OMRON

Super Dual Fiber Sensors
E3X-MDA

The remarkable, new-dimension 2-channel amplifiers

- The thinnest profile in the industry, at only 5 mm per channel.
- AND/OR control output.
- Flexible control from the Mobile Console.

<READ AND UNDERSTAND THIS CATALOG>

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Ordering Information

■ Amplifier Units

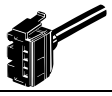
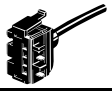
Amplifier Units with Cables

Item	Appearance	Functions	Model	
			NPN output	PNP output
2-channel models		AND/OR output	E3X-MDA11	E3X-MDA41

Amplifier Units with Connectors

Item	Appearance	Functions	Model	
			NPN output	PNP output
2-channel models		AND/OR output	E3X-MDA6	E3X-MDA8

■ Amplifier Unit Connectors (Order Separately)

Item	Appearance	Cable length	No. of conductors	Model
Master Connector		2 m	3	E3X-CN11
			4	E3X-CN21
Slave Connector			1	E3X-CN12
			2	E3X-CN22

Combining Amplifier Units and Connectors

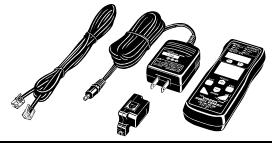
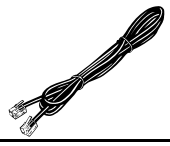
Amplifier Units and Connectors are sold separately. Refer to the following tables when placing an order.

Amplifier Unit				Applicable Connector (Order Separately)	
Model	NPN output	PNP output		Master Connector	Slave Connector
2-channel models	E3X-MDA6	E3X-MDA8	+	E3X-CN21 (4-wire)	E3X-CN22 (2-wire)

When Using 5 Amplifier Units

Amplifier Units (5 Units)	+	1 Master Connector + 4 Slave Connectors

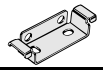
■ Mobile Console (Order Separately)

Appearance	Model	Remarks
	E3X-MC11-S (model number of set)	Mobile Console with Head, Cable, and AC adapter provided as accessories
	E3X-MC11-C1-S	Mobile Console
	E3X-MC11-H1	Head
	E39-Z12-1	Cable (1.5 m)

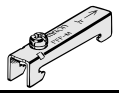
Note: Use the E3X-MC11-S Mobile Console for the E3X-DA-S/MDA-series Amplifier Units. Other Mobile Consoles cannot be used.

■ Accessories (Order Separately)

