

# PROXIMITY SENSOR GUIDE

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Thank you for purchasing Autonics product.

Before use, be sure to read the safety considerations and use them correctly.

**Autonics**

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## Selecting Proximity Sensors

It is an element to select a proximity sensor. Select the right product for each element for the most optimal detection.  
You can check the details by referring to the contents.

**1 Purpose of use** Product selection according to the intended use

**Inductive type, capacitive type**

**2 Appearance** Select the appearance

**Cylindrical type, Rectangular type**

**3 Feature** Select the feature of the Proximity Sensor

**Cylindrical type: Full-metal general type, General type, Full-metal spatter-resistant type, General spatter-resistant type**  
**Rectangular type: General type, Flat type**

**4 Sensing distance** Select the sensing distance

**General type, long distance type**

**5 Installation** Select the installation of the proximity sensor

**Flush type, non-flush type**

**6 Connection** Select the connection of the proximity sensor

**Cable type, cable connector type, connector type**

**7 Control output** Select the control output of proximity sensor

**N.O., N.C. / NPN N.O., NPN N.C. / PNP N.O., PNP N.C.**  
**NPN N.O. + N.C. / PNP N.O. + N.C.**

## What is a Proximity Sensor?

Proximity sensor is the non contact sensor which detects the sensing target when it comes close, not same as the micro switch or the limit switch using the mechanical contact sensing method.

### ■ Inductive type

When the object (metallic) approaches the high-frequency magnetic field which is produced at the detection coil, induced currents flow in the metal, causing thermal loss and resulting in the reduction or stopping of oscillations.

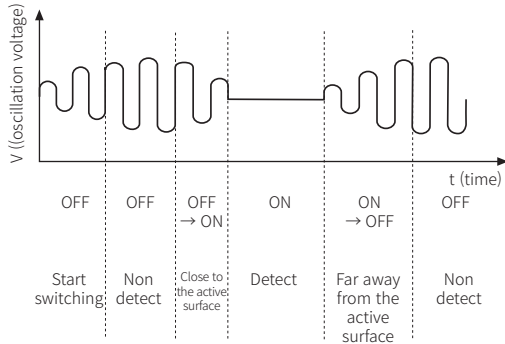
This change in state is detected by an oscillation state sensing circuit which then operates the output circuit.

#### • Operation

When the proximity sensor is on, the oscillation of the current within 60 ms will be increased to certain frequency, and electric field is formed.

After that, if the object approaches, the induced current surrounding the sensing object will be increased, and the oscillation of the current will be decreased. When the object is detected completely, the current will be close to 0 V.

This very little oscillation of the current will be amplified, and will operate the output part.

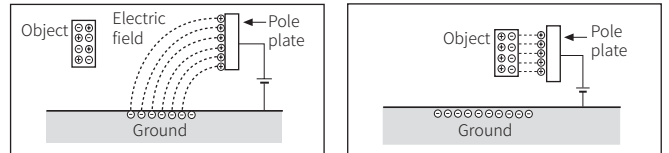


### ■ Capacitive type

As shown below figure, when + current is applied on the pole plate, + charge will be on the pole plate, - charge will be on the ground, and the electric field will be occurred between the pole plate and the ground.

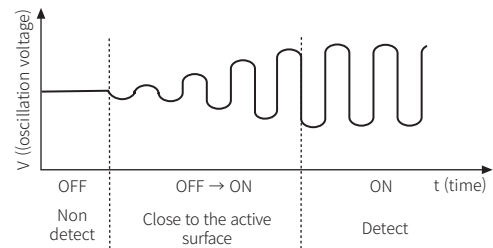
When the object approaches to the pole plate, the charges in the object move by the electrostatic induction. - charge will move to the pole plate side, and + charge will move to the other side. This state is called polarization.

The object is detected by the strength of the polarization which is strong when the object moves to the pole plate side, and is weak when the object moves far away from the pole plate.



#### • Operation

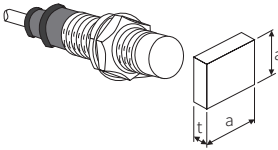
Capacitive proximity sensor works contrary method to the inductive proximity sensor. When the sensor power is on, the oscillation of the current is close to 0V. When the object approaches to the sensor, the capacitance will be increased and the oscillation of the current is increased. This output part will be operated by increasing the oscillation.



## Glossary and Functions

### ■ Standard sensing target

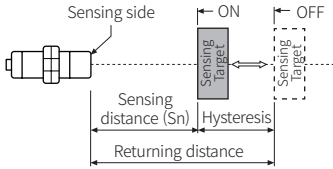
It is the standard of shape, size, and material for each model to measure the standard performance.



t: Thickness of the target (mm)  
a: Length of the one side of the target (mm)

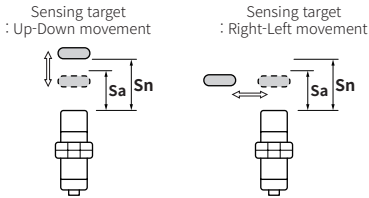
### ■ Sensing distance (Sn)

It is the distance between the sensing side and the surface of the sensing target, when the output works by approaching the sensing target to the sensing side. The specification of sensing distance (Sn) for each series is measured by standard sensing target.



### ■ Setting distance

It is the distance between the active surface and the surface of the sensing target, when the output works by approaching the sensing target to the active surface. The specification of sensing distance (Sn) for each series is measured by standard sensing target.

