Overview

What Are Proximity Sensors?

"Proximity Sensor" includes all sensors that perform non-contact detection in comparison to sensors, such as limit switches, that detect objects by physically contacting them. Proximity Sensors convert information on the movement or presence of an object into an electrical signal. There are three types of detection systems that do this conversion: systems that use the eddy currents that are generated in metallic sensing objects by electromagnetic induction, systems that detect changes in electrical capacity when approaching the sensing object, and systems that use magnets and reed switches.

The Japanese Industrial Standards (JIS) define proximity sensors in JIS C 8201-5-2 (Low-voltage switch gear and control gear, Part 5: Control circuit devices and switching elements, Section 2: Proximity sensors), which conforms to the IEC 60947-5-2 definition of non-contact position detection switches.

JIS gives the generic name "proximity sensor" to all sensors that provide non-contact detection of target objects that are close by or within the general vicinity of the sensor, and classifies them as inductive, capacitive, ultrasonic, photoelectric, magnetic, etc.

This Technical Guide defines all inductive sensors that are used for detecting metallic objects, capacitive sensors that are used for detecting metallic or non-metallic objects, and sensors that utilize magnetic DC fields as Proximity Sensors.

Features

(1) Proximity Sensors detect an object without touching it, and they therefore do not cause abrasion or damage to the object.
Devices such as limit switches detect an object by contacting it, but Proximity Sensors are able to detect the presence of the object electrically, without having to touch it.

(2) No contacts are used for output, so the Sensor has a longer service life (excluding sensors that use magnets).
Proximity Sensors use semiconductor outputs, so there are no contacts to affect the service life.

(3) Unlike optical detection methods, Proximity Sensors are suitable for use in locations where water or oil is used.
Detection takes place with almost no effect from dirt, oil, or water on the object being detected. Models with fluororesin cases are also available for excellent chemical resistance.

(4) Proximity Sensors provide high-speed response, compared with switches that require physical contact.
For information on high-speed response, refer to *Explanation of Terms* on page 3.

(5) Proximity Sensors can be used in a wide temperature range.
Proximity Sensors can be used in temperatures ranging from –40 to 200°C.

(6) Proximity Sensors are not affected by colors.
Proximity Sensors detect the physical changes of an object, so they are almost completely unaffected by the object's surface color.

(7) Unlike switches, which rely on physical contact, Proximity Sensors are affected by ambient temperatures, surrounding objects, and other Sensors.
Both Inductive and Capacitive Proximity Sensors are affected by interaction with other Sensors. Because of this, care must be taken when installing them to prevent *mutual interference* (refer to page 8). Care must also be taken to prevent the effects of surrounding metallic objects on Inductive Proximity Sensors, and to prevent the effects of all surrounding objects on Capacitive Proximity Sensors.

(8) There are Two-wire Sensors.
The power line and signal line are combined. This reduces wiring work to 2/3 of that require for Three-wire Sensors. If only the power line is wired, internal elements may be damaged. Always insert a load (refer to page ntlp 6).

Operating Principles

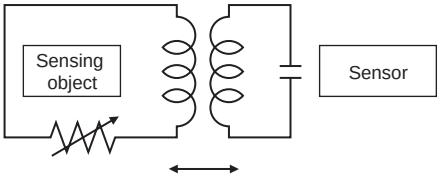
Detection Principle of Inductive Proximity Sensors

Inductive Proximity Sensors detect magnetic loss due to eddy currents that are generated on a conductive surface by an external magnetic field. An AC magnetic field is generated on the detection coil, and changes in the impedance due to eddy currents generated on a metallic object are detected.

Other methods include Aluminum-detecting Sensors, which detect the phase component of the frequency, and All-metal Sensors, which use a working coil to detect only the changed component of the impedance. There are also Pulse-response Sensors, which generate an eddy current in pulses and detect the time change in the eddy current with the voltage induced in the coil.

<Qualitative Explanation>

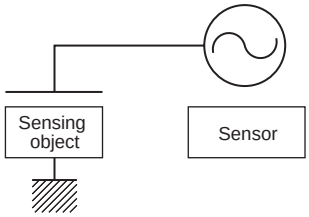
The sensing object and Sensor form what appears to be a transformer-like relationship.



The transformer-like coupling condition is replaced by impedance changes due to eddy-current losses.

The impedance changes can be viewed as changes in the resistance that is inserted in series with the sensing object. (This does not actually occur, but thinking of it this way makes it easier to understand qualitatively.)

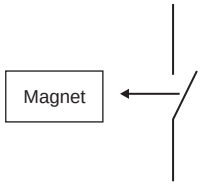
Detection Principle of Capacitive Proximity Sensors



Capacitive Proximity Sensors detect changes in the capacitance between the sensing object and the Sensor. The amount of capacitance varies depending on the size and distance of the sensing object. An ordinary Capacitive Proximity Sensor is similar to a capacitor with two parallel plates, where the capacity of the two plates is detected. One of the plates is the object being measured (with an imaginary ground), and the other is the Sensor's sensing surface. The changes in the capacity generated between these two poles are detected.

The objects that can be detected depend on their dielectric constant, but they include resin and water in addition to metals.

Detection Principle of Magnetic Proximity Sensors



The reed end of the switch is operated by a magnet. When the reed switch is turned ON, the Sensor is turned ON.

