Rectangular Standard Proximity Sensor

TL-N/TL-Q/TL-G

A Wealth of Models for All Types of Applications

- Easy installation, high-speed pulse generator, high-speed rotation control, and more.
- Direct mounted to metal (-N Models).
- A wealth of models ideal for limit control, counting control, and other applications (-N Models).

CE
(excluding TL-G)

⚠ Be sure to read *Safety Precautions* on page 9.

Ordering Information

Sensors

DC 2-Wire Models

Appearance		Sensing distance	Model	
			Operation mode	
			NO	NC
Unshielded	17 × 17	5 mm	TL-Q5MD1	TL-Q5MD2
	25 × 25	7 mm	TL-N7MD1	TL-N7MD2
	30 × 30	12 mm	TL-N12MD1	TL-N12MD2
	40 × 40	20 mm	TL-N20MD1	TL-N20MD2

Note: Models with a different frequency are available to prevent mutual interference. The model numbers are TL-N□MD□5 and TL-Q5MD□5 (e.g., TL-N7MD15).

DC 3-Wire and AC 2-Wire Models

Appearance		Sensing distance	Output configuration	Model	
				Operation mode	
				NO	NC
Unshielded	8 × 9	2 mm	DC 3-wire, NPN	TL-Q2MC1	—
	17 × 17	5 mm		TL-Q5MC1 *2	TL-Q5MC2
	25 × 25	5 mm	DC 3-wire, NPN	TL-N5ME1 *1 *2	TL-N5ME2 *1
			AC 2-wire	TL-N5MY1	TL-N5MY2
	30 × 30	10 mm	DC 3-wire, NPN	TL-N10ME1 *1 *2	TL-N10ME2 *1
			AC 2-wire	TL-N10MY1	TL-N10MY2
	40 × 40	20 mm	DC 3-wire, NPN	TL-N20ME1 *1 *2	TL-N20ME2
			AC 2-wire	TL-N20MY1	TL-N20MY2
	Grooved	7.5 mm	DC 3-wire, NPN	TL-G3D-3	—

Note: Models with a different frequency are available to prevent mutual interference. Models numbers for Sensors with different frequencies are TL-□□M□□5 (example: TL-N5ME15).
*1. Models are also available with 5-m cables. Add the cable length to the model number (example: TL-N5ME1 5M).
*2. Models with robotics cables are also available. Add -R to the end of the model number (example: TL-N5ME1-R).

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Accessories (Order Separately)

Mounting Brackets

Type	Model	Applicable Sensors	
		Provided with these Sensors	Order separately
Mounting Brackets	**Y92E-C5**	TL-N5ME□, TL-N7MD□	TL-N5MY□
	Y92E-C10	TL-N10ME□, TL-N12MD□	TL-N10MY□
	Y92E-C20	TL-N20ME□, TL-N20MD□	TL-N20MY□
Mounting Brackets for Conduits	**Y92E-N5C15**	---	TL-N5ME□, TL-N5MY□
	Y92E-N10C15	---	TL-N10ME□, TL-N10MY□

Ratings and Specifications

DC 2-Wire Models

Item / Model		TL-Q5MD□	TL-N7MD□	TL-N12MD□	TL-N20MD□
Sensing distance		5 mm ±10%	7 mm ±10%	12 mm ±10%	20 mm ±10%
Set distance		0 to 4 mm	0 to 5.6 mm	0 to 9.6 mm	0 to 16 mm
Differential travel		10% max. of sensing distance			
Detectable object		Ferrous metal (The sensing distance decreases with non-ferrous metal. Refer to *Engineering Data* on page 5.)			
Standard sensing object		Iron, 18 × 18 × 1 mm	Iron, 30 × 30 × 1 mm	Iron, 40 × 40 × 1 mm	Iron, 50 × 50 × 1 mm
Response frequency *		500 Hz			300 Hz
Power supply voltage (operating voltage range)		12 to 24 VDC (10 to 30 VDC), ripple (p-p): 10% max.			
Leakage current		0.8 mA max.			
Control output	**Load current**	3 to 100 mA			
	Residual voltage	3.3 V max. (Load current: 100 mA, Cable length: 2 m)			
Indicators		D1 Models: Operation indicator (red), Setting indicator (green) D2 Models: Operation indicator (red)			
Operation mode (with sensing object approaching)		D1 Models: NO D2 Models: NC Refer to the timing charts under *I/O Circuit Diagrams* on page 7 for details.			
Protection circuits		Load short-circuit protection, Surge suppressor			
Ambient temperature range		Operating/Storage: –25 to 70°C (with no icing or condensation)			
Ambient humidity range		Operating/Storage: 35% to 95% (with no condensation)			
Temperature influence		±10% max. of sensing distance at 23°C in the temperature range of –25 to 70°C			
Voltage influence		±2.5% max. of sensing distance at rated voltage in the rated voltage ±15% range			
Insulation resistance		50 MΩ min. (at 500 VDC) between current-carrying parts and case			
Dielectric strength		1,000 VAC for 1 min between current-carrying parts and case			
Vibration resistance		Destruction: 10 to 55 Hz, 1.5-mm double amplitude for 2 hours each in X, Y, and Z directions			
Shock resistance		Destruction: 500 m/s² 3 times each in X, Y, and Z directions	Destruction: 1,000 m/s² 10 times each in X, Y, and Z directions		
Degree of protection		IEC 60529 IP67, in-house standards: oil-resistant			
Connection method		Pre-wired Models (Standard cable length: 2 m)			
Weight (packed state)		Approx. 45 g	Approx. 145 g	Approx. 170 g	Approx. 240 g
Materials	**Case**	Heat-resistant ABS			
	Sensing surface				
Accessories		Instruction manual	Mounting Bracket, Instruction manual		

* The response frequency is an average value.
Measurement conditions are as follows: standard sensing object, a distance of twice the standard sensing object, and a set distance of half the sensing distance.

