INTRODUCTION

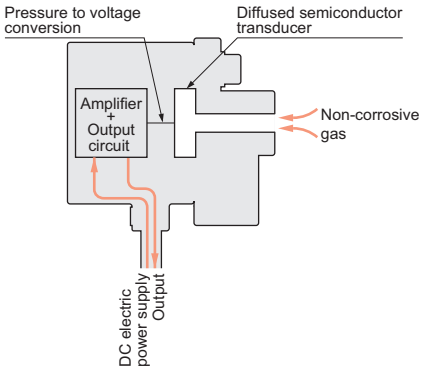
Principle of operation

- A pressure sensor converts changes in pressure of a gas or a liquid into an electrical signal by means of a pressure sensing device, and generates an analog output proportional to the pressure or a switching output which operates at a particular pressure level. All Panasonic Electric Works SUNX pressure sensors incorporate semiconductor transducers, which offer long life and high reliability, as the sensing devices.

Structure of electronic pressure sensor

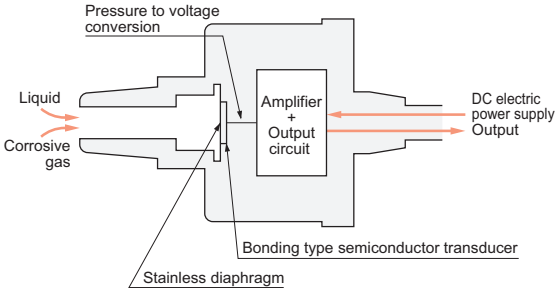
For non-corrosive gases

- The diffused semiconductor transducer converts pressure into an electrical signal, which is then processed by an amplifier and an output circuit.



For other gases and liquids

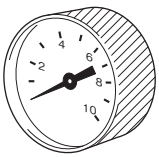
- The pressure is applied to a stainless diaphragm, whose distortion is converted by a bonding type semiconductor transducer, bonded at the back of the diaphragm, into an electrical signal. This signal is then processed by an amplifier and an output circuit.



FEATURES

Features of electronic pressure sensor

- Pressure sensors can be broadly classified into two types: electronic type and mechanical type. Previously, mechanical type pressure sensors, which are relatively inexpensive, were commonly used. However, since they have low reliability and short life, electronic pressure sensors are now being increasingly used.

	Electronic type (Diffusion type, bonding type)	Mechanical type (Bourdon-tube, bellows, etc.)
		
Principle	• Direct conversion from pressure to an electrical signal, providing a non-contact switching output.	• Pressure is changed to displacement, which in turn operates (ON / OFF) a mechanical switch to provide a contact type switching output.
Advantage	• High accuracy • High reliability and long life because of no mechanical parts • Quick response	• Inexpensive • No power supply needed
Disadvantage	• Expensive than mechanical type	• Short lifetime • Poor response

TYPES OF SENSORS

Method of classification

① Classification by applicable fluid

- The fluid whose pressure is measured could be a gas, water, oil, etc. The transducer which can be used depends on the fluid. Be careful because the transducer may be destroyed by corrosion when used with fluids other than those specified.

Pressure sensor
- For non-corrosive gases (diffused semiconductor transducer)
- For other gases and liquids which do not corrode stainless steel SUS 302 and SUS 304 (Stainless diaphragm)

② Classification by type of pressure

- Classification is based on the reference with respect to which the pressure is measured.

Pressure sensor
- Gauge pressure
- Differential pressure

③ Classification by pressure port

- The required pressure port differs with the piping done. If the required shape or size of the pressure port differs, it is necessary to use attachments.

Pressure sensor
- Rc 1/8 female thread
- M5 female thread
- 10-32 UNF female thread
- NPT 1/8 female thread
- NPTF 1/8 female thread
- G 1/8 female thread
- R 1/8 male thread
- R 1/4 male thread
- M5 male thread
- 10-32 UNF male thread
- NPT 1/8 male thread
- NPT 1/4 male thread
- G 1/8 male thread
- ø4.8 mm ø0.189 in pipe

Classification

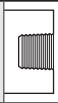
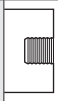
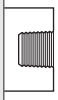
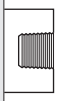
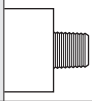
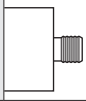
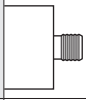
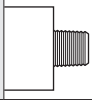
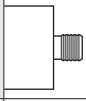
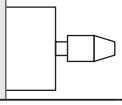
① Classification by applicable fluid

Type	Description
For non-corrosive gases	Diffused semiconductor is used as the transducer. It can be used to measure air pressure.
For other gases and liquids	Stainless diaphragm is used as the transducer. Besides air pressure, it can be used to measure pressure of gases or liquids which do not corrode stainless steel (SUS 302 and SUS 304) port.

