

# Note prior to placing order

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Products or specifications on the catalog are subject to be changed without notice. Please inquire our sales agents for our latest specifications. We require an acknowledgment of specification documents for product use beyond our specifications, and conditions needing high reliability, such as nuclear reactor control, railroads, aviation, automobile, combustion, medical, amusement, Disaster prevention equipment and etc. Furthermore, we ask you to perform a swift incoming inspection for delivered products and we would also appreciate if full attention is given to the storage conditions of the product.

## 〈Warranty Period〉

The Warranty period is one year from the date of delivery. The warranty is only applicable to the product itself, not applicable to consumable products such as batteries and etc.

## 〈Warranty Coverage〉

If any malfunctions should occur due to our fault, NIDEC COPAL ELECTRONICS warrants any part of our product within one year from the date of delivery by repair or replacement at free of charge. However, warranty is not applicable if the causes of defect should result from the following conditions:

- Failure or damages caused by inappropriate use, inappropriate conditions, and inappropriate handling.
- Failure or damages caused by inappropriate modifications, adjustment, or repair.
- Failure or damage caused by technically and scientifically unpredictable factors.
- Failure or damage caused by natural disaster, fire or unavoidable factors.

A pressure sensor is a device that converts fluid pressure into an electrical signal. NIDEC COPAL ELECTRONICS pressure sensors are manufactured from the semiconductor pressure sensing chips to a variety of pressure sensor products at its own facility.

NIDEC COPAL ELECTRONICS pressure sensors feature:

1. Compact and light weight
2. Excellent electrical and mechanical performance
3. Wide range of products to choose from for various applications

## ■ PRODUCT LINE-UP

### a) Diffusion type semi-conductor pressure sensors ...

#### P series

A basic pressure sensing device which converts pressure into an electrical signal.

The output is in the form of voltage which is proportional to the applied pressure.

The output voltage will be positive when the pressure is positive and negative when the pressure is negative with a constant current source connected.

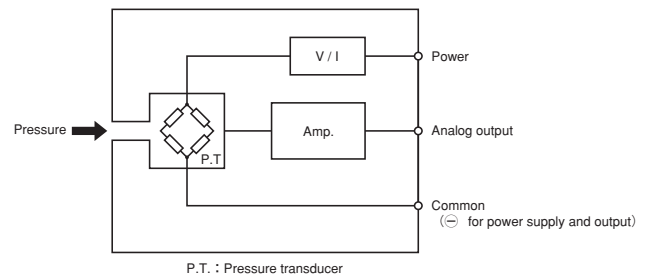
### b) Pressure transducers with a built-in amplifier ...

#### PA series

The PA series pressure transducers are semiconductor (diffusion type) pressure sensors combined with electronic circuits and provide electrical analog output signals.

The electronic circuits consist of a voltage to current conversion for the pressure sensor and an amplifier circuit which amplifies the pressure sensor signals and provides specified output.

The output signals are provided either in the form of voltage change or current change that is proportional to the pressure applied to the pressure transducer.

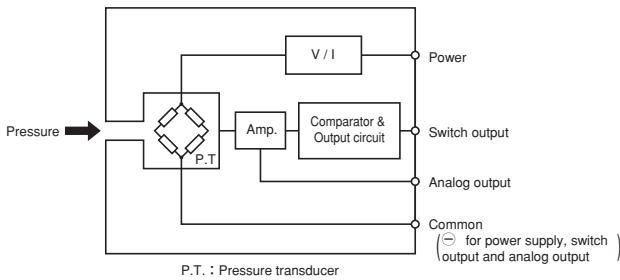


# OUTLINE

## PRESSURE SENSORS

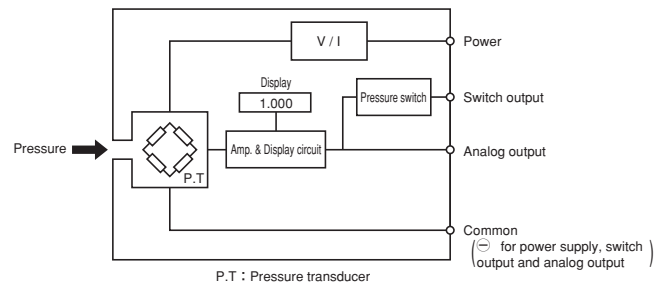
### c) Solid-state pressure switches ... PS series

The PS series pressure switches are solid-state pressure switches consisting of a semiconductor type pressure transducer and electronic circuits which turn on and off according to a preset pressure value. The electronic circuits are composed of a voltage to current conversion circuit which supplies electric current needed for excitation of the pressure transducer, an amplifier which amplifies the pressure transducer signal and a comparator & output circuit which compares the amplified pressure transducer output and the preset voltage corresponding to the preset pressure value and turns the output transistor on and off. The pressure setting can be made easily by adjusting the potentiometer. The switch output is given by an open collector transistor and can turn on and off an external load. The state of the switch output can be visually confirmed by an indicator LED.



### d) Pressure gauges ... PG series

The PG series pressure gauges are pressure gauges composed of a semiconductor type pressure sensor, electronic circuits and a display which measure pressure and display the pressure in the digital/numerical value. The option includes those with a pressure switch function and an analog output function. The pressure setting for the pressure switch can be made looking at the digital pressure display.



### e) Pressure indicators ... PZ series

The indicator is used in combination with a pressure sensor with an amplifier. Pressure is indicated in the digital form with voltage input of 1~5 V or current input of 4~20 mA.

# PRESSURE SENSORS

# OPERATING PRINCIPLES

## ■ Semi conductor type pressure sensors

〈Operation〉

1. The pressure sensor utilizes the piezoresistive properties of a semiconductor which exhibits change in the resistance when stress is applied.
3. Piezoresistors are created on the surface of the single crystal silicone by a heat diffusion process and sense stress when pressure acts on the diaphragm.

〈Output〉

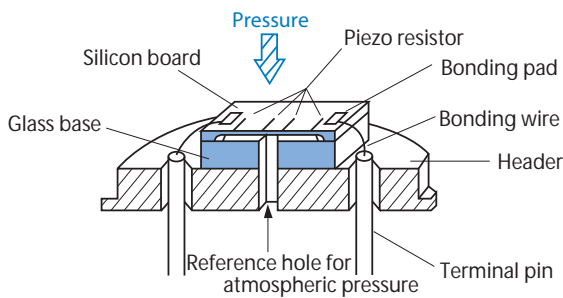
The output obtained is change in the voltage that is proportional to the applied pressure and is approximately 100 mV at the rated pressure. Measurement accuracy is increased by adding temperature compensation resistors which are contained in the pressure sensor.