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DC 3-Wire Models

Item / Model		TL-Q2MC1	TL-Q5MC□	TL-G3D-3
Sensing distance		2 mm ±15%	5 mm ±10%	7.5±0.5mm
Set distance		0 to 1.5 mm	0 to 4 mm	10 mm
Differential travel		10% max. of sensing distance		
Detectable object		Ferrous metal (The sensing distance decreases with non-ferrous metal. Refer to *Engineering Data* on page 6.)		
Standard sensing object		Iron, 8 × 8 × 1 mm	Iron, 15 × 15 × 1 mm	Iron, 10 × 5 × 0.5mm
Response time		---	2 ms max.	1 ms max.
Response frequency *		500 Hz		
Power supply voltage (operating voltage range)		12 to 24 VDC (10 to 30 VDC), ripple (p-p): 10% max.		12 to 24 VDC, ripple (p-p): 5% max.
Current consumption		15 mA max. at 24 VDC (no-load)	10 mA max. at 24 VDC	2 mA max. at 24 VDC (no-load)
Control output	Load current	NPN open collector 100 mA max. at 30 VDC max.	NPN open collector 50 mA max. at 30 VDC max.	NPN transistor output 20 mA max.
	Residual voltage	1 V max. (under load current of 100 mA with cable length of 2 m)	1 V max. (under load current of 50 mA with cable length of 2 m)	---
Indicators		Detection indicator (red)		---
Operation mode (with sensing object approaching)		NO	C1 Models: NO C2 Models: NC	NO
		Refer to the timing charts under *I/O Circuit Diagrams* on page 7 for details.		
Protection circuits		Reverse polarity protection, Surge suppressor		Surge suppressor
Ambient temperature range		Operating/Storage: –10 to 60°C (with no icing or condensation)	Operating/Storage: –25 to 70°C (with no icing or condensation)	
Ambient humidity range		Operating/Storage: 35% to 95% (with no condensation)		
Temperature influence		±10% max. of sensing distance at 23°C in the temperature range of –10 to 60°C	±20% max. of sensing distance at 23°C in the temperature range of –25 to 70°C	±10% max. of sensing distance at 23°C in the temperature range of –10 to 55°C
Voltage influence		±2.5% max. of sensing distance at rated voltage in rated voltage ±10% range		
Insulation resistance		50 MΩ min. (at 500 VDC) between current-carrying parts and case	5 MΩ min. (at 500 VDC) between current-carrying parts and case	
Dielectric strength		1,000 VAC for 1 min between current-carrying parts and case	500 VAC, 50/60 Hz for 1 min between current-carrying parts and case	
Vibration resistance		Destruction: 10 to 55 Hz, 1.5-mm double amplitude for 2 hours each in X, Y, and Z directions		
Shock resistance		Destruction: 1,000 m/s^2 10 times each in X, Y, and Z directions	Destruction: 200 m/s^2 10 times each in X, Y, and Z directions	
Degree of protection		IEC 60529 IP67, in-house standards: oil-resistant	IEC IP67	IEC IP66
Connection method		Pre-wired Models (Standard cable length: 2 m)		Pre-wired Models (Standard cable length: 1m)
Weight (packed state)		Approx. 30 g	Approx. 60 g	Approx. 30 g
Materials	Case	Heat-resistant ABS		PPO
	Sensing surface			
Accessories		Instruction manual	---	

* The response frequency is an average value. Measurement conditions are as follows: standard sensing object, a distance of twice the standard sensing object, and a set distance of half the sensing distance.

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Item / Model		TL-N5ME□, TL-N5MY□	TL-N10ME□, TL-N10MY□	TL-N20ME□, TL-N20MY□
Sensing distance		5 mm ±10%	10 mm ±10%	20 mm ±10%
Set distance		0 to 4 mm	0 to 8 mm	0 to 16 mm
Differential travel		15% max. of sensing distance		
Detectable object		Ferrous metal (The sensing distance decreases with non-ferrous metal. Refer to *Engineering Data* on pages 6 and 7.)		
Standard sensing object		Iron, 30 × 30 × 1 mm	Iron, 40 × 40 × 1 mm	Iron, 50 × 50 × 1 mm
Response frequency *1		E Models: 500 Hz Y Models: 10 Hz		E Models: 40 Hz Y Models: 10 Hz
Power supply voltage *2 (operating voltage range)		E Models: 12 to 24 VDC (10 to 30 VDC), ripple (p-p): 10% max. Y Models: 100 to 220 VAC (90 to 250 VAC), 50/60 Hz		
Current consumption		E Models: 8 mA max. at 12 VDC, 15 mA max. at 24 VDC		
Leakage current		Y Models: Refer to *Engineering Data* on page 5.		
Control output	Load current	E Models: 100 mA max. at 12 VDC, 200 mA max. at 24 VDC Y Models: 10 to 200 mA		
	Residual voltage	E Models: 1 V max. (load current: 200 mA) Y Models: Refer to *Engineering Data* on page 5.		
Indicators		E Models: Detection indicator (red) Y Models: Operation indicator (red)		
Operation mode (with sensing object approaching)		E1/Y1 Models: NO E2/Y2 Models: NC		
		Refer to the timing charts under *I/O Circuit Diagrams* on page 8 for details.		
Protection circuits		E Models: Reverse polarity protection, Surge suppressor Y Models: Surge suppressor		
Ambient temperature range		Operating/Storage: –25 to 70°C (with no icing or condensation)		
Ambient humidity range		Operating/Storage: 35% to 95% (with no condensation)		
Temperature influence		±10% max. of sensing distance at 23°C in the temperature range of –25 to 70°C		
Voltage influence		E Models: ±2.5% max. of sensing distance at rated voltage in rated voltage ±10% range Y Models: ±1% max. of sensing distance at rated voltage in rated voltage ±10% range		
Insulation resistance		50 MΩ min. (at 500 VDC) between current-carrying parts and case		
Dielectric strength		E Models: 1,000 VAC, 50/60 Hz for 1 min between current-carrying parts and case Y Models: 2,000 VAC, 50/60 Hz for 1 min between current-carrying parts and case		
Vibration resistance		Destruction: 10 to 55 Hz, 1.5-mm double amplitude for 2 hours each in X, Y, and Z directions		
Shock resistance		Destruction: 500 m/s^2 10 times each in X, Y, and Z directions		
Degree of protection		IEC 60529 IP67, in-house standards: oil-resistant		
Connection method		Pre-wired Models (Standard cable length: 2 m)		
Weight (packed state)		Approx. 145 g	Approx. 170 g	Approx. 240 g
Materials	Case	Heat-resistant ABS		
	Sensing surface			
Accessories		E Models: Mounting Bracket, Instruction manual Y Models: Instruction manual		

*1. The response frequency is an average value. Measurement conditions are as follows: standard sensing object, a distance of twice the standard sensing object, and a set distance of half the sensing distance.
*2. E Models (DC switching models): A full-wave rectification power supply of 24 VDC ±10% (average value) can be used.