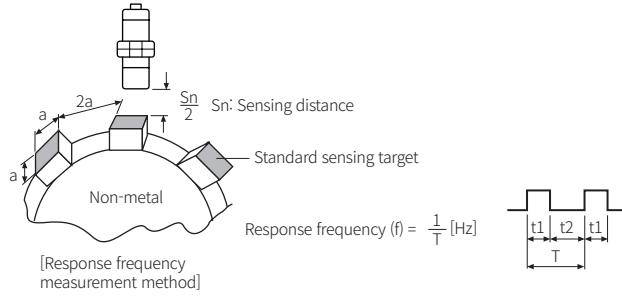


### ■ Hysteresis (differential distance)

The hysteresis is the difference between the operation distance, when the sensor first operates with the standard sensing target approaching from the active surface direction, and the returning distance, when the sensor first stops operating with the standard sensing target receding. This hysteresis prevents chattering of the output due to vibration, etc., of the sensing target.

### ■ Response frequency

The number of times per second at which sensing can be done without malfunction, when approach the standard sensing target to the sensor. It shows Hz.



### ■ Relative dielectric constant

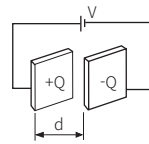
It is the ratio of between the dielectric constant of the material ( $\epsilon$ ) and the dielectric constant of vacuum ( $\epsilon_0$ ). ( $\epsilon_r = \epsilon / \epsilon_0$ )

As the relative dielectric constant is big, the sensing distance is long. And each material has its own value of the relative dielectric constant. The value of the relative dielectric constant for solid is bigger than liquid. There are the relative dielectric constants for typical materials.

Material	Relative dielectric constant ( $\epsilon_0$ )	Material	Relative dielectric constant ( $\epsilon_0$ )
Air	1	Polystyrene	1.2
Paper	2.3	PVC	3
Wood	6 ~ 8	Glass	5
Alcohol	25.8	Water	80

### ■ Capacitance

It is the amount of the accumulated charge (Q), when apply voltage at the insulated conductors. As the accumulated charge (Q) is big, the sensing distance becomes long. As shown above formula, the capacitance (C) will be increased as the amount of charge (Q) is increased. There are the methods to increase the capacitance, increase the area of the pole plate, use the material that the relative dielectric constant is big or narrow the distance between two pole plates.



$$\text{Capacitance (C)} = \frac{Q}{V} = \frac{\epsilon A}{d}$$

A: The area of the pole plate

d: The distance between two pole plate

Q: Charge

$\epsilon$ : Dielectric constant

## Installation

### ■ Flush type mounting (Shield)

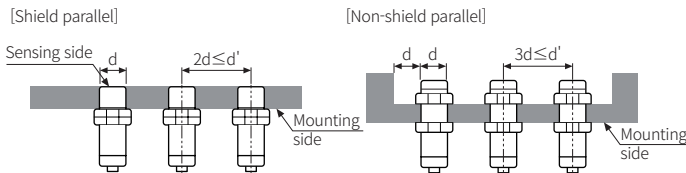
The most area of the proximity sensor is surrounded by metal except the active surface to prevent the effect of the approaching metal from side. Even though the sensing distance is shorter than non-flush type, the active surface of the sensor can be mounted at the same level of the metal enclosure like below figure.

### ■ Non-flush type mounting (Non-Shield)

The sensor is affected easily by approaching metal from side because the side of the active surface was not shield by metal. The sensing distance is longer than the flush type, but when mount the sensor, please mount on the concave side, and keep the distance three times longer than the diameter of the sensor like below figure.

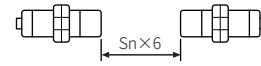
### ■ Parallel mounting

When several proximity sensors are mounted close together, there is the effect of mutual interference. Therefore please keep the distance which is two times longer than the diameter of the sensor for flush type, and three times longer than the diameter of the sensor for the non-flush type.



### ■ Face to face mounting

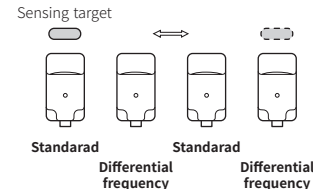
When proximity sensors are mounted in face to face, malfunction of sensor may be caused due to mutual interference. Therefore, please keep the distance which is six times longer than the sensing distance. (Sn: sensing distance)



### ■ Tightly mounting

When proximity sensors are mounted tightly, malfunction of sensor may be caused due to mutual interference.

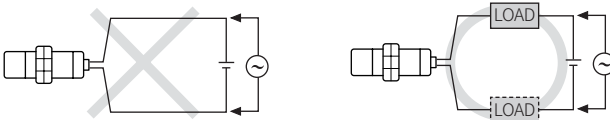
Therefore, please use differential frequency for the application like below picture. Differential frequency type is only for PSN17 series.



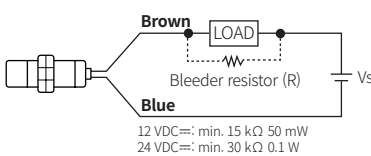
## Load Connection Method

### ■ DC 2-wire / AC 2-wire

When using 2-wire type model, the load must be connected, otherwise internal components may be damaged. The load can be connected to either wire.