Mounting Bracket

Appearance	Model	Quantity
	E39-L143	1

End Plate

Appearance	Model	Quantity
	PFP-M	1

Specifications

■ Ratings/Characteristics

Amplifier Units

Type			2-channel models	
Model		NPN output	E3X-MDA11	E3X-MDA6
Item		PNP output	E3X-MDA41	E3X-MDA8
Light source (wavelength)			Red LED (650 nm)	
Supply voltage			12 to 24 VDC ±10%, ripple (p-p) 10% max.	
Power consumption			1,080 mW max. (current consumption: 45 mA max. at power supply voltage of 24 VDC)	
Control output			Load power supply voltage: 26.4 VDC; open collector; load current: 50 mA max.; residual voltage: 1 V max.	
Circuit protection			Reverse polarity for power supply connection, output short-circuit	
Response time	Super-high-speed mode	NPN	130 μs[*1] for operation and reset respectively	
		PNP		
	Standard mode		1 ms for operation and reset respectively	
	High-resolution mode		4 ms for operation and reset respectively	
Sensitivity setting			Teaching or manual method	
Functions	Power tuning		Light emission power and reception gain, digital control method	
	Timer function		Select from OFF-delay, ON-delay, or one-shot timer. 1 ms to 5 s (1 to 20 ms set in 1-ms increments, 20 to 200 ms set in 10-ms increments, 200 ms to 1 s set in 100-ms increments, and 1 to 5 s set in 1 s-increments)	
	Automatic power control (APC)		High-speed control method for emission current	
	Zero-reset		Display can be reset to zero when required (negative values can be displayed).	
	Initial reset		Settings can be returned to defaults as required.	
	Mutual interference prevention		Possible for up to 9 Units (18 channels)[*2, *3]	
	I/O settings		Output setting (Select from channel 2 output, AND, OR, leading edge sync, falling edge sync, or differential output)	
Display			Operation indicator for channel 1 (orange), Operation indicator for channel 2 (orange)	
Digital display			Select from the following: Incident level for channel 1 + incident level for channel 2, Incident level + threshold, incident level percentage + threshold, incident light peak level + no incident light bottom level, minimum incident light peak level + maximum no incident light bottom level, long bar display, incident level + peak hold, incident level + channel	
Display orientation			Switching between normal/reversed display is possible.	
Ambient illumination (receiver side)			Incandescent lamp: 10,000 lux max. Sunlight: 20,000 lux max.	
Ambient temperature			Operating: Groups of 1 to 2 Amplifiers: −25°C to 55°C Groups of 3 to 10 Amplifiers: −25°C to 50°C Groups of 11 to 16 Amplifiers: −25°C to 45°C (with no icing or condensation) Storage: −30°C to 70°C (with no icing or condensation)	
Ambient humidity			Operating and storage: 35% to 85% (with no condensation)	
Insulation resistance			20 MΩ min. (at 500 VDC)	
Dielectric strength			1,000 VAC at 50/60 Hz for 1 minute	
Vibration resistance (destruction)			10 to 55 Hz with a 1.5-mm double amplitude for 2 hrs each in X, Y and Z directions	
Shock resistance (destruction)			500 m/s^2, for 3 times each in X, Y and Z directions	
Enclosure rating			IEC 60529 IP50 (with Protective Cover attached)	
Connection method			Prewired cable	Standard connector
Weight (packed state)			Approx. 100 g	Approx. 55 g
Materials	Case		Polybutylene terephthalate (PBT)	
	Cover		Polycarbonate (PC)	
Accessories			Instruction sheet	

***1:** When differential output is selected for the output setting, the second channel output is 200 μs for operation and reset respectively.

***2:** Communications are disabled if the detection mode is selected during super-high-speed mode, and the communications functions for mutual interference prevention and the Mobile Console will not function.

***3:** Mutual interference prevention can be used for up to 5 Units (10 channels) if power tuning is enabled.

Amplifier Unit Connectors

Item		E3X-CN11/21/22	E3X-CN12
Rated current		2.5 A	
Rated voltage		50 V	
Contact resistance		20 mΩ max. (20 mVDC max., 100 mA max.) (The figure is for connection to the Amplifier Unit and the adjacent Connector. It does not include the conductor resistance of the cable.)	
No. of insertions (destruction)		50 times (The figure for the number of insertions is for connection to the Amplifier Unit and the adjacent Connector.)	
Materials	Housing	Polybutylene terephthalate (PBT)	
	Contacts	Phosphor bronze/gold-plated nickel	
Weight (packed state)		Approx. 55 g	Approx. 25 g

Mobile Console

Item	E3X-MC11-S
Supply voltage	Charged with AC adapter
Connection method	Connected via adapter
Weight (packed state)	Approx. 580 g (Console only: 120 g)

Refer to *Operation Manual* provided with the Mobile Console for details.

Ordering Information: Fiber Units

■ Through-beam Fiber Units

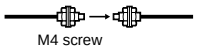
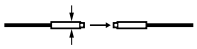
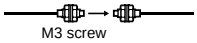
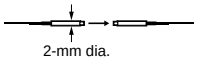
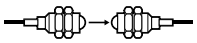
Note 1. Free-cut Indicates models that allow free cutting. Models without this mark do not allow free cutting.

2. The size of standard sensing object is the same as the fiber core diameter (lens diameter for models with lens).

3. The values for the minimum sensing object are representative values that indicate values obtained in standard mode with the sensing distance and sensitivity set to optimum values.

