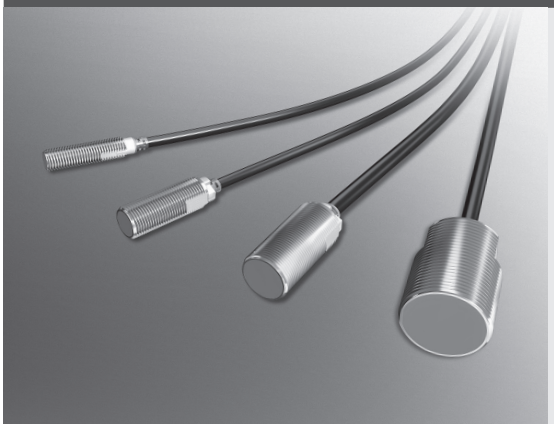
DC2-Wire Environment-Resistant Cylindrical Proximity Switches

CE c UL us LISTED

Model FL7M-C

Proximity switches with oil-resistant polyurethane cables designed for use in harsh environments, such as automobile manufacturing assembly lines, where cables are attacked by coolant.



- **Coolant-resistant polyurethane is used for cable sheathing and insulation.**
- **The lineup includes regular models (M8, M12, M18, M30) and aluminum-chip resistant models (M12, M18, M30).**
- **The seal has been improved with a special cable molding process.**
- **UL/CE certified (excluding some models)**

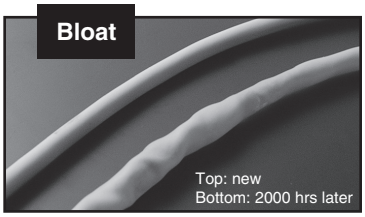
There are good reasons why Model **FL7M-C** switches are used in harsh environments exposed to coolant attacks.

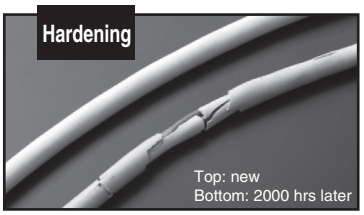
● **Switches incorporate superior materials to meet the evolving needs of the manufacturing plant.**

In metal processing factories, to improve manufacturing speed and efficiency, the use of highly penetrating synthetic coolant has recently increased.

When switches are under constant stress in such harsh environments…

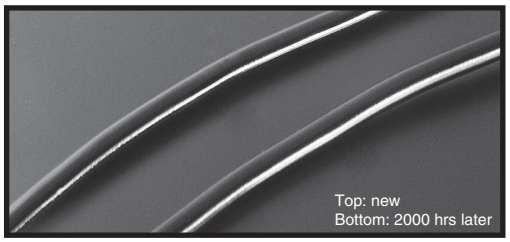
If the cable is PVC... **Chloromethane (PVC) cables bloat or harden when attacked by coolant.**
Eventually the insulation degrades and the connection is lost, causing switch malfunction.





As seen above, chloromethane (PVC) cables become severely deteriorated.

If the cable is PUR... In contrast, polyurethane (PUR) cable retains almost the same appearance and performance.

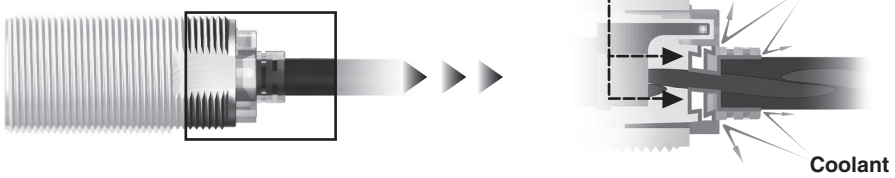




Very reliable oil-resistant
polyurethane (PUR) cables are used in Model FL7M-C
environment-resistant cylindrical proximity switches.

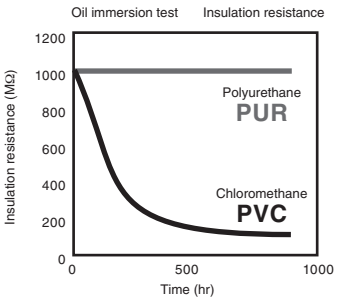
● Effective countermeasures against coolant intrusion.