② Classification by type of pressure

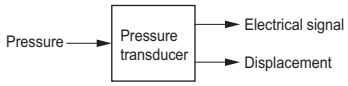
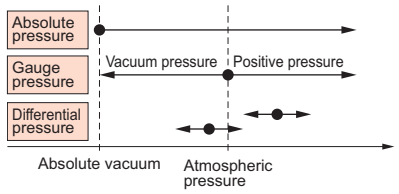
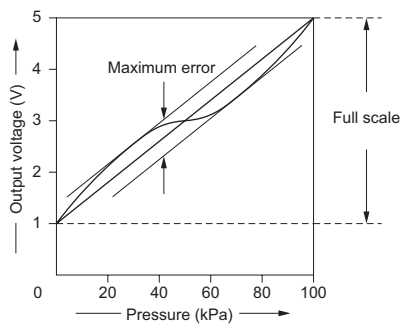
Type	Description
Gauge pressure	Pressure is displayed by taking the atmospheric pressure as zero reference.
Differential pressure	Pressure is measured with respect to an arbitrary reference pressure.

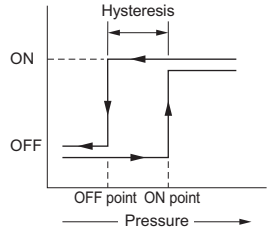
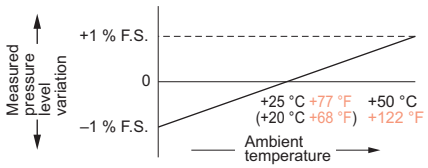
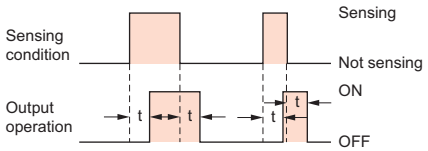
③ Classification by pressure port

Type		Description
Rc 1/8 female thread		• Tapered female thread • Extremely air-tight for high pressure applications • Commonly used in Japan
M5 female thread		• Straight female thread • Fairly air-tight for low pressure applications • Used for low pressure applications
10-32 UNF female thread		• Straight female thread • Fairly air-tight for low pressure applications • Used for low pressure applications • Commonly used in North America
NPT 1/8 female thread		• Tapered female thread • Extremely air-tight for high pressure applications • Commonly used in North America
NPTF 1/8 female thread		• Tapered female thread • Extremely air-tight for high pressure applications • No sealing tape required • Commonly used in North America
G 1/8 female thread		• Straight female thread • Fairly air-tight for low pressure applications, and easily connectable • Commonly used in Europe
R 1/8 male thread R 1/4 male thread		• Tapered male thread • Extremely air-tight for high pressure applications • Commonly used in Japan
M5 male thread		• Straight male thread • Fairly air-tight for low pressure applications, and easily connectable
10-32 UNF male thread		• Straight male thread • Fairly air-tight for low pressure applications, and easily connectable • Commonly used in North America
NPT 1/4 male thread NPT 1/8 male thread		• Tapered male thread • Extremely air-tight for high pressure applications • Commonly used in North America
G 1/8 male thread		• Straight male thread • Fairly air-tight for low pressure applications, and easily connectable • Commonly used in Europe
ø4.8 mm ø0.189 in pipe		• Easy connection with a tube • Used for low pressure applications

Photoelectric Sensors
Pressure Sensors
Flow Sensors
Inductive Proximity Sensors
Displacement Sensors
Electrostatic Sensors
Static Removers
About Laser Beam
General Precautions

