Digital Fiber Sensor
FX-410 SERIES

Related Information
■ General terms and conditions..... F-17
■ Sensor selection guide ..... P.3~
■ Glossary of terms / General precautions... P.1359~ / P.1405
■ Korea's S-mark..... P.1410

CE Conforming to EMC Directive

cULus Recognition (Excluding FX-412□)

Certified (Excluding FX-412□ and PNP output type)

PNP output type available | Timer | Light intensity monitor | Interference prevention

Just "Look" and "Turn", Simple, easy-to-use fiber sensor

Incident light intensity and threshold value are displayed simultaneously

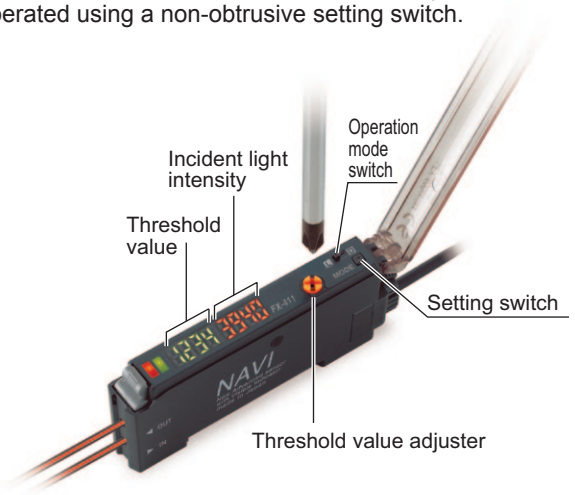
The incident light intensity and threshold value can be checked at the same time with no operations needed. In addition, no complex mode settings are needed when the values are adjusted.

Adjustment variations according to the individual have been eliminated

Accurate control of the adjuster threshold values by using numerical values is possible due to the digital display. This allows anybody to perform the same settings.

Easy-to-understand operating panel layout

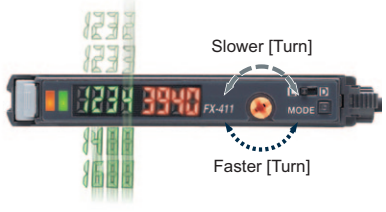
The threshold value adjuster and operation mode switch are large and easy to see, and they can be operated with the same sensitivity as general-purpose photoelectric sensors. Functions which are not commonly used can be operated using a non-obtrusive setting switch.

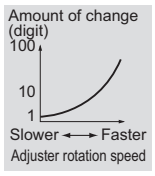


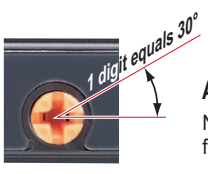
Threshold values can be changed smoothly

This sensor uses the R.S.S.* adjuster with a compact encoder inside.
The sensitivity amount changes depending on the rotation speed of the adjuster, so that adjustment can be carried out speedily.

* Rotation Speed Sensitivity







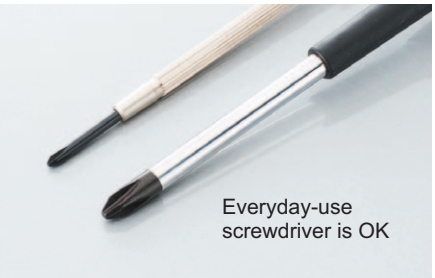
Adjustment in units of 1 digit is also easy

No need for the fine changes in force required for photoelectric sensors.

Large endless adjuster

New concept

Standard screwdrivers can be used to turn the adjuster as well as precision screwdrivers. In addition, an “endless” mechanism is used which eliminates the possibility of any damage being caused by turning the adjuster too far.



FX-412 can be turned by finger!

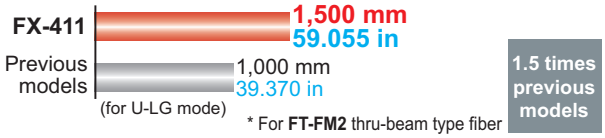
New concept

The adjuster can be turned directly by finger, without the need for a screwdriver.

Beam power greatly increased to give strong performance under adverse environments

Red LED type

The beam power has been greatly increased. This means a longer sensing distance and less trouble from problems such as dust. These sensors have ample performance for workplace needs.



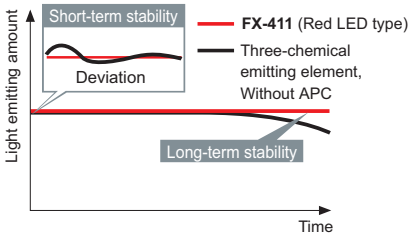
* For **FT-FM2** thru-beam type fiber

Improved stability over both long and short terms

Red LED type

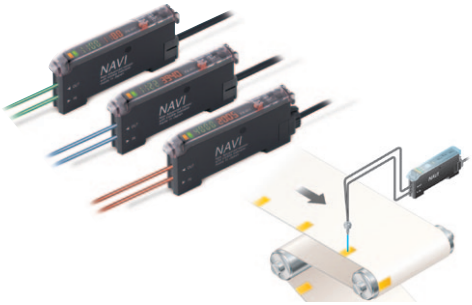
The red LED type sensors have a “four-chemical emitting element” which maintains stability of light emissions for long-term operation. Furthermore, all models have an “APC (Auto Power Control) circuit” which improves stability at times such as when the power is turned on. These features improve overall stability compared to previous models.

• **Stable sensing comparison**



Three types are available, with red, blue and green light

Different sensors can be selected to suit the application.



Color combinations that can be discerned during mark sensing

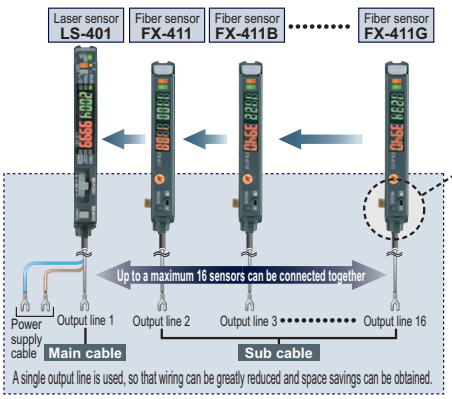
Background color \ Mark color	White	Yellow	Orange	Red	Green	Blue	Black
White		●	●	●●	●●●	●●●	●●●
Yellow	●		●	●	●●●	●●●	●●●
Orange	●	●		●●	●●●	●●●	●●●
Red	●●	●	●●		●	●●	●●
Green	●●●	●●●	●●●	●		●	●
Blue	●●●	●●●	●●●	●●	●		●
Black	●●●	●●●	●●●	●●	●	●	

● :Red LED type ● :Blue LED type ● :Green LED type

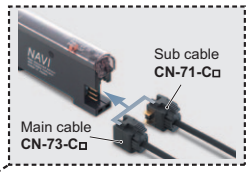
Excellent workability and ease of maintenance

Connector type

The same quick-connection cable that is used for sensors such as the **FX-300** series of digital fiber sensors is used. This means that they can be used together with other types of sensors such as laser sensors, and the number of power supply cables can be reduced.



The sensors can be connected together with other sensors such as the **FX-300** series of digital fiber sensors and the **GA-311** of inductive proximity sensors. In addition, the **SC** series of sensor PLC connection units with MIL connector compatibility can also be used to further reduce the amount of wiring.



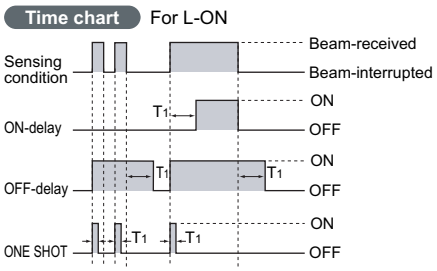
Quick-connection cables can be used for power supply cascade wiring.
Both main and sub units utilize the same amplifier body.

Contributing to device miniaturization

This fiber sensor is the smallest among the dual digital display types, contributing to device miniaturization.

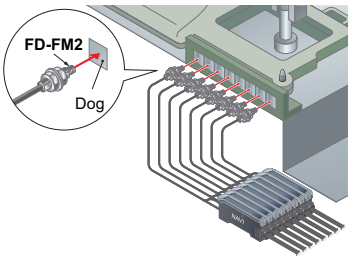
Equipped with 3 types timers

Equipped with OFF-delay / ON-delay / ONE SHOT timer. (Timer period: 1 ms to 3 sec. approx.)



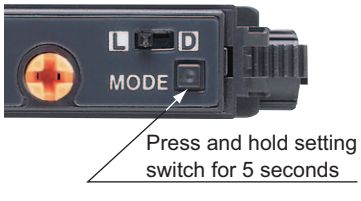
Interference prevention for up to 8 sets fiber heads (for U-LG)

The optical communication function allows up to a maximum of eight sets of fiber heads (four sets for FAST and STD settings) to be installed in contact with each other without mutual interference occurring. (Set automatically when power is turned on.)



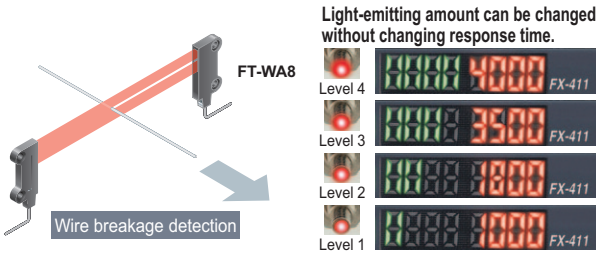
Key lock function prevents wrong operation

This prevents the operator from changing the threshold value by mistake.



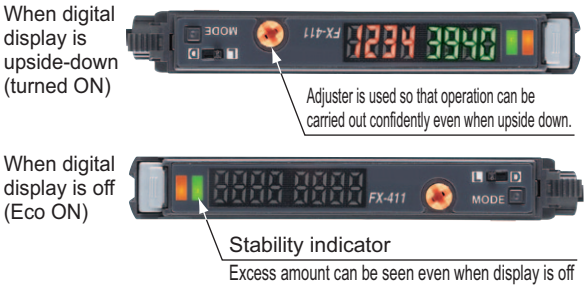
Ideal for dealing with saturation / Light-emitting amount selection function Red LED type New concept

In cases where the incoming light level can become saturated, such as during close-range sensing or when sensing transparent or minute objects, the sensor's light-emitting amount can be adjusted to provide more stable sensing without changing the response time.



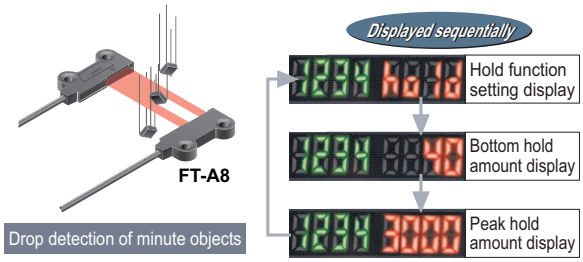
Digital display upside-down / off function

The digital display can be turned upside-down if required to suit the setup location. In addition, a stability indicator is also provided, so that the amount of light-receiving excess can be checked even when the display is turned off.



Hold function

Peak and bottom hold values for the incident light intensity can be displayed. This is useful for checking the incident light intensity during tasks such as drop detection.
In addition, the peak and bottom values can be checked while looking at the threshold value, which makes adjustment much easier.



ORDER GUIDE

Amplifiers

Quick-connection cable is not supplied with the amplifier. Please order it separately.

Type	Appearance	Model No.	Emitting element	Output
NPN output		**FX-411**	Red LED	NPN open-collector transistor
		FX-411B	Blue LED	
		FX-411G	Green LED	
PNP output		**FX-411P**	Red LED	PNP open-collector transistor
		FX-411BP	Blue LED	
		FX-411GP	Green LED	
NPN output		**FX-412** (Note)	Red LED	NPN open-collector transistor
		FX-412B (Note)	Blue LED	
		FX-412G (Note)	Green LED	

Note: The **FX-412**□ has a threshold value adjuster that can be adjusted with your fingers.