Like the Model **FL7M, FL7M-C** switches are protected against coolant infiltration from the cable core.
In **FL7M** switches, the joint between the cable and switch is sealed, so the circuits are completely protected.
This is a successful solution to the problem of coolant infiltration along the cable core wires.



● Switch protection and stability are verified by product tests.

COOLANT IMMERSION TEST

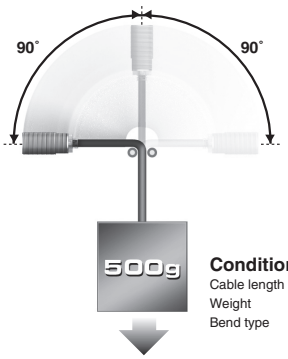


For the soluble cutting oil immersion test,
an accelerated product life test was conducted under the conditions below.

Classification of test oil	JIS classification	Details of test	Oil name
Water-insoluble cutting fluid	Equivalent to type 3 No.8	Immersion in 70˚C oil for 1000 hrs	BM405
Water-miscible cutting fluid (emulsion)	Equivalent to type A1 No.1	Immersion in 70˚C oil for 1000 hrs	EC50-T3
Water-miscible cutting fluid (soluble/synthetic)	Equivalent to type A2 No.1	Immersion in 70˚C oil for 1000 hrs	PFS760

Note: The cutting oils used for these tests are products of Yushiro Chemical Industry Co., Ltd.

CABLE BENDING TEST



Conditions
Cable length : 500 mm
Weight : 500 g
Bend type : 90˚ left and right (one 2-way movement counts as 1 bend)
Bend rate : 60 bends/min
Bend radius : 6R
Temperature : Normal

PVC and PUR cables are tested according to the conditions shown to the left.
The table below shows the number of bends
before the cable's electrical connection was lost.

Cable type	M8 / M12 standard	M8 / M12 bend-tolerant	M8 / M30 standard	M8 / M30 bend-tolerant
Chloromethane (PVC)	7,000	240,000	7,000	581,000
Polyurethane (PUR)	20,000	285,000	36,000	639,000

Note: The values shown are measured values, not guaranteed ones.

Connector with cable
See page F-001

ORDER GUIDE

● Standard type

Exterior		Sensing distance	Operation Mode	Setting indicator	Catalog listing
Appearance	Size (O.D.)				
Preleaded type (2 m cable)*1 	M8	2 mm	N.O.	●	**FL7M-2J6HD-C**
			N.C.		**FL7M-2K6H-C**
	M12	3 mm	N.O.	●	**FL7M-3J6HD-C**
			N.C.		**FL7M-3K6H-C**
	M18	7 mm	N.O.	●	**FL7M-7J6HD-C**
			N.C.		**FL7M-7K6H-C**
	M30	10 mm	N.O.	●	**FL7M-10J6D-C**
			N.C.		**FL7M-10K6-C**
Preleaded connector type (30 cm cable)*2 	M8	2 mm	N.O.	●	**FL7M-2J6HD-CC03**
			N.C.		**FL7M-2K6H-CC03**
	M12	3 mm	N.O.	●	**FL7M-3J6HD-CC03**
			N.C.		**FL7M-3K6H-CC03**
	M18	7 mm	N.O.	●	**FL7M-7J6HD-CC03**
			N.C.		**FL7M-7K6H-CC03**
	M30	10 mm	N.O.	●	**FL7M-10J6D-CC03**
			N.C.		**FL7M-10K6-CC03**

*1. Bend-tolerant cables are available. Their catalog listings have the appended letters "**-CR**" (example: **FL7M-2J6HD-CR**).
Also, 5 m cables are available. Their catalog listings have the appended letters "**-C5/-CR5**" (example: **FL7M-2J6HD-C5**).
*2. 0.5 m and 1 m cables are available. Their catalog listings have the appended letters "**-CC05**" and "**-CC1**" respectively.

