

Inductive Proximity Sensor in full metal housing

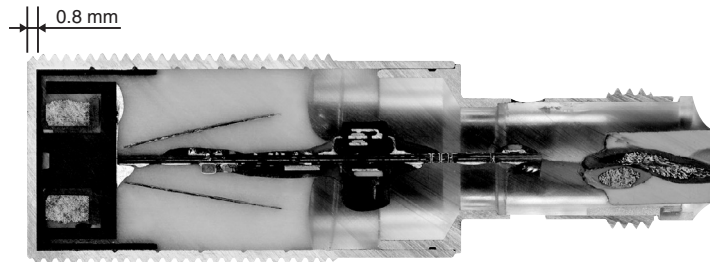
E2FM

- Full body stainless steel housing for highest mechanical protection
- Low frequency modulation for metal chip immunity
- Flame retardant cable for high protection against welding spatter damage



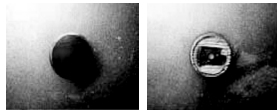
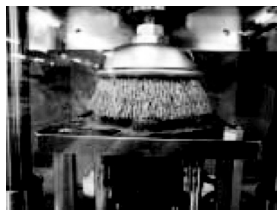
Application

Full body stainless steel housing with 0.8 mm thick sensing face protection



Brush Test

The stainless-steel head shows minimal wear when cleaned with a metal brush.



E2FM Standard sensor

Continuous Impact Test

More than 20 times the durability of standard sensors.



Standard sensor E2FM

The standard sensor with top wall thickness of 0.2 mm was penetrated after 10,000 impacts.

The E2FM was not penetrated after 250,000 impacts (depth: 0.26 mm).

Features

Chemical and Oil Resistance (examples)

Tested resistance against:

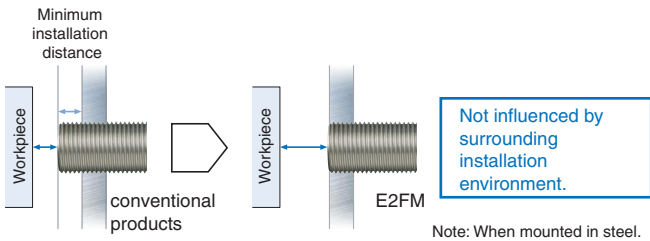
- Sodium chloride
- Gasoline
- Dilute sodium hydroxide
- Dilute hydrochloric acid
- Mineral oil
- Barium hydroxide

Low frequency modulation...

...for metal chip immunity reducing false signals caused by spatter accumulation and small metal objects.




Flush mounting installation possible




Ordering Information

Sensors

DC 2-Wire, Pre-wired Connector Models

| Appearance | Sensing distance | Output configuration | Operation mode | Model | |
|---|------------------|----------------------|----------------|---------------------------------------|-------------------|
| Shielded  | M8 | 1.5 mm | NO | E2FM-X1R5D1-M1GJ | |
| | M12 | 2 mm | | Polarity: Yes, Pin allocations: 1-4 | E2FM-X2D1-M1GJ |
| | | | | No polarity: No, Pin allocations: 3-4 | E2FM-X2D1-M1GJ-T |
| | M18 | 5 mm | | Polarity: Yes, Pin allocations: 1-4 | E2FM-X5D1-M1GJ |
| | | | | No polarity: No, Pin allocations: 3-4 | E2FM-X5D1-M1GJ-T |
| | M30 | 10 mm | | Polarity: Yes, Pin allocations: 1-4 | E2FM-X10D1-M1GJ |
| | | | | No polarity: No, Pin allocations: 3-4 | E2FM-X10D1-M1GJ-T |

DC 3-Wire, M12 Connector Models

| Appearance | Sensing distance | Output configuration | Operation mode | Model |
|---|------------------|----------------------|----------------|----------------|
| Shielded  | M8 | DC 3-Wire, PNP | NO | E2FM-X1R5B1-M1 |
| | M12 | | | E2FM-X2B1-M1 |
| | M18 | | | E2FM-X5B1-M1 |
| | M30 | | | E2FM-X10B1-M1 |