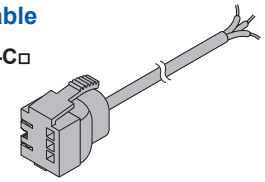
Quick-connection cables

Quick-connection cable is not supplied with the amplifier. Please order it separately.

Type	Model No.	Description	
Main cable (3-core)	**CN-73-C1**	Length: 1 m 3.281 ft	0.15 mm² 3-core cabtyre cable, with connector on one end Cable outer diameter: ø3.0 mm ø0.118 in
	CN-73-C2	Length: 2 m 6.562 ft	
	CN-73-C5	Length: 5 m 16.404 ft	
Sub cable (1-core)	**CN-71-C1**	Length: 1 m 3.281 ft	0.15 mm² 1-core cabtyre cable, with connector on one end Cable outer diameter: ø3.0 mm ø0.118 in
	CN-71-C2	Length: 2 m 6.562 ft	
	CN-71-C5	Length: 5 m 16.404 ft	

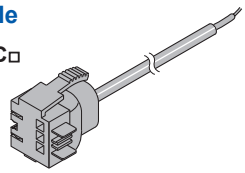
Main cable

• **CN-73-C**□



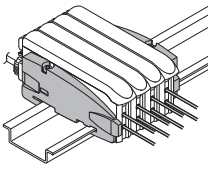
Sub cable

• **CN-71-C**□



End plates

End plates are not supplied with the amplifier. Please order them separately when the amplifiers are mounted in cascade.

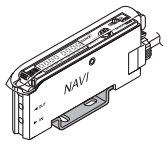
Appearance	Model No.	Description
	**MS-DIN-E**	When cascading multiple amplifiers, or when it moves depending on the way it is installed on a DIN rail, these end plates clamp amplifiers into place on both sides. Make sure to use end plates when cascading multiple amplifiers together. Two pcs. pet set

OPTIONS

Designation	Model No.	Description
Amplifier mounting bracket	**MS-DIN-2**	Mounting bracket for amplifier
Fiber amplifier protection seal	**FX-MB1**	10 sets of 2 communication window seals and 1 connector seal Communication window seal: It prevents malfunction due to transmission signal from another amplifier, as well as, prevents effect on another amplifier. Connector seal: It prevents contact of any metal, etc., with the pins of the quick-connection cable.

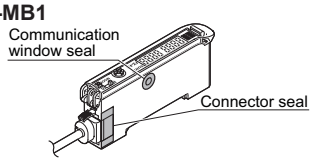
Amplifier mounting bracket

• **MS-DIN-2**



Fiber amplifier protection seal

• **FX-MB1**



LIST OF FIBERS

Thru-beam type (one pair set)

Fibers are listed in alphabetic order. Refer to p.5~ “Fiber Selection” for details of each fiber.

Model No.	Sensing range (mm in) (Note 1)									Dimensions
	Red LED			Blue LED			Green LED			
	U-LG	STD	FAST	U-LG	STD	FAST	U-LG	STD	FAST	
FT-30	600 23.622	145 5.709	95 3.740	90 3.543	24 0.945	15 0.591	45 1.772	12 0.472	8 0.315	P.90
FT-31	540 21.260	140 5.512	85 3.346	85 3.346	20 0.787	14 0.551	38 1.496	10 0.394	7 0.276	P.90
FT-40	1,600 62.992	345 13.582	245 9.646	250 9.843	65 2.559	45 1.772	140 5.512	40 1.575	25 0.984	P.90
FT-41	1,500 59.055	340 13.386	240 9.449	230 9.055	60 2.362	40 1.575	120 4.724	30 1.181	22 0.866	P.90
FT-42	1,550 59.055	340 13.386	240 9.449	230 9.055	60 2.362	40 1.575	125 4.921	33 1.299	22 0.866	P.90
FT-A8	3,500 137.795 (Note 2)	1,500 59.055	1,100 43.307	900 35.433	300 11.811	220 8.661	400 15.748	150 5.906	110 4.331	P.90
FT-A30	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)	3,500 137.795	600 23.622	400 15.748	2,000 78.740	300 11.811	140 5.512	P.90
FT-AFM2	940 37.008	240 9.449	170 6.693	200 7.874	50 1.969	35 1.378	135 5.315	30 1.181	20 0.787	P.90
FT-AFM2E	880 34.646	210 8.268	155 6.102	200 7.874	50 1.969	35 1.378	135 5.315	30 1.181	20 0.787	P.90
FT-B8	2,000 78.740	530 20.866	400 15.748	440 17.323	110 4.331	75 2.953	220 8.661	55 2.165	40 1.575	P.90
FT-E12	11 0.433	1.5 0.059	1 0.039	2.5 0.098	1 0.039	0.8 0.031	2 0.079	———	———	P.91
FT-E13	30 1.181	7 0.276	5 0.197	2.5 0.098	———	———	1 0.039	———	———	P.91
FT-E22	60 2.362	15 0.591	10 0.394	12 0.472	3 0.118	2 0.079	10 0.394	2 0.079	1.5 0.059	P.91
FT-E23	110 4.331	20 0.787	15 0.591	12 0.472	3 0.118	2 0.079	6 0.236	1 0.039	———	P.91
FT-FM2	1,500 59.055	340 13.386	240 9.449	230 9.055	60 2.362	40 1.575	120 4.724	30 1.181	22 0.866	P.91
FT-FM2S	1,500 59.055	340 13.386	240 9.449	230 9.055	60 2.362	40 1.575	120 4.724	30 1.181	22 0.866	P.91
FT-FM2S4	1,500 59.055	340 13.386	240 9.449	230 9.055	60 2.362	40 1.575	120 4.724	30 1.181	22 0.866	P.91
FT-FM10L	19,500 767.715 (Note 3)	10,000 393.700	8,000 314.960	8,000 314.960	2,300 90.551	1,700 66.929	7,000 275.590	1,400 55.118	1,000 39.370	P.91
FT-H13-FM2	1,100 43.307	280 11.024	200 7.874	50 1.969	13 0.512	9 0.354	150 5.906	16 0.630	10 0.394	P.91
FT-H20-J20-S (Note 4)	700 27.559	160 6.299	110 4.331	120 4.724	20 0.787	———	60 2.362	———	———	P.92
FT-H20-J30-S (Note 4)	700 27.559	160 6.299	110 4.331	120 4.724	20 0.787	———	60 2.362	———	———	P.92
FT-H20-J50-S (Note 4)	700 27.559	160 6.299	110 4.331	120 4.724	20 0.787	———	60 2.362	———	———	P.92
FT-H20-M1	550 21.654	150 5.906	100 3.937	100 3.937	25 0.984	20 0.787	65 2.559	17 0.669	12 0.472	P.92
FT-H20-VJ50-S (Note 4)	1,100 43.307	240 9.449	170 6.693	170 6.693	35 1.378	———	90 3.543	———	———	P.92
FT-H20-VJ80-S (Note 4)	1,100 43.307	240 9.449	170 6.693	170 6.693	35 1.378	———	90 3.543	———	———	P.92
FT-H20W-M1	400 15.748	110 4.331	80 3.150	75 2.953	19 0.748	13 0.512	58 2.283	13 0.512	9 0.354	P.92
FT-H30-M1V-S (Note 5)	390 15.354	100 3.937	70 2.756	75 2.953	20 0.787	15 0.591	55 2.165	13 0.512	10 0.394	P.92
FT-H35-M2	600 23.622	150 5.906	110 4.331	115 4.528	28 1.102	20 0.787	90 3.543	20 0.787	14 0.551	P.92
FT-H35-M2S6	600 23.622	150 5.906	110 4.331	115 4.528	28 1.102	20 0.787	90 3.543	20 0.787	14 0.551	P.92
FT-HL80Y	3500 137.795	800 31.496	550 21.654	150 5.906	35 1.378	20 0.787	200 7.874	55 2.165	35 1.378	P.92
FT-K8	3,500 137.795 (Note 2)	1,000 39.370	800 31.496	800 31.496	150 5.906	100 3.937	500 19.685	80 3.150	50 1.969	P.93

Notes: 1) Note that the sensing range of the free-cut type fiber may be reduced by 20 % max. depending upon how the fiber is cut.
2) The fiber cable length practically limits the sensing range to 3,500 mm 137.795 in long.
3) The fiber cable length practically limits the sensing range to 19,500 mm 767.715 in long.
4) Heat-resistant joint fibers and ordinary-temperature fibers (**FT-FM2**) are sold as a set.
5) Sold as a set comprising vacuum type fiber + photo-terminal (**FV-BR1**) + fiber at atmospheric side (**FT-J8**).

LIST OF FIBERS

Thru-beam type (one pair set)

Fibers are listed in alphabetic order. Refer to p.5~ “Fiber Selection” for details of each fiber.