- In case of the load current is small (DC 2-wire)

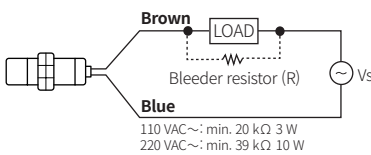


$$R \leq \frac{V_s}{I_o - I_{off}} \text{ (k}\Omega\text{)} \quad P > \frac{V_s^2}{R} \text{ (W)}$$

$V_s$ : Power supply  
 $I_o$ : Min. action current of proximity sensor  
 $I_{off}$ : Return current of load  
 $P$ : Number of Bleeder resistance watt

- Please make the current on proximity sensor smaller than the return current of load by connecting a bleeder resistor in parallel.
- W value of Bleeder resistor should be bigger for proper heat dissipation.

- In case of the load current is small (AC 2-wire)



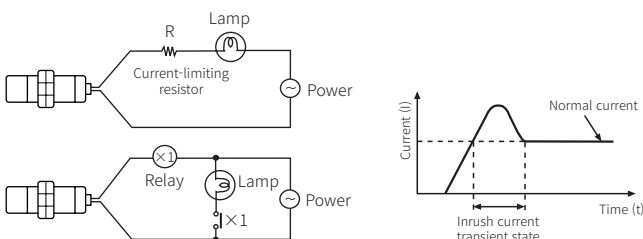
$$R \leq \frac{V_s}{I} \text{ (}\Omega\text{)} \quad P > \frac{V_s^2}{R} \text{ (W)}$$

$I$ : Operating current of load  
 $R$ : Bleeder resistance  
 $P$ : Allowable voltage

- When operating current of load is under 5mA, use bleeder resistance so that current flowing through load can be increased to over 5mA.
- Use the formula below to calculate the value of bleeder resistance and allowable current.
- W value of Bleeder resistor should be bigger for proper heat dissipation.

- Load with large inrush current

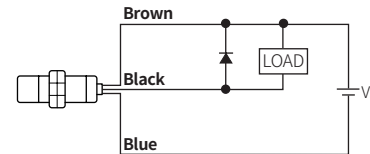
When using load with big inrush current (lamp, motor, etc.), large inrush current flows due to low initial resistance value and it returns to steady state current by high resistance value after certain time. In this case, too large current flows at initial power and it may cause damage to inner circuit of proximity sensor. Use additional relay or current-limit resistance (R) to protect proximity sensor.



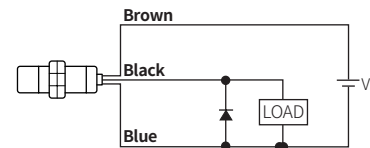
### ■ DC 3-wire

In DC 3-wire type of proximity sensor, there are two types of output, NPN and PNP, and they can either open or close power relay, solenoid, electric counter, PLC, etc. In case of using inductive load (relay, motor, magnet, etc.), connect surge absorber diode in parallel with load. Use diode, of which withstand voltage is threefold over power supply.

- In case of the load current is small (NPN output type)



- In case of the load current is small (PNP output type)



## Series (AND) Connection

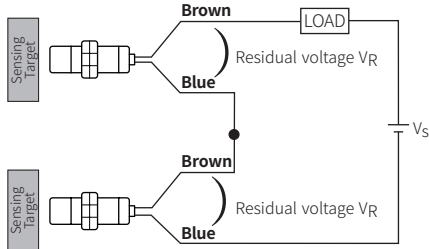
- When it is connected in series (AND), all proximity sensors have to be in working to make loads operated.
- The residual voltage which is related with the number of the sensor should not influence both operating voltage of proximity sensors and driving voltage of a load, and which condition should be considered to choose how many sensors to be connected in series.

### DC 2-wire

To connect sensors in series, choose the number of proximity sensors within the amount that meets formula below.

$$V_s - (n \times V_R) \geq \text{Operating voltage of load.}$$

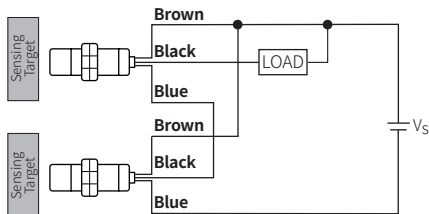
( $V_s$ : Source voltage,  $V_R$ : residual voltage,  $n$ : the number of connected sensors)



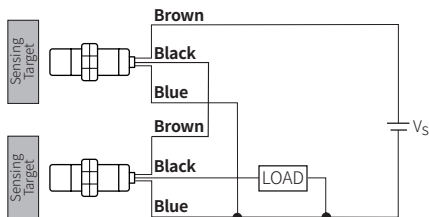
### DC 3-wire

NPN output type sensor and PNP output type sensor cannot be used in a same circuit.

- NPN output type



- PNP output type



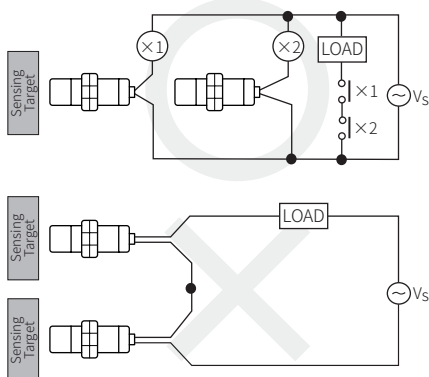
### AC 2-wire

In principle AC type of proximity sensor cannot be used in series connection.