## ■ Semi conductor type pressure sensors

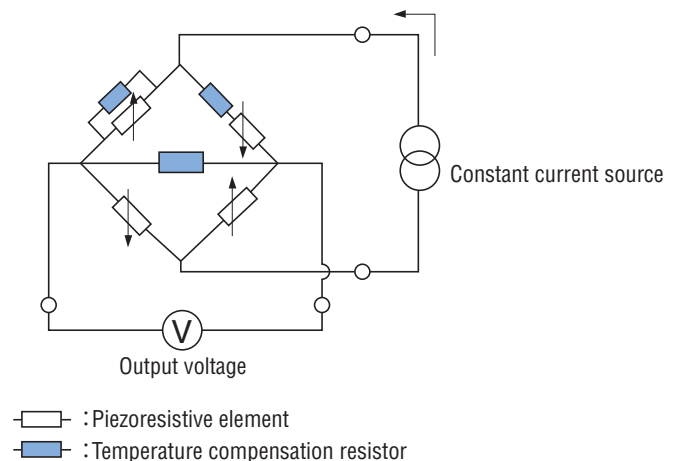
〈Operation〉

2. The pressure sensing chip is made of a single crystal silicone and measures approximately  $4 \times 3 \times 1.7$  mm. The chip has a diaphragm which deforms when pressure is applied.
4. There are four piezoresistors forming a wheatstone bridge which is excited by constant current. When pressure is applied, voltage signals proportional to the pressure can be obtained from the output terminals.

Cross-section view



Electrical schematics



# OPERATING PRINCIPLES

## PRESSURE SENSORS

### ■ Thin-film type pressure sensors

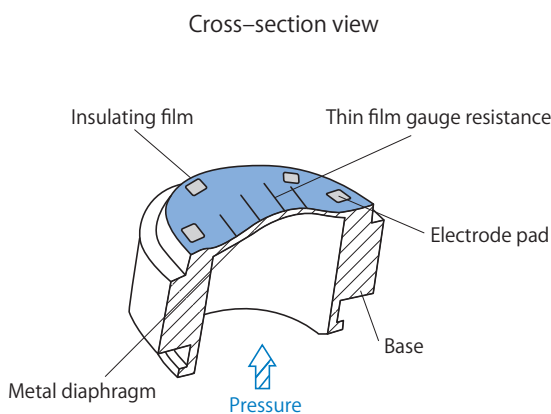
〈Operation〉

1. The structure of our thin film pressure sensor is that insulation film is formed on the metal diaphragm, and thin film gauges are arranged on the insulation film.
3. Four thin film resistors, forming a Wheatstone bridge, is driven by constant voltage and produce output voltage in proportionate to the applied pressure.

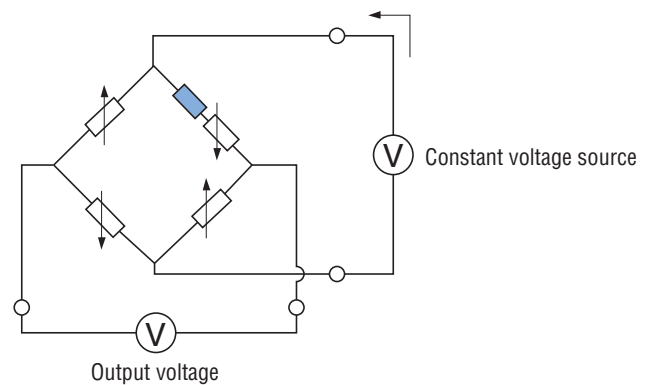
2. If pressure is applied to the sensor, the metal diaphragm is altered. In turn, the thin film gauge on the metal diaphragm is altered and causes a change in its resistance.

〈Output〉

Output voltage is produced in proportion to the applied voltage. It is about 30 mV if rated pressure is applied.



Electrical schematics

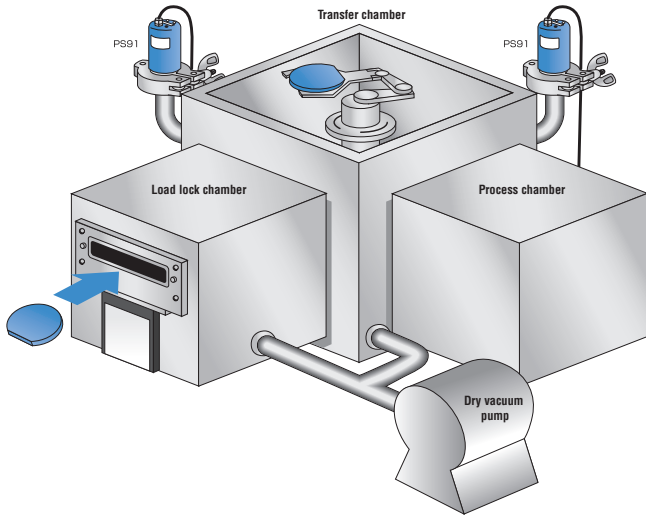


- : Thin film gauge resistor
- : Zero compensation resistor

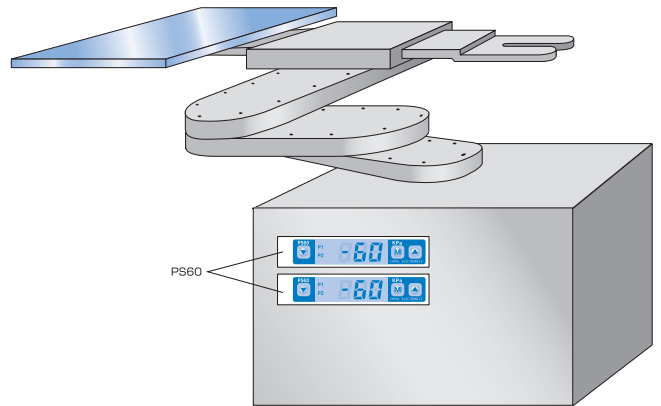
# PRESSURE SENSORS

# APPLICATIONS

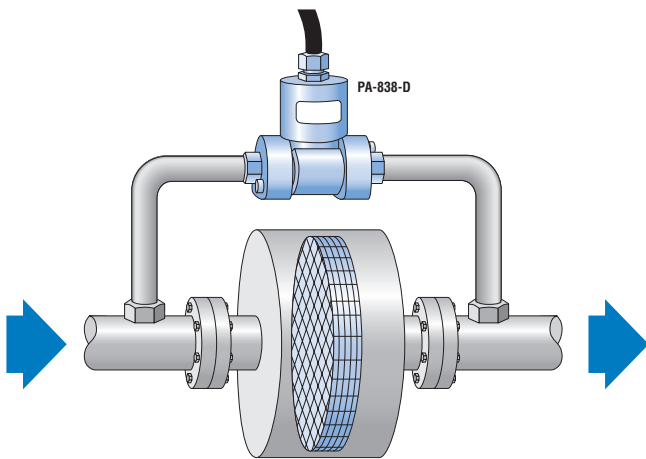
## ● Atmospheric pressure confirmation of chamber