Long-distance Fiber Units

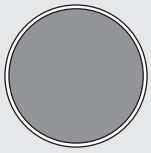
■ : High-resolution mode ■ : Standard mode ■ : Super-high-speed mode

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm) (Parentheses: With E39-F1 Lens Unit)	Standard object (min. sensing object) (Parentheses: Opaque object)	Model	Permissible bending radius
M4 Free-cut	 M4 screw	E3X-MDA	1,100 (2,600)*1 870 (2,000) 350 (840)	1.4-mm dia. (0.01-mm dia.)	E32-T11L	25 mm
3-mm dia. Free-cut	 3-mm dia.	E3X-MDA	1,100 870 350		E32-T12L	
M3 Free-cut	 M3 screw	E3X-MDA	340 260 100	0.9-mm dia. (0.005-mm dia.)	E32-T21L	10 mm
Free-cut 2-mm dia.; small diameter	 2-mm dia.	E3X-MDA	340 260 100		E32-T22L	
Free-cut M14; with lens; ideal for explosion-proof applications	 M14 screw	E3X-MDA	13,000 10,000 4,000	10-mm dia.	E32-T17L	25 mm

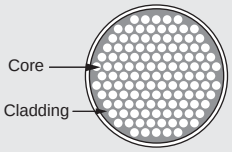
A Wide Range of Flexible Fibers for Easy Installation without Loss of Light Intensity

Flexible fiber models are indicated by an "R" at the end of the model number.
Flexible fiber contains multiple cores.
These cores are all surrounded by cladding, giving a minimum bending radius of 1 mm.

The fiber can be bent at right angles without affecting the light intensity. Handle it just like any other cable.

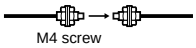
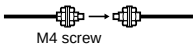
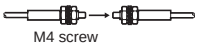
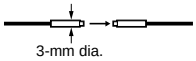
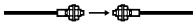
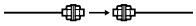
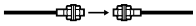


Conventional Fiber
Conventional fiber uses just one core and one cladding section. Bending the fiber may break it or reduce the light intensity.



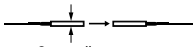
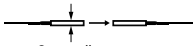
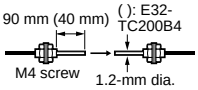
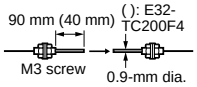
Flexible Fiber
Flexible fiber contains multiple independent cores all surrounded by cladding. The fiber can be bent without breaking or reducing the light intensity.

General-purpose Fiber Units

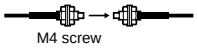
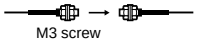
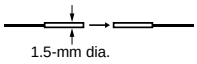
Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm) (Parentheses: With E39-F1 Lens Unit)	Standard object (min. sensing object) (Parentheses: Opaque object)	Model	Permissible bending radius
M4 (Free-cut)	 M4 screw	E3X-MDA	650 (4,000)* 500 (3,700) 200 (1,500)	1.0-mm dia. (0.005-mm dia.)	E32-TC200	25 mm
M4 (Free-cut)	 M4 screw	E3X-MDA	450 (3,100) 350 (2,400) 140 (970)		E32-T11R	1 mm
M4 (Free-cut) Fiber sheath material: fluororesin	 M4 screw	E3X-MDA	580 (3,000)* 450 (2,300) 180 (930)		E32-T11U NEW	4 mm
3-mm dia. (Free-cut)	 3-mm dia.	E3X-MDA	450 350 140		E32-T12R	1 mm
M3 (Free-cut) Possible to mount the E39-F5 Reflective Side-view Conversion Attachment	 M3 screw	E3X-MDA	580 450 180		E32-TC200A	25 mm
(Free-cut) M3; for detecting minute sensing objects	 M3 screw	E3X-MDA	170 130 50	0.5-mm dia. (0.005-mm dia.)	E32-TC200E	10 mm
M3 (Free-cut)	 M3 screw	E3X-MDA	100 75 30		E32-T21R	1 mm

***** The optical fiber is 2 m long on each side, so the sensing distance is 4,000 mm.

Fiber Units with Thin Heads

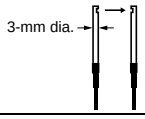
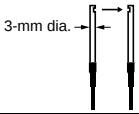
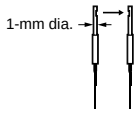
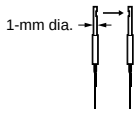
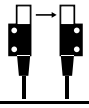
Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm) (Parentheses: With E39-F1 Lens Unit)	Standard object (min. sensing object) (Parentheses: Opaque object)	Model	Permissible bending radius
(Free-cut) 2-mm dia.; for detecting minute sensing objects	 2-mm dia.	E3X-MDA	170 130 50	0.5-mm dia. (0.005-mm dia.)	E32-T22	10 mm
(Free-cut) 2-mm dia.; for detecting minute sensing objects	 2-mm dia.	E3X-MDA	100 75 30		E32-T22R	1 mm
(Free-cut) 1.2-mm dia.; with sleeve	 90 mm (40 mm) ( ): E32-TC200B4 M4 screw 1.2-mm dia.	E3X-MDA	650 500 200	1.0-mm dia. (0.005-mm dia.)	E32-TC200B E32-TC200B4	25 mm
(Free-cut) 0.9-mm dia.; with sleeve	 90 mm (40 mm) ( ): E32-TC200F4 M3 screw 0.9-mm dia.	E3X-MDA	170 130 50	0.5-mm dia. (0.005-mm dia.)	E32-TC200F E32-TC200F4	10 mm