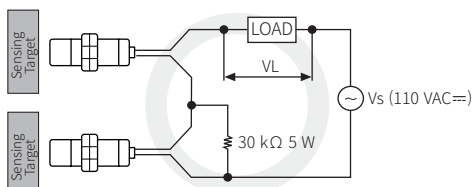
To use it in series connection, put relay or bleeder resistance in circuit.

When connecting in series, operating voltage,  $V_L$ , is calculated as subtraction of power source voltage and residual voltage of proximity sensor.

Thus, it would follow a formula;  $V_L = \text{power source voltage} - (\text{residual voltage of proximity sensor} \times \text{the number of sensor})$



- Bleeder resistance connection method



## Parallel (OR) Connection

- When it is connected in parallel (OR), it works even only one sensor is on operation.
- A little current flows as a leakage current because proximity sensor operates inner circuit even when it is OFF.
- Because a number of sensors connected in parallel increase the amount of leakage current, load could run when proximity sensor is in OFF status.

### DC 2-wire

The number of proximity sensors that can be connected can be connected within the range that can satisfy the following formula.

$$n \times I_L \leq \text{The returning current of load}$$

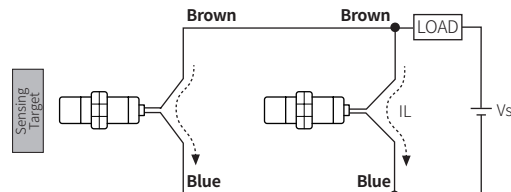
( $I_L$ : the leakage current of sensor,  $n$ : the number of connected sensors)

#### Example of connections

: Proximity sensor PRT18-DO, the returning current of load  $\leq 3.7$  mA,

The leakage current proximity sensor  $\leq 0.6$  mA

→ Six sensors can be connected in parallel in Max.

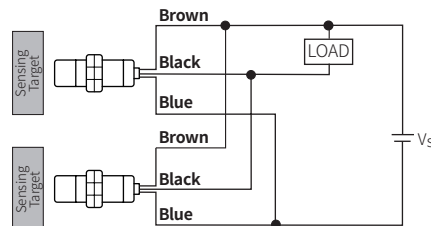


### DC 3-wire

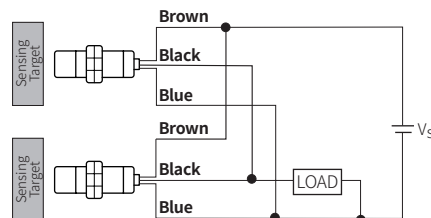
The leakage current which is related with the number of the sensor should not influence the returning current of load, and which condition should be considered to choose how many sensors to be connected in parallel.

NPN output type sensor and PNP output type sensor cannot be used in a same circuit.

- NPN output type



- PNP output type

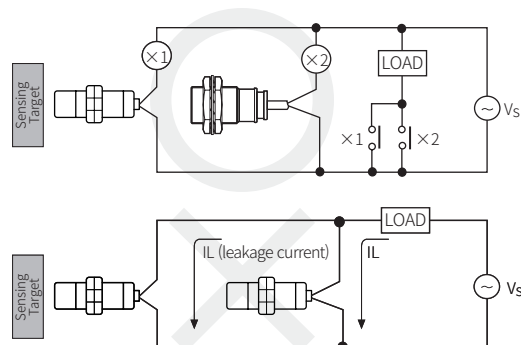


### AC 2-wire

In principle AC type of proximity sensor cannot be used in series connection.

Even though parallel connection is possible when those sensors are not being operated at a same time, because leaking current is increased by  $n$  times, returning faulty of load can occur. ( $n$ : the number of connected sensors)

Thus, connect relay in parallel so that load can work properly.



## PLC Connection Method

### ■ DC 2-wire

DC 2-wire type of proximity sensor can be connected with PLC when input specification of PLC and proximity sensor specification comply with the conditions shown below.

- 1) When ON voltage of PLC and residual voltage of sensor meet following formula.  
:  $V_{ON} \leq V_S - V_R$
- 2) When OFF voltage of PLC and a leakage current of sensor meet following formula.  
:  $I_{off} \geq I_L$
- 3) When ON current of PLC and control output current of sensor meet following formula. :  $I_{out}(\min) \leq I_{on}$

#### [Note]

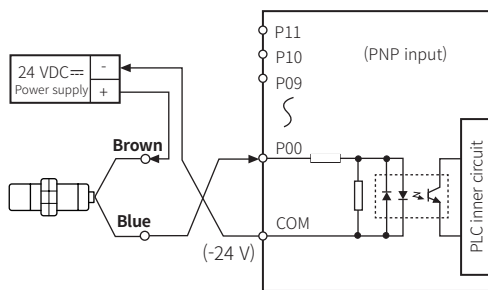
- $V_{ON}$ : ON voltage of PLC
- $V_S$ : Power supply
- $V_R$ : Residual voltage of proximity sensor
- $I_{off}$ : OFF current of PLC
- $I_L$ : Leakage current of proximity sensor
- $I_{out}(\min)$ : The min. value of proximity sensor's control output
- $I_{on}$ : ON current of PLC