GLOSSARY

Term	Description
Transducer	A device which converts one physical quantity into another physical quantity. For example, a pressure transducer converts pressure into an electrical signal or displacement. 
Non-corrosive gas	Gases in the air (nitrogen, carbon dioxide, etc.) and inert gases (argon, neon, etc).
Absolute pressure Gauge pressure Differential pressure	Absolute pressure: Pressure determined with respect to absolute vacuum as zero Gauge pressure: Pressure determined with respect to the atmospheric pressure as zero Pressure higher than the atmospheric pressure is called “positive pressure”, and lower than it is called “vacuum pressure”. Pressure ranging from vacuum pressure to positive pressure is called “compound pressure”. Differential pressure: Difference between two pressures 
Rated pressure range	Pressure range over which specified capabilities can be maintained.
Set pressure range	Operable pressure range over which the threshold level can be set for the comparison output.
Pressure withstandability	The maximum pressure outside the rated pressure range which can be applied to the pressure sensor without its performance deteriorating when the pressure is brought back to the rated pressure range.
Repeatability	Variations in ON level when the applied pressure is repeatedly changed to switch the output ON / OFF under constant supply voltage and temperature. It is expressed as a percentage of the full scale. $\frac{\text{Maximum operating point} - \text{Minimum operating point}}{\text{Rated pressure range}} \times 100\ (\%\ \text{F.S.})$
Linearity	Although the analog output changes almost linearly with respect to the measured pressure, there is a slight deviation from an ideal straight line. This deviation, expressed as a percentage of full-scale, is the linearity. 

Term	Description
Hysteresis	Difference in pressure level at which the output turns ON and OFF. 
Temperature characteristics	They are specified as the variation in the measured pressure which occurs when the ambient temperature is varied over the rated temperature range, taking the pressure measured at +25 °C +77 °F or +20 °C +68 °F as the reference. The variation is expressed as a percentage of full scale.  However, the graph shows typical values. There may be slight variations depending on the product.
Sampling rate	It is the rate at which data is read and displayed. Since the internal circuit is constantly processing the signal even during display hold, it is possible that the display and the switching output do not match.
Response frequency	When the pressure is applied intermittently under constant conditions, the frequency with which the output can follow the changes is the response frequency.
Response time	The time delay between the change in the sensing condition and the turning of the output to ON or OFF. 

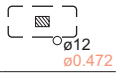
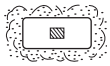
GLOSSARY

Term	Description
Protection	Degree of protection against water, human body and solid foreign material. Protection degree is specified as per IEC (International Electrotechnical Commission).

IEC standard

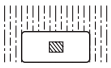
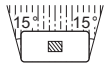
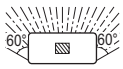
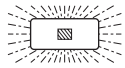
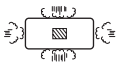
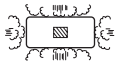
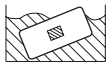
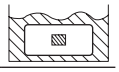
IP□□
- Second figure . . . Protection against water penetration
- First figure . . . . . .Protection against human body and solid foreign material

• Protection degree specified by the first figure

First figure	Description
0	No protection
1	Protection against contact with internal live parts by a human hand (ø50 mm ø1.969 in) 
2	Protection against contact with internal live parts by a human finger (ø12 mm ø0.472 in) 
3	Protection against contact with internal live parts by a solid object more than 2.5 mm 0.098 in in thickness or diameter 
4	Protection against contact with internal live parts by a solid object more than 1.0 mm 0.039 in in thickness or diameter 
5	Protection against dust penetration which can affect operation 
6	Complete protection against dust penetration 

Note: The IEC standard prescribes test procedures for each protection degree given above. The protection degree specified in the product specifications has been decided according to these tests.

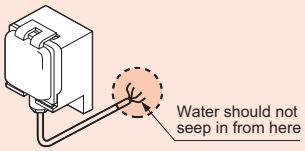
• Protection degree specified by the second figure

Second figure	Description
0	No protection
1	No harmful effect due to vertically falling water drops 
2	No harmful effect due to water drops falling from a range 15° wider than the vertical 
3	No harmful effect due to water drops falling from a range 60° wider than the vertical 
4	No harmful effect due to water splashes from any direction 
5	No harmful effect due to direct water jet from any direction 
6	No water penetration due to direct water jet from any direction 
7	No water penetration due to immersion in water under specified conditions 
8	No water penetration during immersion, even under conditions that are more harsh than the ones in No.7. 