Flexible Fiber Units (Resists Breaking) (R4)

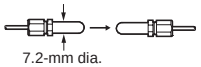
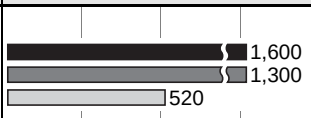
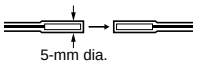
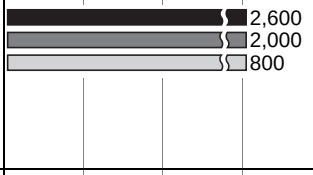
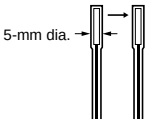
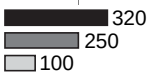
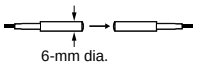
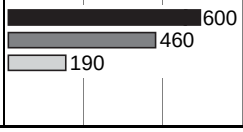
Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm) (Parentheses: With E39-F1 Lens Unit)	Standard object (min. sensing object) (Parentheses: Opaque object)	Model	Permissible bending radius
Free-cut Ideal for mounting on moving sections (R4)		E3X-MDA	580 (3,000) 450 (2,300) 180 (930)	1.0-mm dia. (0.005-mm dia.)	E32-T11	4 mm
		E3X-MDA	150 110 45	0.5-mm dia. (0.005-mm dia.)	E32-T21	
		E3X-MDA	150 110 45		E32-T22B	

***** The optical fiber is 2 m long on each side, so the sensing distance is 4,000 mm.

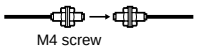
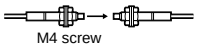
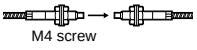
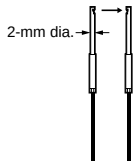
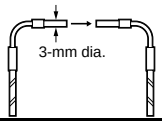
Side-view Fiber Units

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm) (Parentheses: With E39-F1 Lens Unit)	Standard object (min. sensing object) (Parentheses: Opaque object)	Model	Permissible bending radius
Free-cut Long distance; space-saving		E3X-MDA	390 300 120	1.0-mm dia. (0.005-mm dia.)	E32-T14L	25 mm
Free-cut Space-saving		E3X-MDA	170 130 50		E32-T14LR	1 mm
Free-cut Suitable for detecting minute sensing objects; small diameter		E3X-MDA	100 70 30	0.5-mm dia. (0.005-mm dia.)	E32-T24	10 mm
Free-cut Suitable for detecting minute sensing objects; small diameter		E3X-MDA	35 27 10		E32-T24R	1 mm
Free-cut Screw-mounting type		E3X-MDA	2,900 2,200 900	4-mm dia. (0.1-mm dia.)	E32-T14	25 mm

Chemical-resistant Fiber Units

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm) (Parentheses: With E39-F1 Lens Unit)	Standard object (min. sensing object) (Parentheses: Opaque object)	Model	Permissible bending radius
Free-cut Fluororesin-covered; round head that resists water drops		E3X-MDA		4-mm dia. (0.1-mm dia.)	E32-T11F *NEW*	4 mm
Free-cut Fluororesin-covered; withstands chemicals and harsh environments (operating ambient temperature: –30°C to 70°C)		E3X-MDA		4-mm dia. (0.1-mm dia.)	E32-T12F	40 mm
Free-cut Fluororesin-covered; withstands chemicals and harsh environments; side-view (operating ambient temperature: –30°C to 70°C)		E3X-MDA		3-mm dia. (0.1-mm dia.)	E32-T14F	
Fluororesin; withstands chemicals and harsh environments (operating ambient temperature: –40°C to 200°C)		E3X-MDA		1.0-mm dia. (0.005-mm dia.)	E32-T81F-S *NEW*	10 mm