● Aluminum-chip resistant type

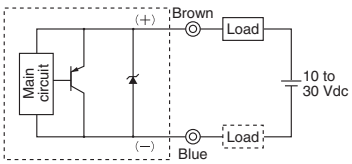
Exterior		Sensing distance	Operation Mode	Setting indicator	Catalog listing
Appearance	Size (O.D.)				
Preleaded type (2 m cable)*1 	M12	2 mm	N.O.	●	**FL7M-2J6AD-C**
			N.C.		**FL7M-2K6A-C**
	M18	4 mm	N.O.	●	**FL7M-4J6AD-C**
			N.C.		**FL7M-4K6A-C**
	M30	8 mm	N.O.	●	**FL7M-8J6AD-C**
			N.C.		**FL7M-8K6A-C**
Preleaded connector type (30 cm cable)*2 	M12	2 mm	N.O.	●	**FL7M-2J6AD-CC03**
			N.C.		**FL7M-2K6A-CC03**
	M18	4 mm	N.O.	●	**FL7M-4J6AD-CC03**
			N.C.		**FL7M-4K6A-CC03**
	M30	8 mm	N.O.	●	**FL7M-8J6AD-CC03**
			N.C.		**FL7M-8K6A-CC03**

*1. Bend-tolerant cables are available. Their catalog listings have the appended letters "**-CR**" (example: **FL7M-2J6AD-CR**).
Also, 5 m cables are available. Their catalog listings have the appended letters "**-C5/-CR5**" (example: **FL7M-2J6AD-C5**).
*2. 0.5 m and 1 m cables are available. Their catalog listings have the appended letters "**-CC05**" and "**-CC1**" respectively.

WIRING DIAGRAMS

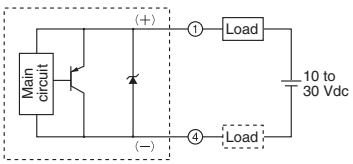
● Standard and aluminum-chip resistant types

Preleaded type



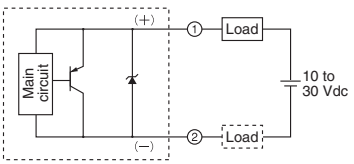
The load may be connected to either pole.

Preleaded connector type (N.O.)



The load may be connected to either pole.

Preleaded connector type (N.C.)



The load may be connected to either pole.

SPECIFICATIONS

● Standard type

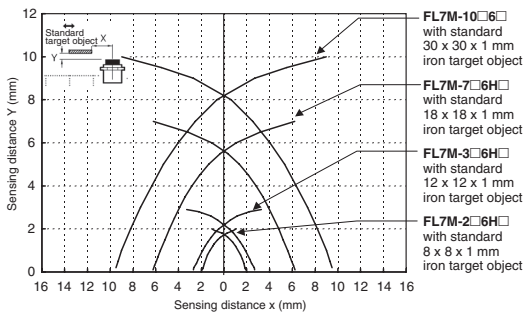
Size			M8	M12	M18	M30
Catalog listing			FL7M-2□6H(D)-C	FL7M-3□6H(D)-C	FL7M-7□6H(D)-C	FL7M-10□6(D)-C
			FL7M-2□6H(D)-CC03	FL7M-3□6H(D)-CC03	FL7M-7□6H(D)-CC03	FL7M-10□6(D)-CC03
Actuation method			High-frequency oscillation (shielded)			
Rated sensing distance			2 ±0.2 mm	3 ±0.3 mm	7 ±0.7 mm	10 ±1 mm
Standard target object			8 x 8, 1 mm, iron	12 x 12, 1 mm, iron	18 x 18, 1 mm, iron	30 x 30, 1 mm, iron
Differential travel			15% max. of sensing distance			
Rated supply voltage (operating voltage range)			12/24 Vdc (10 to 30 Vdc)			
Leakage current			0.55 mA max.			
Control output			Switching current 3 to 100 mA, voltage drop 3 V max. (at 100 mA switching current with 2 m cable), output dielectric strength 30 Vdc			
Indicator lamps			N.O. type: Operation indication: Lights up (orange or green) upon output Setting indication: Lights up (green) in stable sensing area			
			N.C. type: Operation indication: Lights up orange upon output			
Ambient operating temperature			–25 to +70˚C			
Protective structure			IP67 (IEC standard), IP67G (JEM standard)			
Circuit protection			Surge absorption, load short-circuit protection, reverse connection protection circuit			
Wiring method			Preleaded, Preleaded connector			
Material	Cable	Sheath	Polyurethane (PUR)			
		Insulation	Polyurethane (PUR)			
	Switch	Housing	SUS	Ni-plated brass		
		Sensing surface	PBT			
	Connector	Housing	Polyurethane (PUR), PBT			
		Holder	Glass-lined polyester resin			
		Contacts	Gold-plated brass			