Classification

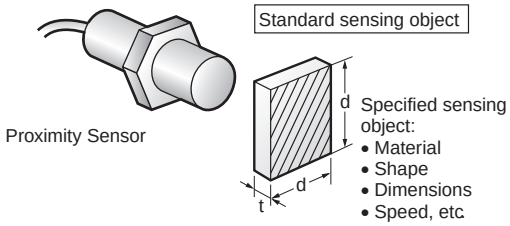
Selection by Detection Method

Items Requiring Confirmation	Inductive Proximity Sensors	Capacitive Proximity Sensors	Magnetic Proximity Sensors
Sensing object	Metallic objects (iron, aluminum, brass, copper, etc.)	Metallic objects, resins, liquids, powders, etc.	Magnets
Electrical noise	Affected by positional relationship of power lines and signal lines, grounding of cabinet, etc. CE Marking (EC Directive compliance) Sensor covering material (metal, resin). Easily affected by noise when the cable is long.		Almost no effect.
Power supply	DC, AC, AC/DC, DC with no polarity, etc. Connection method, power supply voltage.		
Current consumption	Depends on the power supply, i.e., DC 2-wire models, DC 3-wire models, AC, etc. DC 2-wire models are effective for suppressing current consumption.		
Sensing distance	The sensing distance must be selected by considering the effects of factors such as the temperature, the sensing object, surrounding objects, and the mounting distance between Sensors. Refer to the set distance in the catalog specifications to determine the proper distance. When high precision sensing is required, use a Separate Amplifier model.		
Ambient environment	Temperature or humidity, or existence of water, oils, chemicals etc. Confirm that the degree of protection matches the ambient environment.		
Physical vibration, shock	An extra margin must be provided in the sensing distance when selecting Sensors for use in environments subject to vibration and shock. To prevent Sensors from vibrating loose, refer to the catalog values for tightening torque during assembly.		
Assembly	Effects of tightening torque, Sensor size, number of wiring steps, cable length, distance between Sensors, surrounding objects. Check the effects of surrounding metallic and other objects, and the specifications for the mutual interference between Sensors.		

Explanation of Terms

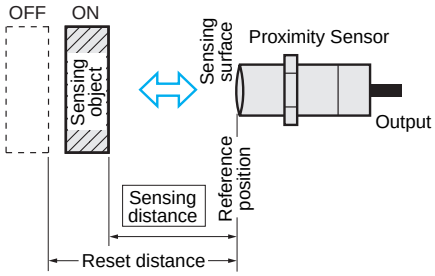
Standard Sensing Object

A sensing object that serves as a reference for measuring basic performance, and that is made of specified materials and has a specified shape and dimensions.



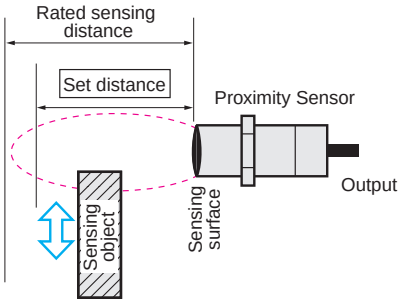
Sensing Distance

The distance from the reference position (reference surface) to the measured operation (reset) when the standard sensing object is moved by the specified method.



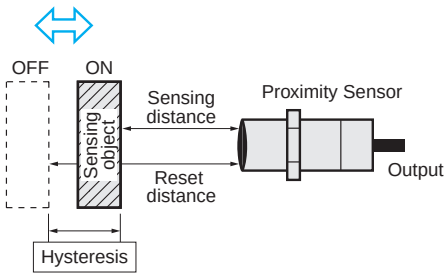
Set Distance

The distance from the reference surface that allows stable use, including the effects of temperature and voltage, to the (standard) sensing object transit position. This is approximately 70% to 80% of the normal (rated) sensing distance.



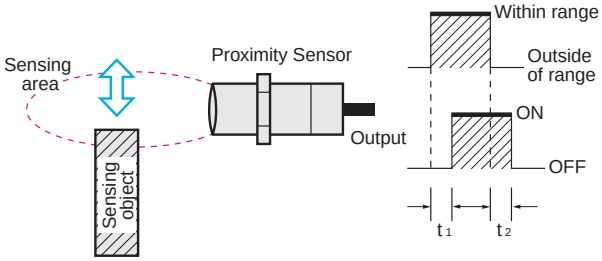
Hysteresis (Differential Travel)

With respect to the distance between the standard sensing object and the Sensor, the difference between the distance at which the Sensor operates and the distance at which the Sensor resets.



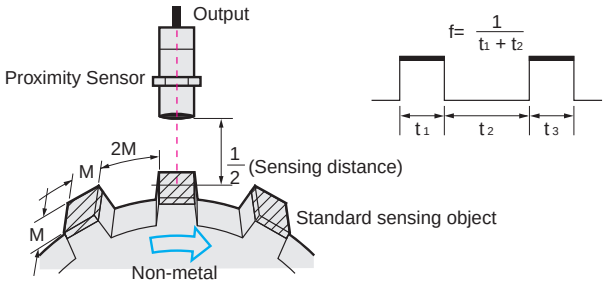
Response Time

- t_1: The interval from the point when the standard sensing object moves into the sensing area and the Sensor activates, to the point when the output turns ON.
- t_2: The interval from the point when the standard sensing object moves out of the Sensor sensing area to the point when the Sensor output turns OFF.



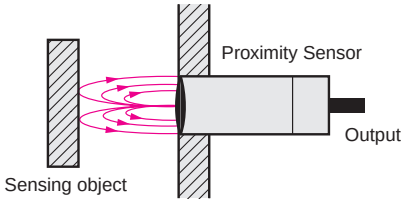
Response Frequency

- The number of detection repetitions that can be output per second when the standard sensing object is repeatedly brought into proximity.
- See the accompanying diagram for the measuring method.



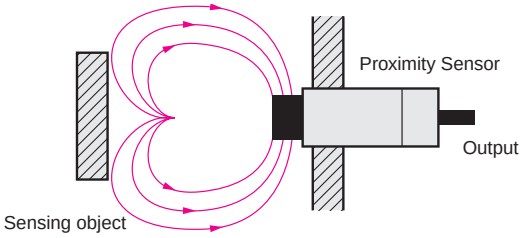
Shielded

- With a Shielded Sensor, magnetic flux is concentrated in front of the Sensor and the sides of the Sensor coil are covered with metal.
- The Sensor can be mounted by embedding it into metal.