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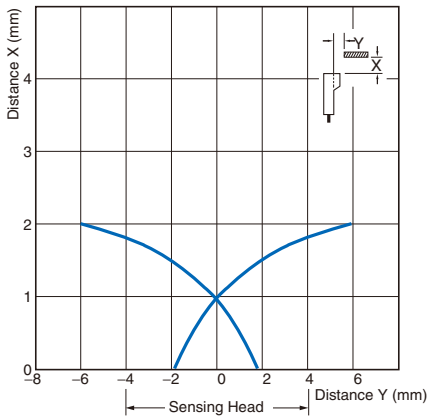
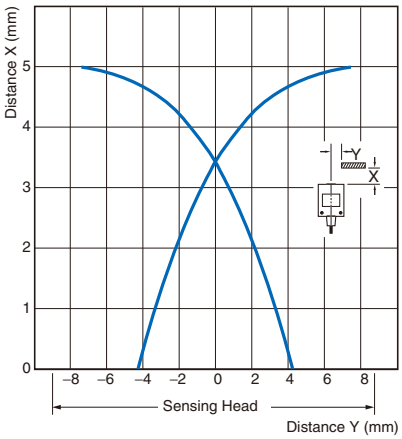
Engineering Data (Typical)

Sensing Area

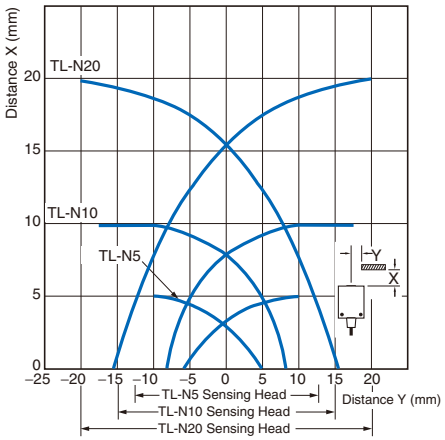
TL-Q2MC1



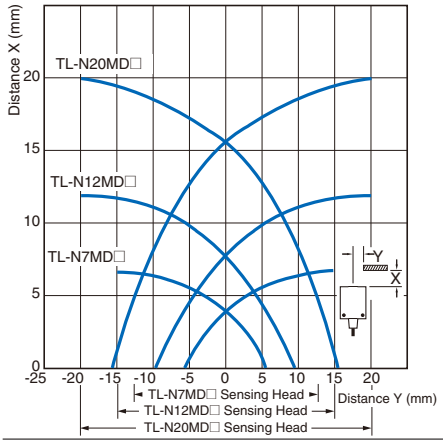
TL-Q5M□□



TL-N□ME□
TL-N□MY□

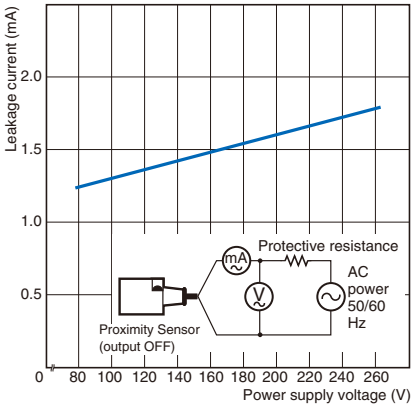


TL-N□MD□



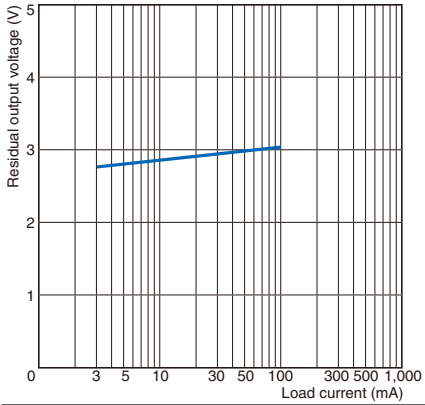
Leakage Current

TL-N□MY

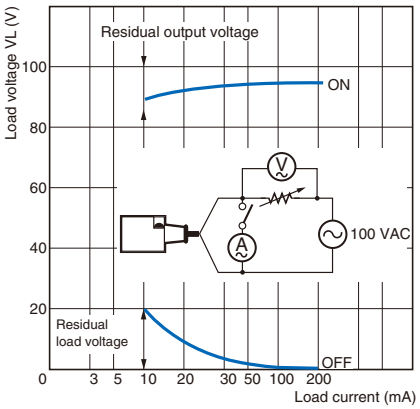


Residual Output Voltage

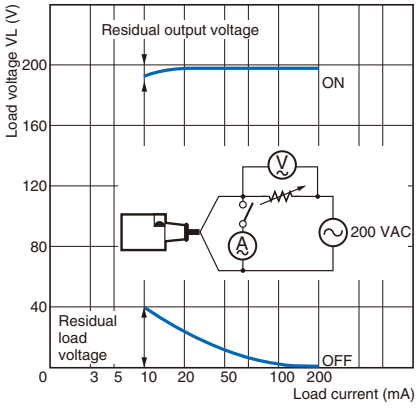
TL-N□MD



TL-N□MY at 100 VAC



TL-N□MY at 200 VAC



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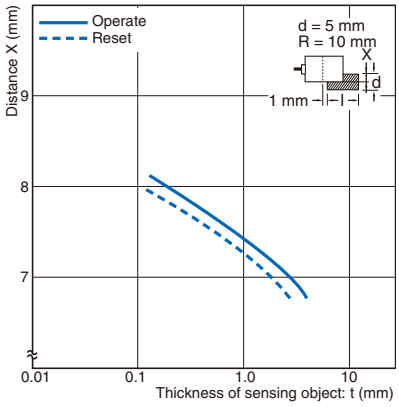
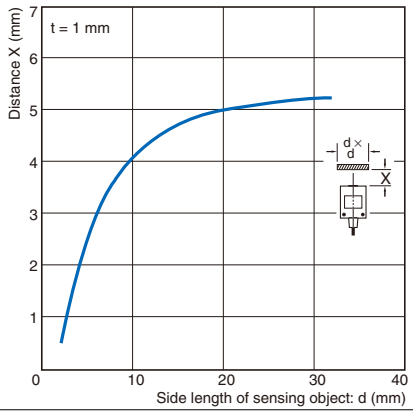
Thickness of Sensing Object vs. Sensing Distance