Rating and Specifications

DC 2-Wire (E2FM-X□D□)

| Size | | M8 | M12 | M18 | M30 | M12 | M18 | M30 | |
|--|--------------------|--|-------------------------|---|-------------------------|---|-------------------------|-------------------------|--|
| Shielded | | Shielded | | | | | | | |
| Item | Model | E2FM-X1R5D1 -M1GJ | E2FM-X2D1 -M1GJ | E2FM-X5D1 -M1GJ | E2FM-X10D1 -M1GJ | E2FM-X2D1 -M1GJ-T | E2FM-X5D1 -M1GJ-T | E2FM-X10D1 -M1GJ-T | |
| Sensing distance | | 1.5 mm±10% | 2 mm±10% | 5 mm±10% | 10 mm±10% | 2 mm±10% | 5 mm±10% | 10 mm±10% | |
| Set distance | | 0 to 1.05 mm | 0 to 1.4 mm | 0 to 3.5 mm | 0 to 7 mm | 0 to 1.4 mm | 0 to 3.5 mm | 0 to 7 mm | |
| Differential travel | | 15% max. of sensing distance | | | | | | | |
| Sensing object | | Ferrous metal (The sensing distance decreases with non-ferrous metal. Refer to <i>Engineering Data</i> on page 5.) | | | | | | | |
| Standard sensing object | | Iron, 8 × 8 × 1 mm | Iron, 12 × 12 × 1 mm | Iron, 30 × 30 × 1 mm | Iron, 54 × 54 × 1 mm | Iron, 12 × 12 × 1 mm | Iron, 30 × 30 × 1 mm | Iron, 54 × 54 × 1 mm | |
| Response frequency * | | 200 Hz | 100 Hz | 100 Hz | 50 Hz | 100 Hz | 100 Hz | 50 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. | | | | | | | |
| Output configuration | | With polarity | | | | Without polarity | | | |
| Control output | Switching capacity | 3 to 100 mA | | | | | | | |
| | Residual voltage | 3 V max. (Load current: 100 mA, Cable length: 2 m) | | | | 5 V max. (Load current: 100 mA, Cable length: 2 m) | | | |
| Indicators | | Operation indicator (red LED), Setting/Operation indicator (green LED) | | | | | | | |
| Operation mode (with sensing object approaching) | | NO | | | | | | | |
| Protection circuits | | Surge suppressor, Load short-circuit protection | | | | | | | |
| 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 | | ±20% max. of sensing distance at 23° C in the temperature range of -25 to 70° C. | | | | | | | |
| Voltage influence | | ±1% 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, 50/60 Hz for 1 minute between current carry 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 | | Destruction: 1,000 m/s ² 10 times each in X, Y, and Z directions | | | | | |
| Degree of protection | | IEC 60529 IP67, DIN 40050 part 9: IP69k | | | | | | | |
| Connection method | | Pig-tail Connector Models (Standard cable length: 0.3 m) | | | | | | | |
| Weight (packed state) | | Approx. 65 g | Approx. 85 g | Approx. 110 g | Approx. 190 g | Approx. 85 g | Approx. 110 g | Approx. 190 g | |
| Materials | Case | Stainless steel (SUS303) | | | | | | | |
| | Sensing surface | Stainless steel (SUS303) | | | | | | | |
| | (thickness) | (0.4 mm) | (0.8 mm) | | | | (0.8 mm) | | |
| | Clamping nuts | Stainless steel (SUS303) | | | | | | | |
| | Cable | PVC (flame retardant) | | | | | | | |
| | Toothed washer | Zinc-plated iron | | | | | | | |
| Accessories | | Instruction manual | | | | | | | |

* The response frequency of the DC switching section 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.

DC 3-Wire (E2FM-X□B□)