● Aluminum-chip resistant type

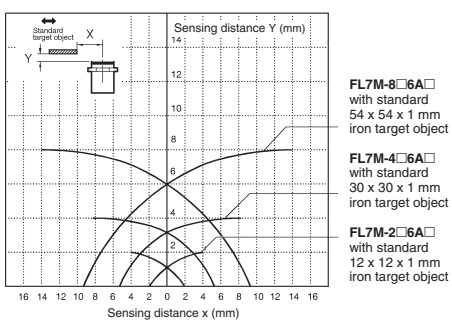
Size			M12	M18	M30
Catalog listing			FL7M-2□6A(D)-C	FL7M-4□6A(D)-C	FL7M-8□6A(D)-C
			FL7M-2□6A(D)-CC03	FL7M-4□6A(D)-CC03	FL7M-8□6A(D)-CC03
Actuation method			High-frequency oscillation (shielded)		
Rated sensing distance			2 ±0.2 mm	4 ±0.4 mm	8 ±0.8 mm
Standard target object			12 x 12, 1 mm, iron	30 x 30, 1 mm, iron	54 x 54, 1 mm, iron
Differential travel			20 % max. of sensing distance		
Rated supply voltage (operating voltage range)			12/24 Vdc (10 to 30 Vdc)		
Leakage current			0.55 mA max.		
Control output			Switching current 3 to 100 mA, voltage drop 3 V max. (at 100 mA switching current with 2 m cable), output dielectric strength 30 Vdc		
Indicator lamps			N.O. type: Operation indication: Lights up (orange or green) upon output Setting indication: Lights up (green) in stable sensing area		
			N.C. type: Operation indication: Lights up orange upon output		
Ambient operating temperature			–25 to +70˚C		
Protective structure			IP67 (IEC standard), IP67G (JEM standard)		
Circuit protection			Surge absorption, load short-circuit protection, reverse connection protection circuit		
Wiring method			Preleaded, Preleaded connector		
Material	Cable	Sheath	Polyurethane (PUR)		
		Insulation	Polyurethane (PUR)		
	Switch	Housing	SUS	Ni-plated brass	
		Sensing surface	PBT		
	Connector	Housing	Polyurethane (PUR), PBT		
		Holder	Glass-lined polyester resin		
		Contacts	Gold-plated brass		

SENSING AREA (typical)

● Standard type



● Aluminum-chip resistant type



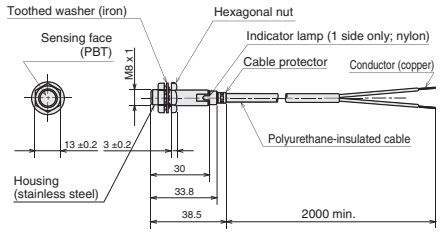
Connector with cable
See page F-001

EXTERNAL DIMENSIONS (for both standard and aluminum-chip resistant types)

(unit: mm)

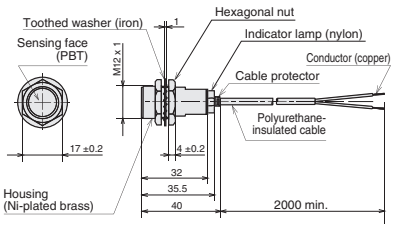
● Preleaded type

M8
(standard type only)



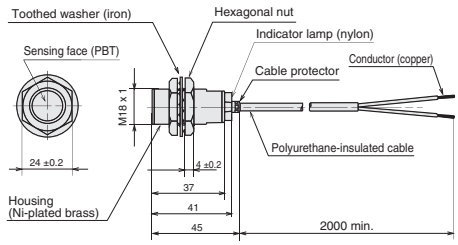
Insulated cable (oil-resistant, 0.3 mm², 27/0.12 dia., 2-core), dia. 4.1
Cap color: blue