TL-G3D-3

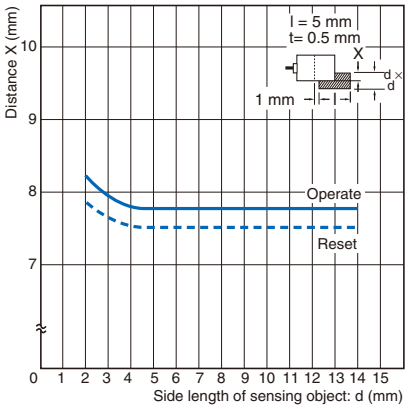


Sensing Object Size vs. Sensing Distance

TL-Q5MC□

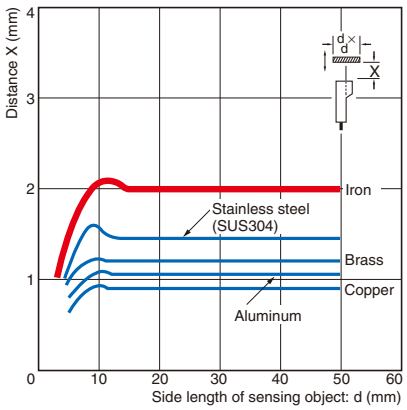


TL-G3D-3

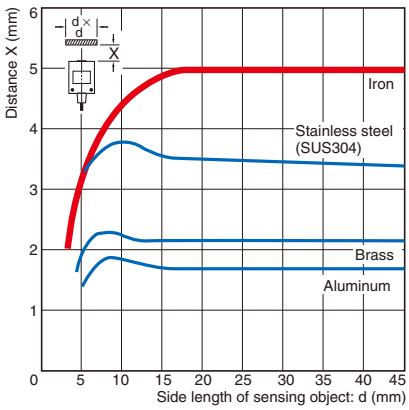


Influence of Sensing Object Size and Material

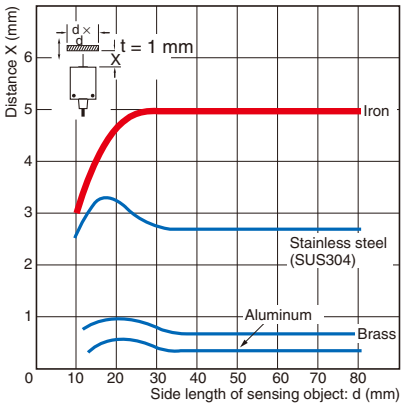
TL-Q2MC1



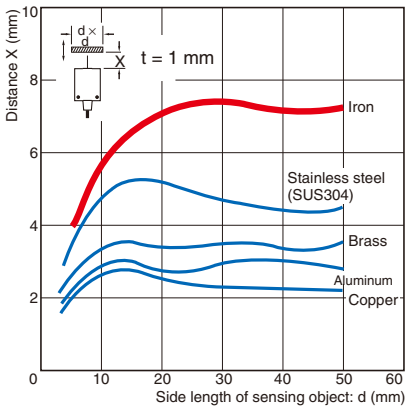
TL-Q5M□□



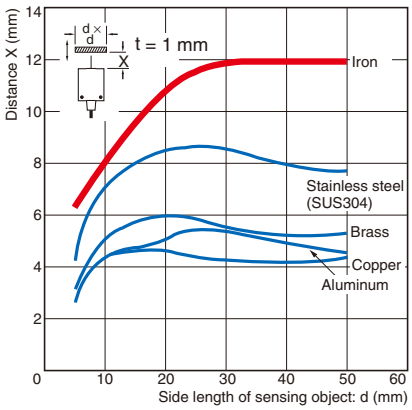
TL-N5□



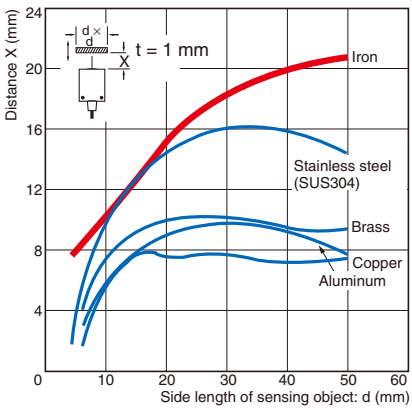
TL-N7MD□



TL-N12MD□



TL-N20MD□



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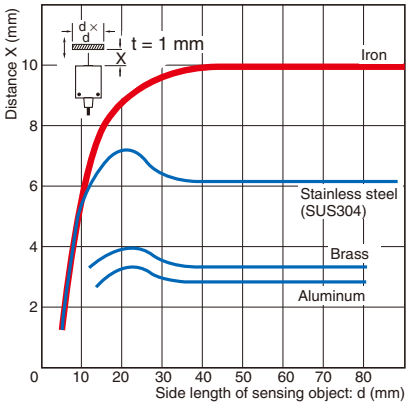
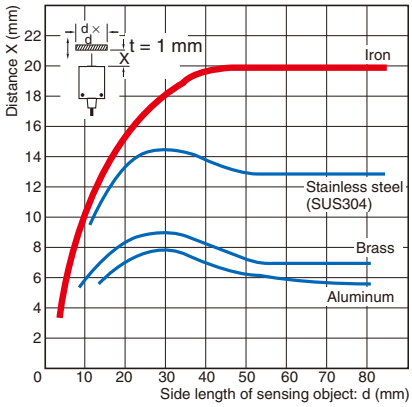
TL-N10□

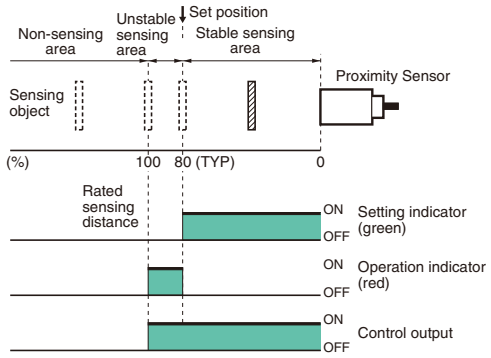
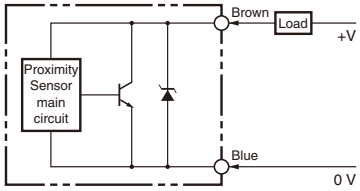
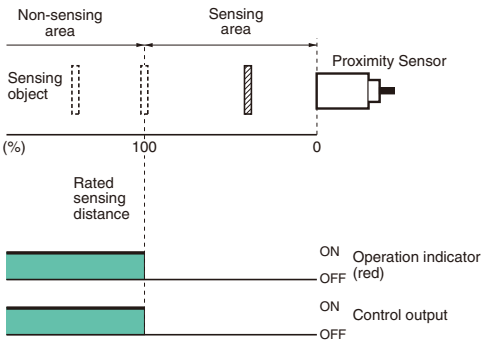


TL-N20□



I/O Circuit Diagrams

DC 2-Wire Models

Operation mode	Model	Timing chart	Output circuit
NO	TL-Q5MD1 TL-N7MD1 TL-N12MD1 TL-N20MD1		
NC	TL-Q5MD2 TL-N7MD2 TL-N12MD2 TL-N20MD2		

Note: The load can be connected to either the +V or 0 V side.