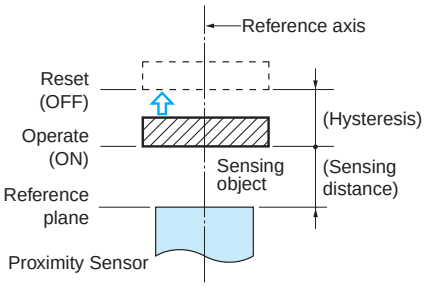
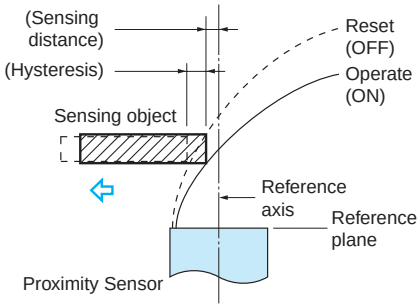
Unshielded

- With an Unshielded Sensor, magnetic flux is spread widely in front of the Sensor and the sides of the Sensor coil are not covered with metal.
- This model is easily affected by surrounding metal objects (magnetic objects), so care must be taken in selecting the mounting location.

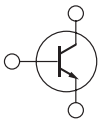
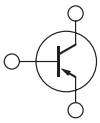
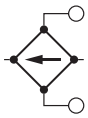


Expressing the Sensing Distance
When measuring the sensing distance of a Proximity Sensor, the reference position and the direction of approach of the sensing object are determined as follows:

Cylindrical/Rectangular Sensors

Perpendicular sensing distance	Horizontal sensing distance and sensing area diagram
	
Expressed as the measured distance from the reference surface when the standard sensing object approaches from the radial direction (perpendicular to the sensing surface).	Expressed as the measured distance from the reference axis when the standard sensing object is moved parallel to the reference surface (sensing surface). This distance depends on the transit position (distance from the reference surface), so it can be expressed as an operating point track. (Sensing Area Diagram)

Output Configuration

NPN transistor output	PNP transistor output	Non-polarity/non-contact output
		
A general-use transistor can be directly connected to a Programmable Controller or Counter.	Primarily built into machines exported to Europe and other overseas destinations.	A 2-wire AC output that can be used for both AC and DC Sensors. Eliminates the need to be concerned about reversing the polarity.

Take the following points into account when selecting a DC 2-wire model (polarity/no-polarity). (For details, refer to page 9).

- Leakage current: A maximum current of 0.8 mA flows to the load current even when the output is OFF. Check that the load will not operate with this current.
  Check that the load will operate with this load voltage.
- Output residual voltage: When the output is ON, voltage remains in the Sensor, and the voltage applied to the load decreases.
  Check that the load will operate with this load voltage.

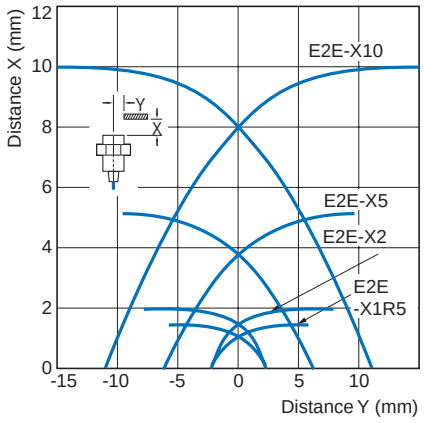
Output Configuration

NO (normally open)	NC (normally closed)	NO/NC switchable
NO	NC	NO/NC switching
When there is an object in the sensing area, the output switching element is turned ON.	When there is no object in the sensing area, the output switching element is turned ON.	NO or NC operation can be selected for the output switching element by a switch or other means.

Interpreting Engineering Data

Sensing Area
Refer to Explanation of Terms on page 3.

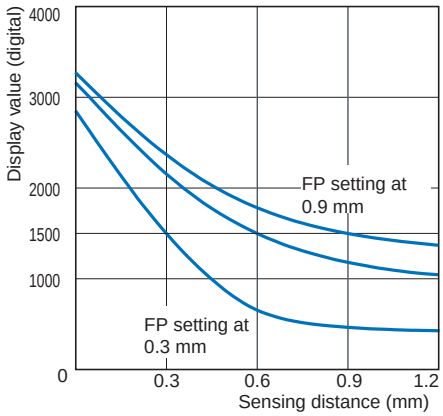
E2E-X□E□/-X□Y□/-X□F1



- This graph shows engineering data from moving the sensing object parallel to the sensing surface of the Proximity Sensor.
- Refer to this graph for Proximity Sensor applications, such as positioning. When a high degree of precision is required, use a Separate Amplifier Proximity Sensor.

Sensing Distance vs. Display Characteristics

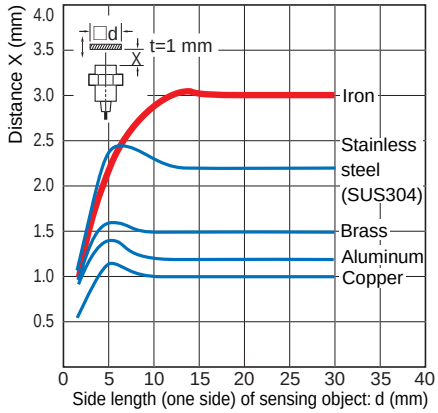
E2C-EDR6-F



- This type of graph is used with Separate Amplifier Proximity Sensors. It shows the values when executing FP (Fine Positioning) at specified distances. FP settings are possible at any desired distance, with a digital value of 1,500 as a reference for the E2C-EDA.
- The above graph shows numerical examples when Fine Positioning is executed at the three points of 0.3, 0.6, and 0.9 mm.