Model No.	Sensing range (mm in) (Note 1)									Dimensions
	Red LED			Blue LED			Green LED			
	U-LG	STD	FAST	U-LG	STD	FAST	U-LG	STD	FAST	
FT-KV1	500 19.685	135 5.315	100 3.937	100 3.937	15 0.591	———	90 3.543	10 0.394	———	P.93
FT-KV8	3,500 137.795 (Note 2)	1,000 39.370	700 27.559	700 27.559	170 6.693	120 4.724	500 19.685	100 3.937	65 2.559	P.93
FT-L80Y	3,500 137.795 (Note 2)	900 35.433	600 23.622	250 9.843	60 2.362	40 1.575	300 11.811	70 2.756	45 1.772	P.93
FT-NFM2	450 17.717	130 5.118	85 3.346	85 3.346	20 0.787	14 0.551	38 1.496	10 0.394	7 0.276	P.93
FT-NFM2S	450 17.717	130 5.118	85 3.346	85 3.346	20 0.787	14 0.551	38 1.496	10 0.394	7 0.276	P.93
FT-NFM2S4	450 17.717	130 5.118	85 3.346	85 3.346	20 0.787	14 0.551	38 1.496	10 0.394	7 0.276	P.93
FT-P2	315 12.402	80 3.150	60 2.362	60 2.362	14 0.551	10 0.394	44 1.732	9 0.354	7 0.276	P.93
FT-P40	210 8.268	58 2.283	43 1.693	45 1.772	11 0.433	8 0.315	40 1.575	9 0.354	7 0.276	P.93
FT-P60	600 23.622	140 5.512	100 3.937	95 3.740	24 0.945	17 0.669	60 2.362	14 0.551	8 0.315	P.93
FT-P80	1,000 39.370	230 9.055	170 6.693	190 7.480	45 1.772	35 1.378	130 5.118	30 1.181	20 0.787	P.93
FT-P81X	1,200 47.244	320 12.598	230 9.055	240 9.449	64 2.520	45 1.772	120 4.724	32 1.260	22 0.866	P.94
FT-PS1	105 4.134	25 0.984	19 0.748	18 0.709	4 0.157	3 0.118	14 0.551	3 0.118	2 0.079	P.93
FT-R80	630 24.803	160 6.299	110 4.331	130 5.118	33 1.299	24 0.945	80 3.150	18 0.709	10 0.394	P.94
FT-S20	600 23.622	145 5.709	95 3.740	90 3.543	24 0.945	15 0.591	45 1.772	12 0.472	8 0.315	P.94
FT-S21	540 21.260	140 5.512	85 3.346	85 3.346	20 0.787	14 0.551	38 1.496	10 0.394	7 0.276	P.94
FT-S30	1,600 62.992	345 13.583	245 9.646	250 9.843	65 2.559	45 1.772	140 5.512	40 1.575	25 0.984	P.94
FT-SFM2	1,500 59.055	340 13.386	240 9.449	230 9.055	60 2.362	40 1.575	120 4.724	30 1.181	22 0.866	P.94
FT-SFM2L	3,500 137.795 (Note 2)	800 31.496	580 22.835	600 23.622	140 5.512	100 3.937	400 15.748	85 3.346	60 2.362	P.94
FT-SFM2SV2	600 23.622	150 5.906	110 4.331	120 4.724	30 1.181	21 0.827	90 3.543	18 0.709	12 0.472	P.94
FT-SNFM2	450 17.717	130 5.118	85 3.346	85 3.346	20 0.787	14 0.551	38 1.496	10 0.394	7 0.276	P.95
FT-T80	1,500 59.055	340 13.386	240 9.449	230 9.055	60 2.362	40 1.575	120 4.724	30 1.181	22 0.866	P.95
FT-V10	3,500 137.795 (Note 2)	950 37.402	700 27.559	770 30.315	165 6.496	120 4.724	500 19.685	115 4.528	80 3.150	P.95
FT-V22	500 19.685	130 5.118	85 3.346	85 3.346	19 0.748	13 0.512	60 2.362	13 0.512	8 0.315	P.95
FT-V41	130 5.118	30 1.181	25 0.984	30 1.181	———	———	20 0.787	———	———	P.95
FT-V80Y	1,500 59.055	350 13.780	250 9.843	240 9.449	55 2.165	35 1.378	180 7.087	38 1.496	24 0.945	P.95
FT-W4	250 9.843	65 2.559	45 1.772	35 1.378	8 0.315	5 0.197	34 1.339	5 0.197	3 0.118	P.95
FT-W8	950 37.402	290 11.417	200 7.874	170 6.693	45 1.772	30 1.181	100 3.937	26 1.024	18 0.709	P.95
FT-WA8	3,500 137.795 (Note 2)	1,500 59.055	1,100 43.307	900 35.433	300 11.811	220 8.661	400 15.748	150 5.906	110 4.331	P.95
FT-WA30	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)	3,500 137.795	600 23.622	400 15.748	2,000 78.740	300 11.811	140 5.512	P.95
FT-WKV8	3,500 137.795 (Note 2)	700 27.559	600 23.622	500 19.685	100 3.937	70 2.756	500 19.685	100 3.937	70 2.756	P.96
FT-WR80	950 37.402	290 11.417	200 7.874	170 6.693	45 1.772	30 1.181	100 3.937	26 1.024	18 0.709	P.96
FT-WR80L	2,100 82.677	600 23.622	400 15.748	280 11.024	75 2.953	58 2.283	150 5.906	70 2.756	50 1.969	P.96
FT-WS3	950 37.402	290 11.417	200 7.874	170 6.693	45 1.772	30 1.181	100 3.937	26 1.024	18 0.709	P.96
FT-WS4	250 9.843	65 2.559	45 1.772	35 1.378	8 0.315	5 0.197	34 1.339	5 0.197	3 0.118	P.96
FT-WS8	950 37.402	290 11.417	200 7.874	170 6.693	45 1.772	30 1.181	100 3.937	26 1.024	18 0.709	P.96
FT-WS8L	2,100 82.677	600 23.622	400 15.748	280 11.024	75 2.953	58 2.283	150 5.906	70 2.756	50 1.969	P.96
FT-WV42	68 2.677	15 0.591	12 0.472	———	———	———	———	———	———	P.96
FT-WZ4	400 15.748	100 3.937	70 2.756	72 2.835	18 0.709	10 0.394	36 1.417	6 0.236	4 0.157	P.96
FT-WZ4HB	280 11.024	70 2.756	49 1.929	64 2.520	16 0.630	10 0.394	28 1.102	7 0.276	5 0.197	P.97
FT-WZ7	880 34.646	220 8.661	150 5.906	180 7.087	45 1.772	27 1.063	80 3.150	20 0.787	12 0.472	P.97
FT-WZ7HB	1,000 39.370	250 9.843	175 6.890	220 8.661	55 2.165	33 1.299	110 4.331	30 1.181	18 0.709	P.97
FT-WZ8	950 37.402	250 9.843	180 7.087	115 4.528	27 1.063	18 0.709	100 3.937	20 0.787	13 0.512	P.97
FT-WZ8E	1,900 74.803	500 19.685	350 13.780	390 15.354	90 3.543	67 2.638	300 11.811	60 2.362	40 1.575	P.97
FT-WZ8H	3,500 137.795 (Note 2)	700 27.559	500 19.685	350 13.780	100 3.937	70 2.756	350 13.780	75 2.953	50 1.969	P.97
FT-Z8	1,250 49.213	310 12.205	220 8.661	120 4.724	30 1.181	20 0.787	100 3.937	20 0.787	15 0.591	P.97
FT-Z8E	1,900 74.803	600 23.622	400 15.748	400 15.748	100 3.937	70 2.756	300 11.811	70 2.756	50 1.969	P.97
FT-Z8H	3,500 137.795 (Note 2)	980 38.583	700 27.559	560 22.047	140 5.512	100 3.937	390 15.354	80 3.150	54 2.126	P.97
FT-Z802Y	3,500 137.795 (Note 2)	750 29.528	540 21.260	450 17.717	110 4.331	80 3.150	300 11.811	80 3.150	60 2.362	P.97

Notes: 1) Note that the sensing range of the free-cut type fiber may be reduced by 20 % max. depending upon how the fiber is cut.
2) The fiber cable length practically limits the sensing range to 3,500 mm 137.795 in long.

LIST OF FIBERS

Retroreflective type

Fibers are listed in alphabetic order. Refer to p.5~ “Fiber Selection” for details of each fiber.

Model No.	Sensing range (mm in) (Note 1,2)									Dimensions
	Red LED			Blue LED			Green LED			
	U-LG	STD	FAST	U-LG	STD	FAST	U-LG	STD	FAST	
FR-KV1	15 to 350 0.591 to 13.780	15 to 140 0.591 to 5.512	15 to 100 0.591 to 3.937	———	———	———	———	———	———	P.98
FR-KZ21	20 to 200 0.787 to 7.874	20 to 200 0.787 to 7.874	20 to 200 0.787 to 7.874	20 to 200 0.787 to 7.874	20 to 170 0.787 to 6.693	20 to 140 0.787 to 5.512	20 to 200 0.787 to 7.874	20 to 120 0.787 to 4.724	———	P.98
FR-KZ21E	20 to 200 0.787 to 7.874	20 to 200 0.787 to 7.874	20 to 200 0.787 to 7.874	20 to 200 0.787 to 7.874	20 to 140 0.787 to 5.512	20 to 80 0.787 to 3.150	20 to 200 0.787 to 7.874	20 to 80 0.787 to 3.150	———	P.98
FR-WKZ11	100 to 910 3.937 to 35.827	100 to 520 3.937 to 20.472	100 to 460 3.937 to 18.110	———	———	———	———	———	———	P.98

Notes: 1) Note that the sensing range of the free-cut type fiber may be reduced by 20 % max. depending upon how the fiber is cut.
The sensing range of **FR-WKZ11** is specified for the **RF-13**. The sensing range of **FR-KZ21** and **FR-KZ21E** is specified for the attached reflector **RF-003**. The sensing range of **FR-KV1** is specified for the attached reflector.
2) The sensing range of retroreflective type is the possible setting range for the attached reflector. The fiber can detect an object less than setting range for the reflector. However, note that if there are any white or highly-reflective surfaces near the fiber head, reflected incident light may affect the fiber head. If this occurs, adjust the threshold value of the amplifier unit before use.

Reflective type

Fibers are listed in alphabetic order. Refer to p.5~ “Fiber Selection” for details of each fiber.

Model No.	Sensing range (mm in) (Note 1, 2)									Dimensions
	Red LED			Blue LED			Green LED			
	U-LG	STD	FAST	U-LG	STD	FAST	U-LG	STD	FAST	
FD-30	200 7.874	48 1.890	35 1.378	40 1.575	9 0.354	6 0.236	18 0.709	5 0.197	3 0.118	P.99
FD-31	175 6.890	45 1.772	34 1.339	35 1.378	8 0.315	5 0.197	16 0.630	4 0.157	2 0.079	P.99
FD-40	200 7.874	48 1.890	35 1.378	40 1.575	9 0.354	6 0.236	18 0.709	5 0.197	3 0.118	P.99
FD-41	175 6.890	45 1.772	34 1.339	35 1.378	8 0.315	5 0.197	16 0.630	4 0.157	2 0.079	P.99
FD-60	600 23.622	150 5.906	100 3.937	130 5.118	30 1.181	20 0.787	70 2.756	20 0.787	13 0.512	P.99
FD-61	510 20.079	140 5.512	90 3.543	105 4.134	27 1.063	18 0.709	65 2.559	16 0.630	11 0.433	P.99
FD-A15	280 11.024	100 3.937	74 2.913	100 3.937	15 0.591	10 0.394	90 3.543	10 0.394	8 0.315	P.99
FD-AFM2	310 12.205	85 3.346	60 2.362	70 2.756	14 0.551	9 0.354	45 1.772	8 0.315	5 0.197	P.99
FD-AFM2E	310 12.205	85 3.346	60 2.362	70 2.756	14 0.551	9 0.354	45 1.772	8 0.315	5 0.197	P.99
FD-B8	650 25.591	180 7.087	120 4.724	160 6.299	40 1.575	26 1.024	86 3.386	21 0.827	14 0.551	P.99
FD-E12	13 0.512	3.5 0.138	2.5 0.098	2.4 0.094	———	———	1.5 0.059	———	———	P.100
FD-E22	54 2.126	13 0.512	10 0.394	10 0.394	2 0.079	1.5 0.059	6 0.236	1.2 0.047	0.9 0.035	P.100
FD-EG1	50 1.969	13 0.512	10 0.394	9 0.354	2 0.079	1 0.039	6 0.236	1 0.039	0.8 0.031	P.100
FD-EG2	45 1.772	7 0.276	5 0.197	9 0.354	2 0.079	1 0.039	5 0.197	0.9 0.035	———	P.100
FD-EG3	23 0.906	5 0.197	4 0.157	4 0.157	———	———	2 0.079	———	———	P.100
FD-EN500S1	4.5 0.177	1.2 0.047	1 0.039	———	———	———	———	———	———	P.100
FD-ENM1S1	48 1.890	12 0.472	9 0.354	10 0.394	2 0.079	1.5 0.059	6 0.236	1.3 0.051	0.9 0.035	P.100
FD-F4	Applicable pipe diameter: Outer dia. ø6 to ø26 mm ø0.236 to ø1.024 in transparent pipe [PFA (fluorine resin) or equivalently transparent pipe, wall thickness 1 mm 0.039 in]									P.100
FD-F41	Applicable pipe diameter: Outer dia. ø6 to ø26 mm ø0.236 to ø1.024 in transparent pipe [PVC (vinyl chloride), fluorine resin, polycarbonate, acrylic, glass, wall thickness 1 to 3 mm 0.039 to 0.118 in]									P.100
FD-F41Y	ø4 mm ø0.157 in Protective tube: fluorine resin, length:500 mm 19.685 in (allowable cutting) Liquid surface not contacted: Beam received, Liquid surface contacted: Beam interrupted									P.101
FD-F8Y	———	———	———	———	———	———	———	———	———	P.101
FD-FA90	Applicable pipe diameter: Outer dia. ø8 mm ø0.315 in or more transparent pipe (When used with the tying bands: ø8 to ø80 mm ø0.315 to ø3.150 in) [PFA (fluorine resin), including translucent] Liquid absent: Beam received, Liquid present: Beam interrupted									P.101
FD-FM2	460 18.110	110 4.331	80 3.150	90 3.543	23 0.906	15 0.591	46 1.811	12 0.472	8 0.315	P.101
FD-FM2S	400 15.748	90 3.543	70 2.756	65 2.559	15 0.591	11 0.433	46 1.811	12 0.472	8 0.315	P.101
FD-FM2S4	400 15.748	90 3.543	70 2.756	65 2.559	15 0.591	11 0.433	46 1.811	12 0.472	8 0.315	P.101
FD-G4	220 8.661	52 2.047	38 1.496	48 1.890	11 0.433	8 0.315	20 0.787	5 0.197	3 0.118	P.101
FD-G6	220 8.661	52 2.047	38 1.496	48 1.890	11 0.433	8 0.315	20 0.787	5 0.197	3 0.118	P.102

Notes: 1) The standard sensing objects of the sensing ranges vary depending on the fibers.
2) Note that the sensing range of the free-cut type fiber may be reduced by 20 % max. depending upon how the fiber is cut.