Heat-resistant Fiber Units

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm) (Parentheses: With E39-F1 Lens Unit)	Standard object (min. sensing object) (Parentheses: Opaque object)	Model	Permissible bending radius
Free-cut Resists 150°C*1; fiber sheath material: fluororesin (operating ambient temperature: –40°C to 150°C)		E3X-MDA	650 500 200	1.5-mm dia. (0.1-mm dia.)	E32-T51	35 mm
Resists 200°C; flexible (R10); fiber sheath material: fluororesin (operating ambient temperature: –40°C to 200°C)		E3X-MDA	230 (1,700) 180 (1,300) 70 (520)	1.0-mm dia. (0.005-mm dia.)	E32-T81R-S *NEW*	10 mm
Resists 350°C*2, with spiral tube; high mechanical strength; fiber sheath material: stainless steel (operating ambient temperature: –60°C to 350°C)		E3X-MDA	390 (3,000) 300 (2,200) 120 (900)		E32-T61-S *NEW*	25 mm
Free-cut Side-view; resists 150°C*1; suitable for detecting minute sensing objects; fiber sheath material: fluororesin (operating ambient temperature: –40°C to 150°C)		E3X-MDA	190 150 60		E32-T54	35 mm
Resists 200°C*2; L-shaped; fiber sheath material: stainless steel		E3X-MDA	1,100 870 350	1.7-mm dia. (0.1-mm dia.)	E32-T84S-S *NEW*	25 mm

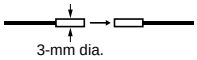
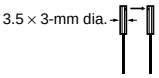
***1:** For continuous operation, use the products within a temperature range of –40°C to 130°C.

***2:** Indicates the heat-resistant temperature at the fiber tip.

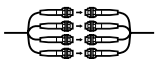
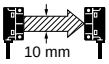
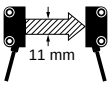
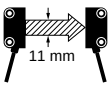
Fiber Unit with Slot Sensor

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm) (Parentheses: With E39-F1 Lens Unit)	Standard object (min. sensing object) (Parentheses: Opaque object)	Model	Permissible bending radius
Free-cut Suitable for film sheet detection; no optical axis adjustment required; easy to mount		E3X-MDA	10 10 10	4-mm dia. (0.1-mm dia.)	E32-G14	25 mm

Fiber Units with a Narrow Vision Field

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm) (Parentheses: With E39-F1 Lens Unit)	Standard object (min. sensing object) (Parentheses: Opaque object)	Model	Permissible bending radius
Free-cut Suitable for detecting wafers		E3X-MDA	1,600 1,250 500	1.7-mm dia. (0.1-mm dia.)	E32-T22S	25 mm
Free-cut Side-view; suitable for detecting wafers		E3X-MDA	1,100 870 350	2-mm dia. (0.1-mm dia.)	E32-T24S	10 mm

Area-sensing Fiber Units

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm) (Parentheses: With E39-F1 Lens Unit)	Standard object (min. sensing object) (Parentheses: Opaque object)	Model	Permissible bending radius
Multi-point detection (4-head)		E3X-MDA	470 360 140	2-mm dia. (0.1-mm dia.)	E32-M21	25 mm
Free-cut Detects in a 30-mm area		E3X-MDA	1,400 1,100 450	(0.3-mm dia.)*1	E32-T16W	10 mm
		E3X-MDA	1,100 860 340		E32-T16WR	1 mm
Free-cut Side-view; suitable for applications with limited spatial depth		E3X-MDA	800 650 260	(0.2-mm dia.)*1	E32-T16J	10 mm
		E3X-MDA	600 480 190		E32-T16JR	1 mm
Free-cut Suitable for detecting over a 10-mm area; long distance		E3X-MDA	2,400 1,800 740	(0.6-mm dia.)*2	E32-T16	25 mm
Free-cut Stable for detecting minute sensing objects in a wide area		E3X-MDA	970 750 300	(0.2-mm dia.)*1	E32-T16P	10 mm
		E3X-MDA	730 560 220		E32-T16PR	1 mm

***1:** These figures are for a sensing distance of 300 mm. (Figures for the diameter of sensing objects are in the still state.)