Effects of Sensing Object Size and Material
Refer to Explanation of Terms on page 3.
Refer to Precautions for Correct Use on page 8.

E2E-X3D□/-X3T1



- Here, the horizontal axis indicates the size of the sensing object, and the vertical axis indicates the sensing distance. It shows changes in the sensing distance due to the size and material of the sensing object. Refer to this data when using the same Sensor to detect various different sensing objects, or when confirming the allowable leeway for detection.

Leakage Current Characteristics
Refer to Precautions for Correct Use on page 9.

- In contrast with contact-type limit switches, which have physical contacts, leakage current in a 2-wire Proximity Sensor is related to an electrical switch that consists of transistors and other components. This graph indicates the leakage current characteristics caused by transistors in the output section of the Sensor.
- Generally speaking, the higher the voltage, the larger the leakage current. Because leakage current flows to the load connected to the Proximity Sensor, care must be taken to select a load that will not cause the Sensor to operate from the leakage current.
- Be careful of this factor when replacing a limit switch, micro-switch, or other switch with a Proximity Sensor.

Residual Voltage Characteristics
Refer to Precautions for Correct Use on page 7.

- Similar to leakage current characteristics, residual voltage is something that occurs due to electrical switches that are comprised of transistors and other components. For example, whereas the voltage in a normally open switch should be 0 V in the ON state, and the same as the power supply voltage in the OFF state, residual voltage refers to a certain level of voltage remaining in the switch. Be careful of this factor when replacing a limit switch, micro-switch, or other switch with a Proximity Sensor.

General Precautions

For precautions on individual products, refer to the *Safety Precautions* in individual product information.

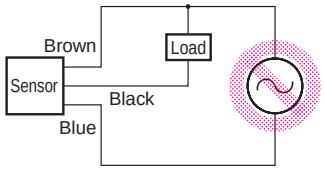
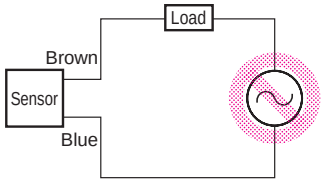
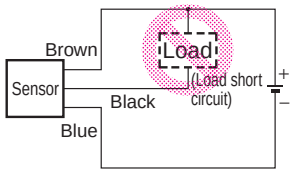
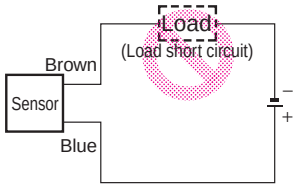
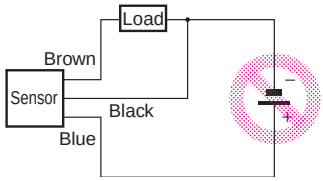
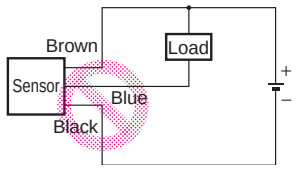
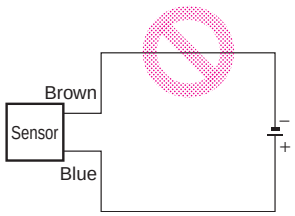
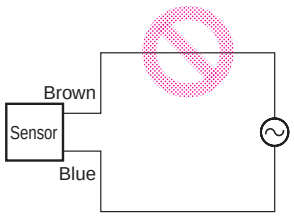
⚠ WARNING

These products cannot be used in safety devices for presses or other safety devices used to protect human life.
These products are designed for use in applications for sensing workpieces and workers that do not affect safety.

Precautions for Safe Use

To ensure safety, always observe the following precautions.

●Wiring Considerations

Item	Typical examples	
Power Supply Voltage Do not use a voltage that exceeds the operating voltage range. Applying a voltage that is higher than the operating voltage range, or using an AC power supply (100 VAC or higher) for a Sensor that requires a DC power supply may cause explosion or burning.	DC 3-Wire NPN Output Sensors 	DC 2-Wire Sensors 
Load short-circuiting • Do not short-circuit the load. Explosion or burning may result. • The load short-circuit protection function operates when the power supply is connected with the correct polarity and the power is within the rated voltage range.	DC 3-Wire NPN Output Sensors 	• DC 2-Wire Sensors • Even with the load short-circuit protection function, protection will not be provided when a load short circuit occurs if the power supply polarity is not correct. 
Incorrect Wiring Be sure that the power supply polarity and other wiring is correct. Incorrect wiring may cause explosion or burning.	DC 3-Wire NPN Output Sensors 	
Connection without a Load If the power supply is connected directly without a load, the internal elements may explode or burn. Be sure to insert a load when connecting the power supply.	• DC 2-Wire Sensors • Even with the load short-circuit protection function, protection will not be provided if both the power supply polarity is incorrect and no load is connected. 	AC 2-Wire Sensors 

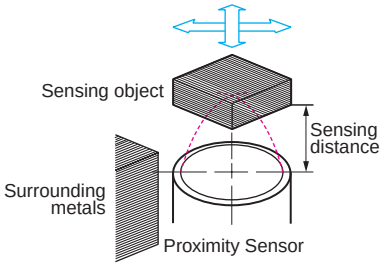
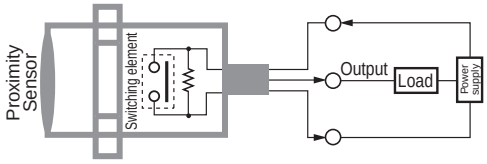
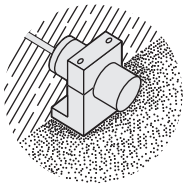
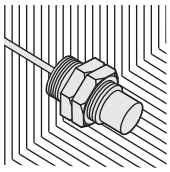
●Operating Environment

Do not use the Sensor in an environment where there are explosive or combustible gases.