Caution

- Although the protection degree is specified for the sensor including the cable, the cable end is not waterproof, and is not covered by the protection specified. Hence, make sure that water does not seep in from the cable end.
- The protection specified concerns the environment in which the sensor can be used. It does not relate to the applicable fluid.

(The **DP2** series IP67 type cannot be used with water or other liquids.)

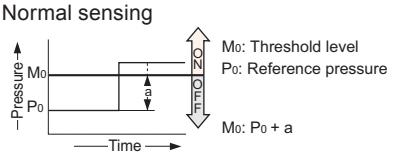
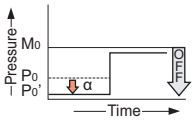
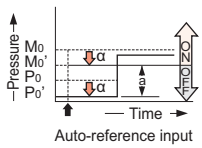
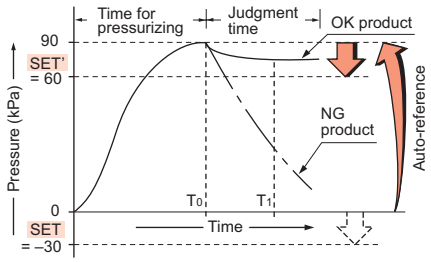


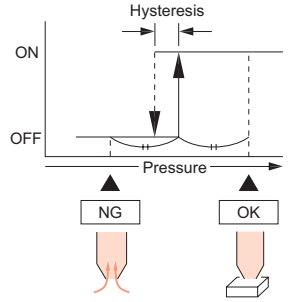
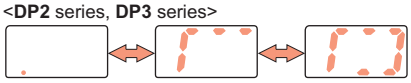
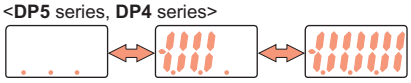
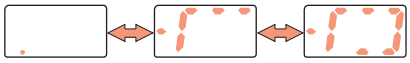
JEM standards (Standards of the Japan Electrical Manufacturer's association)

- IP67g / IP68g

This specifies protection against oil in addition to IP67 / IP68 protection of IEC standards. It specifies that oil drops or bubbles should not enter from any direction.

FUNCTIONS

Function	Description
Auto-reference function	This function compensates the set threshold level for a change in the reference pressure. **Operation** ① Normal sensing  M0: Threshold level P0: Reference pressure M0: P0 + a ② With reference pressure change  If the threshold level is set with respect to a particular reference level and if this reference level changes, correct operation will not be possible. ③ With auto-reference function  If the auto-reference input is made ON when the reference pressure changes, the threshold level M0 is corrected to a new threshold level M0', which maintains proper judgment. $M_0' = P_0 - \alpha + a$ $= P_0' + a$ Note: Take care that the data on the reference pressure value is lost when the power supply is switched off. **Application** <Air leak test>  ①The above graph shows a pressure curve of the air leak test. The decision on whether the product is OK or NG is based upon whether, after reaching the peak value, the pressure reduces by 30 kPa, or more, within a fixed time interval. ②The set value is input before applying pressure. SET = –30 ③Apply pressure and then apply the auto-reference input at time T0, when the pressure reaches the peak value. As the peak pressure is 90 kPa , the threshold level is automatically changed to 60 kPa . SET = –30 + 90 = 60 kPa
Remote zero-adjustment function	The remote zero-adjustment function forcibly sets the pressure value at time of application of an external input signal to zero.

Function	Description
Automatic sensitivity setting function	The threshold level is automatically set by making the sensor record pressure values corresponding to actual OK and NG products. **Application** <Confirming for suction> 
Pressure unit selection function	Different pressure units can be selected. It is possible to switch to Pa (kPa, MPa), mmHg, kgf/cm², bar, psi, mmH2O, and inHg. Note: The pressure units that can be selected to will vary depending on the model. Contact our office for details.
Peak hold & bottom hold function	Peak hold and bottom hold functions enable the display of the peak value (maximum pressure value) and the bottom value (minimum pressure value) of the varying measured pressure. These functions are convenient for finding the pressure variation range or determining the reference for pressure settings. • Please note that the peak value and the bottom value data is erased when it is no longer displayed. • While the peak hold and bottom hold are displayed, there is a delay in the comparative output response time.
Analog bar display function	Pressure changes can also be displayed in an analog fashion using LED bars. Hence, sudden pressure changes can be recognized at a glance. LED bars indicate the pressure level in steps of 10 % F.S. (**DP5** series and **DP4** series are 14 % F.S.) **Analog bar of positive pressure** Atmospheric pressure condition — High pressure condition <**DP5** series, **DP4** series>  <**DP2** series, **DP3** series>  **Analog bar of vacuum pressure** Atmospheric pressure condition — High vacuum condition <**DP5** series, **DP4** series>  <**DP2** series, **DP3** series> 