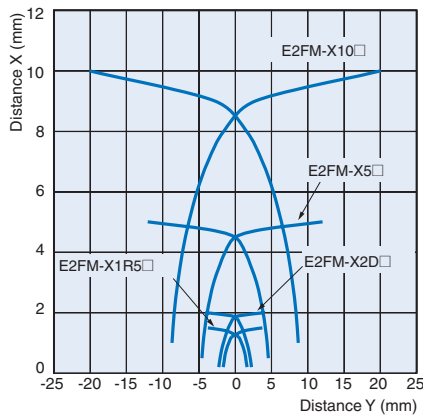
| Size | | M8 | M12 | M18 | M30 |
|--|--------------------|---|----------------------|---|----------------------|
| Shielded | | Shielded | | | |
| Item | Model | E2FM-X1R5B1-M1 | E2FM-X2B1-M1 | E2FM-X5B1-M1 | E2FM-X10B1-M1 |
| Sensing distance | | 1.5 mm±10% | 2 mm±10% | 5 mm±10% | 10 mm±10% |
| Set distance | | 0 to 1.05 mm | 0 to 1.4 mm | 0 to 3.5 mm | 0 to 7 mm |
| Differential travel | | 15% max. of sensing distance | | | |
| Sensing object | | Ferrous metal (The sensing distance decreases with non-ferrous metal. Refer to <i>Engineering Data</i> on page 5.) | | | |
| Standard sensing object | | Iron, 8 × 8 × 1 mm | Iron, 12 × 12 × 1 mm | Iron, 30 × 30 × 1 mm | Iron, 54 × 54 × 1 mm |
| Response frequency * | | 200 Hz | 100 Hz | 100 Hz | 50 Hz |
| Power supply voltage (operating voltage range) | | 12 to 24 VDC (10 to 30 VDC), ripple (p-p): 10% max. | | | |
| Current consumption | | 10 mA max. | | | |
| Output configuration | | PNP open collector output | | | |
| Control output | Switching capacity | 200 mA max. | | | |
| | Residual voltage | 2 V max. (Load current: 200 mA, Cable length: 2 m) | | | |
| Indicators | | Operation indicator (yellow LED) | | | |
| Operation mode (with sensing object approaching) | | NO | | | |
| Protection circuits | | Reversed power supply polarity protection, Surge suppressor, Load short-circuit protection, and Reversed output polarity protection (except the E2FM-X1R5B1-M1) | | | |
| 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 | | ±20% max. of sensing distance at 23°C in the temperature range of -25 to 70°C. | | | |
| Voltage influence | | ±1% max. of sensing distance in the rated voltage ±15% range (using the sensing distance at the rated voltage as standard) | | | |
| Insulation resistance | | 50 MΩ min. (at 500 VDC) between current-carrying parts and case | | | |
| Dielectric strength | | 1,000 VAC, 50/60 Hz for 1 minute between current carry 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 | | Destruction: 1,000 m/s ² 10 times each in X, Y, and Z directions | |
| | | | | | |
| Degree of protection | | IEC 60529 IP67, DIN 40050 part 9: IP69k | | | |
| Connection method | | Connector Models | | | |
| Weight (packed state) | | Approx. 45 g | Approx. 55 g | Approx. 75 g | Approx. 160 g |
| Materials | Case | Stainless steel (SUS303) | | | |
| | Sensing surface | Stainless steel (SUS303) | | | |
| | (thickness) | (0.4mm) | (0.8mm) | | |
| | Clamping nuts | Stainless steel (SUS303) | | | |
| | Toothed washer | Zinc-plated iron | | | |
| Accessories | | Instruction manual | | | |

* The response frequency of the DC switching section 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.

Engineering Data (Typical)