Precautions for Correct Use

The following conditions must be considered to understand the conditions of the application and location as well as the relation to control equipment.

●Model Selection

Item	Points of consideration
Sensing object and operating condition of Proximity Sensor	Check the relation between the sensing object and the Proximity Sensor.  Specific conditions of object → Material, size, shape, existence of plating, etc. Direction of object movement → Transit interval, speed, existence of vibration, etc. Peripheral metal → Material, distance to Sensor, orientation, etc. Sensing distance → Fluctuation in transit point, allowable error, etc. Sensing (set) distance, shape of Sensor (rectangular, cylindrical, through-beam, grooved), influence of peripheral metal (Shielded Sensors, Non-shielded Sensors), response speed (response frequency), influence of temperature, influence of voltage, etc.
Electrical conditions	Verify the electrical conditions of the control system to be used and the electrical performance of the Proximity Sensor.  Power supply: DC (voltage fluctuation, current capacity value); AC (voltage fluctuation, frequency, etc.); Need for S3D2 Controller → Selecting the power supply type: DC / DC + S3D2 Controller / AC Load: Resistive load - Non-contact control system; Inductive load - Relay, solenoid, etc.; • Steady-state current, inrush current; • Operating, reset voltage (current); Lamp load; • Steady-state current, inrush current; Open/close frequency → Selecting the power supply type: DC / DC + S3D2 Controller / AC; Control output: Maximum current (voltage); Leakage current; Residual load voltage
Environmental conditions	 The environmental tolerance of the Proximity Sensor is better than that of other types of Sensors. However, investigate carefully before using a Proximity Sensor under harsh temperatures or in special atmospheres. Temperature and humidity — Highest or lowest values, existence of direct sunlight, etc. → Temperature influence, high-temperature use, low temperature use, need for shade, etc. Atmosphere — Water, oil, iron powder, or other special chemicals → Need for water resistance or oil resistance, need for explosion-proof structure Vibration and shock — Size, duration → Need for strength, mounting method • Water Resistance Do not use the Sensor in water, rain, or outdoors. • Ambient Conditions To maintain reliability of operation, do not use the Sensor outside the specified temperature range or outdoors. Even though the Proximity Sensor has a water-resistant structure, it must be covered to prevent direct contact with water or water-soluble cutting oil. Do not use the Sensor in atmospheres with chemical vapors, in particular, strong alkalis or acids (nitric acid, chromic acid, or hot concentrated sulfuric acid). • Explosive Atmospheres Do not use the Sensor in atmospheres where there is a danger of explosion. Use an Explosion-proof Sensor.
Mounting conditions	 When deciding the mounting method, take into consideration not only restrictions due to mechanical devices, but also ease of maintenance and inspection, and interference between Sensors. Wiring method, existence of inductance surges — Wires: Wire type, length, oil-resistant cable, shielded cable, robot cable, etc. Connection — Conduits, ducts, pre-wired, terminal wiring, ease of maintenance and inspection Mounting procedure — Existence of mounting brackets, direct mounting, secured with bolts or screws Installation location — Ease of maintenance and inspection, mounting space
Influence of external electromagnetic fields	• The influence within a DC magnetic field is 20 mT* max. Do not use the Sensor at a level higher than 20 mT. • Sudden changes in the DC magnetic field may cause malfunction. Do not use the Sensor for applications that involve turning a DC electromagnet ON and OFF. • Do not place a transceiver near the Sensor or its wiring. Doing so may cause malfunction.
Other considerations	Cost feasibility: Price/delivery time Life: Power-ON time/frequency of use

* mT (millitesla) is a unit for expressing magnetic flux density. One tesla is the equivalent of 10,000 gauss.

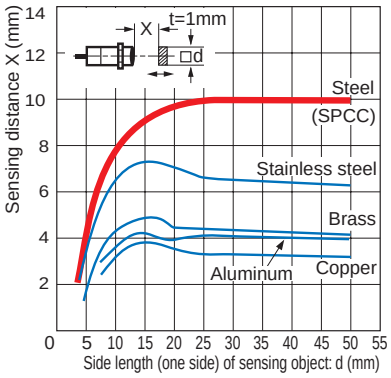
●Design

Sensing Object Material

The sensing distance varies greatly depending on the material of the sensing object. Study the engineering data for the influence of sensing object material and size and select a distance with sufficient leeway.

- In general, if the sensing object is a non-magnetic metal (for example, aluminum), the sensing distance decreases.

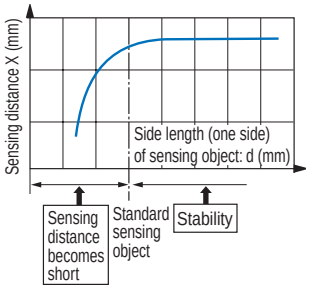
Example: E2-X10D□



Size of Sensing Object

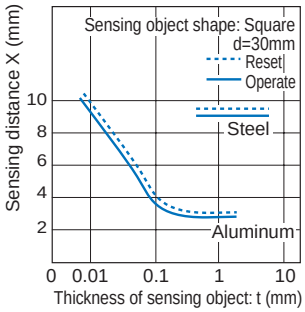
In general, if the object is smaller than the standard sensing object, the sensing distance decreases.

- Design the setup for an object size that is the same or greater than the standard sensing object size from the graphs showing the sensing object size and sensing distance.
- When the size of the standard sensing object is the same or less than the size of the standard sensing object, select a sensing distance with sufficient leeway.