#### Example of connections

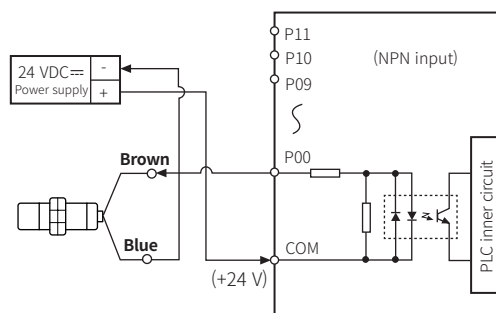
[PLC input spec.]  
ON voltage( $V_{ON}$ ):  $\geq 15 \text{ VDC} \Rightarrow$   
ON current ( $I_{on}$ ):  $\geq 4.3 \text{ mA}$   
OFF current ( $I_{off}$ ):  $\leq 1.5 \text{ mA}$   
[Proximity sensor]  
PRT18-5DO (power supply:  $24 \text{ VDC} \Rightarrow$ )

- 1)  $V_{ON} (15 \text{ V}) \leq V_S (24 \text{ V}) - V_R (3.5 \text{ V})$   
=  $20.5 \text{ V}$ : OK
- 2)  $I_{off} (1.5 \text{ mA}) \geq I_L (0.6 \text{ mA})$ : OK
- 3)  $I_{out}(\min) (2 \text{ mA}) \leq I_{on} (4.3 \text{ mA})$ : OK

- PLC's Common terminal is -24 V



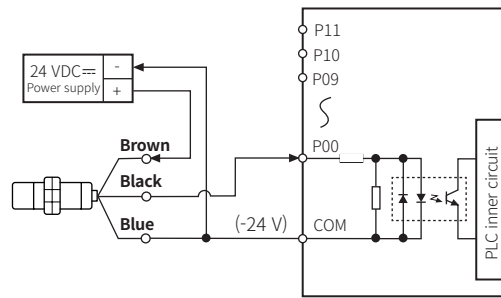
- PLC's Common terminal is +24 V



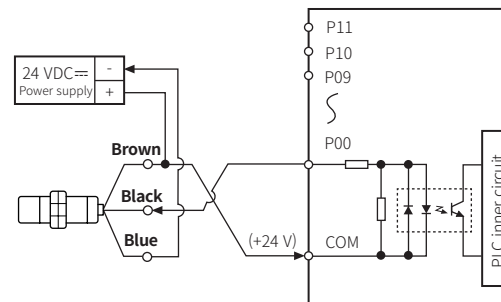
### ■ DC 3-wire

When connecting DC 3-wire type of proximity sensor with PLC, applicable sensor is chosen differently depend on common terminal status.

- PLC's Common terminal is -24 V



- PLC's Common terminal is +24 V





## Change in Sensing Distance

The sensing distance can be changed depending on the condition of the sensing object.

### ■ Changing by material and size

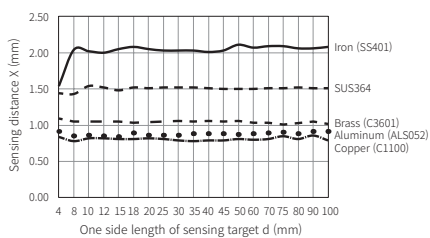
Material of the standard sensing object is magnetic metal (iron). Be sure that sensing distance of nonmagnetic metal (aluminum, etc) for a sensing object is shorten extremely.

If a sensing object is smaller than the standard sensing object, the sensing distance is shorten.

- Sensing distance by target material

Material	Distance
Iron	100 %
Stainless steel	≈ 65 %
Brass	≈ 40 %
Aluminum	≈ 30 %
Copper	≈ 28 %

- Sensing distance feature data by target material and size (based on PR08-2D model)



### ■ Changing by thickness

Thickness of standard sensing object is 1 mm. If the thickness is over 1 mm and sensing distance does not have any variation. Even though material of a sensing object is nonmagnetic metal (aluminum, copper, etc) and the thickness is around 0.01 mm, the sensing object has the same sensing distance as magnetic metal's. If a sensing object which is ultra thin by film, etc or has no conductive cannot be detected.

### ■ Changing by plate of object

If the sensing object is plated, the sensing distance may be subject to change. The below table is a representative example, and the reference value is the % value for the detection distance without plating.

Thickness of plated type	Applied metal	
	Iron	Brass
Not plated	100	100
Zn 5 to 15 $\mu\text{m}$	90 to 120	95 to 105
Cd 5 to 15 $\mu\text{m}$	100 to 110	95 to 100
Ag 5 to 15 $\mu\text{m}$	60 to 90	85 to 100
Cu 10 to 20 $\mu\text{m}$	70 to 95	95 to 105
Cu 5 to 15 $\mu\text{m}$	-	95 to 105
Cu 5 to 10 $\mu\text{m}$ + Ni (10 to 20 $\mu\text{m}$ )	70 to 95	-
Cu (5 to 15 $\mu\text{m}$ ) + Ni (10 $\mu\text{m}$ ) + Cr (0.3 $\mu\text{m}$ )	75 to 95	-

## Maintenance

For long-term using proximity sensor, check the below items.

- Installation environment for sensing target and proximity sensor, untightening of nut and distortion
- Untightening of wiring and connection, wrong connection, and disconnection
- Attached or accumulated metal dust at sensing part
- Setting distance
- Ambient environment and temperature

# APPENDIX

<b>Safety Certification for Product and Component</b> .....	III
<b>Communication Standards</b> .....	V
<b>IP Code (protection against dust and water)</b> .....	VI

## Safety Certification for Product and Component

- For detailed certification information, visit the website of each certification body.
- For the status of certification on our product, visit the Autonics website.