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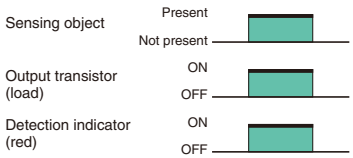
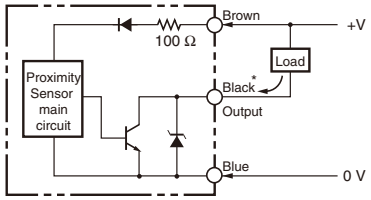
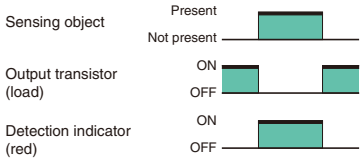
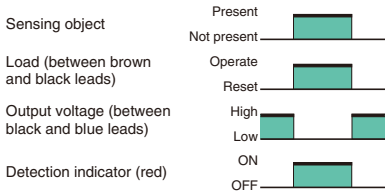
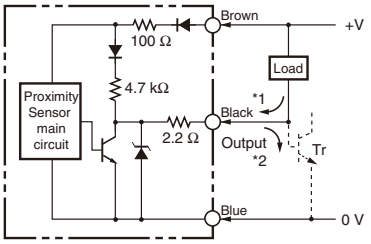
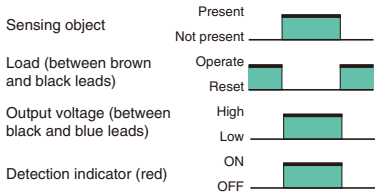
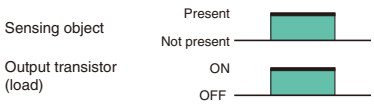
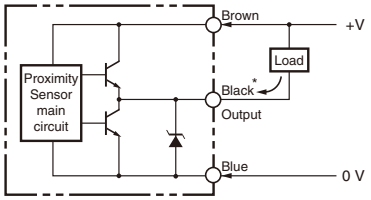
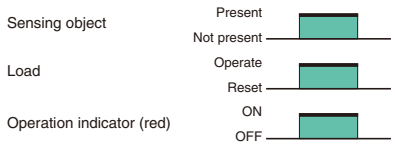
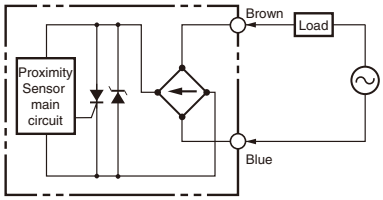
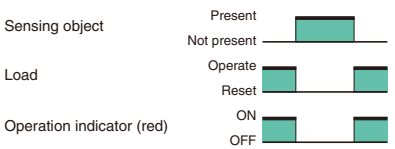
DC 3-Wire Models

Operation mode	Model	Timing chart	Output circuit
NO	TL-Q2MC1 TL-Q5MC1		 * Load current: 100 mA max., TL-Q2MC1 Load current: 50 mA max., TL-Q5MC1
NC	TL-Q5MC2		
NO	TL-N5ME1 TL-N10ME1 TL-N20ME1		 *1. Load current: 200 mA max. *2. When a transistor is connected.
NC	TL-N5ME2 TL-N10ME2 TL-N20ME2		
Transistor output	TL-G3D-3		 * Load current: 20 mA max.

AC 2-Wire Models

Operation mode	Model	Timing chart	Output circuit
NO	TL-N5MY1 TL-N10MY1 TL-N20MY1		
NC	TL-N5MY2 TL-N10MY2 TL-N20MY2		

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Safety Precautions

Refer to *Warranty and Limitations of Liability*.

⚠ WARNING

This product is not designed or rated for ensuring safety of persons either directly or indirectly. Do not use it for such purposes.

- Do not short-circuit the load, otherwise the Sensor may be damaged.
- Do not supply power to the Sensor with no load, otherwise the Sensor may be damaged.
  Applicable Models: AC 2-Wire Models

Precautions for Correct Use

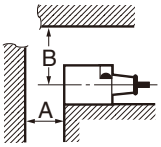
Do not use this product under ambient conditions that exceed the ratings.

● Design

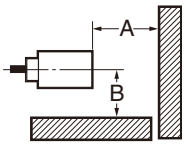
Influence of Surrounding Metal

When mounting the Sensor within a metal panel, ensure that the clearances given in the following table are maintained. Failure to maintain these distances may cause deterioration in the performance of the Sensor.

Rectangular Models TL-N



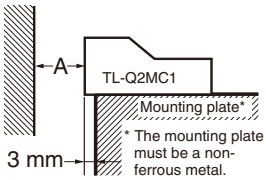
TL-Q

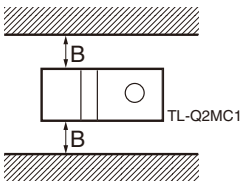


Influence of Surrounding Metal (Unit: mm)

Model / Distance	A *	B *
TL-Q5M□□	20	20
TL-N7MD□	40	35
TL-N12MD□	50	40
TL-N20MD□	70	60
TL-N5ME□, TL-N5MY□	20	23
TL-N10ME□, TL-N10MY□	40	30
TL-N20ME□, TL-N20MY□	80	45

* The figure is applicable for one metal object. (The figure must be multiplied by the number of metal objects.)

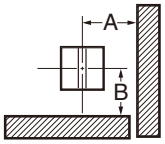




Influence of Surrounding Metal (Unit: mm)

Model / Distance	A	B
TL-Q2MC1	12	3

Grooved Model



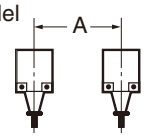
Influence of Surrounding Metal (Unit: mm)

Model / Distance	A	B
TL-G3D-3	11	17

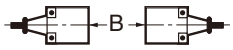
Mutual Interference

When installing Sensors face-to-face or side-by-side, ensure that the minimum distances given in the following table are maintained.

Parallel



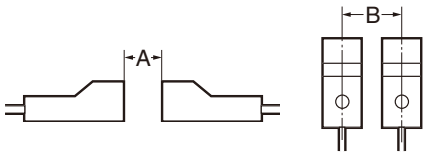
Face-to-face



Mutual Interference (Unit: mm)

Model / Distance	A *	B *
TL-Q5MC□	60 (17)	120 (60)
TL-Q5MD□	60 (30)	120 (80)
TL-N7MD□	100 (50)	120 (60)
TL-N12MD□	120 (60)	200 (100)
TL-N20MD□	200 (100)	200 (100)
TL-N5ME□	80 (40)	80 (40)
TL-N5MY□	80 (40)	90 (40)
TL-N10ME□, TL-N10MY□	120 (60)	120 (60)
TL-N20ME□, TL-N20MY□	200 (100)	120 (60)

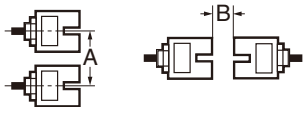
* Values in parentheses apply to Sensors operating at different frequencies.



Mutual Interference (Unit: mm)

Model / Distance	A	B
TL-Q2MC1	30 (8)	90 (45)

Grooved Model



Mutual Interference (Unit: mm)

Model / Distance	A	B
TL-G3D-3	31	25

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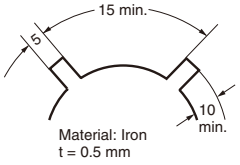
Designing the Sensing Object for TL-G3D-3 Grooved Model

For high-speed response to a toothed metal plate, the sensing objects must be at least the size of the standard sensing object and there must be sufficient distance between sensing objects. The response frequency for a toothed wheel like the one shown at the right is 1 kHz min. The response frequency will be reduced if the wheel is smaller or the width of the teeth or the distance between the teeth is reduced.