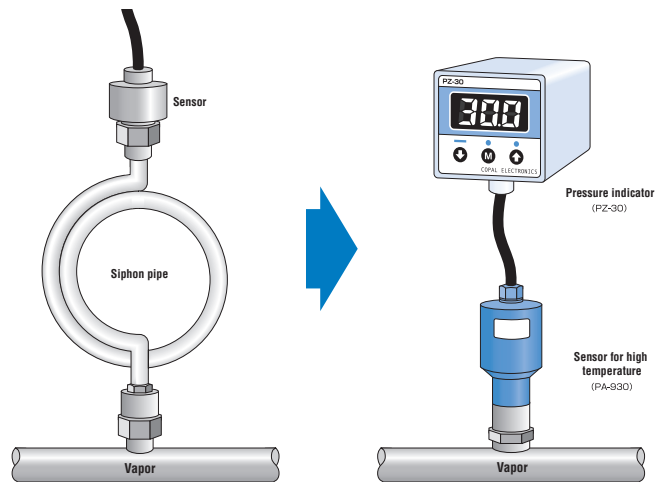
## ● Suction detection



## ● Clogging detection in strainer



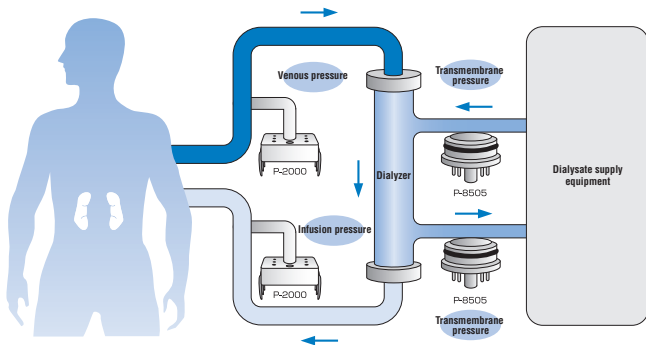
## ● Pressure sensing for water vapor



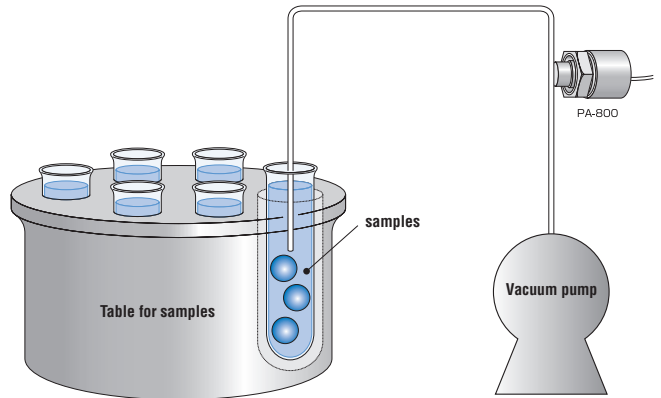
# APPLICATIONS

## PRESSURE SENSORS

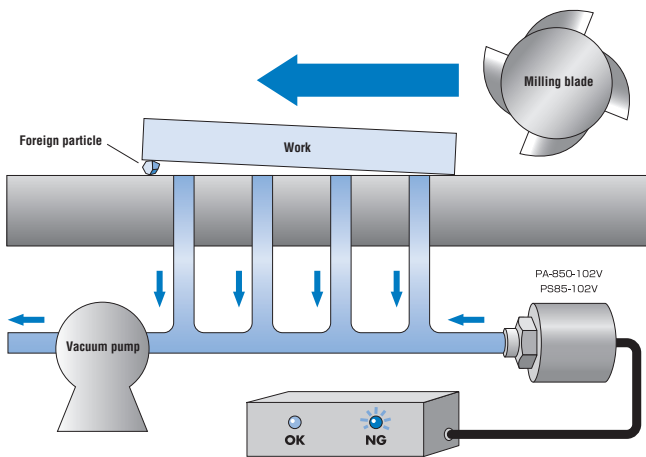
### ● Dialysis system



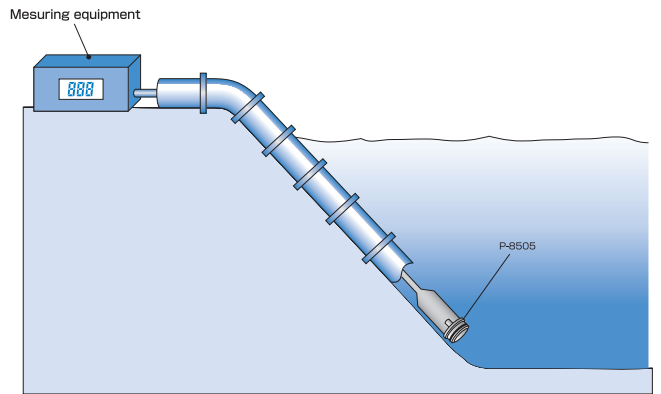
### ● Detection of vacuum level for blood analyzing apparatus



### ● Detection of foreign particle by fraise



### ● Measuring of water level



## ■ Handling notes of all pressure sensors

### • Please check the pressure medium.

Each product of our pressure sensors has different pressure medium compatibility. Select proper products after checking the materials of the components in contact with media.

### • Excessive pressure

Please do not apply pressure exceeding the maximum pressure as shown in the specifications/catalogs. The excessive pressure may affect the sensor characteristics and may make accurate measurement impossible.

### • Freezing

When the moisture on the sensor chip freezes, it may cause deformation or damage of the diaphragm. To avoid this, please be careful of the installation direction and the surrounding environment.

### • Effect of outside light

For the sensors without double diaphragm structure, care must be taken so that the light does not reach the sensor chip especially when transparent tubes are used. The sensor output may fluctuate when the sensor chip is exposed to the outside light.

### • Please check the specifications of the products.

Please make sure of the Pressure range, Power voltage, Output and Fitting. The misapplication may result in failure. Please also check the contents of the instruction manual if it's included, and keep it handy in order to look at it any-time when needed.

### • No entry/contact of foreign matter

A diaphragm is placed inside the pressure port. If foreign matter such as wire enters through the pressure port, damage could occur. So, this must be absolutely avoided. In the case of double diaphragm type, please avoid contact with the diaphragm or force solid matter into the diaphragm as it may deform the diaphragm and damage the sensor. Also care must be taken not to put foreign matter on the surface of the diaphragm.

### • Drip proof and moisture resistance

Please do not use sensors at anyplace where they are exposed to dripping water or oil, except drip proof type. In such a place, please put sensors in a case for protection. At the same time, in case of Gauge type (except the absolute pressure type), sensors must be open to the atmosphere. Even drip proof type is not compatible with submergence, an excessive liquid adhesion or an outdoor use, thus, please protect sensors by putting in a case. Please note that sensors must be open to the atmosphere in case of Gauge type. In the rapid temperature change, condensation may occur in the sensor. The use with the condensation may cause the following. - Internal circuits may be damaged or original characteristics are not maintained.

### • VR/Switch

Small size VRs are used for adjustment setting. So use a small screw driver with proper bit size.