LIST OF FIBERS

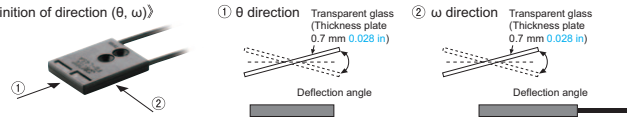
Reflective type

Fibers are listed in alphabetic order. Refer to p.5~ “Fiber Selection” for details of each fiber.

Model No.	Sensing range (mm in) (Note 1, 2)									Dimensions
	Red LED			Blue LED			Green LED			
	U-LG	STD	FAST	U-LG	STD	FAST	U-LG	STD	FAST	
FD-G6X	200 7.874	45 1.772	35 1.378	50 1.969	11 0.433	6 0.236	22 0.866	6 0.236	4 0.157	P.102
FD-G40	220 8.661	52 2.047	38 1.496	48 1.890	11 0.433	8 0.315	20 0.787	5 0.197	3 0.039	P.101
FD-G60	460 18.110	110 4.331	80 3.150	90 3.543	23 0.906	15 0.591	46 1.811	12 0.472	8 0.315	P.102
FD-H13-FM2	430 16.929	100 3.937	70 2.756	40 1.575	10 0.394	7 0.276	40 1.575	10 0.394	7 0.276	P.102
FD-H18-L31	0 to 25 0 to 0.984	0 to 10 0 to 0.394	0 to 8 0 to 0.315	———	———	———	———	———	———	P.102
FD-H20-21	350 13.780	90 3.543	65 2.559	65 2.559	13 0.512	9 0.354	45 1.772	10 0.394	7 0.276	P.102
FD-H20-M1	270 10.630	85 3.346	60 2.362	60 2.362	14 0.551	10 0.394	58 2.283	10 0.394	7 0.276	P.102
FD-H25-L43	2.5 to 29 0.098 to 1.142	4 to 20 0.157 to 0.787	4 to 16 0.157 to 0.630	———	———	———	———	———	———	P.103
FD-H25-L45	5 to 42 0.197 to 1.654	7 to 38 0.276 to 1.496	7 to 35 0.276 to 1.437	———	———	———	———	———	———	P.103
FD-H30-KZ1V-S (Note 3)	20 to 300 0.787 to 11.811	25 to 100 0.984 to 3.937	25 to 45 0.984 to 1.772	———	———	———	———	———	———	P.103
FD-H30-L32	0 to 20 0 to 0.787	1 to 8 0.039 to 0.315	1 to 6 0.039 to 0.236	———	———	———	———	———	———	P.103
FD-H30-L32V-S (Note 3)	0 to 11 0 to 0.433	1.5 to 5 0.059 to 0.197	2 to 4 0.079 to 0.157	———	———	———	———	———	———	P.103
FD-H35-20S	210 8.268	50 1.969	35 1.378	45 1.772	10 0.394	7 0.276	20 0.787	6 0.236	4 0.157	P.104
FD-H35-M2	300 11.811	83 3.268	60 2.362	50 1.969	12 0.472	9 0.354	50 1.969	10 0.394	7 0.276	P.104
FD-H35-M2S6	300 11.811	80 3.150	50 1.969	50 1.969	14 0.551	10 0.394	40 1.575	10 0.394	7 0.276	P.104
FD-HF40Y	ø4 mm ø0.157 in Protective tube: fluorine resin, length:500 mm 19.685 in (allowable cutting) Liquid surface not contacted: Beam received, Liquid surface contacted: Beam interrupted									P.104
FD-L4	2 to 20 0.079 to 0.787 (Convergent point 6 0.236)	4 to 10 0.157 to 0.394 (Convergent point 6 0.236)	4.5 to 9 0.177 to 0.354 (Convergent point 6 0.236)	4 to 9.5 0.157 to 0.374 (Convergent point 6 0.236)	5 to 8 0.197 to 0.315 (Convergent point 6 0.236)	5.5 to 7 0.217 to 0.276 (Convergent point 6 0.236)	5 to 8.5 0.197 to 0.335 (Convergent point 6 0.236)	———	———	P.104
FD-L41	1 to 14 0.039 to 0.551 (Convergent point 8 0.315)	3 to 12 0.118 to 0.472 (Convergent point 8 0.315)	2.5 to 10 0.098 to 0.394 (Convergent point 8 0.315)	———	———	———	———	———	———	P.104
FD-L43	———	0 to 23 0 to 0.906	———	———	———	———	———	———	———	P.104
FD-L44	0 to 8.2 0 to 0.323	0 to 6 0 to 0.236	0 to 5.7 0 to 0.224	———	———	———	———	———	———	P.104
FD-L44S	0 to 4.4 0 to 0.173	0 to 4 0 to 0.157	0 to 3.8 0 to 0.150	———	———	———	———	———	———	P.104
FD-L45	0 to 50 0 to 1.969	0 to 30 0 to 1.181	0 to 30 0 to 1.181	———	———	———	———	———	———	P.104
FD-L45A	10 to 33 0.394 to 1.299 (Note 4)	10 to 32 0.394 to 1.260 (Note 4)	10 to 27 0.394 to 1.063 (Note 4)	10 to 31 0.394 to 1.220 (Note 4)	———	———	———	———	———	P.105
FD-L46	12 to 50 0.472 to 1.969	15 to 30 0.591 to 1.181	20 to 25 0.787 to 0.984	———	———	———	———	———	———	P.105
FD-L47	30 1.181	30 1.181	28 1.102	———	———	———	———	———	———	P.105
FD-NFM2	170 6.693	40 1.575	30 1.181	35 1.378	8 0.315	5 0.197	16 0.630	4 0.157	2 0.079	P.105
FD-NFM2S	170 6.693	40 1.575	30 1.181	35 1.378	8 0.315	5 0.197	16 0.630	4 0.157	2 0.079	P.105
FD-NFM2S4	170 6.693	40 1.575	30 1.181	35 1.378	8 0.315	5 0.197	16 0.630	4 0.157	2 0.079	P.105
FD-P2	80 3.150	18 0.709	13 0.512	12 0.472	2 0.079	1.5 0.059	7 0.276	1.5 0.059	1 0.039	P.105
FD-P40	50 1.969	12 0.472	9 0.354	11 0.433	2.5 0.098	1.5 0.059	7 0.276	1.5 0.059	1 0.039	P.105
FD-P50	165 6.496	45 1.772	30 1.181	40 1.575	10 0.394	6 0.236	25 0.984	5 0.197	3 0.118	P.105
FD-P60	165 6.496	45 1.772	30 1.181	40 1.575	10 0.394	6 0.236	25 0.984	5 0.197	3 0.118	P.105
FD-P80	350 13.780	88 3.465	65 2.559	74 2.913	15 0.591	11 0.433	45 1.772	10 0.394	7 0.276	P.105
FD-P81X	280 11.024	80 3.150	55 2.165	70 2.756	16 0.630	10 0.394	32 1.260	8 0.315	5 0.197	P.106
FD-R80	260 10.236	60 2.362	40 1.575	57 2.244	13 0.512	10 0.394	30 1.181	5 0.197	4 0.157	P.106
FD-S30	200 7.874	48 1.890	35 1.378	40 1.575	9 0.354	6 0.236	18 0.709	5 0.197	3 0.118	P.106
FD-S31	175 6.890	45 1.772	34 1.339	35 1.378	8 0.315	5 0.197	16 0.630	4 0.157	2 0.079	P.106
FD-S80	400 15.748	90 3.543	70 2.756	65 2.559	15 0.591	11 0.433	46 1.811	12 0.472	8 0.315	P.106

Notes: 1) The standard sensing objects of the sensing ranges vary depending on the fibers.
2) Note that the sensing range of the free-cut type fiber may be reduced by 20 % max. depending upon how the fiber is cut.
3) Sold as a set comprising vacuum type fiber + photo-terminal (**FV-BR1**) + fiber at atmospheric side (**FT-J8**).
4) Value when sensing object is inclined (θ, ω) = (±2°, ±2°)

《Definition of direction (θ, ω)》



LIST OF FIBERS

Reflective type

Fibers are listed in alphabetic order. Refer to p.5~ “Fiber Selection” for details of each fiber.

Model No.	Sensing range (mm in) (Note 1, 2)									Dimensions
	Red LED			Blue LED			Green LED			
	U-LG	STD	FAST	U-LG	STD	FAST	U-LG	STD	FAST	
FD-SFM2SV2	140 5.512	35 1.378	25 0.984	30 1.181	7 0.276	4 0.157	20 0.787	———	———	P.106
FD-SNFM2	170 6.693	40 1.575	30 1.181	35 1.378	8 0.315	5 0.197	16 0.630	4 0.157	2 0.079	P.106
FD-T40	170 6.693	40 1.575	30 1.181	35 1.378	8 0.315	5 0.197	16 0.630	4 0.157	2 0.079	P.106
FD-T80	400 15.748	90 3.543	70 2.756	65 2.559	15 0.591	11 0.433	46 1.811	12 0.472	8 0.315	P.106
FD-V41	80 3.150	19 0.748	14 0.551	18 0.709	5 0.197	4 0.157	10 0.394	———	———	P.106
FD-W8	300 11.811	70 2.756	50 1.969	53 2.087	11 0.433	8 0.315	28 1.102	7 0.276	4 0.157	P.107
FD-W44	60 2.362	15 0.591	11 0.433	11 0.433	1.8 0.071	1 0.039	7 0.276	1 0.039	———	P.107
FD-WG4	150 5.906	32 1.260	25 0.984	26 1.024	5 0.197	3 0.118	12 0.472	3 0.118	2 0.079	P.107
FD-WKZ1	20 to 480 0.787 to 18.898	20 to 130 0.787 to 5.118	20 to 100 0.787 to 3.937	———	———	———	———	———	———	P.107
FD-WL41	6.5 to 12 0.256 to 0.472 (Convergent point 8 0.315)	7 to 11 0.276 to 0.433 (Convergent point 8 0.315)	7.5 to 10 0.295 to 0.394 (Convergent point 8 0.315)	———	———	———	———	———	———	P.107
FD-WL48	0.5 to 7.5 0.020 to 0.295	1 to 4.5 0.039 to 0.177	1 to 3.5 0.039 to 0.138	———	———	———	———	———	———	P.107
FD-WS8	300 11.811	70 2.756	50 1.969	53 2.087	11 0.433	8 0.315	28 1.102	7 0.276	4 0.157	P.107
FD-WSG4	150 5.906	32 1.260	25 0.984	26 1.024	5 0.197	3 0.118	12 0.472	3 0.118	2 0.079	P.107
FD-WT4	60 2.362	15 0.591	11 0.433	11 0.433	1.8 0.071	1 0.039	7 0.276	1 0.039	———	P.107
FD-WT8	300 11.811	70 2.756	50 1.969	53 2.087	11 0.433	8 0.315	28 1.102	7 0.276	4 0.157	P.107
FD-WV42	20 0.787	5 0.197	3 0.118	———	———	———	1 0.039	———	———	P.108
FD-WZ4	1 to 56 0.039 to 2.205	3 to 14 0.118 to 0.551	3.5 to 9 0.138 to 0.354	4 to 12 0.157 to 0.472	———	———	———	———	———	P.108
FD-WZ4HB	1 to 70 0.039 to 2.756	3 to 15 0.118 to 0.591	3 to 10 0.118 to 0.394	4 to 16 0.157 to 0.630	———	———	———	———	———	P.108
FD-WZ7	200 7.874	1 to 48 0.039 to 1.890	2 to 33 0.079 to 1.299	3 to 37 0.118 to 1.457	———	———	4 to 15 0.157 to 0.591	———	———	P.108
FD-WZ7HB	0.5 to 320 0.020 to 12.598	1 to 80 0.039 to 3.150	1 to 56 0.039 to 2.205	1 to 64 0.039 to 2.520	3 to 16 0.118 to 0.630	4 to 9.6 0.157 to 0.378	1 to 32 0.039 to 1.260	4 to 8 0.157 to 0.315	———	P.108

Notes: 1) The standard sensing objects of the sensing ranges vary depending on the fibers.
2) Note that the sensing range of the free-cut type fiber may be reduced by 20 % max. depending upon how the fiber is cut.