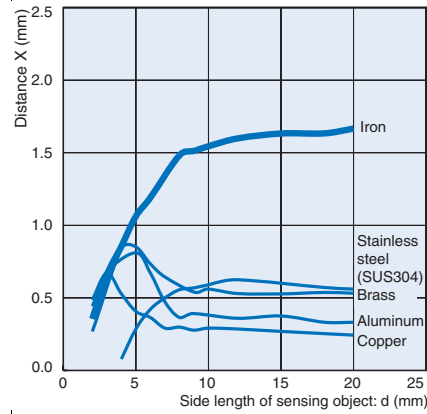
Sensing Area

E2FM-X□

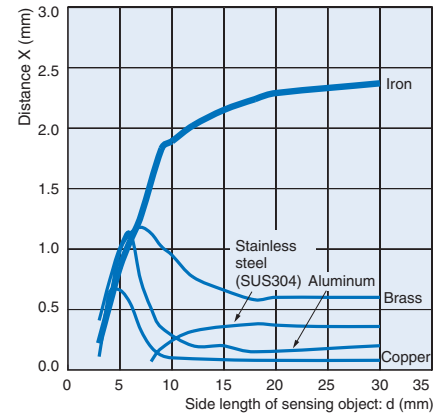


Influence of Sensing Object Size and Material

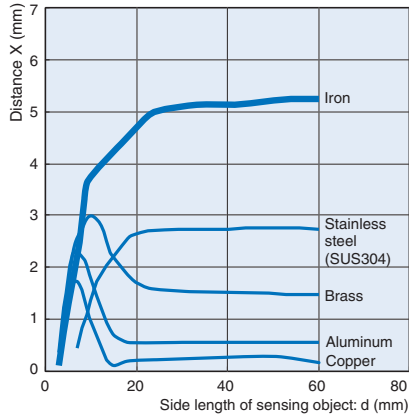
E2FM-X1R5□



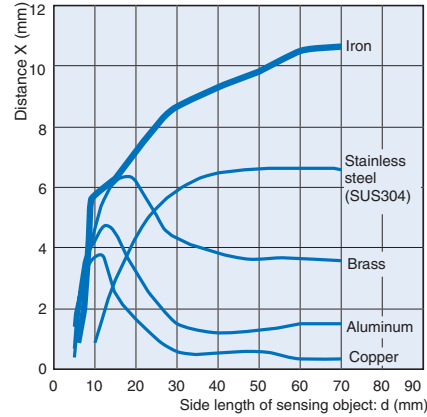
E2FM-X2□



E2FM-X5□

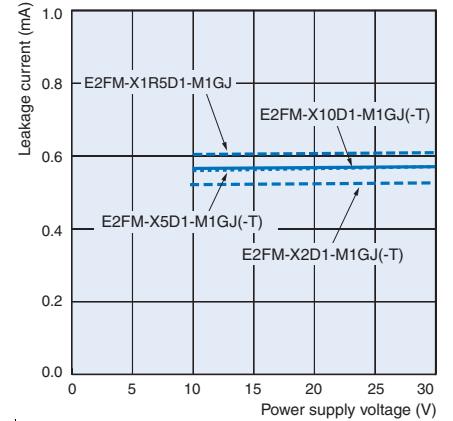


E2FM-X10□



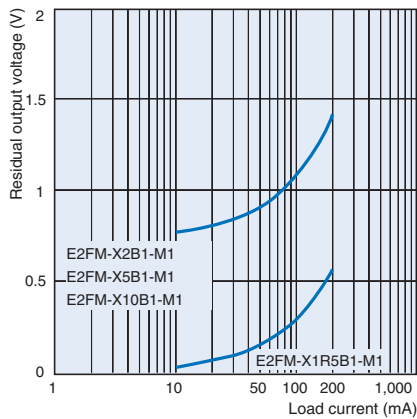
Leakage Current

E2FM-X□D1-M1GJ(-T)

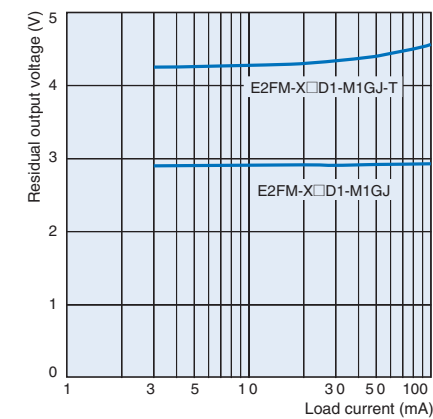


Residual Output Voltage

E2FM-X□B1-M1



E2FM-X□D1-M1GJ(-T)



I/O Circuit Diagrams

DC 2-Wire Models

| Operation mode | Model | Timing chart | Output circuit |
|----------------|------------------|--|--|
| NO | E2FM-X□D1-M1GJ | <p>Timing chart for E2FM-X□D1-M1GJ. The x-axis represents distance from the sensor, divided into Non-sensing area, Unstable sensing area, and Stable sensing area. A 'Sensing object' is shown in the sensing areas. A 'Set position' is marked at the start of the stable sensing area. The y-axis shows the sensor's output percentage from 0 to 100. A 'Rated sensing distance' is indicated at 100%.</p> | <p>Output circuit diagram for E2FM-X□D1-M1GJ. The load is connected between pins 1 and 4. Pin 1 is connected to +V (12 to 24 VDC) and pin 4 is connected to 0 V. The circuit includes a proximity sensor main circuit and a protection diode. Connector Pin Arrangement: Pin 1 at top, Pin 4 at bottom, Pin 2 on left, Pin 3 on right. Note: Pins 2 and 3 are not used.</p> |
| | E2FM-X□D1-M1GJ-T | <p>Timing chart for E2FM-X□D1-M1GJ-T. The x-axis is distance from the sensor. The y-axis shows the states of three indicators: Setting indicator (green), Operation indicator (red), and Control output. The Setting indicator is ON during the stable sensing area. The Operation indicator is ON during the unstable sensing area. The Control output is ON during the sensing area.</p> | <p>Output circuit diagram for E2FM-X□D1-M1GJ-T. The load is connected between pins 4 and 3. Pin 4 is connected to +V (12 to 24 VDC) and pin 3 is connected to 0 V (12 to 24 VDC). The circuit includes a proximity sensor main circuit and a protection diode. Connector Pin Arrangement: Pin 1 at top, Pin 4 at bottom, Pin 2 on left, Pin 3 on right. Note: Pins 1 and 2 are not used.</p> |