### ■ CE

- Country: European Union



CE marking is the conformity marking, meaning that it complies with all Directives of the Council of European Union regarding safety, health, environmental, and consumer protection standards.

If a product judged to be a risk to the consumer's health, safety, and environmental protection, is sold in the European market, the CE mark must be affixed. It is an essential certification for entry into the European market.

### ■ UL Listed

- Country: United States



UL listing is the American standard for safety. It is a non-mandatory standard, but most States mandate this standard. This certification is highly favored by consumers. UL Listed Mark means the end product meets standards of safety.

### ■ TR CU

- Country: Eurasian Economic Union



The EAC certification is accredited by five member countries of the Eurasian Economic Union (EAEU): Russia, Kazakhstan, Belarus, Armenia, and Kyrgyzstan.

Regulated products without the EAC mark are prohibited to access the markets of 5 members of EAEU.

- Type of certification
  - : Certificate of Conformity (CoC),
  - Declaration of Conformity (DoC)

### ■ KC

- Country: Republic of Korea



The KC certification mark must be affixed on an imported or domestically manufactured electrical product that is to be distributed or sold in Korea.

Type of certification: safety certification, EMC certification

- Safety certification: Korean Agency for Technology and Standards (KATS) affixes and manages the KC certification mark for electrical appliances, household goods, and children's products by dividing the steps into safety certification / safety confirmation / supplier's declaration of conformity (SODC) according to the different levels of potential danger.
- EMC certification: Manufacture, sale, or import for equipment that may cause harm to the radio environment and broadcasting communication network, or that may cause or receive significant electromagnetic interference, the KC certification mark is issued through electromagnetic compatibility (EMC) testing.

### ■ S-Mark

- Country: Republic of Korea



The S-Mark is the optional certification system to prevent industrial accidents. Korea Occupational Safety and Health Agency (KOSHA) conducts a comprehensive evaluation for the safety and reliability of product, and the capability of quality control in manufacturing.

Due to non-mandatory, there is no regulation or disadvantage on the uncertified product.

### ■ UKCA

- Country: United Kingdom



UK Conformity Assessed (UKCA) is a certification mark that indicates conformity with the applicable requirements for products sold within Great Britain (England, Scotland and Wales).

UK certification authorities can not issue EU legal certificates and existing UK certificates are no longer recognized on the EU market. Manufacturers who have previously used legally required certificates from UK authorities must transfer them to institutions within the EU or apply to new institutions.

For products to be released in the EU market, CE certification marks are required as before.

### ■ UL Recognized

- Country: United States



UL listing is the American standard for safety. It is a non-mandatory standard, but most States mandate this standard. This certification is highly favored by consumers.

UL Recognized Mark means the components intended for use in a complete product or system meet standards of safety.

### ■ KCs

- Country: Republic of Korea



The Minister of Employment and Labor evaluates the safety of hazardous or dangerous machinery, equipment, facilities, protective devices, and protective equipment based on the 'safety certification standards.' Occupational Safety and Health Agency (Ulsan, in South Korea) certifies safety through comprehensive tests complying with the 'safety certification standards.'

Any person who intends to manufacture, import, or change major structural parts of products subject to safety certification, must obtain this certification.

## ■ TUV NORD

- Country: Germany



TUV is a leading German private certification body that has been responsible for many testing and certification tasks related to safety in the industry for a long time. It is intended to protect people and property from fire and other accidents. Currently, TUV is conducting tests and inspections on safety and quality in various industries such as machinery, electronics and electricity, automobiles, chemical facilities, nuclear power, and aircraft. It is voluntary standards, and certification is issued complying with various EU Directives and German safety regulations.

## ■ Metrology Certification

- Country: Russia



Metrology Certification is a certificate for measuring and test equipment. Registration of measuring equipment is currently being revised and implemented following the Russian Federal Law, and is managed and supervised by the measurement authority, which is the subject of the certification. Measurement authorities review and test measuring equipment to be used in the Russian Federation based on the State System of Measurement (SSM), issue certificates, and manage them in the government's online database for users and buyers to browse.

## ■ CCC

- Country: China



The China Compulsory Certificate system (CCC) is a compulsory mark for products that met Chinese technical standards and are allowed to be imported by the Chinese government. Foreign-imported industrial products are examined through CCC certification process whether they meet safety standards or not. The certified products are distributed and sold with the CCC mark or factory code according to the product. CCC certification is administered by the China Quality Certification Center (CQC).

## ■ PSE

- Country: Japan



PSE is a compulsory certification administered by the Ministry of Economy, Trade and Industry (METI) and governs by the Electrical Appliances Safety Law in Japan. The purpose is to minimize the occurrence of harm and damage caused by electrical equipment by regulating the manufacture and sale of electrical appliances and bring an engagement of the private sector to ensure the safety of electrical appliances. Manufacture, import, and sell electrical appliances in the Japanese market, the technical standards for those products must be satisfied and the PSE certification mark must be displayed.