Thickness of Sensing Object

- The thickness of ferrous metals (iron, nickel, etc.) must be 1 mm or greater.
- For non-magnetic metal, a sensing distance equivalent to a magnetic body can be obtained when the coating thickness is 0.01 mm or less. With pulse-response models (e.g., E2V), however, the characteristics may vary. Be sure to check the catalog information for the relevant model.
  When the coating is extremely thin and is not conductive, such as a vacuum deposited film, detection is not possible.



- Influence of Plating If the sensing object is plated, the sensing distance will change (see the table below).

Effect of Plating (Typical)
(Reference values: Percent of non-plated sensing distance)

Thickness and base material of plating	Steel	Brass
No plating	100	100
Zn 5 to 15 μm	90 to 120	95 to 105
Cd 5 to 15 μm	100 to 110	95 to 105
Ag 5 to 15 μm	60 to 90	85 to 100
Cu 10 to 20 μm	70 to 95	95 to 105
Cu 5 to 15 μm	-	95 to 105
Cu (5 to 10 μm) + Ni (10 to 20 μm)	70 to 95	-
Cu (5 to 10 μm) + Ni (10 μm) + Cr (0.3 μm)	75 to 95	-

Mutual Interference

- Mutual interference refers to a state where a Sensor is affected by magnetism (or static capacitance) from an adjacent Sensor and the output is unstable.
- One means of avoiding interference when mounting Proximity Sensors close together is to alternate Sensors with different frequencies. The model tables indicate whether different frequencies are available. Please refer to the tables.
- When Proximity Sensors with the same frequency are mounted together in a line or face-to-face, they must be separated by a minimum distance. For details, refer to *Mutual Interference* in the *Safety Precautions* for individual Sensors.

Power Reset Time

A Sensor is ready for detection within 100 ms after turning ON the power. If the load and Sensor are connected to separate power supplies, design the system so that the Sensor power turns ON first.

Turning OFF the Power

An output pulse may be generated when the power is turned OFF, so design the system so that the load or load line power turns OFF first.

Influence of Surrounding Metal

The existence of a metal object other than the sensing object near the sensing surface of the Proximity Sensor will affect detection performance, increase the apparent operating distance, degrade temperature characteristics, and cause reset failures. For details, refer to the influence of surrounding metal table in *Safety Precautions* for individual Sensors.
Particularly the distance m that separates a metal surface that faces the Sensor's sensing surface will influence performance, such as shortening the sensing distance.
The values in the table are for the nuts provided with the Sensors. Changing the nut material will change the influence of the surrounding metal.

Power Transformers

Be sure to use an insulated transformer for a DC power supply. Do not use an auto-transformer (single-coil transformer).

Precautions for AC 2-Wire/DC 2-Wire Sensors

Surge Protection

Although the Proximity Sensor has a surge absorption circuit, if there is a device (motor, welder, etc.) that causes large surges near the Proximity Sensor, insert a surge absorber near the source of the surges.

Influence of Leakage Current

Even when the Proximity Sensor is OFF, a small amount of current runs through the circuit as leakage current.
For this reason, a small current may remain in the load (residual voltage in the load) and cause load reset failures. Verify that this voltage is lower than the load reset voltage (the leakage current is less than the load reset current) before using the Sensor.

Using an Electronic Device as the Load for an AC 2-Wire Sensor

When using an electronic device, such as a Timer, some types of devices use AC half-wave rectification. When a Proximity Sensor is connected to a device using AC half-wave rectification, only AC half-wave power will be supplied to the Sensor. This will cause the Sensor operation to be unstable. Also, do not use a Proximity Sensor to turn the power supply ON and OFF for electronic devices that use DC half-wave rectification. In such a case, use a relay to turn the power supply ON and OFF, and check the system for operating stability after connecting it.

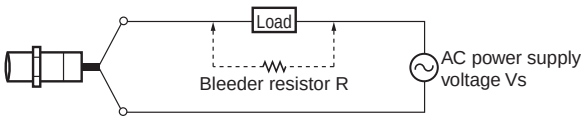
Examples of Timers that Use AC Half-wave Rectification
Timers: H3Y, H3YN, H3RN, H3CA-8, and H3CR (-A, -A8, -AP, -F, -G)

Countermeasures for Leakage Current (Examples)

AC 2-Wire Sensors

Connect a bleeder resistor to bypass the leakage current flowing in the load so that the current flowing through the load is less than the load reset current.

> When using an AC 2-Wire Sensor, connect a bleeder resistor so that the Proximity Sensor current is at least 10 mA, and the residual load voltage when the Proximity Sensor is OFF is less than the load reset voltage.



Calculate the bleeder resistance and allowable power using the following equation.

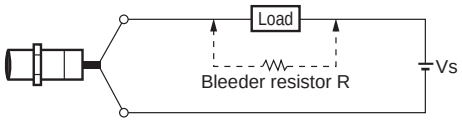
$$R \leq \frac{Vs}{10 - I}\ (k\Omega) \qquad P > \frac{Vs^2}{R}\ (mW)$$

P : Watts of bleeder resistance (the actual number of watts used should be several times this number)
I : Load current (mA)

It is recommend that leeway be included in the actual values used. For 100 VAC, use 10 kΩ or less and 3 W (5 W) or higher, and for 200 VAC, use 20 kΩ or less and 10 W (20 W) or higher. If the effects of heat generation are a problem, use the number of watts in parentheses ( ) or higher.

DC 2-Wire Sensors

Connect a bleeder resistor to bypass the leakage current flowing in the load, and design the load current so that (leakage current) × (load input impedance) < reset voltage.



Calculate the bleeder resistance and allowable power using the following equation.

$$R \leq \frac{Vs}{i_R - i_{OFFR}}\ (k\Omega) \qquad P > \frac{Vs^2}{R}\ (mW)$$

P : Watts of bleeder resistance (the actual number of watts used should be several times this number)
i_R : Leakage current of Proximity Sensor (mA)
i_{OFFR} : Load reset current (mA)

It is recommend that leeway be included in the actual values used. For 12 VDC, use 15 kΩ or less and 450 mW or higher, and for 24 VDC, use 30 kΩ or less and 0.1 W or higher.