DC 3-Wire Models

| Operation mode | Output configuration | Model | Timing chart | Output circuit |
|----------------|--------------------------|---|---|--|
| NO | PNP open-collector model | E2FM-X1R5B1-M1 | <p>Timing chart for E2FM-X1R5B1-M1. The x-axis represents distance from the sensor, divided into Non-sensing area and Sensing area. A 'Sensing object' is shown in the sensing area. The y-axis shows the sensor's output percentage from 0 to 100. A 'Rated sensing distance' is indicated at 100%.</p> | <p>Output circuit diagram for E2FM-X1R5B1-M1. The load is connected between pins 1 and 3. Pin 1 is connected to +V (12 to 24 VDC) and pin 3 is connected to 0 V. The circuit includes a proximity sensor main circuit and a protection diode. Connector Pin Arrangement: Pin 1 at top, Pin 4 at bottom, Pin 2 on left, Pin 3 on right. Note: Pin 2 is not used.</p> |
| | | E2FM-X2B1-M1 E2FM-X5B1-M1 E2FM-X10B1-M1 | <p>Timing chart for E2FM-X2B1-M1, E2FM-X5B1-M1, and E2FM-X10B1-M1. The x-axis is distance from the sensor. The y-axis shows the states of two indicators: Operation indicator (yellow) and Control output. The Operation indicator is ON during the sensing area. The Control output is ON during the sensing area.</p> | <p>Output circuit diagram for E2FM-X2B1-M1, E2FM-X5B1-M1, and E2FM-X10B1-M1. The load is connected between pins 1 and 3. Pin 1 is connected to +V (12 to 24 VDC) and pin 3 is connected to 0 V. The circuit includes a proximity sensor main circuit and a protection diode. Connector Pin Arrangement: Pin 1 at top, Pin 4 at bottom, Pin 2 on left, Pin 3 on right. Note: Pin 2 is not used.</p> |

Safety Precautions

⚠ WARNING

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



Never use this product with an AC power supply. Otherwise, explosion may result.



Precautions for Safe Use

The following precautions must be observed to ensure safe operation.

1. Do not use the Sensor in an environment where inflammable or explosive gas is present.
2. Do not attempt to disassemble, repair, or modify any Sensors.
3. Power Supply Voltage
Do not use a voltage that exceeds the rated operating voltage range. Applying a voltage that is higher than the operating voltage range may result in explosion or fire.
4. Incorrect Wiring
Be sure that the power supply polarity and other wiring is correct. Incorrect wiring may cause explosion or fire.
5. 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.

Precautions for Correct Use

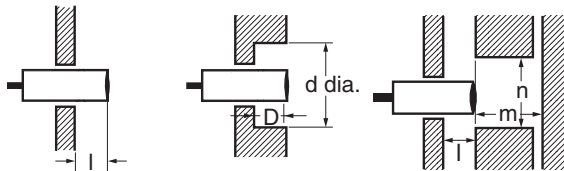
Do not use the Sensor under ambient conditions that exceed the ratings to ensure maximum lifetime:

1. Please do not use the Sensor in the following locations.
 - (1) Outdoor locations directly subject to sunlight, rain, snow, or water droplets
 - (2) Locations subject to atmospheres with chemical vapors, in particular solvents and acids
 - (3) Locations subject to corrosive gas
2. The Sensor may malfunction if used near ultrasonic cleaning equipment, high-frequency equipment, transceivers, cellular phones, inverters, or other devices that generate a high-frequency electric field. Refer to the *Sensor General Catalog* for typical measures.
3. Laying the Sensor wiring in the same conduit or duct as high-voltage wires or power lines may result in incorrect operation and damage due to induction. Wire the Sensor using a separate conduit or independent conduit.
4. Cleaning
Never use thinner or other solvents. Otherwise, the Sensor surface may be dissolved.