SENSING RANGE WHEN USING IN COMBINATION WITH FR-WKZ11 REFLECTOR (OPTIONAL)

The sensing ranges are the values for red LED types. (Unit: mm in)

RF-230	100 to 3,500 3.937 to 137.795 (U-LG), 100 to 1,600 3.937 to 62.992 (STD), 100 to 1,300 3.937 to 51.181 (FAST)
RF-220	100 to 2,600 3.937 to 102.362 (U-LG), 100 to 900 3.937 to 35.433 (STD), 100 to 800 3.937 to 31.496 (FAST)
RF-210	100 to 1,000 3.937 to 39.370 (U-LG), 100 to 570 3.937 to 22.441 (STD), 100 to 500 3.937 to 19.685 (FAST)

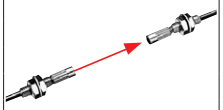
Note: The sensing range is the possible setting range for the reflector. The fiber can detect an object less than 100 mm 3.937 in away. However, note that if there are any white or highly-reflective surfaces near the fiber head, reflected incident light may affect the fiber head. If this occurs, adjust the threshold value of the amplifier before use.

FIBER OPTIONS

Lens (for thru-beam type fiber)

For thru-beam type fiber

Expansion lens (Note 1) — FX-LE1

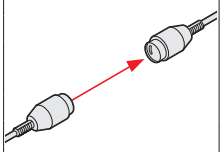


Increases the sensing range by 5 times or more.
- Ambient temperature: –60 to +350 °C –76 to +662 °F (Note 5)

Sensing range for red LED type (mm in) [Lens on both sides] (Note 3)

Fiber \ Mode	U-LG	STD	FAST
FT-B8	3,500 137.795 (Note 2)	1,900 74.803	1,400 55.118
FT-FM2	3,500 137.795 (Note 2)	2,500 98.425	1,800 70.866
FT-T80	3,500 137.795 (Note 2)	2,500 98.425	1,800 70.866
FT-R80	3,500 137.795 (Note 2)	1,500 59.055	1,000 39.370
FT-W8	3,500 137.795 (Note 2)	2,200 86.614	1,600 62.992
FT-P80	3,500 137.795 (Note 2)	2,500 98.425	1,700 66.929
FT-P60	3,500 137.795 (Note 2)	2,000 78.740	1,400 55.118
FT-P81X	1,600 62.992 (Note 2)	1,600 62.992 (Note 2)	1,000 39.370
FT-H35-M2	3,500 137.795 (Note 2)	1,100 43.307	800 31.496
FT-H20W-M1	1,600 62.992 (Note 2)	1,200 47.244	800 31.496
FT-H20-M1	1,600 62.992 (Note 2)	800 31.496	600 23.622

Super-expansion lens (Note 1) — FX-LE2

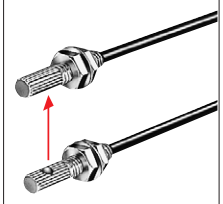


Tremendously increases the sensing range with large diameter lenses.
- Ambient temperature: –60 to +350 °C –76 to +662 °F (Note 5)

Sensing range for red LED type (mm in) [Lens on both sides] (Note 3)

Fiber \ Mode	U-LG	STD	FAST
FT-B8	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)
FT-FM2	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)
FT-R80	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)	2,800 110.236
FT-W8	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)
FT-P80	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)
FT-P60	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)
FT-P81X	1,600 62.992 (Note 2)	1,600 62.992 (Note 2)	1,600 62.992 (Note 2)
FT-H35-M2	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)
FT-H20W-M1	1,600 62.992 (Note 2)	1,600 62.992 (Note 2)	1,600 62.992 (Note 2)
FT-H20-M1	1,600 62.992 (Note 2)	1,600 62.992 (Note 2)	1,600 62.992 (Note 2)
FT-H13-FM2	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)	3,500 137.795 (Note 2)

Side-view lens — FX-SV1

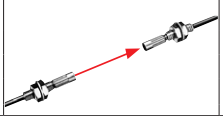


Beam axis is bent by 90°.
- Ambient temperature: –60 to +300 °C –76 to +572 °F (Note 5)

Sensing range for red LED type (mm in) [Lens on both sides] (Note 3)

Fiber \ Mode	U-LG	STD	FAST
FT-B8	1,800 70.866	480 18.898	350 13.780
FT-FM2	1,800 70.866	450 17.717	330 12.992
FT-T80	1,800 70.866	450 17.717	320 12.598
FT-W8	1,300 51.181	340 13.386	250 9.843
FT-P80	1,500 59.055	380 14.961	270 1.630
FT-P60	850 33.465	220 8.661	160 6.299
FT-P81X	1,600 62.992	450 17.717	300 11.811
FT-H35-M2	870 34.252	220 8.661	160 6.299
FT-H20W-M1	750 29.528	200 7.874	140 5.512
FT-H20-M1	870 34.252	220 8.661	160 6.299

Expansion lens for vacuum fiber (Note 1) — FV-LE1

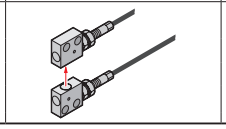


Sensing range increases by 4 times or more.
- Ambient temperature: –60 to +350 °C –76 to +662 °F (Note 5)

Sensing range for red LED type (mm in) [Lens on both sides] (Note 3, 4)

Fiber \ Mode	U-LG	STD	FAST
FT-H30-M1V-S	1,600 62.992	450 17.717	300 11.811

Vacuum resistant side-view lens (Note 1) — FV-SV2



Beam axis is bent by 90°.
- Ambient temperature: –60 to +300 °C –76 to +572 °F (Note 5)

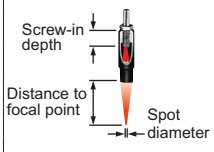
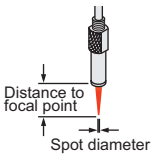
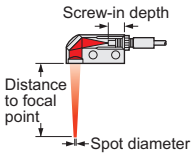
Sensing range for red LED type (mm in) [Lens on both sides] (Note 3, 4)

Fiber \ Mode	U-LG	STD	FAST
FT-H30-M1V-S	1,600 62.992	450 17.717	300 11.811

Notes: 1) Be careful when installing the thru-beam type fiber equipped with the expansion lens, as the beam envelope becomes narrow and alignment is difficult. Especially when installing a fiber with many cores (sharp bending fibers and heat-resistant glass fiber), please be sure to use it only after you have adjusted it sufficiently.
2) The fiber cable length practically limits the sensing range to 3,500 mm 137.795 in long (**FT-P81X**, **FT-H20W-M1** and **FT-H20-M1**: 1,600 mm 62.992 in).
3) The sensing ranges are the values for red LED type amplifier. Please contact our office for details on sensing ranges for other types of amplifiers.
4) The fiber cable length for the **FT-H30-M1V-S** is 1 m 3.281 ft. The sensing ranges in U-LG mode take into account the length of the **FT-J8** atmospheric side fiber.
5) Refer to p.76~ for the ambient temperatures of fibers to be used in combination.

FIBER OPTIONS

Lens (for reflective type fiber)

Designation		Model No.		Description
For reflective type fiber	Pinpoint spot lens	**FX-MR1**		Pinpoint spot of ø0.5 mm ø0.020 in. Enables detection of minute objects or small marks. • Distance to focal point: 6 ±1 mm 0.236 ±0.039 in • Applicable fibers: **FD-WG4**, **FD-G4** • Ambient temperature: –40 to +70 °C –40 to +158 °F (Note 2)
	Zoom lens	**FX-MR2**		The spot diameter is adjustable from ø0.7 to ø2 mm ø0.028 to ø0.079 in according to how much the fiber is screwed in. • Applicable fibers: **FD-WG4**, **FD-G4** • Ambient temperature: –40 to +70 °C –40 to +158 °F (Note 1) • Accessory: **MS-EX-3** (mounting bracket)
	Finest spot lens	**FX-MR3**		Extremely fine spot of ø0.3 mm ø0.012 in approx. achieved. • Applicable fibers: **FD-WG4**, **FD-G4**, **FD-EG1**, **FD-EG2**, **FD-EG3**, **FD-G6X**, **FD-G6** • Ambient temperature: –40 to +70 °C –40 to +158 °F (Note 2)
	Finest spot lens	**FX-MR6**		Extremely fine spot of ø0.1 mm ø0.004 in approx. achieved. • Applicable fibers: **FD-WG4**, **FD-G4**, **FD-EG1**, **FD-EG2**, **FD-EG3**, **FD-G6X**, **FD-G6** • Ambient temperature: –20 to +60 °C –4 to +140 °F (Note 2)
	Zoom lens (Side-view type)	**FX-MR5**		**FX-MR2** is converted into a side-view type and can be mounted in a very small space. • Applicable fibers: **FD-WG4**, **FD-G4** • Ambient temperature: –40 to +70 °C –40 to +158 °F (Note 2)

Sensing range for red LED type (Note 1)

Screw-in depth	Distance to focal point	Spot diameter
7 mm 0.276 in	ø18.5 mm ø0.728 in approx.	ø0.7 mm ø0.028 in
12 mm 0.472 in	ø27 mm ø1.063 in approx.	ø1.2 mm ø0.047 in
14 mm 0.551 in	ø43 mm ø1.693 in approx.	ø2.0 mm ø0.079 in

Sensing range for red LED type (Note 1)

Fiber	Distance to focal point	Spot diameter
FD-EG3	7.5 ±0.5 mm 0.295 ±0.020 in	ø0.15 mm ø0.006 in approx.
FD-EG2	7.5 ±0.5 mm 0.295 ±0.020 in	ø0.2 mm ø0.008 in approx.
FD-EG1	7.5 ±0.5 mm 0.295 ±0.020 in	ø0.3 mm ø0.012 in approx.
FD-WG4/G4/G6X/G6	7.5 ±0.5 mm 0.295 ±0.020 in	ø0.5 mm ø0.020 in approx.

Sensing range for red LED type (Note 1)

Fiber	Distance to focal point	Spot diameter
FD-EG3	7 ±0.5 mm 0.276 ±0.020 in	ø0.1 mm ø0.004 in approx.
FD-EG2	7 ±0.5 mm 0.276 ±0.020 in	ø0.15 mm ø0.006 in approx.
FD-EG1	7 ±0.5 mm 0.276 ±0.020 in	ø0.2 mm ø0.008 in approx.
FD-WG4/G4/G6X/G6	7 ±0.5 mm 0.276 ±0.020 in	ø0.4 mm ø0.016 in approx.

Sensing range for red LED type (Note 1)

Screw-in depth	Distance to focal point	Spot diameter
8 mm 0.315 in	13 mm 0.512 in approx.	ø0.5 mm ø0.020 in
10 mm 0.394 in	15 mm 0.591 in approx.	ø0.8 mm ø0.031 in
14 mm 0.551 in	30 mm 1.181 in approx.	ø3.0 mm ø0.118 in

Notes: 1) The sensing ranges are the values when used in combination with red LED type amplifier. Please contact our office for details on sensing ranges for other types of amplifier.
2) Refer to p.76~ for the ambient temperatures of fibers to be used in combination.