***2:** These figures are ones for which detection is possible in each sensing area at a digital incident level of 1,000. (Figures for the diameter of sensing objects are in the still state.)

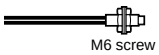
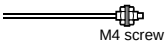
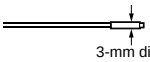
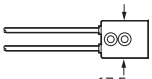
■ Fiber Units with Reflective Sensors

Note 1. (Free-cut) Indicates models that allow free cutting. Models without this mark do not allow free cutting.

2. The values for the minimum sensing object are representative values that indicate values obtained in standard mode with the sensing distance and sensitivity set to optimum values.

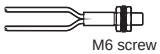
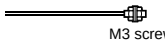
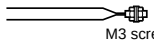
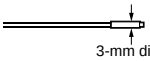
3. When set to the maximum sensitivity setting, internal light reflection may cause the sensor to detect incident light. In such case, use adjust the threshold either manually or using teaching.

Long-distance Fiber Units

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)*	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
M6 (Free-cut)	 M6 screw	E3X-MDA	400 270 110	500×500 (0.005-mm dia.)	E32-D11L	25 mm
(Free-cut) 3-mm dia.; small diameter	 3-mm dia.	E3X-MDA	230 160 70	300×300 (0.005-mm dia.)	E32-D12	
M4 (Free-cut)	 M4 screw	E3X-MDA	130 85 35	200×200 (0.005-mm dia.)	E32-D21L	10 mm
(Free-cut) 3-mm dia.; small diameter	 3-mm dia.	E3X-MDA	130 85 35		E32-D22L	
(Free-cut) Square head, super-long distance	 17.5 mm	E3X-MDA	40 to 600 40 to 490 40 to 240	300×300	E32-D16 *NEW*	4 mm

***** Values are sensed for white paper (standard sensing object).

General-purpose Fiber Units

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)*	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
M6 (Free-cut)	 M6 Screw	E3X-MDA	300 210 90	400×400 (0.005-mm dia.)	E32-DC200	25 mm
M6 (Free-cut)	 M6 screw	E3X-MDA	300 170 50	300×300 (0.005-mm dia.)	E32-D11R	1 mm
M6 (Free-cut) Fiber sheath material: fluororesin	 M6 screw	E3X-MDA	170 125 50		E32-D11U *NEW*	4 mm
3-mm dia. (Free-cut)	 3-mm dia.	E3X-MDA	170 120 50		E32-D12R	1 mm
(Free-cut) M3; small diameter	 M3 screw	E3X-MDA	80 55 22	100×100 (0.005-mm dia.)	E32-DC200E	10 mm
(Free-cut) M3; small diameter	 M3 screw	E3X-MDA	30 22 8	50×50 (0.005-mm dia.)	E32-D21R	1 mm
(Free-cut) 3-mm dia.; small diameter	 3-mm dia.	E3X-MDA	30 22 8		E32-D22R	

***** Values are sensed for white paper (standard sensing object).

Fiber Units with Thin Heads

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)*	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
Free-cut 2.5-mm dia.; with sleeve	( ): E32-DC200B4 90 mm (40 mm) M6 screw 2.5-mm dia.	E3X-MDA	300 210 90	400×400 (0.005-mm dia.)	E32-DC200B E32-DC200B4	25 mm
Free-cut 1.2-mm dia.; with sleeve	( ): E32-DC200F4 90 mm (40 mm) M3 screw 1.2-mm dia.	E3X-MDA	80 55 22	100×100 (0.005-mm dia.)	E32-DC200F E32-DC200F4	10 mm
Free-cut 0.8-mm dia.; for detecting minute sensing objects	3-mm dia. 0.8-mm dia.	E3X-MDA	16 10 4	25×25 (0.005-mm dia.)	E32-D33	4 mm
0.5-mm dia.; for detecting very minute sensing objects	2-mm dia. 0.5-mm dia.	E3X-MDA	3 2 0.8		E32-D331	

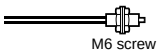
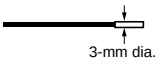
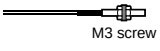
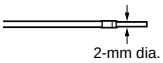
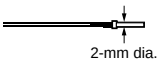
***** Values are sensed for white paper (standard sensing object).