Design

Influence of Surrounding Metal

When the Proximity Sensor is embedded in metal, make sure that the clearances given in the following table are maintained. The values depend on the type of nuts used for mounting. Be sure to use the supplied nuts (SUS303).



(Unit: mm)

| Model | Item | Embedding material | l | d | D | m | n |
|------------|------|--------------------|----|-----|----|-----|-----|
| E2FM-X1R5□ | Iron | Iron | 0 | 8 | 0 | 4.5 | 30 |
| | | Aluminum | 10 | 50 | 10 | 4.5 | 50 |
| E2FM-X2□ | Iron | Iron | 0 | 12 | 0 | 8 | 40 |
| | | Aluminum | 16 | 70 | 16 | 8 | 70 |
| E2FM-X5□ | Iron | Iron | 0 | 18 | 0 | 20 | 60 |
| | | Aluminum | 16 | 80 | 16 | 20 | 80 |
| E2FM-X10□ | Iron | Iron | 0 | 30 | 0 | 40 | 100 |
| | | Aluminum | 24 | 120 | 24 | 40 | 120 |

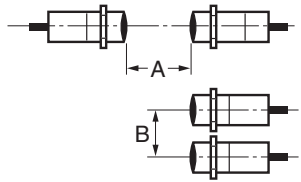
Note: The influence from other non-magnetic surrounding metals is nearly the same as that from aluminum.

Mutual Interference

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

(Unit: mm)

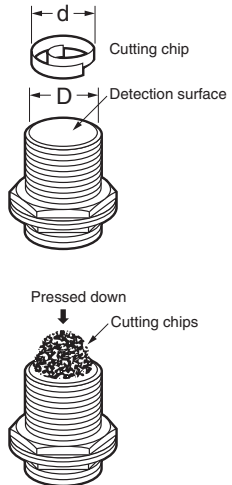
| Model | Item | A | B |
|------------|------|-----|-----|
| E2FM-X1R5□ | | 35 | 30 |
| E2FM-X2□ | | 40 | 35 |
| E2FM-X5□ | | 65 | 60 |
| E2FM-X10□ | | 110 | 100 |



Chips from Cutting Aluminum or Cast Iron

Normally, chips from cutting aluminum or cast iron will not cause a detection signal to be output even if it adheres to or accumulates on the detection surface. In the following cases, however, a detection signal may be output. Remove the cutting chips in these cases.

1. If $d \geq \frac{2}{3} D$ at the center of the detection surface where d is the cutting chip size and D is the detection surface size



| Model | Dimension (mm) | D |
|------------|----------------|----|
| E2FM-X1R5□ | | 6 |
| E2FM-X2□ | | 10 |
| E2FM-X5□ | | 16 |
| E2FM-X10□ | | 28 |

Mounting

Do not tighten the nut with excessive force. A washer must be used with the nut. Do not use tightening force that exceeds the values in the following table.

| Model | Torque |
|------------|---------|
| E2FM-X1R5□ | 9 N·m |
| E2FM-X2□ | 30 N·m |
| E2FM-X5□ | 70 N·m |
| E2FM-X10□ | 180 N·m |



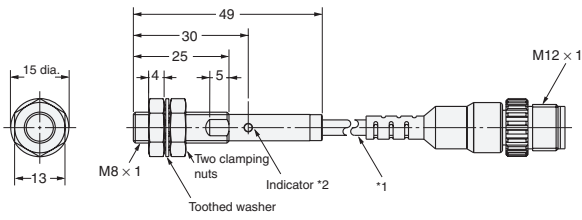
Dimensions

(Unit: mm)

Sensors

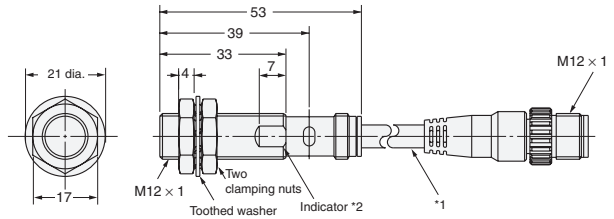
Pig-tail Connector Models

E2FM-X1R5D1-M1GJ



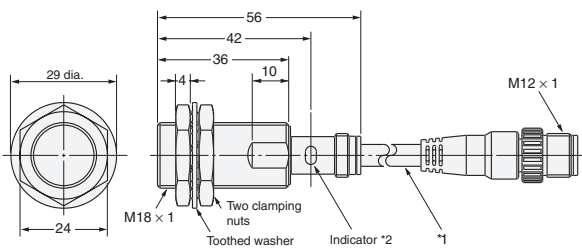
*1. 4-dia. vinyl-insulated round cable (flame retardant), Standard length; 300 mm
*2. Operation indicator (red/green)
Setting indicator (green)

