Repair service is not available for electronic/mechanism parts.), or
(b) Free replacement of the malfunctioning Omron products with the same number of replacement/alternative products.

(3) Exceptions: Omron will not cover Omron products under its warranty if the cause of the malfunction falls under any of the following:
(a) Usage in a manner other than the original intended use for the Omron products.
(b) Usage outside of the usage conditions.
(c) Modification or repair made to the Omron products by other than Omron personnel.
(d) Software program embedded by other than Omron or usage of such software.
(e) Causes which could not have been foreseen with the level of science and technology at the time of shipping from Omron.
(f) Causes originating from other than Omron or Omron products (including force majeure such as but not limited to natural disasters).

5. Limitation of Liability

The warranty set out in these Terms and Conditions is the whole and sole liability for Omron products. There are no other warranties, expressed or implied. Omron and the distributors of Omron products are not liable for any damages which may arise from or be related to Omron products.

6. Export Controls

Customers of Omron products shall comply with all applicable laws and regulations of Japan and/or other relevant countries with regard to security export control, when exporting Omron products and/or technical documents or providing such products and/or documents to a non-resident. Omron may not provide customers with Omron products and/or technical documents should they fail to comply with such laws and regulations.

Please check each region's Terms & Conditions by region website.

OMRON Corporation
Device & Module Solutions Company

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