● Mounting

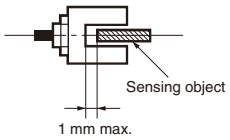
When tightening the mounting screws, do not exceed the torque in the following table.

Model	Torque
TL-Q2MC1	0.59 N·m
TL-Q5M□□	
TL-N□M□□	0.9 to 1.5 N·m
TL-G3D-3	2 N·m

● Adjustment

Sensing Object Passing Position for the TL-G3D-3 Grooved Model

The gap between the sensing object and the bottom of the groove must be 1 mm or less.

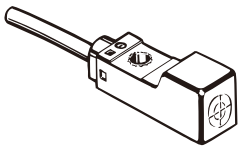


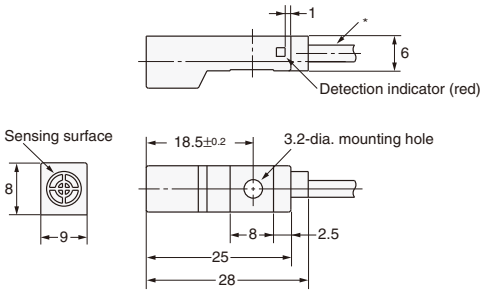
Dimensions

(Unit: mm)

Sensors

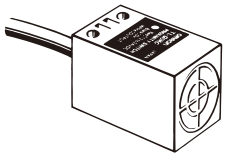
TL-Q2MC1

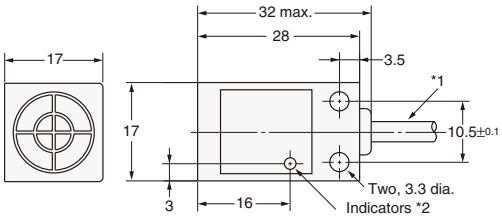




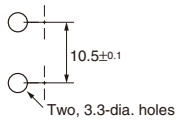
* 2.9-dia. vinyl-insulated round cable with 3 conductors (Conductor cross section: 0.15 mm², Insulator diameter: 0.9 mm), Standard length: 2 m

TL-Q5M□□





Mounting Hole Dimensions



*1. C Models: 4-dia. vinyl-insulated round cable with 3 conductors (Conductor cross section: 0.2 mm², Insulator diameter: 1.2 mm), Standard length: 2 m
D Models: 4-dia. vinyl-insulated round cable with 2 conductors (Conductor cross section: 0.3 mm², Insulator diameter: 1.3 mm), Standard length: 2 m
*2. C Models: Detection indicator (red)
D Models: Operation indicator (red), Setting indicator (green)

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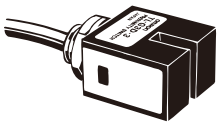
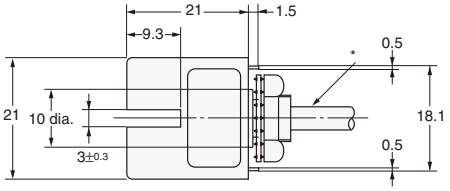
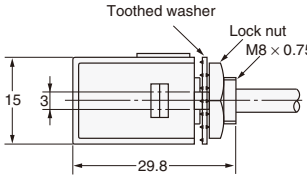
TL-G3D-3

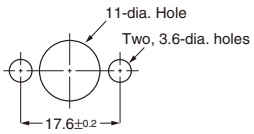




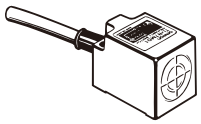


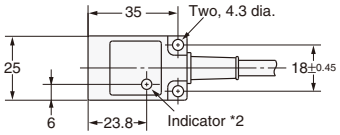
* 4-dia. vinyl-insulated round cable with 3 conductors (Conductor cross section: 0.2 mm^2, Insulator diameter: 1.2 mm), Standard length: 1 m

Mounting Hole Dimensions

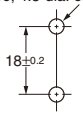


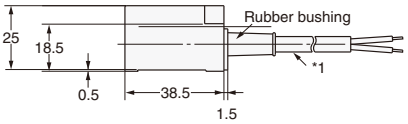
TL-N7MD□, TL-N5ME□





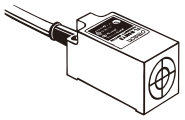
Mounting Hole Dimensions

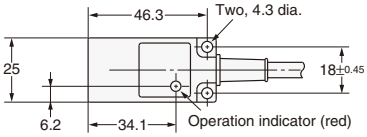




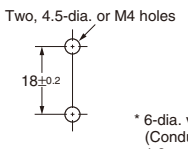
*1. D Models: 6-dia. vinyl-insulated round cable with 2 conductors (Conductor cross section: 0.5 mm^2, Insulator diameter: 1.9 mm), Standard length: 2 m
E Models: 6-dia. vinyl-insulated round cable with 3 conductors (Conductor cross section: 0.5 mm^2, Insulator diameter: 1.9 mm), Standard length: 2 m
*2. D1 Models: Operation indicator (red), Setting indicator (green)
D2 Models: Operation indicator (red)
E Models: Detection indicator (red)

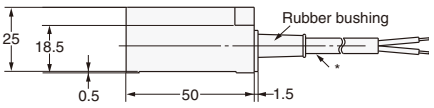
TL-N5MY□





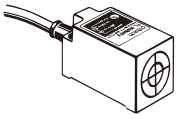
Mounting Hole Dimensions

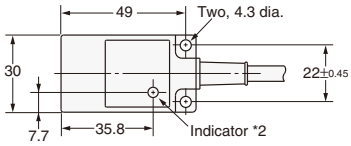




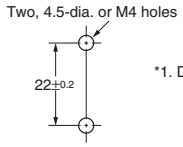
* 6-dia. vinyl-insulated round cable with 2 conductors (Conductor cross section: 0.5 mm^2, Insulator diameter: 1.9 mm), Standard length: 2 m

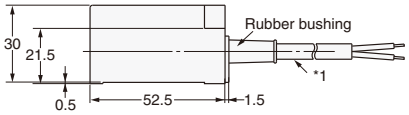
TL-N12MD□, TL-N10ME□, TL-N10MY□





Mounting Hole Dimensions





*1. D/Y Models: 6-dia. vinyl-insulated round cable with 2 conductors (Conductor cross section: 0.5 mm^2, Insulator diameter: 1.9 mm), Standard length: 2 m
E Models: 6-dia. vinyl-insulated round cable with 3 conductors (Conductor cross section: 0.5 mm^2, Insulator diameter: 1.9 mm), Standard length: 2 m
*2. D1 Models: Operation indicator (red) and Setting indicator (green)
D2 Models: Operation indicator (red)
E Models: Detection indicator (red)
Y Models: Operation indicator (red)