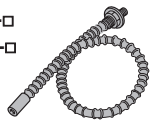
Others

Designation	Model No.			Description
Protective tube (For thru-beam type fiber)	**FTP-500** (0.5m 1.641 ft)	For M4 thread	Applicable fibers: **FT-42**, **FT-B8**, **FT-FM2**, **FT-FM2S**, **FT-FM2S4**, **FT-H13-FM2**, **FT-P60**, **FT-P80**	The protective tube, made of noncorrosive stainless steel, protects the inner fiber cable from any external forces.
	FTP-1000 (1m 3.281 ft)			
	FTP-1500 (1.5m 4.922 ft)			
	FTP-N500 (0.5m 1.641 ft)	For M3 thread	Applicable fibers: **FT-31**, **FT-NFM2**, **FT-NFM2S**, **FT-NFM2S4**, **FT-P40**, **FT-T80**, **FD-P40**, **FD-T40**	
	FTP-N1000 (1m 3.281 ft)			
	FTP-N1500 (1.5m 4.922 ft)			
Protective tube (For reflective type fiber)	**FDP-500** (0.5m 1.641 ft)	For M6 thread	Applicable fibers: **FD-61**, **FD-B8**, **FD-FM2**, **FD-FM2S**, **FD-FM2S4**, **FD-H13-FM2**, **FD-P80**	
	FDP-1000 (1m 3.281 ft)			
	FDP-1500 (1.5m 4.922 ft)			
	FDP-N500 (0.5m 1.641 ft)	For M4 thread	Applicable fibers: **FD-41**, **FD-NFM2**, **FD-NFM2S**, **FD-NFM2S4**, **FD-T80**	
	FDP-N1000 (1m 3.281 ft)			
	FDP-N1500 (1.5m 4.922 ft)			
Fiber bender	**FB-1**	The fiber bender bends the sleeve part of the fiber head at the proper radius. (Note 1)		
Universal sensor mounting stand (Note 2)	**MS-AJ1-F**	Horizontal mounting type	Mounting stand assembly for fiber (For M3,M4 or M6 threaded head fiber)	
	MS-AJ2-F	Vertical mounting type		
Single-core holder	**FX-AT15A**	The incident light intensity may vary when using a multi-core fiber or a thin type sharp bending fiber. This holder suppresses the variation in the incident light intensity. Brown.		

Notes: 1) Do not bend the sleeve part of any side-view type fiber or ultra-small diameter head type fiber.
2) Refer to the universal sensor mounting stand **MS-AJ** series pages for details.

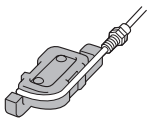
Protective tube

• **FTP-□**
• **FDP-□**



Fiber bender

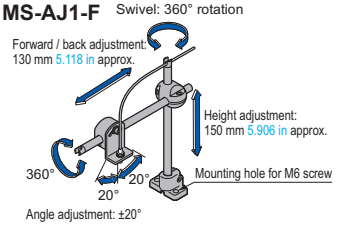
• **FB-1**



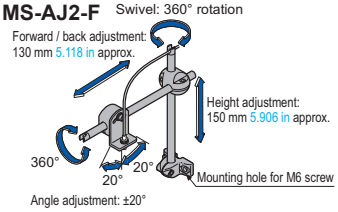
Universal sensor mounting stand

Using the arm which enables adjustment in the horizontal direction, sensing can also be done from above an assembly line.

• **MS-AJ1-F** Swivel: 360° rotation



• **MS-AJ2-F** Swivel: 360° rotation



Single-core holder

• **FX-AT15A**

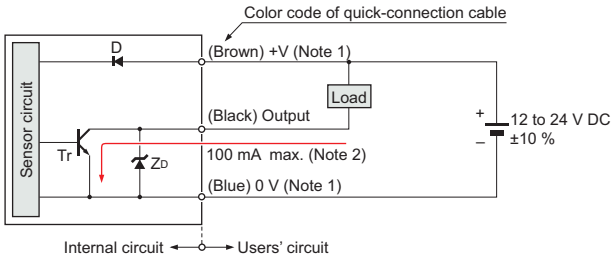
SPECIFICATIONS

Item \ Type	NPN output			PNP output		
	Red LED	Blue LED	Green LED	Red LED	Blue LED	Green LED
Model No.	**FX-411**	**FX-411B**	**FX-411G**	**FX-411P**	**FX-411BP**	**FX-411GP**
	FX-412 (Note 2)	**FX-412B** (Note 2)	**FX-412G** (Note 2)			
Supply voltage	12 to 24 V DC ±10 % Ripple P-P 10 % or less					
Power consumption	<Red LED type> Normal operation: 960 mW or less (Current consumption 40 mA or less at 24 V supply voltage) ECO mode: 840 mW or less (Current consumption 35 mA or less at 24 V supply voltage) <Blue LED / Green LED type> Normal operation: 720 mW or less (Current consumption 30 mA or less at 24 V supply voltage) ECO mode: 580 mW or less (Current consumption 24 mA or less at 24 V supply voltage)					
Output	<NPN output type> NPN open-collector transistor • Maximum sink current: 100 mA (50 mA, if five, or more, amplifiers are connected in cascade) • Applied voltage: 30 V DC or less (between output and 0 V) • Residual voltage: 1.5 V or less [at 100 mA sink current (50 mA, if five, or more, amplifiers are connected in cascade)]			<PNP output type> PNP open-collector transistor • Maximum source current: 100 mA (50 mA, if five, or more, amplifiers are connected in cascade) • Applied voltage: 30 V DC or less (between output and +V) • Residual voltage: 1.5 V or less [at 100 mA sink current (50 mA, if five, or more, amplifiers are connected in cascade)]		
Utilization category	DC-12 or DC-13					
Output operation	Switchable either Light-ON or Dark-ON					
Short-circuit protection	Incorporated					
Response time	150 µs or less (FAST), 500 µs or less (STD), 4.5 ms or less (U-LG) selectable with setting switch					
Operation indicator	Orange LED (lights up when the output is ON)					
Stability indicator	Green LED (lights up under stable light received condition or stable dark condition)					
Timer function	Incorporated with variable ON-delay / OFF-delay / ONE SHOT timer, switchable either effective or ineffective. [Timer period (Note 3): 1 ms to 3 sec. approx. (1 to 10 ms: Setting possible in units of 1 ms, 10 to 100 ms: Setting possible in units of 10 ms, 100 to 500 ms: Setting possible in units of 50 ms, 500 ms to 1 sec.: Setting possible in units of 100 ms, 1 to 3 sec.: Setting possible in units of 500 ms)]					
Automatic interference prevention function	Incorporated (Up to four sets of fiber heads can be mounted close together. However, U-LG mode is 8 fiber heads.)(Note 4)					
Environmental resistance: Pollution degree	3 (Industrial environment)					
Environmental resistance: Ambient temperature	–10 to +55 °C –14 to +131 °F (If 4 to 7 units are connected in cascade: –10 to +50 °C +14 to +122 °F, if 8 to 16 units are connected in cascade: –10 to +45 °C +14 to +113 °F) (No dew condensation or icing allowed), Storage: –20 to +70 °C –4 to +158 °F					
Environmental resistance: Ambient humidity	35 to 85 % RH, Storage: 35 to 85 % RH					
Environmental resistance: Ambient illuminance	Incandescent light: 3,000 ℓx or less at the light-receiving face					
Environmental resistance: EMC	EN 60947-5-2					
Environmental resistance: Voltage withstandability	1,000 V AC for one min. between all supply terminals connected together and enclosure (Note 5)					
Environmental resistance: Insulation resistance	20 MΩ, or more, with 250 V DC megger between all supply terminals connected together and enclosure (Note 5)					
Environmental resistance: Vibration resistance	10 to 150 Hz frequency, 0.75 mm 0.030 in amplitude in X, Y and Z directions for two hours each					
Environmental resistance: Shock resistance	98 m/s² acceleration (10 G approx.) in X, Y and Z directions for five times each					
Emitting element (modulated)	Red LED	Blue LED	Green LED	Red LED	Blue LED	Green LED
Peak emission wavelength	650 nm 0.026 mil	470 nm 0.019 mil	525 nm 0.021 mil	650 nm 0.026 mil	470 nm 0.019 mil	525 nm 0.021 mil
Material	Enclosure: Heat-resistant ABS, Case cover: Polycarbonate					
Cable length	Total length up to 100 m 328.084 ft (50 m 164.042 ft for 5 to 8 units, 20 m 65.617 ft for 9 to 16 units) is possible with 0.3 mm², or more, cable.					
Weight	Net weight: 20 g approx., Gross weight: 30 g approx.					

Notes: 1) Where measurement conditions have not been specified precisely, the conditions used were an ambient temperature of +23 °C +73.4 °F.
2) The **FX-412**□ has a threshold value adjuster that can be adjusted with your fingers.
3) For models manufactured up until June 2005, the timer period is approx. 1 to 500 ms.
4) When the power supply is switched on, the light emission timing is automatically set for interference prevention.
5) The voltage withstandability and the insulation resistance values given in the above table are for the amplifier only.

I/O CIRCUIT DIAGRAMS

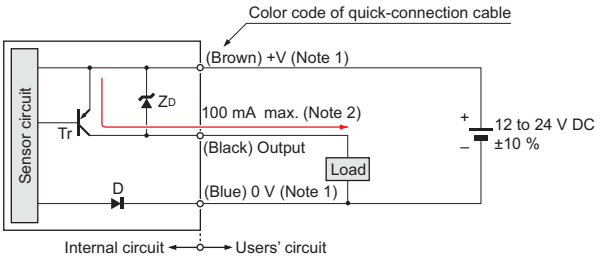
FX-41□ NPN output type



Notes: 1) The quick-connection sub cable does not have +V (brown) and 0 V (blue). The power is supplied from the connector of the main cable.
2) 50 mA max., if five amplifiers, or more, are connected together.

Symbols … D : Reverse supply polarity protection diode
ZD: Surge absorption zener diode
Tr : NPN output transistor

FX-41□P PNP output type



Notes: 1) The quick-connection sub cable does not have +V (brown) and 0 V (blue). The power is supplied from the connector of the main cable.
2) 50 mA max., if five amplifiers, or more, are connected together.

Symbols … D : Reverse supply polarity protection diode
ZD: Surge absorption zener diode
Tr : PNP output transistor

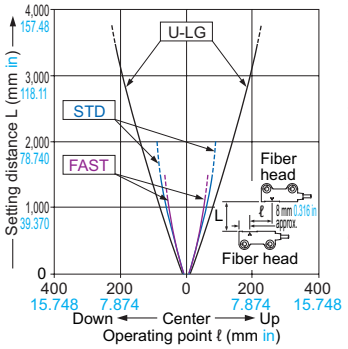
SENSING CHARACTERISTICS (TYPICAL)

The following sensing characteristics pertain to the red LED type. Please contact our office for the sensing characteristics pertaining corresponding to types other than the red LED or to types not mentioned here.

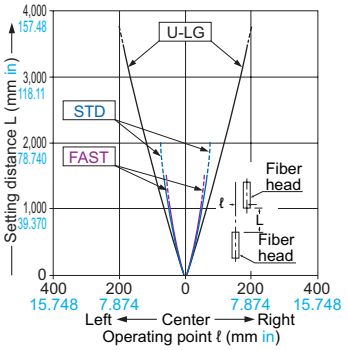
FT-A8 FT-WA8 Thru-beam type

Parallel deviation

• Vertical direction

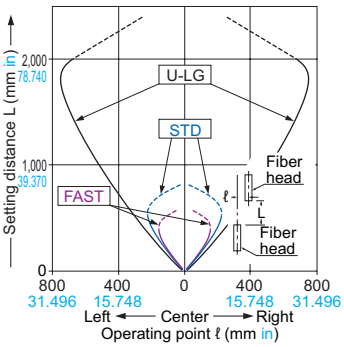


• Horizontal direction



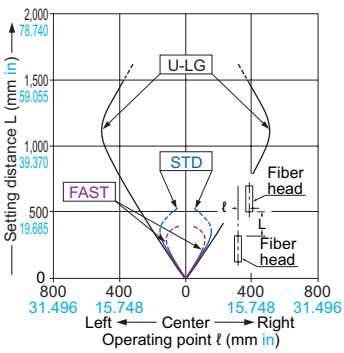
FT-B8 Thru-beam type

Parallel deviation



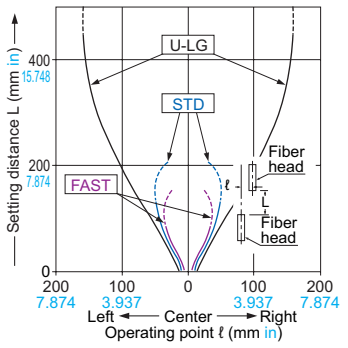
FT-FM2 FT-FM2S FT-FM2S4 FT-SFM2 FT-T80 Thru-beam type