Loads with Large Inrush Current

Loads, such as lamps or motors, that cause a large inrush current* will weaken or damage the switching element. In this situation, use a relay.

* E2K, TL-N□Y: 1 A or higher

●Mounting

Mounting the Sensor

When mounting a Sensor, do not tap it with a hammer or otherwise subject it to excessive shock. This will weaken water resistance and may damage the Sensor. If the Sensor is being secured with bolts, observe the allowable tightening torque. Some models require the use of toothed washers.

For details, refer to the mounting precautions in *Precautions for Correct Use* in individual product information.

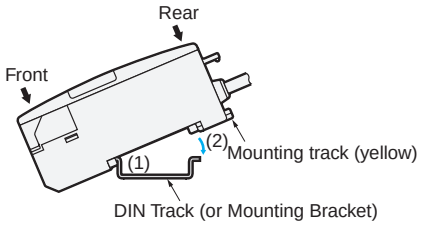
Mounting/Removing Using DIN Track

(Example for E2CY)

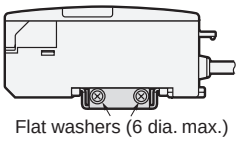
<Mounting>

(1)Insert the front of the Sensor into the special Mounting Bracket (included) or DIN Track.

(2)Press the rear of the Sensor into the special Mounting Bracket or DIN Track.

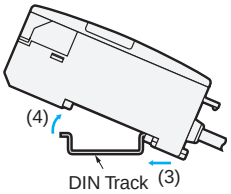


- When mounting the side of the Sensor using the special Mounting Bracket, first secure the Amplifier Unit to the special Mounting Bracket, and then mount the special Mounting Bracket with M3 screws and flat washers with a diameter of 6 mm maximum.



<Removing>

- While pressing the Amplifier Unit in the direction of (3), lift the fiber plug in the direction of (4) for easy removal without a screwdriver.

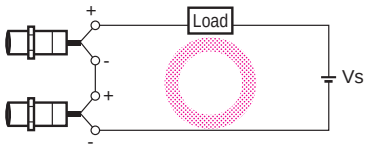
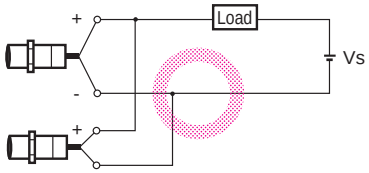
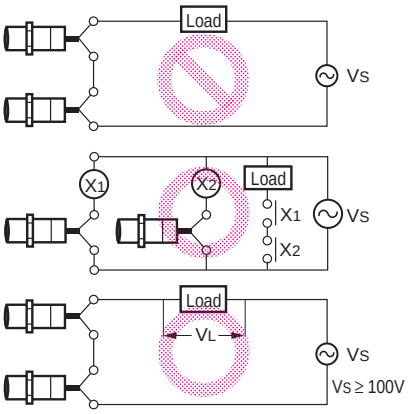
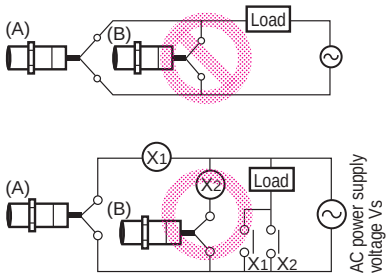


Set Distance

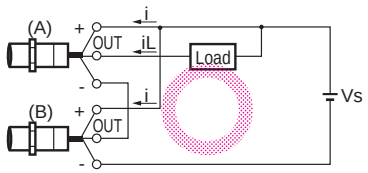
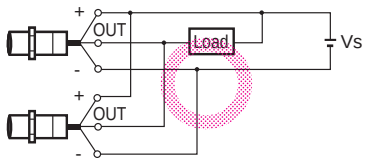
The sensing distance may vary due to fluctuations in temperature and voltage. When mounting the Sensor, it is recommend that installation be based on the set distance.

●Wiring Considerations

AND/OR Connections for Proximity Sensors

Model	Type of connection	Connection	Description
DC 2-Wire	AND (series connection)		Keep the number of connected Sensors (N) within the range of the following equation. $V_S - N \times V_R \geq$ Operating load voltage (N : Number of Sensors that can be connected V_R: Residual output voltage of Proximity Sensor V_S: Power voltage) It is possible, however, that the indicators may not light correctly and error pulses (of approximately 1 ms) may be generated because the rated power supply voltage and current are not supplied to individual Proximity Sensors. Verify that this is not a problem before operation.
	OR (parallel connection)		Keep the number of connected Sensors (N) within the range of the following equation. $N \times i \leq$ Load reset current (N: Number of Sensors that can be connected i: Leakage current of Proximity Sensor) Example: When an MY (24-VDC) Relay is used as the load, the maximum number of Sensors that can be connected is 4.
AC 2-wire	AND (series connection)		<TL-NY, TL-MY, E2K-□MY□> The above Proximity Sensors cannot be used in a series connection. If needed, connect through relays. <E2E-X□Y> For the above Proximity Sensors, the voltage VL that can be applied to the load when ON is $V_L = V_S$ - (Output residual voltage × Number of Sensors), for both 100 VAC and 200 VAC. The load will not operate unless V_L is higher than the load operating voltage. This must be verified before use. When using two or more Sensors in series with an AND circuit, the limit is three Sensors. (Be careful of the VS value in the diagram at left.)
	OR (parallel connection)		In general it is not possible to use two or more Proximity Sensors in parallel with an OR circuit. A parallel connection can be used if A and B will not be operated simultaneously and there is no need to hold the load. The leakage current, however, will be n times the value for each Sensor and reset failures will frequently occur. ("n" is the number of Proximity Sensors.) If A and B will be operated simultaneously and the load is held, a parallel connection is not possible. If A and B operate simultaneously and the load is held, the voltages of both A and B will fall to about 10 V when A turns ON, and the load current will flow through A causing random operation. When the sensing object approaches B, the voltage of both terminals of B is too low at 10 V and the switching element of B will not operate. When A turns OFF again, the voltages of both A and B rise to the power supply voltage and B is finally able to turn ON. During this period, there are times when A and B both turn OFF (approximately 10 ms) and the loads are momentarily restored. In cases where the load is to be held in this way, use a relay as shown in the diagram at left.