# HANDLING NOTES

## PRESSURE SENSORS

### Reference data

#### Pressure medium compatibility by material

	SUS304	SUS316L	Hastelloy®	PP	PFA	PPS
Acetone	○	○	○	△	○	○
Ammonia water	○	○	○	○	○	△
Ethyl alcohol	○	○	○	○	○	○
Ferric chloride	×	×	△	○	○	○
Hydrochloric acid	×	×	△	○	○	○
Gasoline	○	○	○	○	○	○
Oxygen	○	○	○	○	○	○
Distilled water	○	○	○	○	○	○
Shaft lubricant	○	○	○	○	○	○
Carbon dioxide	○	○	○	○	○	○
Natural gas	○	○	○	○	○	○
Beer	○	○	○	○	○	○
Brake oil	○	○	○	○	○	○
Sulphuric acids	×	×	○	○	○	○
Hydrogen sulphide	×	×	○	○	○	○

The above table shows the compatibility of the pressure medium in general.

#### Recommended fittings

The following are recommended fittings to connect our pressure sensors (M5 female screw) to a urethan/nylon tube. (please contact the following manufacturer for the detail.)

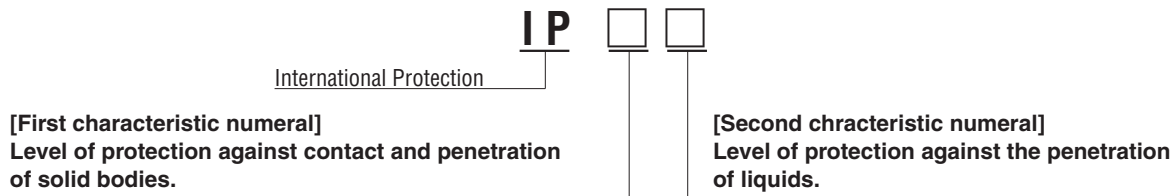
Manufacturer	Appellation	Tube dimensions	
		φ 4 (2.5 × 4)	φ 6 (4 × 6)
Koganei Corporation	Quick Fitting	TS-4-M5	TS-6-M5
	Quick Fitting	TS-4-M5M	TS-6-M5M
	TAC Fitting	BF4	BF6
NIHON PISCO CO., Ltd.	Tube Fitting	PC4-M5	PC6-M5
	Tube Fitting	PC4-M5M	PC6-M5M
	Tube Fitting Minimal	LC-0425-M5	LC-0640-M5

# HANDLING NOTES

## PRESSURE SENSORS

### PROTECTIVE CONSTRUCTION

- Protective construction applies to the environment of sensor use. Regarding the pressure medium compatibility, please refer to each product specification.
- The protective construction aims at water protection. For the oil or various types of liquid, please be reminded that the degree of protection is different.
- The cable end of our pressure sensor is not waterproof. When handling, please pull out the cable to avoid penetration of water.



Grade	Degree of protection	
0		No protection
1		Protected against solid foreign objects such as hands of $\varphi$ 50 mm and greater.
2		Protected against solid foreign objects such as finger of $\varphi$ 12.5 mm and greater.
3		Protected against solid foreign objects such as tools or wires of ( $\varphi$ or thickness of) 2.5mm and greater.
4		Protected against solid foreign objects such as tools or wires of ( $\varphi$ or thickness of) 2.5mm and greater.
5		Protected against such dust as damages the equipment operation.
6		Dust-tight

**[Related standards]**  
 IEC60529  
 IEC (The International Electrotechnical Commission) standard  
 IEC 60529  
 Degrees of protection provided by enclosures

JIS-C-0920  
 JIS(Japanese Industrial Standards ) standards JIC-C-0920  
 Test to prove protection against ingress of water and degree of protection

Grade	Category	Degree of protection	
0			No protection
1	Drip-proof I type		Protected against vertically falling water drops.
2	Drip-proof II type		Protected against vertically falling water drops when enclosure is tilted up to 15°.
3	Rain-proof type		Protected against rainfall when enclosure is tilted up to 60°.
4	Splash-proof type		Protected against splashing water.
5	Water-jets-proof type		Protected against water jets.
6	Waterproof type		Protected against powerful water jets.
7	Watertight type		Protected against the effects of temporary immersion in water.
8	Underwater type		Protected against the effects of continuous immersion in water.

# HANDLING NOTES

## PRESSURE SENSORS

### ■ Electrical handling note

#### ● General

##### • Please turn off the power when wiring

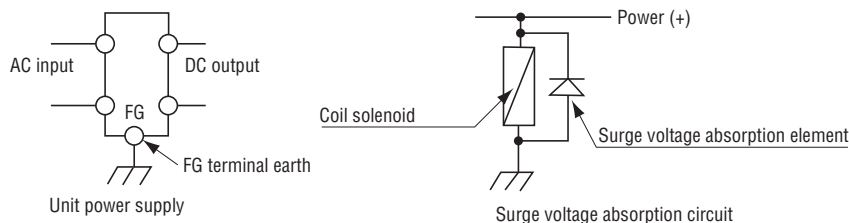
When wiring or changing wire, please turn off the power. Care must be taken when checking operations by connecting wires with clips.

Please turn off the power when pulling out or putting on the connector as well.

Please make sure of appropriate wiring before turning on the power.

##### • Dedicated DC power is preferable

Please use stabilized DC power. We recommend that power supply for sensors should be different from power supply for actuator. In case of use of unit power supply, please earth the FG terminal. (Fig. 1)



(Fig. 1)

##### • No electrical connections

N.C. (Non-connection) cables/terminals in Copal's sensors are provided in order to maintain the mechanical strength. Please avoid electrical connections.

##### • Watch out for excessive switch output load

Please make sure the switch load does not exceed the specification value. Considering rush current or surge current, please try to reduce loads as much as possible. Electronic load such as PLC input is recommended. In the case of a relay or solenoid, please use one with a built-in surge voltage absorption circuit or please attach a surge voltage absorption circuit such as diode.

Please do not short circuit between switch output line and other lines.

##### • Wiring should be separated from power line

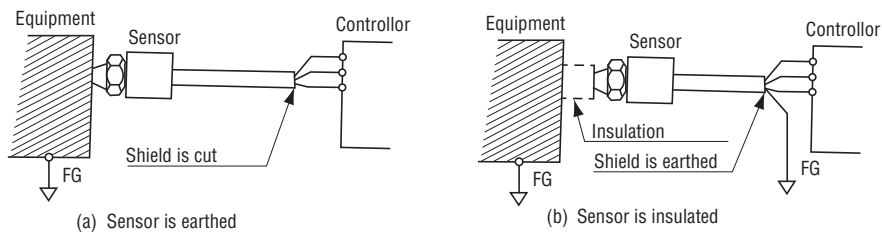
Sensor wiring should be separated from the other power lines or motors or heaters in order to protect sensors from electric field/magnetic field/surge voltage. Please do not bundle sensor wire with the other power line, and do not install sensor wire in the same conduit.

# HANDLING NOTES

## PRESSURE SENSORS

### • Wiring for shield cable

If the sensor cable is shielded please handle as follows. Shield is to be cut at the receiving end (the side of power supply) when sensor itself is earthed through piping. Shield is to be earthed at the receiving end (the side of power supply) when sensor itself isn't earthed. When cable is extended, please use the same kind of shield. (Fig. 2)



(Fig. 2)

### • Stability after power is applied

In case of pressure indicators, it may take approximately 1 second to the proper switch operation after power is applied. Thus, sequence, which is switchable from “ON” to “OFF” on power supply, should not be arranged. Much higher-performance can be expected for sensors with analog output, by taking 10 minutes' warm-up after power is applied.