## ■ GOST

- Country: Russia



GOST is national technical standards set by the Euro Asian Council for Standardization, Metrology and Certification (EASC). The abbreviation GOST stands for GOSudarstvennyy STandart, which means State Union Standard in Russian. The current GOST standard includes over 20,000 titles and is widely used in common in the Commonwealth of Independent States (CIS) (12 countries). All countries of the CIS currently adopt and use the GOST standard, but the certificates issued by each country and the subject of the issuing certification body are different, so each country's GOST certificate can be regarded as a different certificate. The national standards of Russia are the GOST R, those of Kazakhstan are GOST K, etc.

## ■ China RoHS

- Country: China



China RoHS is the Chinese government regulation to control and eliminate the environmental impact of toxic and hazardous substances and elements in electrical/ electronic equipment. China's Measures for the Administration of the Control of Pollution by Electronic Information Products like the EU RoHS Directive have been enacted, and regulate additional hazardous substances compare to EU RoHS. Marking a logo or label for marking information is mandatory. In addition, there is a certification system before selling the product to ensure its conformity by conducting test analysis. Products to be exported to China will be screened prior to customs entry. Customs entry is only permitted for products that meet conformance standards.

## Communication Standards

• For detailed information on communication, visit the related association's website.

### ■ EtherNet/IP

## EtherNet/IP™

EtherNet/IP is an industrial network protocol that conforms Common Industrial Protocol to standard Internet. It is one of the leading industrial protocols in the United States and is widely used in a variety of industries, including factories.

EtherNet/IP and CIP technologies are managed by ODVA, Inc., a global trade and standards development organization founded in 1995 with over 300 corporate members.

EtherNet/IP uses the most widely adopted Ethernet standards - Internet Protocol and IEEE 802.3 - to define functions for the transport, network, data link, and physical layer. CIP uses object-oriented design to provide EtherNet/IP with services and device profiles needed for real-time control and to promote consistent implementation of automation functions across a diverse ecosystem of products.

### ■ DeviceNet

## DeviceNet

DeviceNet is a digital multidrop network to interconnect industrial controllers and I/O devices. DeviceNet provides users a cost-effective network for distribution at no cost, deploys and manages simple devices across the architecture.

DeviceNet uses CAN (Controller Area Network), a network technology used in automobile vehicles, for its data link layer, and this network is used in almost all industries. DeviceNet is approved by CENELEC for its official standard and is also used as a global standard.

### ■ ProfiNet



PROFINET, designated and announced by PI (PROFIBUS & PROFINET), is the open standard for industrial Ethernet in automation technology. It provides solutions for process automation, factory automation and motion control. It enables the integration of existing fieldbus systems such as PROFIBUS, Interbus and DeviceNet into an open Ethernet-based network. PROFINET, the protocol for communication, configuration and diagnosis in the network, uses Ethernet standard as well as TCP, UDP, IP. It achieves fast and safe data exchange, enabling the concepts of innovative machine and plant. Thanks to its flexibility and openness, PROFINET offers the users a freedom in building machine and plant architectures and significantly increases plant availability by optimal use of resources available to users.

### ■ CC-Link



CC-Link is the open field network and the global standard with SEMI certification. As high-speed field network, CC-Link can process both control data and information data at the same time. With a high communication speed of 10 Mbps, it supports a transmission distance of 100 meters and connects to 64 stations.

It achieved high-speed response of up to 10 Mbps, guaranteeing punctuality. With CC-Link, complex production lines can be simplified and built at low cost. There are advantages of reducing the cost of wiring components, shortening the wiring construction period, and improving maintainability.

CLPA provides a memory map profile that allocates data for each product type. CC-Link compatible products can be developed based on this profile, and users can use the same program for connection and control even if existing product is replaced to other vendors' one.

### ■ EtherCAT



EtherCAT (Ethernet for Control Automation Technology) is an Ethernet-based fieldbus system developed by Beckhoff Automation. After releasing the technology from ETG (EtherCAT Technology Group) in 2003, it is standardized in IEC 61158 since 2007. It is a communication method that uses the frame according to IEEE 802.3 and physical layer and is an Ethernet protocol-based automation software that requires low jitter, short cycle time, and reduced hardware cost.

EtherCAT supports almost all topologies which have the advantage of flexibility and user-friendly. Due to the high-speed network, EtherCAT is suitable for applications requiring simultaneous operation.

### ■ HART



HART is the global standard for digital information communication via analog wires between smart devices and control or monitoring systems.

It is the duplex communication protocol and supports various analog I/O modules with HART connection. It sends and receives digital information through 4-20 mA current. It provides a reliable and long-term solution for plant operators who seek the benefits of smart devices with digital communication while maintaining existing facilities for analog instrumentation and plant wiring. Many sites that have applied the HART protocol can access to many digital process, maintenance and diagnostic information.

### ■ ProfiBus



ProfiBus is the open standard commonly used for process automation in the production site.

- Configuration
    - Master: It determines data traffic, transmits messages, and performs as role of Active Station.
    - Slave: It means I/O devices, valves, motor drivers, transmitters, etc. Slave receives a message and transmits the message depending on the Master's request.
- Up to 124 slaves and 3 masters can be connected to one communication line, and the communication method uses the half duplex method. Each device is connected to the bus in parallel and each device has its network address, so the installation location is irrelevant. Each device can be moved or removed during the communication.

# IP Code (protection against dust and water)

## IEC (International Electro-technical Commission) Standard

The IP Codes are defined in the IEC standard 60529.