Flexible Fiber Units (Resists Breaking) (R4)

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)*	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
Ideal for mounting on moving sections (R4) Free-cut	M6 screw	E3X-MDA	170 125 50	300×300 (0.005-mm dia.)	E32-D11	4 mm
Free-cut	M3 screw	E3X-MDA	30 22 8	50×50 (0.005-mm dia.)	E32-D21	
Free-cut	M4 screw	E3X-MDA	70 50 20	100×100 (0.005-mm dia.)	E32-D21B	
	1.5-mm dia.	E3X-MDA	30 22 8	50×50 (0.005-mm dia.)	E32-D22B	

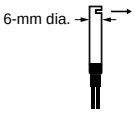
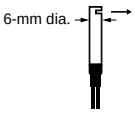
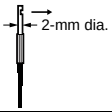
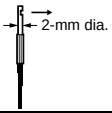
***** Values are sensed for white paper (standard sensing object).

Coaxial Fiber Units

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)*	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
Free-cut M6 coaxial; high-precision positioning		E3X-MDA	300 210 90	500×500 (0.005-mm dia.)	E32-CC200	25 mm
Free-cut 3-mm dia.; small diameter; coaxial; high-precision positioning		E3X-MDA	150 100 45	300×300 (0.005-mm dia.)	E32-D32L	
Free-cut M3 coaxial; high-precision positioning		E3X-MDA	75 50 22	100×100 (0.005-mm dia.)	E32-C31	
M3 coaxial; high-precision positioning		E3X-MDA	35 22 8	50×50 (0.005-mm dia.)	E32-C41	
2-mm dia. coaxial; high-precision positioning		E3X-MDA	35 22 8		E32-C42	
Free-cut 2-mm dia. coaxial; high-precision positioning		E3X-MDA	75 52 22	100×100 (0.005-mm dia.)	E32-D32	

***** Values are sensed for white paper (standard sensing object).

Side-view Fiber Units

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)*	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
Free-cut 6-mm dia.; long distance		E3X-MDA	110 80 36	200×200 (0.005-mm dia.)	E32-D14L	25 mm
6-mm dia. Free-cut		E3X-MDA	45 33 14	100×100 (0.005-mm dia.)	E32-D14LR	1 mm
Free-cut 2-mm dia.; small diameter; space-saving		E3X-MDA	30 22 8	50×50 (0.005-mm dia.)	E32-D24	10 mm
		E3X-MDA	15 10 4		E32-D24R	1 mm

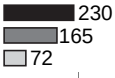
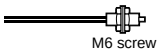
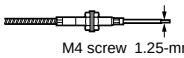
***** Values are sensed for white paper (standard sensing object).

Chemical-resistant Fiber Units

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)*	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
Free-cut Fluororesin-covered; withstands chemicals and harsh environments (operating ambient temperature: −30°C to 70°C		E3X-MDA	95 70 30	200×200 (0.005-mm dia.)	E32-D12F	40 mm

***** Values are sensed for white paper (standard sensing object).

Heat-resistant Fiber Units

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)*1	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
Free-cut Resists 150°C*2; fiber sheath material: fluororesin (operating ambient temperature: −40°C to 150°C)		E3X-MDA		200×200 (0.005-mm dia.)	E32-D51	35 mm
Resists 200°C*3; fiber sheath material: fluororesin (operating ambient temperature: −40°C to 200°C)		E3X-MDA			E32-D81R-S *NEW*	10 mm
Resists 350°C*3; fiber sheath material: stainless steel (operating ambient temperature: −60°C to 350°C)		E3X-MDA			E32-D61-S *NEW*	25 mm
Resists 400°C*3; fiber sheath material: stainless steel (operating ambient temperature: −40°C to 400°C)		E3X-MDA		100×100 (0.005-mm dia.)	E32-D73-S *NEW*	

***1:** Values are sensed for white paper (standard sensing object).

***2:** For continuous operation, use the products within a temperature range of −40°C to 130°C.

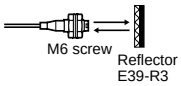
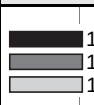
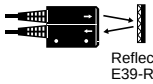
***3:** Indicates the heat-resistant temperature at the fiber tip.

Area-sensing Fiber Units

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)*	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
Free-cut Side-view; detection over wide areas		E3X-MDA		300×300 (0.005-mm dia.)	E32-D36P1	25 mm

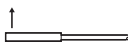
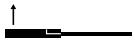
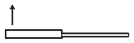
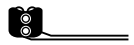
***** Values are sensed for white paper (standard sensing object).