Note: When AND/OR connections are used with Proximity Sensors, the effects of erroneous pulses or leakage current may prevent use. Verify that there are no problems before use.

Model	Type of connection	Connection	Description
DC 3-wire	AND (series connection)		Keep the number of connected Sensors (N) within the range of the following equation. iL + (N - 1) × i ≤ Upper limit of Proximity Sensor control output Vs - N × VR ≥ Operating load voltage N : Number of Sensors that can be connected VR: Residual output voltage of Sensor Vs: Power supply voltage i : Current consumption of Sensor iL: Load current Example: A maximum of two Sensors can be used when an MY (24-VDC) Relay is used for the load. Note: When an AND circuit is connected, the operation of Proximity Sensor B causes power to be supplied to Proximity Sensor A, and thus erroneous pulses (approximately 1 ms) may be generated in A when the power is turned ON. For this reason, take care when the load has a high response speed because malfunction may result.
	OR (parallel connection)		For Sensors with a current output, a minimum of three OR connections is possible. Whether or not four or more connections is possible depends on the model.

Note: When AND/OR connections are used with Proximity Sensors, the effects of erroneous pulses or leakage current may prevent use. Verify that there are no problems before use.

Extending Cable Length

The cable of a Built-in Amplifier Sensor can be extended to a maximum length of 200 m with each of the standard cables (excluding some models).
For Separate Amplifier Sensors (E2C-EDA, E2C, E2J, E2CY), refer to the specific precautions for individual products.

Bending the Cable

If you need to bend the cable, we recommend a bend radius that is at least 3 times the outer diameter of the cable. (For coaxial and shielded cables, at least 5 times the outer diameter of the cable is recommended.)

Cable Tensile Strength

In general, do not subject the cable to a tension greater than that indicated in the following table.

Cable diameter	Tensile strength
Less than 4 mm	30 N max.
4 mm min.	50 N max.

Note: Do not subject a shielded cable or coaxial cable to tension.

Separating High-voltage Lines

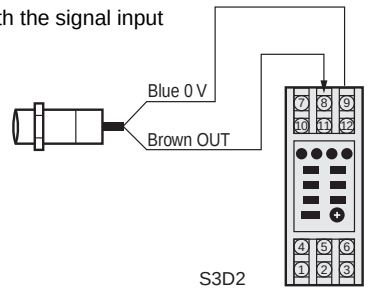
Using Metal Conduits
If a power line is to be located near the Proximity Sensor cable, use a separate metal conduit to prevent malfunction or damage. (Same for DC models.)

Example of Connection with S3D2 Sensor Controller

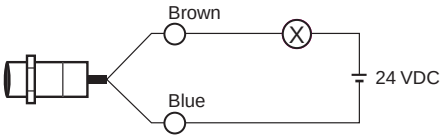
DC 2-Wire Sensors

Using the S3D2 Sensor Controller

Operation can be reversed with the signal input switch on the S3D2.



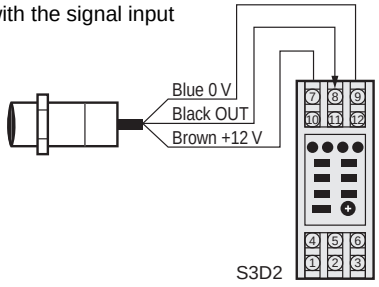
Connecting to a Relay Load



Note: DC 2-Wire Sensors have a residual voltage of 3 V. Check the operating voltage of the relay before use.
The residual voltage of the E2E-XD-M1J-T is 5 V.

DC 3-Wire Sensors

Operation can be reversed with the signal input switch on the S3D2.



●Operating Environment

Water Resistance

Do not use the Sensor in water, rain, or outdoors.

Ambient Conditions

Do not use the Sensor in the following environments.
Doing so may cause malfunction or failure of the Sensor.

1. To maintain operational reliability and service life, use the Sensor only within the specified temperature range and do not use it outdoors.
2. The Sensor has a water resistant structure, however, attaching a cover to prevent direct contact with water will help improve reliability and prolong product life.
3. Avoid using the Sensor where there are chemical vapors, especially strong alkalis or acids (nitric acid, chromic acid, or hot concentrated sulfuric acid).

At low temperatures (0°C or less), the vinyl cable will harden and the wires may break if the cable is bent. Do not bend a Standard or Robot Cable at low temperature.

●Maintenance and inspection

Periodic Inspection

To ensure long-term stable operation of the Proximity Sensor, inspect for the following on a regular basis. Conduct these inspections also for control devices.

1. Shifting, loosening, or deformation of the sensing object and Proximity Sensor mounting
2. Loosening, bad contact, or wire breakage in the wiring and connections
3. Adherence or accumulation of metal powder
4. Abnormal operating temperature or ambient conditions
5. Abnormal indicator flashing (on setting indicator types)

Disassembly and Repair

Do not under any circumstances attempt to disassemble or repair the product.

Quick Failure Check

You can conveniently check for failures by connecting the E39-VA Handy Checker to check the operation of the Sensor.