### 1 Degree of protection against dust (protected from solid foreign objects)

Numeral	Degree of protection	Degree of protection
0	Non-protected	
1		Protection against the objects with 50 mm diameter or more The object probe, sphere of 50 mm diameter, must not fully penetrate. - Test means : Rigid sphere without handle or guard. - Test force: 50 N ± 10%
2		Protection against the objects with 12.5 mm diameter or more. The object probe, sphere of 12.5 mm diameter, must not fully penetrate. - Test means : Rigid sphere without handle or guard. - Test force: 30 N ± 10%
3		Protection against the objects with 2.5 mm diameter or more. The object probe, sphere of 2.5 mm diameter, must not fully penetrate. - Test means : Rigid steel rod with edges free from burrs. - Test force: 3 N ± 10%
4		Protection against the objects with 1 mm diameter or more. The object probe, sphere of 1 mm diameter, must not fully penetrate. - Test means : Rigid steel rod with edges free from burrs. - Test force: 1 N ± 10%
5		Protection against the dust with or without pressure. - Dust-protected enclosures allow a limited quantity of dust to penetrate; complete protection against contact.  Test duration: 8 hours Dust (the talcum powder) : It must be able to pass a square-meshed sieve that its nominal wire with 50 µm diameter; the nominal width of a gap between wires 75 µm. The amount of talcum powder: 2 kg/m <sup>3</sup>
6		Protection against the dust under pressure. - Dust-tight enclosures do not allow any dust to penetrate.  Test duration : 2 hours (a volume of dust: 40 to 60 / hour) 8 hours (a volume of dust: less than 40 / hour Depression : Less than 2 kPa (20 mbar) on the manometer. Dust (the talcum powder) : It must be able to pass a square-meshed sieve that its nominal wire with 50 µm diameter; the nominal width of a gap between wires 75 µm. The amount of talcum powder: 2 kg/m <sup>3</sup>

### 2 Degree of protection against ingress of water (protected from liquids)

Numeral	Degree of protection	Degree of protection
0	Non-protected	
1		Protection against vertically falling water drops.  Water drops flow over the whole area of four sides on a fixed and tilting enclosure. - Test duration : 10 min (2.5 min in each of four sides)
2		Protection against vertically falling water drops when the enclosure is tilted up to 15° from its normal position.  Uniform flow of water drops over the whole area of the enclosure. - A rotation speed of turntable: 1r / min - Test duration: 10 min
3		Protection against spraying water at an angle up to 60° on either side of the vertical.  The oscillating tube has spray holes over an arc of 60° either side of the center point. It sprinkles through an angle of 120° and 60° on either side of vertical. Then, the enclosure is turned through a horizontal angle of 90°, and continue the test for 5 min. - Test duration : 10 min (5 min in each of sides) - Mean flow rate per hole: 0.07 L/min
4		Protection against splashing water from any direction. - No harmful effects on the product.  The oscillating semicircle tube with spray holes sprinkles through an angle of 360°. - Test duration: 10 min - Mean flow rate per hole: 0.07 L/min
5 <sup>01)</sup>		Protection against projecting water in jets from any direction. - No harmful effects on the product.  Spraying a stream of water from the test nozzle (internal diameter: Ø 6.3 mm) at all directions. - Test duration: 3 min - Distance from nozzle to enclosure surface : 2.5 to 3 m - Delivery rate: 12.5 L/min ± 5%
6 <sup>01)</sup>		Protection against powerfully projecting water in jets from any direction. - No harmful effects on the product.  Spraying a stream of water from the test nozzle (internal diameter: Ø 12.5 mm) at all directions. - Test duration: 3 min - Distance from nozzle to enclosure surface : 2.5 to 3 m - Delivery rate: 100 L/min ± 5%
7 <sup>02)</sup>		Protection against temporary immersion in water under defined conditions of pressure and time. - The product is hermetically sealed.  Immersion in water under defined conditions - Test duration: 30 min - Water level: 1 m
8 <sup>02)</sup>		Complete protection against continuous immersion in water. - The product is hermetically sealed. - Conditions negotiated between the manufacturer and the user - Strict conditions than IPX7

01) The degree of protection against spraying does not guarantee the effects of immersion.

02) The degree of protection against immersion does not guarantee the effects of spray.

## ■ DIN (Deutsche Industrie Normen) Standard

The DIN standard is defined in the DIN 40050-9.

IP 1 2

### 1 Degree of protection against dust (protected from solid foreign objects)

Same as IEC standard

### 2 Degree of protection against ingress of water (under high temperature and high pressure)

Letters	Degree of protection	
9K	Water resistance under high temperature and high pressure	Protection against high-temperature vapor and high-pressure water at all directions. - No harmful effects on the product.

## ■ JEM (Japan Electrical Manufacturers' Association) Standard

The JEM standard is defined in the JEM 1030.

IP 1 2 3

### 1 Degree of protection against dust (protected from solid foreign objects)

Same as IEC standard

### 2 Degree of protection against ingress of water (protected from liquids)

Same as IEC standard

### 3 Degree of oil proof / oil resistance

Letters	Degree of protection	
F	Oil proof type	Protection against oil drop and oil powder in all directions - Even if oil penetrates in the product, it operates normally.
G	Oil resistant type	Protection against oil drop and oil powder in all directions - Special coating prevents penetration of oil into the product.

# **Autonics**

**[www.autonics.com](http://www.autonics.com)**

Dimensions or specifications on this manual are subject to change and some models may be discontinued without notice.