M12



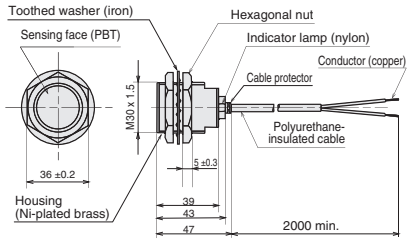
Insulated cable (oil-resistant, 0.3 mm², 27/0.12 dia., 2-core), dia. 4.1
Cap color: blue

M18



Insulated cable (oil-resistant, 0.5 mm², 20/0.18 dia., 2-core), dia. 5.7
Cap color: blue

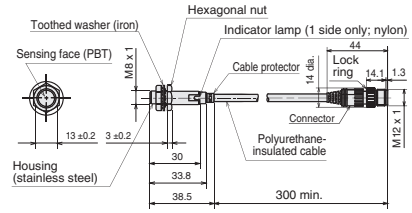
M30



Insulated cable (oil-resistant, 0.5 mm², 20/0.18 dia., 2-core), dia. 5.7
Cap color: blue

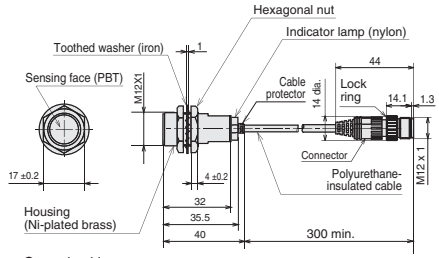
● Preleaded Connector type

M8
(standard type only)



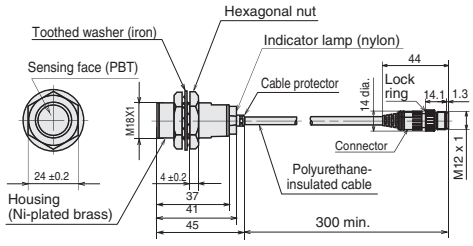
Cap color: blue

M12



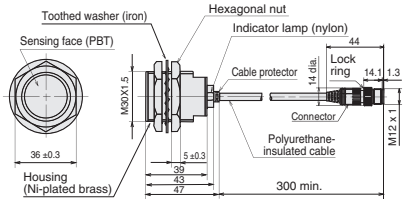
Cap color: blue

M18



Cap color: blue

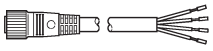
M30



Cap color: blue

CONNECTOR WITH CABLE

● Model PA5 connector with cable

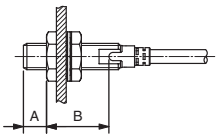
Shape	Power	Cable properties	Cable length	Catalog listing	Core colors
	DC	Oil-resistant, polyurethane-insulated	2 m	**PA5-4ISX2CK**	1: brown, 2: white, 3: blue, 4: black
			5 m	**PA5-4ISX5CK**	

PRECAUTIONS FOR USE

1. Precautions for use

1.1 Mounting

The allowable tightening torque varies according to the distance from the sensing face.



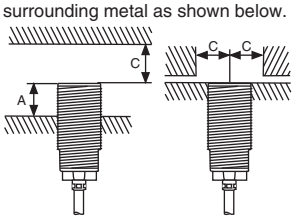
Catalog listing	Length A (mm)	Max. tightening torque (N·m)	
		A	B
FL7M-2□6H□-C	10	9	12
FL7M-3□6H□-C	10	20	30
FL7M-7□6H□-C	0	–	70
FL7M-10□6□-C	0	–	150
FL7M-2□6A□-C	10	20	30
FL7M-4□6A□-C	0	–	70
FL7M-8□6A□-C	0	–	150

Note: The table shows the allowable tightening torque when toothed washers (provided) are used.

The allowable tightening torque varies depending on the materials and surface conditions of the mounting plates, mounting housings, nuts, washers and other parts used for the switch.
Check that the torque is appropriate for the actual combination of parts used before putting the switch into operation.

1.2 Influence of surrounding metal

Metal other than the target object surrounding the switch may influence operating characteristics. Leave space between the switch and surrounding metal as shown below.



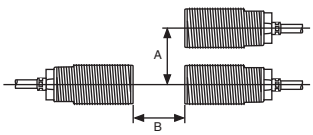
A: Distance from sensing face of proximity switch to mounting surface
B: Distance from surface of iron plate to sensing face of proximity switch.
C: Distance from surface of iron plate to center of proximity switch when A=0

Note: Hatched areas indicate surrounding metal other than the target object.