Parallel deviation



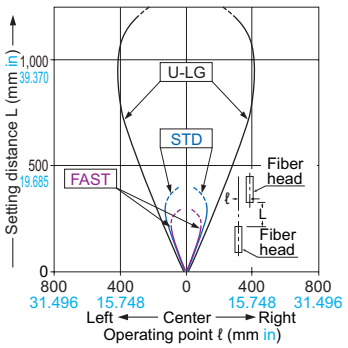
FT-NFM2 FT-NFM2S FT-NFM2S4 FT-SNFM2 Thru-beam type

Parallel deviation



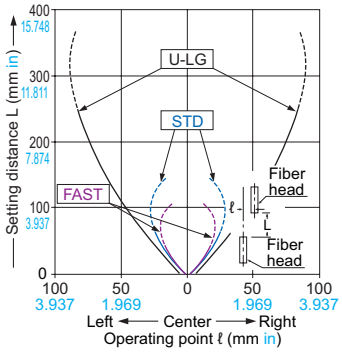
FT-P81X Thru-beam type

Parallel deviation



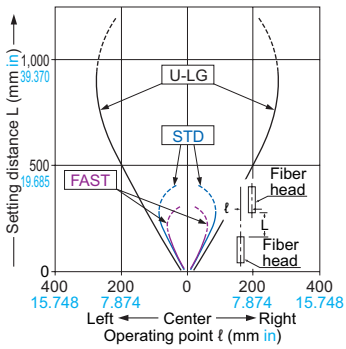
FT-W4 FT-WS4 Thru-beam type

Parallel deviation



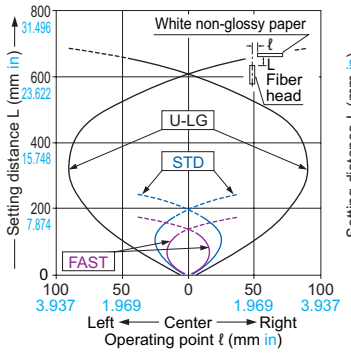
FT-W8 FT-WS8 Thru-beam type

Parallel deviation



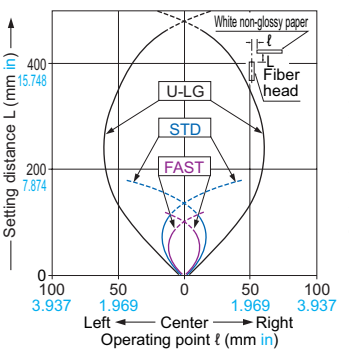
FD-B8 Reflective type

Sensing field



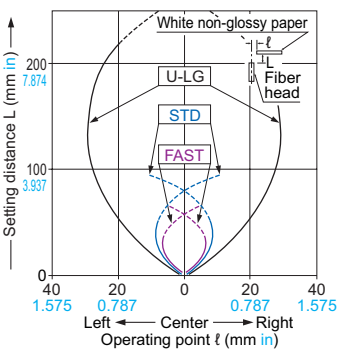
FD-FM2 Reflective type

Sensing field



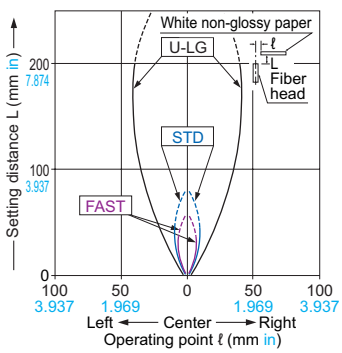
FD-G4 Reflective type

Sensing field



FD-G6X Reflective type

Sensing field

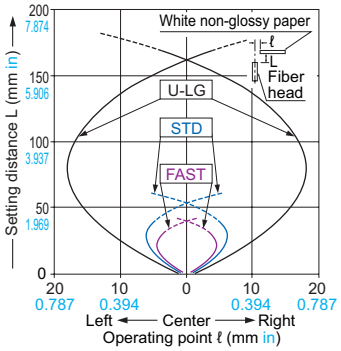


SENSING CHARACTERISTICS (TYPICAL)

The following sensing characteristics pertain to the red LED type. Please contact our office for the sensing characteristics pertaining corresponding to types other than the red LED or to types not mentioned here.

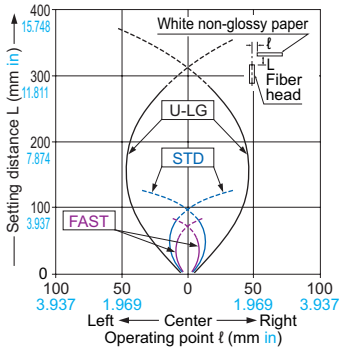
FD-NFM2 FD-NFM2S FD-NFM2S4 FD-SNFM2 FD-T40 Reflective type

Sensing field



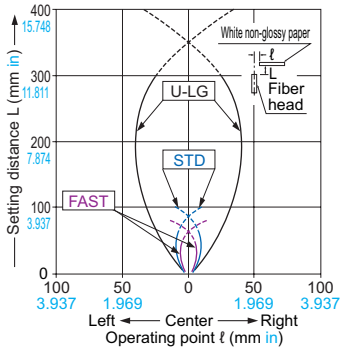
FD-P81X Reflective type

Sensing field



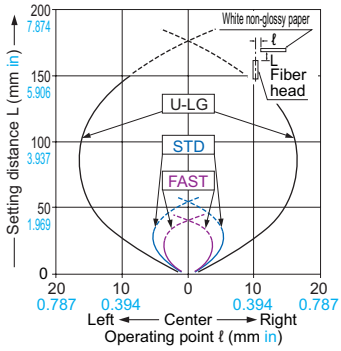
FD-W8 FD-WS8 FD-WT8 Reflective type

Sensing field



FD-WG4 FD-WSG4 Reflective type

Sensing field

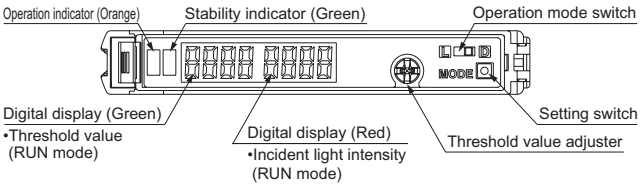


PRECAUTIONS FOR PROPER USE

Refer to General precautions and P.80~ for fiber precautions.

- Never use this product as a sensing device for personnel protection.
- In case of using sensing devices for personnel protection, use products which meet laws and standards, such as OSHA, ANSI or IEC etc., for personnel protection applicable in each region or country.

Part description



Wiring

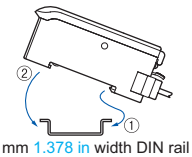
- Make sure that the power supply is off while wiring.
- Verify that the supply voltage variation is within the rating.
- Take care that if a voltage exceeding the rated range is applied, or if an AC power supply is directly connected, the product may get burnt or damaged.
- In case noise generating equipment (switching regulator, inverter motor, etc.) is used in the vicinity of this product, connect the frame ground (F.G.) terminal of the equipment to an actual ground.
- If power is supplied from a commercial switching regulator, ensure that the frame ground (F.G.) terminal of the power supply is connected to an actual ground.
- Take care that short circuit of the load wrong wiring may burn or damage the product.
- Do not run the wires together with high-voltage lines or power lines or put them in the same raceway. This can cause malfunction due to induction.
- Extension up to total 100 m 328.084 ft (if 5 to 8 units are connected in cascade: 50 m 164.042 ft, if 9 to 16 units are connected in cascade: 20 m 65.617 ft) is possible with 0.3 mm², or more, cable. However, in order to reduce noise, make the wiring as short as possible.
- Take care that cable extension increases the residual voltage.

Mounting

- Make sure that the power supply is off while connecting / disconnecting the amplifiers and the quick-connection cables.

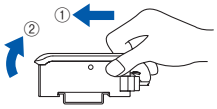
How to mount the amplifier

① Fit the rear part of the mounting section of the amplifier on a width DIN rail.
② Press down the rear part of the mounting section of the unit on the width DIN rail and fit the front part of the mounting section to the DIN rail.



How to remove the amplifier

① Push the amplifier forward.
② Lift up the front part of the amplifier to remove it.

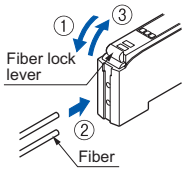


Note: Take care that if the front part is lifted without pushing the amplifier forward, the hook on the rear portion of the mounting section is likely to break.

Fiber installation

- Insert the fiber into the amplifier after attaching the attachment. Refer to the "Instruction Manual" included with the fiber for details.

① Push the fiber lock lever down.
② Slowly insert the fiber into the insertion slot until it stops. (Note 1)
③ Push the fiber lock lever back up until it stops.



Notes: 1) Note that if the fiber is not fully inserted, the sensing distance will decrease. Also note that the flexible fiber may bend during insertion.
2) In case of coaxial reflective type fibers (**FD-G4**, **FD-FM2**, etc.), mount the central fiber (single-core) to the emitter part and the peripheral fiber (multi-core) to the receiver. Note that sensing precision will deteriorate when done in reverse.

PRECAUTIONS FOR PROPER USE

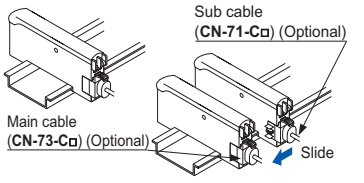
Refer to General precautions and P.80~ for fiber precautions.

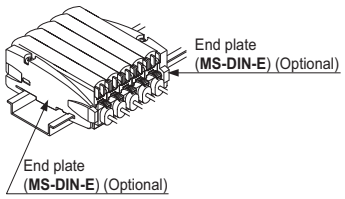
Cascading

- Make sure that the power supply is off while adding or removing the amplifiers.
- Make sure to check the allowable ambient temperature, as it depends on the number of amplifiers connected in cascade.
- In case two, or more, amplifiers are connected in cascade, make sure to mount them on a DIN rail.
- When the amplifiers move on the DIN rail depending on the attaching condition or the amplifiers are mounted close to each other in cascade, fit them between the optional end plates (**MS-DIN-E**) mounted at the two ends.
- Up to maximum 15 amplifiers can be added (total 16 amplifiers connected in cascade.)
- When connecting more than two amplifiers in cascade, use the sub cable (**CN-71-C□**) as the quick-connection cable for the second amplifier onwards.
- When connecting amplifiers not close to each other in parallel, be sure to mount the optional end plate (**MS-DIN-E**) at both sides of each amplifier or affix the communication window seal of the optional fiber amplifier protection seal (**FX-MB1**) to the communication windows. For details, refer to the instruction manual enclosed with the **FX-MB1**.
- When the different LED (red / blue / green) types are connected in cascade, mount the identical models together.
- When this product is used with the other digital fiber amplifiers, be sure to place this product to the left most position (When you look from the connector side). If this product is not placed to the leftmost position, this product may not operate properly.

Cascading method

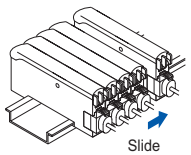
① Mount the amplifiers, one by one, on the DIN rail.
② Slide the amplifiers next to each other, and connect the quick-connection cables.
③ Mount the optional end plates (**MS-DIN-E**) at both the ends to hold the amplifiers between their flat sides.
④ Tighten the screws to fix the end plates.





Dismantling

① Loosen the screws of the end plates.
② Remove the end plates.
③ Slide the amplifiers and remove them one by one.



Switching output operation

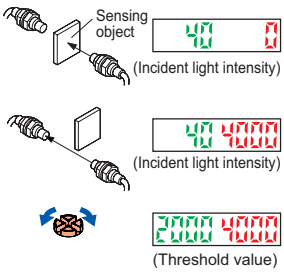
- The operation selection switch can be used to display different output operations (L-ON / D-ON) on the digital display.

When set to Dark-ON (D-ON)

When set to Light-ON (L-ON)

Threshold value (sensitivity) adjustment

① Check the incident light intensity [in the digital display (red)] when a sensing object is placed in the sensing position.
② Check the incident light intensity [in the digital display (red)] when the sensing object is removed from the sensing position.



③ Turn the threshold value adjuster to the threshold value [in the digital display (green)] that is the value in between ① and ②. (The threshold value is automatically written to the EEPROM.)