### ● Handling notes of pressure transducers

#### • Main power

Fluctuations in the main power source will cause fluctuations in the output, so please use power source that matches the characteristics of the sensor. NIDEC COPAL ELECTRONICS's transducers are temperature-compensated to bring out the best characteristics when excited at 1.5 mA.

#### • Amplification circuitry

To sufficiently utilize transducer characteristics, use differential amplification circuitry considering input impedance, thermal error and common-mode voltage rejection ratio.

### ■ About lower limit of vacuum pressure range

While measuring the pressure in the range of vacuum by taking use of the pressure sensor (oil-enclosed type) as listed in the following table.

- Be attention that the the measurable pressure is limited to 1.3 kPa abs.
- For the measurement of pressure beyond the limitation, high-vacuum sensors such as thin film type are recommended.

#### Oil-enclosed type

The model	Pressure lower limit
P-8300,P-8305,P-8505,PA-750,PA-758,PA-800,PA-830,PA-838,PA-838-D,PA-840,PA-848,PA-850,PA-858,PS8,PS83,PS85,PG-35,PG-75,PG-208,PG-100B	1.3kPa abs

#### Thin film type

The model	Pressure lower limit
PA-920S,PA-928S,PA-930,PA-930-A,PS91,PG-20,PG-35L	1.4×10 <sup>-4</sup> kPa abs

# HANDLING NOTES

## PRESSURE SENSORS

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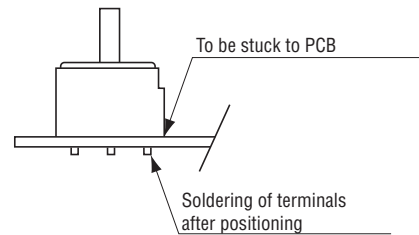
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### • Mounting on PCB

Mounting of pressure transducers on PCB should be made by manual soldering, and not by flow soldering nor by infrared reflow soldering.

To clean flux, please wipe it with a cloth dipped in a cleaning liquid. Please do not immerse the PCB in the cleaning liquid. Please pay attention so that vapor barrier agent, the flux, cleaning liquid and deoxidant etc. do not get inside the sensor or the atmospheric pressure vent hole.

Terminals are recommended to be soldered on PCB after proper positioning in order to prevent from mechanical stress on pressure port or on terminals. (Fig. 3)



### • External force such as piping

Please be sure that excessive stress such as by piping or by fixed "O" ring is not exerted on the transducer terminals on the PCB.

### ● Pressure switch/Pressure Gauge

#### • Battery for PG-100, PG-200 and PG-208

When the voltage of the battery becomes low, the indication for battery change appears on the display. Please replace it accordingly. (Fig. 3)

When replacing batteries, use the designated battery. The product doesn't perform with alkaline battery offered commercially. This battery is not available on the market; therefore please contact a supplier of our product for ordering.

On handling, the following must be avoided; "dismantling batteries" "short-circuiting + and - end of batteries" "charging batteries" "heating batteries" "putting batteries into a fire". Consumed lithium battery should be discarded according to the local rules.

When not using the units for a long time, remove batteries from the units and store them in a dry and cool place.

### • External power

When using an external DC power source, use a stable power source. The series-regulator type power source unit is recommended rather than the switching-regulator type. Please take necessary measures to protect the product from external noise by grounding the FG terminal of the power supply.

### • Response

There are some products that have delay in the indication or analog output or products that are available to set delay (digital filter). Those products are not affected by the sudden pressure change, however due to this time lag, the pressure change may not be responded. Please check it in accordance with the intended use.

# HANDLING NOTES

## PRESSURE SENSORS

### ■ CE marking/List of series that conform to EMC directive

Series name	EMI directive	
	EMI standards	EMS standards
PG-100	EN55011	EN61000-6-1 (Transportable equipment)
PS6, PS20, PS30, PS60, PS91, PG-30, PG-35/35L, PZ-30※1, WL10, PG-75		EN61326-1 (Industrial equipment)
PA-20, PA-708, PA-750, PA-758, PA-853, PG-20, PA-920S/928S, PA-960, PA-968		EN61326-1, -2-3 (Industrial equipment, Pressure transducers)

For details on each standards, "EC Declaration of conformity" is available.

※ 1 : PZ-30 (Current output type) is not applicable.

### ■ UL products

Series name		File No.
Pressure transducers with AMP	PA-20, PA-708, PA-750, PA-758, PA-830, PA-838, PA-853, PA-920S/928S, PA-930, PA-960, PA-968	E222253
Pressure switches	PS20, PS30, PS60, PS83	
Pressure gauges	PG-20, PG-30, PG-35, PG-35H, PG-35L, PG-75	
Pressure indicators	PZ-30 ※ 1	
Liquid leak esnsors	WL10	E255230

※ 1 : PZ-30 (Current output type) is not applicable.

### ■ Calibration

#### ● List of series that can be calibrated

The following are series that can be calibrated.

"Calibration certificate", "Traceability system chart" and "Outgoing inspection result" are available (For value). As for the lead-time or the prices, please contact our sales office nearby or your local retailer.

- PG-100 series
- PG-100N series
- PG-100B series
- PG-200 series
- PG-208 series

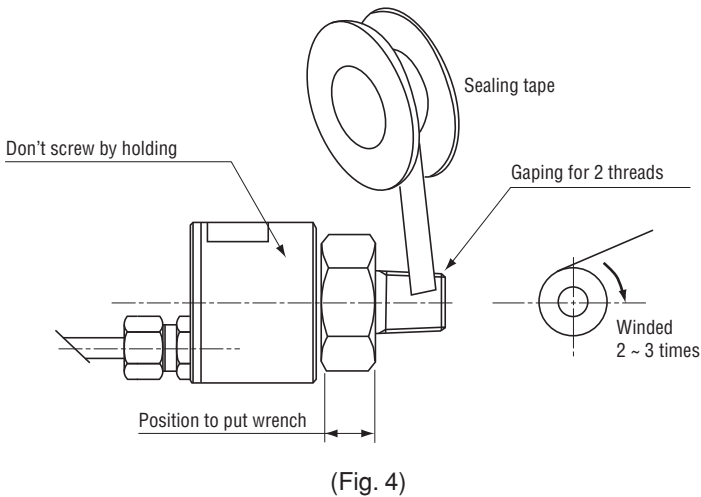
# HANDLING NOTES

## PRESSURE SENSORS

### ■ Installation

#### • Installation to piping

When installing the sensor to a piping, turn the sensor by using a wrench on the hexagonal part. Please do not turn the sensor by holding the body (especially at the plastic housing).