E2FM-X2D1-M1GJ
E2FM-X2D1-M1GJ-T



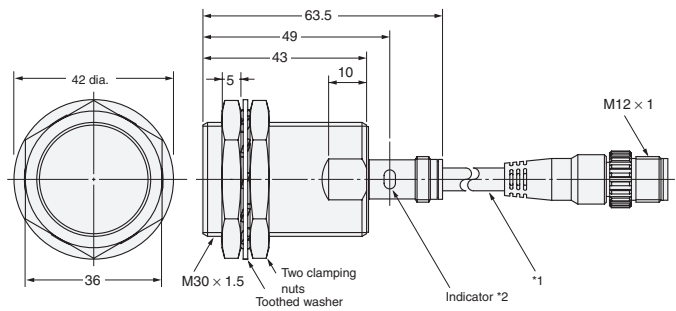
*1. 6-dia. vinyl-insulated round cable (flame retardant), Standard length; 300 mm
*2. Operation indicator (red/green)
Setting indicator (green)

E2FM-X5D1-M1GJ
E2FM-X5D1-M1GJ-T



*1. 6-dia. vinyl-insulated round cable (flame retardant), Standard length; 300 mm
*2. Operation indicator (red/green)
Setting indicator (green)

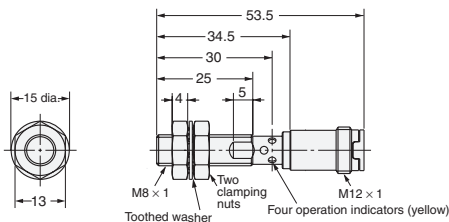
E2FM-X10D1-M1GJ
E2FM-X10D1-M1GJ-T



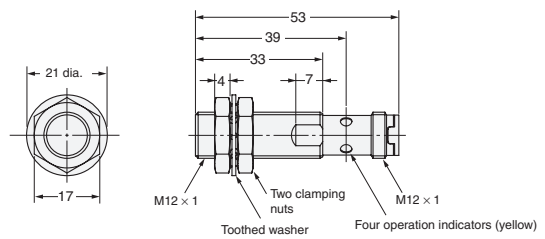
*1. 6-dia. vinyl-insulated round cable (flame retardant), Standard length; 300 mm
*2. Operation indicator (red/green)
Setting indicator (green)

M12 Connector Models

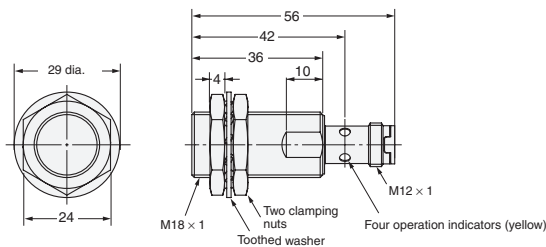
E2FM-X1R5B1-M1



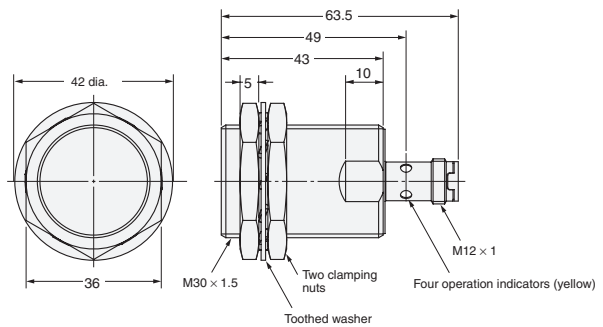
E2FM-X2B1-M1



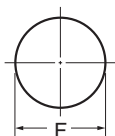
E2FM-X5B1-M1



E2FM-X10B1-M1



Mounting Hole Dimensions



| Dimension | M8 | M12 | M18 | M30 |
|-----------|---------------------------------------|--|--|--|
| F (mm) | 8.5 ^{+0.5} ₀ dia. | 12.5 ^{+0.5} ₀ dia. | 18.5 ^{+0.5} ₀ dia. | 30.5 ^{+0.5} ₀ dia. |

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In the interest of product improvement, specifications are subject to change without notice.

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