Threshold value setting method

- When the threshold value adjuster is turned clockwise, the threshold value increases. When the threshold value adjuster is turned counterclockwise, the threshold value decreases.

- If there is a sufficient level of margin in the incident light intensity, the stability indicator (green) will light up.

Mode selection

- When the setting switch is pressed and held for 2 sec. or more, “SET” mode (mode setting screen) is activated.
- If the setting switch is pressed while in “SET” mode, the mode will change.
- If the threshold value adjuster is turned while a mode is active, the setting item will change and blink.
- When the setting switch is pressed at the item you would like to set, it blinks 3 times and then the setting is confirmed and the mode switches to the next mode.
- If the setting switch is pressed and held for 2 sec. or more or do not press any key for 15 sec. while “SET” mode is active, the mode will switch automatically to “RUN” mode.

PRECAUTIONS FOR PROPER USE

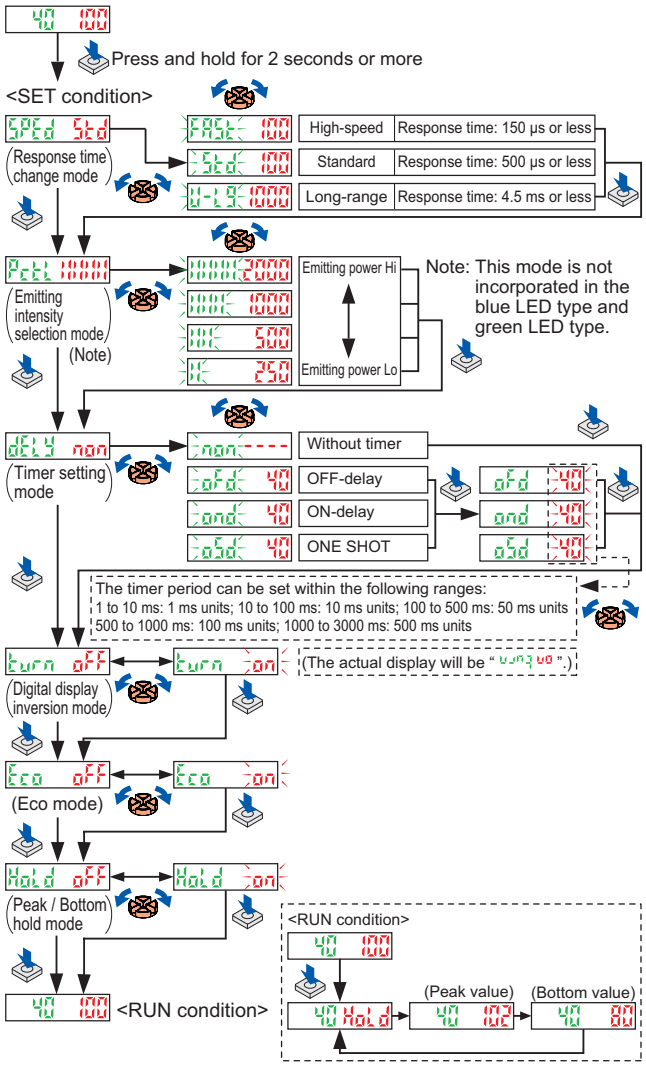
Refer to General precautions and P.80~ for fiber precautions.

Mode table

Mode	Factory setting	Description
Response time change mode	SPEd Std	The response time can be set.
Light-emitting amount selection mode (Note 1)	PoEL HIGH	The light-emitting amount can be switched among four levels.
Timer setting mode	dELY non	Timer settings can be selected; Without timer / OFF-delay timer / ON-delay timer / ONE SHOT timer. Also the timer period can be set.
Digital display inversion mode	turn oFF	The display on the digital display can be inverted.
Eco mode (Note 2)	Eco oFF	If no key is pressed for 20 sec. approx. while in "RUN" mode, the digital display turns off automatically. Press the setting switch or move the operation mode switch to make the display light up again. The digital display will light up when the threshold value adjuster is turned, but note that this will also cause the threshold value to change.
Peak / Bottom hold mode	Hold oFF	If the setting switch is pressed while "RUN" mode is active, the display will alternate between the peak hold value and the bottom hold value. (The display will refresh every 2 sec.) The display will return to normal if any operation other than threshold value setting is carried out.

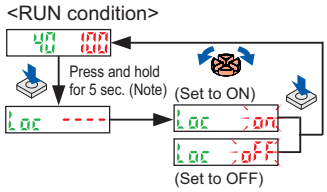
Notes: 1) This mode is not incorporated in the blue LED type and green LED type.
2) While the peak / bottom hold mode is ON, the digital display is not turned off even if the Eco mode is set to ON.

<RUN condition>



Key lock function

- When the setting switch is pressed and hold for 5 sec. while in 'RUN' mode, the key lock function can be set / canceled.
- When the key lock function is set to ON, even if the threshold value adjuster or the setting switch is operated, "Loc " is displayed and the key operation cannot be carried out.



Note: Although the display changes to the indication of 'SET' condition 2 sec. after pressing the setting switch, keep pressing the switch. Furthermore, the sensor does not go into the key lock setting from 'SET' condition.

Factory setting

- When the setting switch is pressed and held for 10 sec., until "---- ----" is displayed while in 'RUN' mode, the all settings are returned to the factory setting. (For the factory setting, refer to 'Mode table' in '**Mode selection**'.)

Error display indicator readings

Display	Error description	Measures
Er-1	The load has short-circuited and excess current is flowing.	Turn off the power, then check the load.
Er-5	Communication error has occurred at time of connection.	Check if the mounted amplifiers are in close contact with each other.

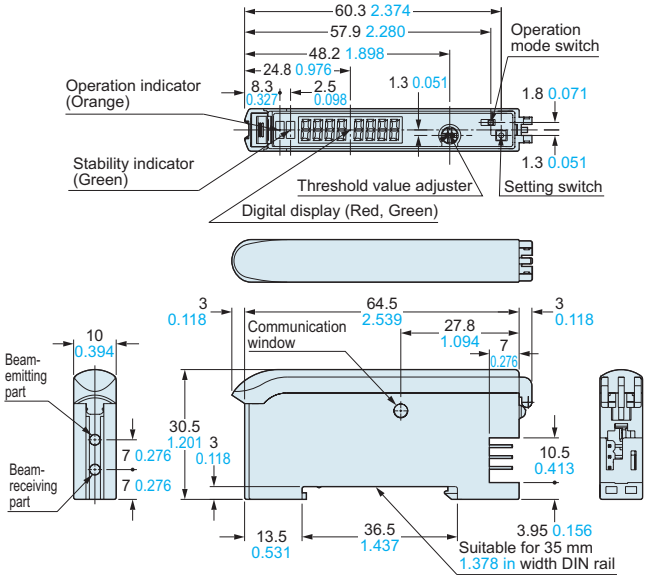
Others

- Do not use during the initial transient time (0.5 sec.) after the power supply is switched on.
- This sensor is suitable for indoor use only.
- Do not use this sensor in places having excessive vapor, dust, etc., or where it may come in contact with corrosive gas.
- Take care that the sensor does not come in direct contact with oil, grease, organic solvents, such as, thinner etc., or strong acid, and alkaline.
- This sensor cannot be used in an environment containing inflammable or explosive gases.
- Never disassemble or modify the sensor.
- The changes to the settings are written to the EEPROM, but because the EEPROM has a limited service life, you should avoid changing the settings any more than 1 million times.

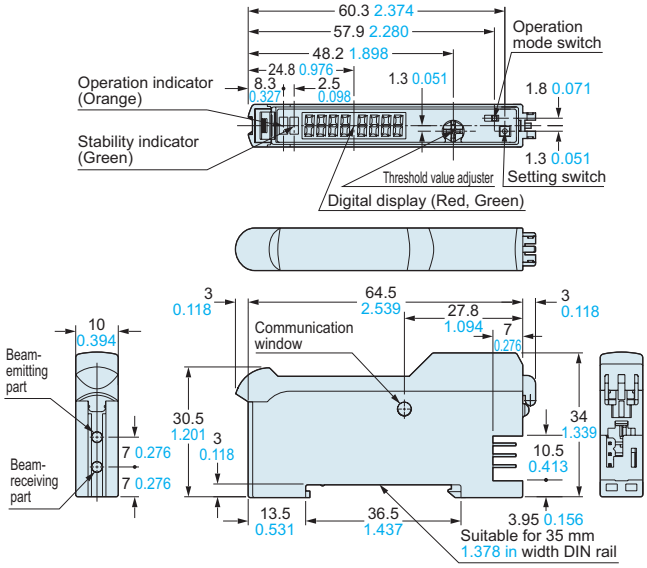
DIMENSIONS (Unit: mm in)

The CAD data in the dimensions can be downloaded from our website.

FX-411□ FX-411□P — Amplifier



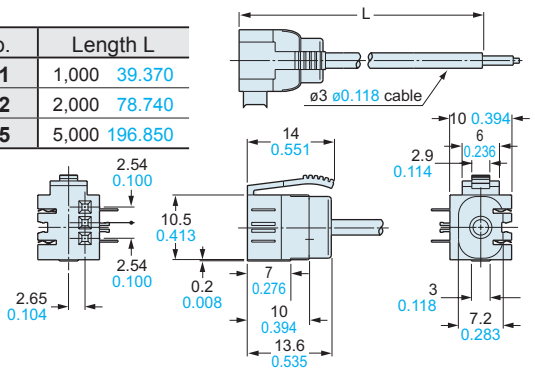
FX-412□ — Amplifier



CN-71-C1 CN-71-C2 CN-71-C5 — Sub cable (Optional)

• Length L

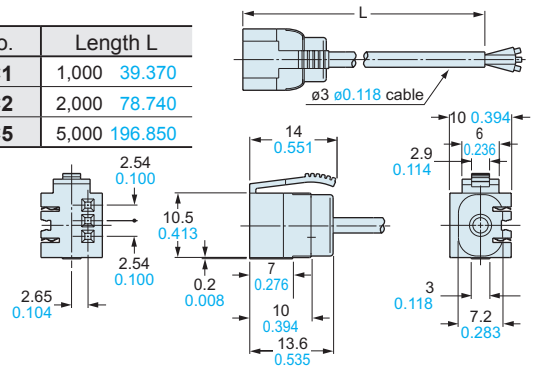
Model No.	Length L
CN-71-C1	1,000 39.370
CN-71-C2	2,000 78.740
CN-71-C5	5,000 196.850



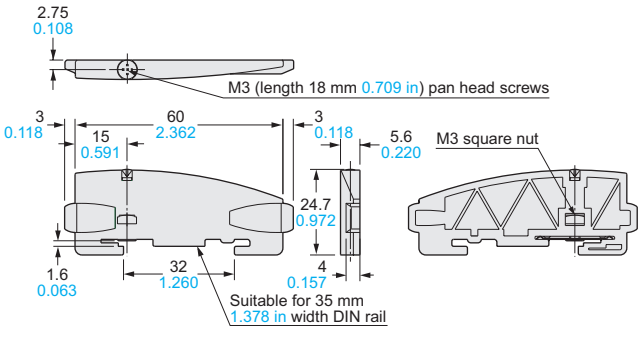
CN-73-C1 CN-73-C2 CN-73-C5 — Main cable (Optional)

• Length L

Model No.	Length L
CN-73-C1	1,000 39.370
CN-73-C2	2,000 78.740
CN-73-C5	5,000 196.850

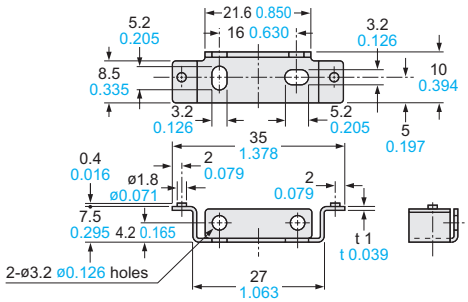


MS-DIN-E — End plate (Optional)



Material: Polycarbonate

MS-DIN-2 — Amplifier mounting bracket (Optional)



Material: Cold rolled carbon steel (SPCC) (Uni-chrome plated)

MEMO