CONVERSION TABLE FOR PRESSURE UNITS

	kPa	mmHg (Torr)	kgf/cm^2	atm	bar	psi (pound/inch^2)	mmH$_2$O	inHg
1 kPa	1	7.50062	1.01972×10^{-2}	9.86923×10^{-3}	1×10^{-2}	1.45038×10^{-1}	1.01972×10^{2}	0.2953
1 mmHg (1 Torr)	1.33322×10^{-1}	1	1.35951×10^{-3}	1.31579×10^{-3}	1.33322×10^{-3}	1.93368×10^{-2}	1.35951×10	3.9370×10^{-2}
1 kgf/cm^2	9.80665×10	7.35559×10^{2}	1	9.67841×10^{-1}	9.80665×10^{-1}	1.42234×10	1×10^{4}	2.8959×10
1 atm	1.01325×10^{2}	7.60000×10^{2}	1.03323	1	1.01325	1.46960×10	1.03323×10^{4}	2.99213×10
1 bar	1×10^{2}	7.50062×10^{2}	1.01972	9.86923×10^{-1}	1	1.45038×10	1.01972×10^{4}	2.953×10
1 psi (pound/inch^2)	6.89475	5.17149×10	7.03069×10^{-2}	6.80459×10^{-2}	6.89475×10^{-2}	1	7.03069×10^{2}	2.03602
1 mmH$_2$O	9.80665×10^{-3}	7.35559×10^{-2}	1×10^{-4}	9.67841×10^{-5}	9.80665×10^{-5}	1.42234×10^{-3}	1	2.8959×10^{-3}
1 inHg	3.3864	2.5400×10	3.4532×10^{-2}	3.3421×10^{-2}	3.3864×10^{-2}	0.4912	3.4532×10^{2}	1

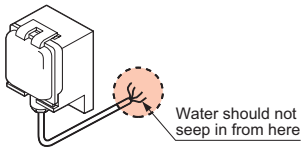
PRECAUTIONS FOR PROPER USE

Wring

- Make sure that the power supply is off while wiring.
- Verify that the supply voltage variation is within the rating.
- If power is supplied from a commercial switching regulator, ensure that the frame ground (F.G.) terminal of the power supply is connected to an actual ground.
- In case noise generating equipment (switching regulator, inverter motor, etc.) is used in the vicinity of this sensor, connect the frame ground (F.G.) terminal of the equipment to an actual ground.
- If the used power supply generates a surge, connect a surge absorber to the power supply to absorb the surge.
- Do not run the wires together with high-voltage lines or power lines or put them in the same raceway. This can cause malfunction due to induction.
- In order to reduce noise, make the wiring as short as possible.
- Make sure that stress by forcible bend or pulling is not applied directly to the sensor cable joint.

Other precautions

- Our products have been developed / produced for industrial use only.
- Although the protection degree is specified for the sensor including the cable, the cable end is not waterproof, and is not covered by the protection specified. Hence, make sure that water does not seep in from the cable end.



- Use within the rated pressure range.
- Do not apply pressure exceeding the pressure withstandability value. The diaphragm will get damaged and correct operation shall not be maintained.
- Avoid dust, dirt, and steam.
- Take care that the sensor does not come in direct contact with water, oil, grease, or organic solvents, such as, thinner, etc.
- Do not insert wires, etc., into the pressure port. The diaphragm will get damaged and correct operation shall not be maintained.
- Do not operate the keys with pointed or sharp objects.
- The usage environment should be within the ranges described in the specifications.
  Use sensors within the range shown in the white part of the ambient temperature / humidity graph below and also within the certified ambient temperature and humidity range of each product. When using sensors within the range shown in the diagonal line shaded part of the graph, there is a possibility that condensation may occur depending on changes in the ambient temperature. Please be careful not to let this happen.
  Furthermore, pay attention that freezing does not occur when using below 0 °C +32 °F. Please avoid condensation and freezing when storing the product as well.