#### • Handling of taper screw thread

In case of joint of taper screw thread, please screw into the fitted pipe, winding the sealing tape on the screw part. In this case, the seal tape should be wound gaping for 2 threads from the head of thread. If the seal tape is wound from the head of thread, a piece of seal tape may go into the piping. Please screw the joint, after the seal tape is pressed down until the tape fits in the screw.

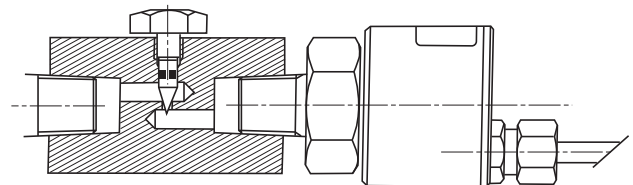
Please refer to the tightening torque as follows. (Fig. 4)

Screw figure	N·m Tightening torque
R 1/8	7 ~ 9
R 1/4	12 ~ 14
R 3/8	22 ~ 24
M 5	1.0 ~ 1.5

#### • Surge pressure

A sudden surge pressure may occur in the liquid piping such as water. When sensors get pressure from the piping, it may cause a damage on the sensor chip. It is the best way to hold the pressure under control as the surge pressure may give damage in the piping. If there is still a possibility of occurrence, we recommend the use of a diaphragm apparatus or an accumulator in order to prevent from the damage of sensors.

Another method may work such as to lengthen the distance of piping or to change the direction of mounting as well. (Fig. 5)



Measure for surge pressure

(Fig. 5)

# HANDLING NOTES

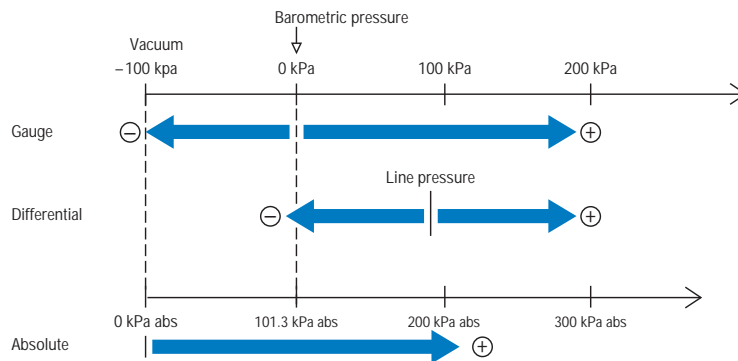
## PRESSURE SENSORS

### ■ PRESSURE CONVERSION TABLE

	Pa(N/m <sup>2</sup> )	kPa	MPa	bar	mbar(hPa)	kgf/cm <sup>2</sup>	mmH <sub>2</sub> O(mmAq)	inH <sub>2</sub> O	mmHg(Torr)	inHg	psi	atm
Pa(N/m <sup>2</sup> )	1	1 × 10 <sup>-3</sup>	1 × 10 <sup>-6</sup>	1 × 10 <sup>-5</sup>	1 × 10 <sup>-2</sup>	1.01972 × 10 <sup>-5</sup>	1.01974 × 10 <sup>-1</sup>	4.01474 × 10 <sup>-3</sup>	7.50062 × 10 <sup>-3</sup>	2.95300 × 10 <sup>-4</sup>	1.45038 × 10 <sup>-4</sup>	9.86923 × 10 <sup>-6</sup>
kPa	1 × 10 <sup>3</sup>	1	1 × 10 <sup>-3</sup>	1 × 10 <sup>-2</sup>	1 × 10	1.01972 × 10 <sup>-2</sup>	1.01974 × 10 <sup>2</sup>	4.01474	7.50062	2.95300 × 10 <sup>-1</sup>	1.45038 × 10 <sup>-1</sup>	9.86923 × 10 <sup>-3</sup>
MPa	1 × 10 <sup>6</sup>	1 × 10 <sup>3</sup>	1	1 × 10	1 × 10 <sup>4</sup>	1.01972 × 10	1.01974 × 10 <sup>5</sup>	4.01474 × 10 <sup>3</sup>	7.50062 × 10 <sup>3</sup>	2.95300 × 10 <sup>2</sup>	1.45038 × 10 <sup>2</sup>	9.86923
bar	1 × 10 <sup>5</sup>	1 × 10 <sup>2</sup>	1 × 10 <sup>-1</sup>	1	1 × 10 <sup>3</sup>	1.01972	1.01974 × 10 <sup>4</sup>	4.01474 × 10 <sup>2</sup>	7.50062 × 10 <sup>2</sup>	2.95300 × 10	1.45038 × 10	9.86923 × 10 <sup>-1</sup>
mbar(hPa)	1 × 10 <sup>2</sup>	1 × 10 <sup>-1</sup>	1 × 10 <sup>-4</sup>	1 × 10 <sup>-3</sup>	1	1.01972 × 10 <sup>-3</sup>	1.01974 × 10	4.01474 × 10 <sup>-1</sup>	7.50062 × 10 <sup>-1</sup>	2.95300 × 10 <sup>-2</sup>	1.45038 × 10 <sup>-2</sup>	9.86923 × 10 <sup>-4</sup>
kgf/cm <sup>2</sup>	9.80665 × 10 <sup>4</sup>	9.80665 × 10	9.80665 × 10 <sup>-2</sup>	9.80665 × 10 <sup>-1</sup>	9.80665 × 10 <sup>2</sup>	1	1.00003 × 10 <sup>4</sup>	3.93712 × 10 <sup>2</sup>	7.35559 × 10 <sup>2</sup>	2.89590 × 10	1.42233 × 10	9.67841 × 10 <sup>-1</sup>
mmH <sub>2</sub> O(mmAq)	9.80638	9.80638 × 10 <sup>-3</sup>	9.80638 × 10 <sup>-6</sup>	9.80638 × 10 <sup>-5</sup>	9.80638 × 10 <sup>-2</sup>	9.99972 × 10 <sup>-5</sup>	1	3.93701 × 10 <sup>-2</sup>	7.35559 × 10 <sup>-2</sup>	2.89582 × 10 <sup>-3</sup>	1.42229 × 10 <sup>-3</sup>	9.67814 × 10 <sup>-5</sup>
inH <sub>2</sub> O	2.49082 × 10 <sup>2</sup>	2.49082 × 10 <sup>-1</sup>	2.49082 × 10 <sup>-4</sup>	2.49082 × 10 <sup>-3</sup>	2.49082	2.53993 × 10 <sup>-3</sup>	2.54000 × 10	1	1.86827	7.35539 × 10 <sup>-2</sup>	3.61263 × 10 <sup>-2</sup>	2.45825 × 10 <sup>-3</sup>
mmHg(Torr)	1.33322 × 10 <sup>2</sup>	1.33322 × 10 <sup>-1</sup>	1.33322 × 10 <sup>-4</sup>	1.33322 × 10 <sup>-3</sup>	1.33322	1.35951 × 10 <sup>-3</sup>	1.35955 × 10	5.35255 × 10 <sup>-1</sup>	1	3.93701 × 10 <sup>-2</sup>	1.93368 × 10 <sup>-2</sup>	1.31579 × 10 <sup>-3</sup>
inHg	3.38639 × 10 <sup>3</sup>	3.38639	3.38639 × 10 <sup>-3</sup>	3.38639 × 10 <sup>-2</sup>	3.38639 × 10	3.45316 × 10 <sup>-2</sup>	3.45325 × 10 <sup>2</sup>	1.35955 × 10	2.54000 × 10	1	4.91154 × 10 <sup>-1</sup>	3.34211 × 10 <sup>-2</sup>
psi	6.89476 × 10 <sup>3</sup>	6.89476	6.89476 × 10 <sup>-3</sup>	6.89476 × 10 <sup>-2</sup>	6.89476 × 10	7.03070 × 10 <sup>-2</sup>	7.03089 × 10 <sup>2</sup>	2.768076 × 10	5.17149 × 10	2.03602	1	6.80460 × 10 <sup>-2</sup>
atm	1.01325 × 10 <sup>5</sup>	1.01325 × 10 <sup>2</sup>	1.01325 × 10 <sup>-1</sup>	1.01325	1.01325 × 10 <sup>3</sup>	1.03323	1.03326 × 10 <sup>4</sup>	4.06794 × 10 <sup>2</sup>	7.60000 × 10 <sup>2</sup>	2.99213 × 10	1.46960 × 10	1