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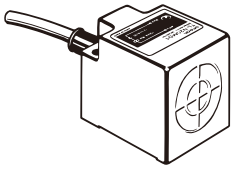
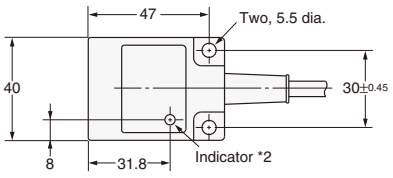
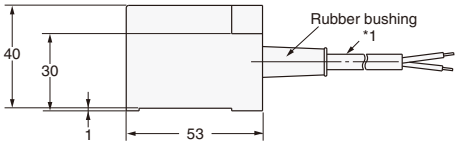
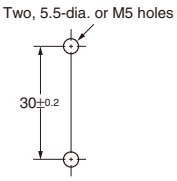
TL-N20MD□, TL-N20ME□, TL-N20MY□







Mounting Hole Dimensions

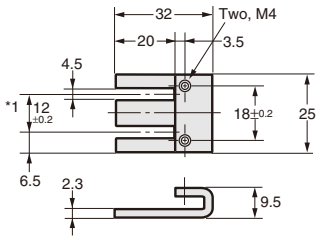


*1. D/Y Models: 6-dia. vinyl-insulated round cable with 2 conductors (Conductor cross section: 0.5 mm^2, Insulator diameter: 1.9 mm), Standard length: 2 m
E Models: 6-dia. vinyl-insulated round cable with 3 conductors (Conductor cross section: 0.5 mm^2, Insulator diameter: 1.9 mm), Standard length: 2 m
*2. D1 Models: Operation indicator (red) and Setting indicator (green)
D2 Models: Operation indicator (red)
E Models: Detection indicator (red)
Y Models: Operation indicator (red)

Accessories (Order Separately)

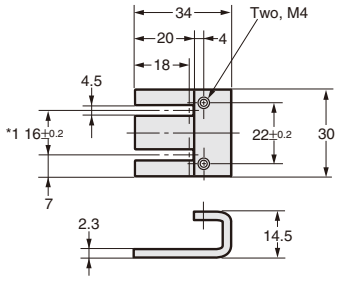
Mounting Bracket

Y92E-C5



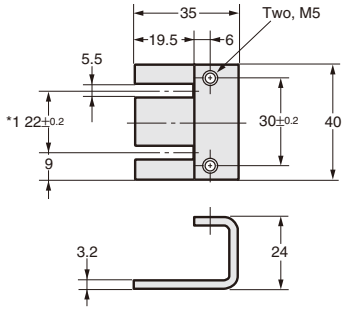
Applicable Models: TL-N5ME□ *2
Applicable Models: TL-N5MY□
Applicable Models: TL-N7MD□ *2

Y92E-C10



Applicable Models: TL-N10ME□ *2
Applicable Models: TL-N10MY□
Applicable Models: TL-N12MD□ *2

Y92E-C20

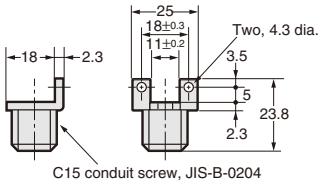


Applicable Models: TL-N20ME□ *2
Applicable Models: TL-N20MY□
Applicable Models: TL-N20MD□ *2

*1. These are the mounting dimensions of the base of the Mounting Bracket.
*2. Provided with the product.

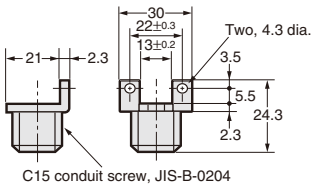
Mounting Brackets for Wiring Conduit Use (Sold Separately)

Y92E-N5C15



Applicable Models: TL-N5ME□
Applicable Models: TL-N5MY□
Applicable Models: TL-N7MD□

Y92E-N10C15



Applicable Models: TL-N10ME□
Applicable Models: TL-N10MY□
Applicable Models: TL-N12MD□

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General Precautions

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

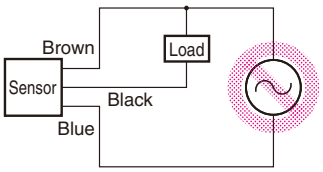
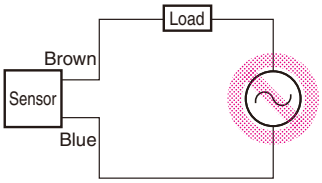
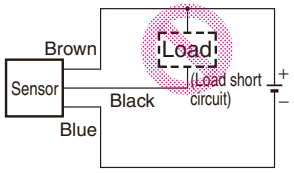
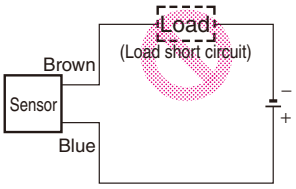
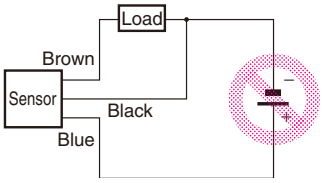
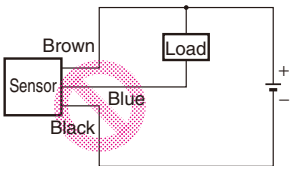
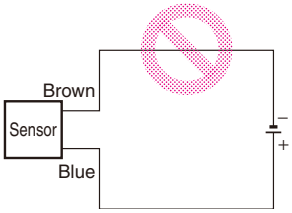
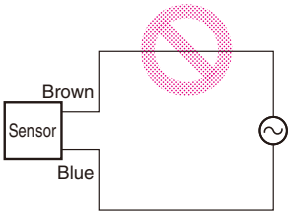
⚠ WARNING

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.

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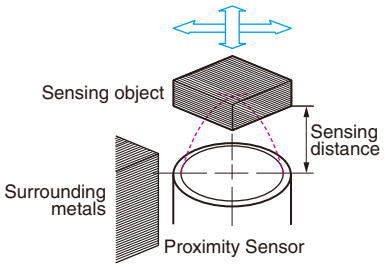
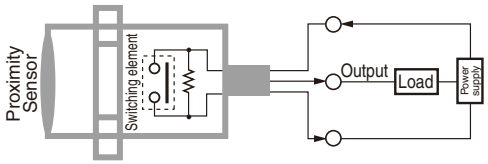
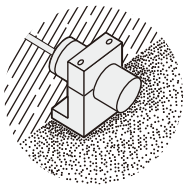
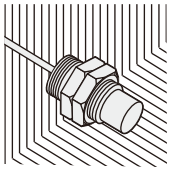
Precautions for Correct Use

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.

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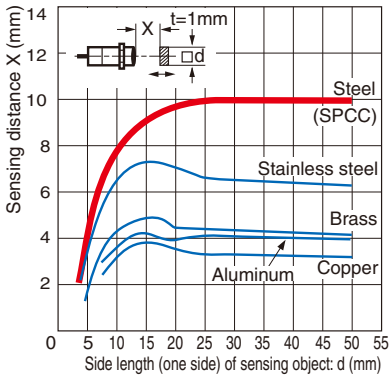
●Design

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.