Catalog listing	A (mm)	B (mm)	C (mm)
FL7M-2□6H□-C	0	8	8
FL7M-3□6H□-C	0	8	9
FL7M-7□6H□-C	0	20	13.5
FL7M-10□6□-C	0	40	22.5
FL7M-2□6A□-C	0	6	9
FL7M-4□6A□-C	0	20	13.5
FL7M-8□6A□-C	0	40	22.5

1.3 Mutual interference prevention

If proximity switches are mounted either parallel to or facing each other, mutual interference may cause the switch to malfunction. Maintain at least the distances indicated in the table below.



Catalog listing	A (mm)	B (mm)
FL7□-2□6H□-C	16	20
FL7M-3□6H□-C	20	30
FL7M-7□6H□-C	35	50
FL7M-10□6□-C	70	100
FL7M-2□6A□-C	20	30
FL7M-4□6A□-C	35	50
FL7M-8□6A□-C	70	100

1.4 Cautions for series or parallel connection

Series connection (AND switching circuit)

When two or more proximity switches are connected in series, erroneous output (1 to 3 ms) may occur without the rated current being supplied to each of the switches. For this reason, series connection of proximity switches is not recommended. However, if proximity switches must be connected in series, a 10 kΩ resistor must be put in parallel with each of the switches. Note that the maximum leakage current in a series connection will be 3.5 mA. Operation lag also will occur, resulting in increased voltage drop, and the operation indicator lamp will not light.

Operation lag = 40 ms (Al-resistant type, 80 ms) x (No. of switches in series - 1)
Voltage drop = Voltage drop of single switch x No. of switches in series

Parallel connection (OR switching circuit)

- If two or more proximity switches are connected in parallel, total leakage current increases according to the following formula, and may result in the load not turning OFF.
  (Leakage current = Leakage current of single switch x No. of switches in parallel)
- When two or more switches in parallel turn ON, one (or more) of their operating indicators may not light up. This is normal.

1.5 Relay loads

The voltage drop of **FL7M-C** series switches is 3V. Pay attention to this voltage drop when using a relay load. (With 12 Vdc relays, switching is not possible.)

1.6 Operation upon power ON

After the power is turned ON, it takes at most 40 ms until the proximity switch is ready for sensing. If the load and the proximity switch use different power supplies, be sure to turn the proximity switch ON before turning the load ON.

1.7 Influence of leakage current

A minimal current flows as leakage current for operating the circuits even when the proximity switch is OFF. Keep this in mind when turning off connected loads.

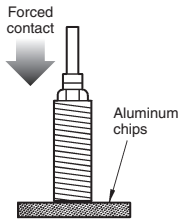
1.8 Minimum cable bend radius (R)

The minimum bend radius (R) of the cable is 3 times the cable diameter. Take care not to bend the cable beyond this radius. Also, do not excessively bend the cable within 30 mm of the cable lead-in port.

2. ALUMINUM CHIPS AND CAST IRON CHIPS

Generally, even if aluminum and cast iron chips are attached to or pressing against the sensing face, no signal is output. Take care, however, because under the conditions described below, a signal may sometimes be output.

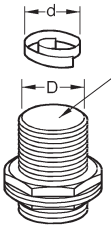
2.1 FL7M-2□6A□-C



Length of one side of aluminum chip	FL7M-2J6AD-C
0.1 mm max.	OFF
0.5 mm approx.	OFF
2 mm max.	OFF or ON
4 mm min.	ON

2.2 FL7M-4□6A□-C, L7M-8□6A□-C

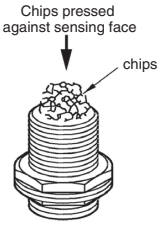
(1) Chip size (d) x size of sensing face (D)



When chip dia. is 2/3 or more of the sensing face dia. (d 2/3 D)

Catalog listing	D(mm)
FL7M-4J6AD-C FL7M-4K6A-C	16
FL7M-8J6AD-C FL7M-8K6A-C	28

(2) When chips are pressed against the sensing face.



Connector with cable
See page F-001

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