※ The data is for reference.

### ■ PRESSURE REFERENCE



#### ● Gauge pressure

The gauge pressure is measured by the difference from atmospheric pressure on the basis of the atmospheric pressure. The vacuum pressure (negative pressure) is displayed in minus. The pressure is used for the measurement of degree of pressurization by compressor or by hydraulic equipment, the measurement of degree of high vacuum by ejector, the confirmation of the vacuum suction or the confirmation of ambient pressure in a vacuum chamber.

#### ● Absolute pressure

The absolute pressure is measured by the difference from absolute vacuum as the basis. The absolute pressure, that isn't affected by the fluctuation caused by the condition of atmosphere or altitude, is used for the measurement of atmosphere, altitude, water depth, or degree of vacuum. **Please consult us in case of use in the high vacuum.**

#### ● Differential pressure



The differential pressure is measured by the difference of pressure between 2 ports. It is measured on the basis of either pressure. The pressure is used for the measurement of flow rate, the check of clogged filter or leak test.

#### ● Compound pressure is a pressure ranged from

Negative(vacuum) to positive(gauge) pressure. Pressure sensor for compound pressure alone can measure both positive and negative pressure, useful for application like a pump whose pressure can be either vacuum or positive.



## ● General specifications

- **Rated pressure**  
The maximum value of the pressure at which all the specifications of the pressure sensor can be met or the value of the pressure which can be continuously applied to the pressure sensor without losing the performance characteristics to meet all the sensor specifications.
- **Maximum pressure**  
The maximum pressure which can be applied to the pressure sensor. The sensor specifications are to be met even after the maximum pressure is applied to the sensor for a short period of time. (However, there is a possibility that the offset voltage/zero voltage changes.)
- **Break-down pressure**   
The pressure at which the pressure sensor is mechanically or electrically damaged.  
It should be noted that at this pressure, pressure media may leak out from the pressure sensor.
- **Compensated temperature range**  
The temperature range within which the sensor specifications are satisfied.  
Our standard pressure sensors are compensated for a temperature range of 0 to 50 °C.
- **Operating temperature range**  
The temperature range within which the pressure sensor can be used without causing any permanent damage.  
Pressure sensors may be used at a temperature beyond the compensated temperature range but within the operating temperature range. However, in this case, sensor specifications may not be met.
- **Storage temperature range**  
The temperature range within which the pressure sensor can be stored without causing any permanent change in the sensor specifications. No load conditions, namely, no power supply and no pressure application are assumed for the storage.
- **Operating humidity range**   
The humidity range within which the pressure sensor can be operated without causing any permanent change in the sensor specifications.  
It is to be noted that the condensation that may be generated due to a rapid temperature change may damage the pressure sensor.
- **Bridge resistance**  
The resistance between the input terminals of the pressure sensor which is measured with the input and output terminals open.

- **Pressure medium**  
Our pressure sensors consist of two compatible fluids type: Gases only and gases and liquids.
- **Insulation resistance**  
The DC resistance between the housing of the pressure sensor (pressure port) and the sensor circuit.
- **Dielectric strength**  
The AC voltage which can be applied between the housing of the pressure sensor and the sensor circuit without leakage current.
- **Excitation/power supply**  
The supply voltage/current to operate the pressure sensor.  
Our standard pressure sensors without amplifier is excited by current, whereas other pressure sensors are driven by voltage.

## ● Analog output

- **Offset voltage**  
The output voltage when no pressure is applied to the pressure sensor.  
In the case of absolute pressure type pressure sensors, the offset voltage is at the absolute vacuum.
- **Zero voltage/current**  
The output when no pressure is applied to the pressure sensor.  
In the case of absolute pressure type, zero voltage / current is at the absolute vacuum.
- **Span voltage/current**  
The difference between the output when rated pressure is applied to the pressure sensor and the zero voltage/current.
- **Linearity**  
The maximum deviation of the actually measured output from the linear output which is defined by connecting the no load output and rated output points when the pressure is increased from no load to the rated pressure. (Fig. 1) The error is expressed in percent against the span output.
- **Hysteresis**  
The maximum difference between the output when the pressure to the pressure sensor is increased from no load to the rated pressure and the output when the pressure is decreased from the rated pressure to no load. The error is expressed in percent against the span output. (Fig. 1)

# GLOSSARY

## PRESSURE SENSORS

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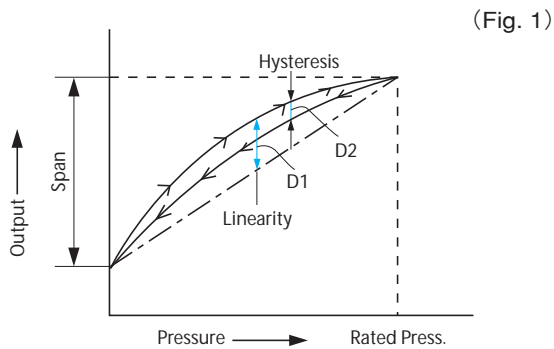


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- Linearity/hysteresis  
The sum of the linearity and hysteresis errors.



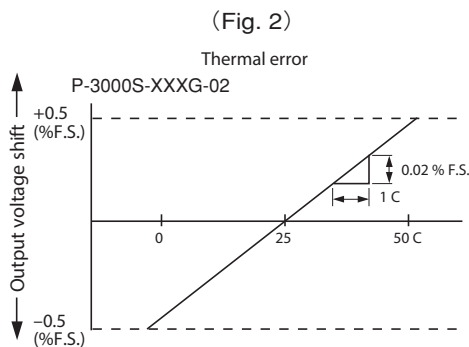
$$\text{LINEARITY} = \frac{D1_{\text{max.}}}{\text{Span}} \times 100 \text{ [%F.S.]}$$

$$\text{HYSTERESIS} = \frac{D2_{\text{max.}}}{\text{Span}} \times 100 \text{ [%F.S.]}$$

- Response time  
The time that the rated output voltage increases from 10 % to 90 % in the maximum amplitude or decreases after the pulse of the rated pressure is applied to a pressure sensor.
- Supply voltage effect  
The percentage change in the zero output and span output, when the supply voltage is varied from its minimum spec. value to the maximum spec. value.