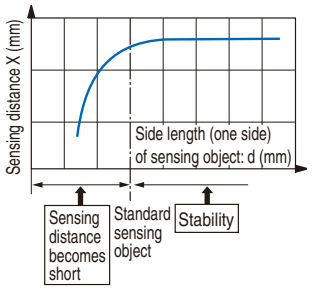
Example: E2-X10D□



Size of Sensing Object

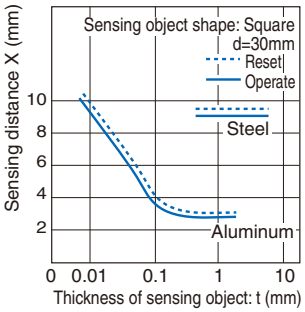
In general, if the object is smaller than the standard sensing object, the sensing distance decreases.

- 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.
- When the coating thickness is 0.01 mm or less, a sensing distance equivalent to a magnetic body can be obtained. 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.

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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.
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.

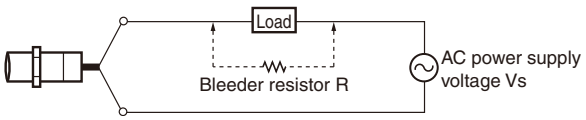
Examples of Timers that Use AC Half-wave Rectification
Timers: H3Y, H3YN, H3RN, H3CA-8, RD2P, and H3CR (-A, -A8, -AP, -F, -G)

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.

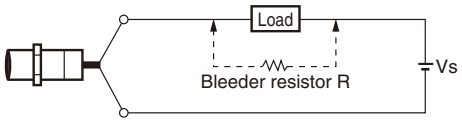
$$R \leq \frac{Vs}{10 - I}\ (k\Omega) \qquad P > \frac{Vs^2}{R}\ (mW)$$

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_{OFF} : 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.

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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.

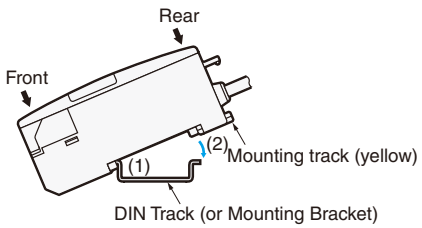
For details, refer to the mounting precautions in *Precautions for Correct Use* in individual product information.

Mounting/Removing Using DIN Track (Example for E2CY)

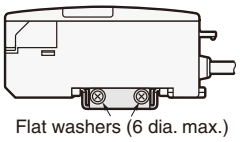
<Mounting>

(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.

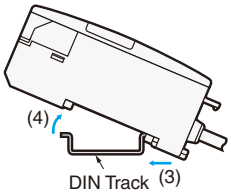


- When mounting the side of the Sensor using the special Mounting Bracket, first secure the Amplifier Unit to the special Mounting Bracket, and then mount the special Mounting Bracket with M3 screws and flat washers with a diameter of 6 mm maximum.



<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.

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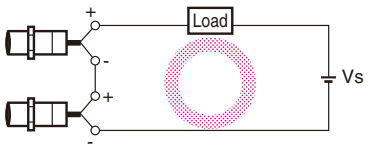
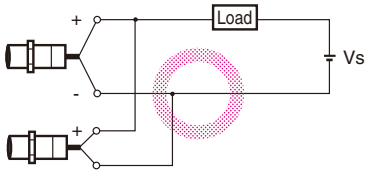
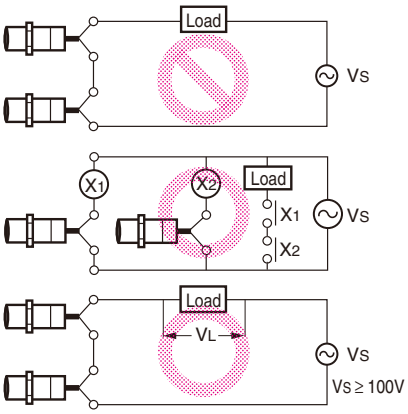
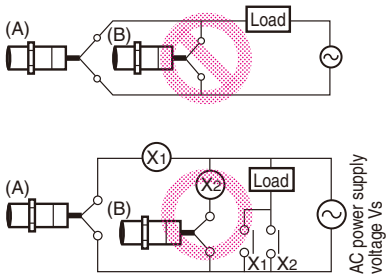
●Wiring Considerations

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□, TL-T□Y> The above Proximity Sensors cannot be used in a sereis 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.

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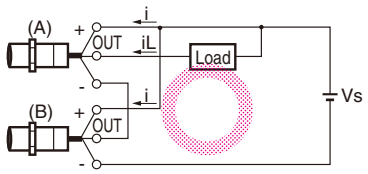
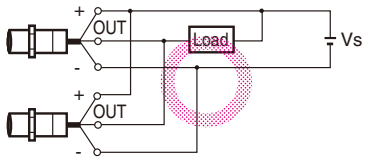
Model	Type of connection	Connection	Description
DC 3-wire	AND (series connection)		Keep the number of connected Sensors (N) within the range of the following equation. iL + (N - 1) × i ≤ Upper limit of Proximity Sensor control output Vs - N × VR ≥ Operating load voltage N : Number of Sensors that can 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 (with the exception of coaxial and shielded cables).

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

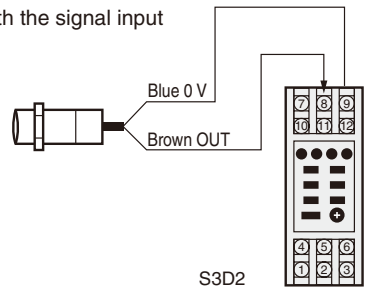
Using Metal Conduits
If a power line is to be located near the Proximity Sensor cable, use a separate metal conduit to prevent malfunction or damage. (Same for DC models.)

Example of Connection with S3D2 Sensor Controller

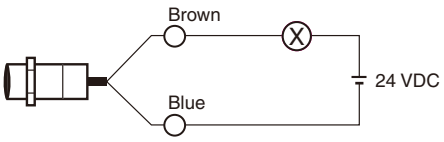
DC 2-Wire Sensors

Using the S3D2 Sensor Controller

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



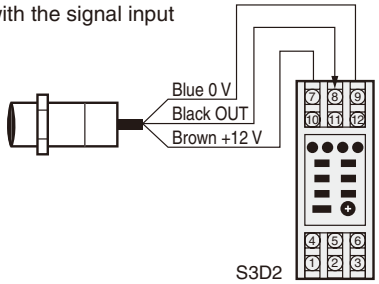
Connecting to a Relay Load



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.



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●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).

●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.

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