- Gravitational effect  
The percentage change in the zero output due to gravity.

- Thermal error  
The percentage change per one degree C in the zero voltage/current and span voltage/current against the span voltage/current at 25 °C when the ambient temperature of the pressure sensor is varied from 25 °C (reference temperature) to 0 °C (cold side) and to 50 °C (hot side).



### ● Switch output

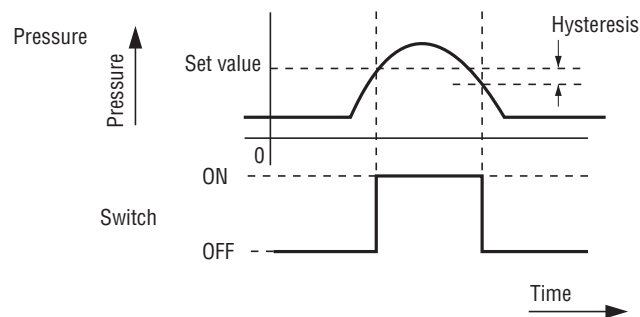
- Output interface

The output interface of our standard pressure switches is an open collector ended switching transistor of either NPN or PNP junctions.

- Hysteresis

The change in the operating pressure point (where the pressure switch operates on and off) when the pressure is increased/decreased.

(Fig. 3)



- Setting range

The adjustable pressure range for the switch output.

- Operating accuracy

The accuracy of the operating pressure point when the ambient temperature is varied.

- Switching capacity

The maximum capacity of the output transistor of the pressure switch.

# GLOSSARY

## PRESSURE SENSORS

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### ● Display (for pressure gauges and pressure monitors)

- Rated display range  
The range of pressure displayed and is from a no load value to the rated pressure.
- Display accuracy  
The display accuracy when the ambient temperature of the display is varied.

### ● Environmental test

- Vibration  
This test checks for the effect the pressure sensor undergoes after the vibration of certain frequency and certain amplitude is applied to the pressure sensor for a specified period of time.
- Pressure cycling  
The pressure sensor is checked after the application of no load and rated pressure is repeated a specified number of times.

※ The environmental test conditions for the above tests are specified for each product individually.  
The effect of the test is checked in terms of a percentage change in the output voltage/current, switch output settings and displayed pressure against either the span voltage/current or the rated pressure.

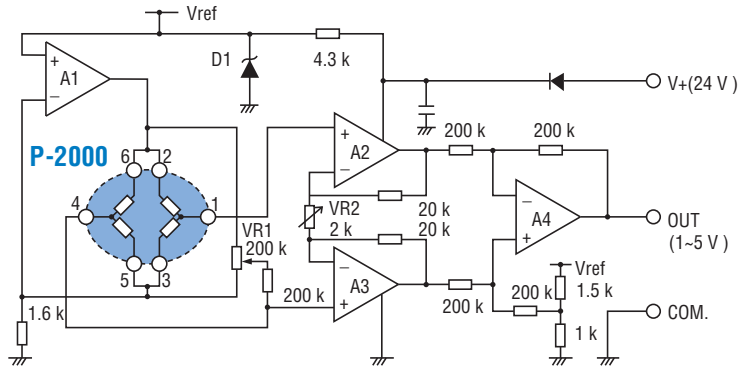
- Display cycle (Sampling rate)  
The number of display cycles per second.

- Shock  
This test checks for the effect on the pressure sensor after the shock of certain magnitude and certain wave shape is applied to the pressure sensor a specified number of times.
- Moisture resistance  
The effect on the pressure sensor is checked after the sensor is subjected to a high temperature and high humidity condition for a specified period of time.

# PRESSURE TRANSDUCERS RECOMMENDED EXTERNAL CIRCUIT

## RECOMMENDED EXTERNAL CIRCUIT

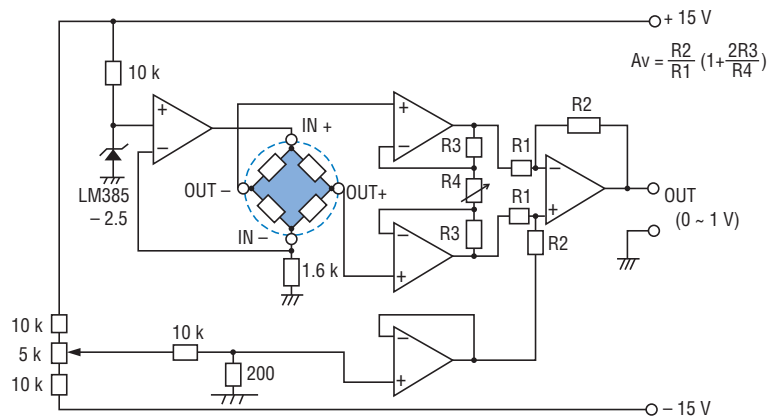
### 1 ~ 5 V Output



A1~4: LM324 ※ D1 :LM385-2.5

※ In case of being required the improvement of accuracy, high accuracy amp. such as LT1014 is recommended.

### 0 ~ 1 V Output

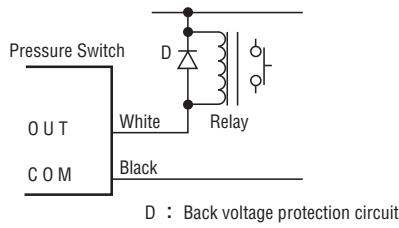


# PRESSURE SWITCHES TYPICAL CIRCUIT CONNECTION

## TYPICAL CIRCUIT CONNECTION

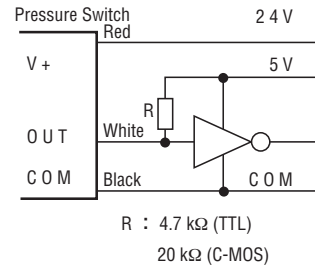
### ● Connection with a small size relay or a solenoid

Practically the switch can directly drive a small size, 1 W class, relay or a similar wattage solenoid at 24 V. Back voltage protection must be prepared.



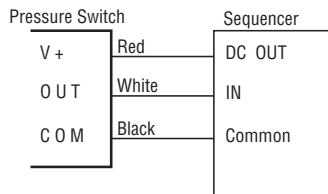
### ● Connection with TTL or CMOS

Due to the employment of the open collector configuration, a pull-up resistor is required.



### ● Connection with a sequence controller

The switch output can be directly connected to the non-contact input terminal of the sequence controller. The switch can make use of the sensor power supply from the sequence controller.



### ● Load current

A lamp load or like that may cause excessive current flow and requires the proper preventive measure.