Retroreflective Fiber Units

Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)*	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
Free-cut Transparent object detection		E3X-MDA		35-mm dia. (0.1-mm dia.)	E32-R21 + E39-R3 (Attachment)	10 mm
Free-cut Transparent object detection (operating ambient temperature: −25°C to 55°C); degree of protection: IEC60529 IP66		E3X-MDA		35-mm dia. (0.2-mm dia.)	E32-R16 + E39-R1 (Attachment)	25 mm

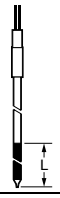
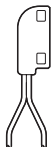
***** Values are sensed for white paper (standard sensing object).

Limited-reflective Fiber Units

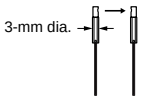
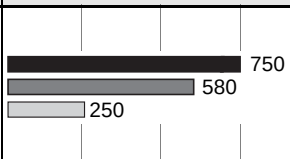
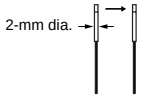
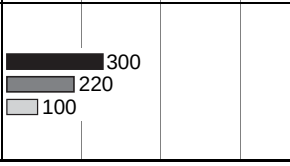
Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)*	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
Free-cut Suitable for positioning liquid crystal glass		E3X-MDA	0 to 15 0 to 15 0 to 15	100×100 Soda glass with reflection factor of 7%	E32-L16 NEW	25 mm
Free-cut Suitable for positioning liquid crystal glass		E3X-MDA	4 to 12 4 to 12 4 to 12		E32-L56E1 E32-L56E2	35 mm
Suitable for positioning liquid crystal glass (Resists 300°C)		E3X-MDA	5 to 18 5 to 18 5 to 18		E32-L66 NEW	25 mm
Free-cut Liquid crystal glass, mounting detection, small		E3X-MDA	0 to 4 0 to 4 0 to 4	25×25 (0.005-mm dia.)	E32-L24S NEW	10 mm
Free-cut Detects wafers and small differences in height; (operating ambient temperature: −40°C to 105°C); degree of protection: IEC60529 IP50		E3X-MDA	4±2 4±2 4±2		E32-L24L	10 mm
		E3X-MDA	7.2±1.8 7.2±1.8 7.2±1.8		E32-L25L	
Free-cut Detects wafers and small differences in height; degree of protection: IEC60529 IP50		E3X-MDA	3.3 3.3 3.3		E32-L25	25 mm
		E3X-MDA	3.3 3.3 3.3		E32-L25A	

***** Values are sensed for white paper (standard sensing object).

Fluid-level Detection Fiber Units

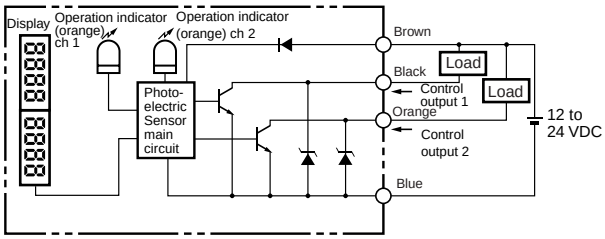
Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
Fluid contact type: unbendable section L 150 mm, 350 mm (two types); (operating ambient temperature: –40°C to 200°C)		E3X-MDA	---	Pure water at 25°C	E32-D82F1 E32-D82F2	40 mm
Free-cut Tube-mounting type; Light ON when fluid is present; minimal influence from bubbles and water drops		E3X-MDA	Applicable tube: Transparent tube Tube diameter: 3.2, 6.4, or 9.5 mm (Tube must be FEP or material with equivalent transparency; recommended wall thickness: 1 mm)		E32-A01	4 mm
Free-cut Tube-mounting type; light ON when fluid is present; minimal influence from bubbles and water drops		E3X-MDA	Applicable tube: Transparent tube Tube diameter: 6 to 13 mm (Tube must be FEP or material with equivalent transparency; recommended wall thickness: 1 mm)		E32-A02	
Free-cut Tube-mounting type; dense mounting to detect level differences of 4 mm		E3X-MDA	Applicable tube: Transparent tube Tube diameter: 8 to 10 mm (Tube must be FEP or material with equivalent transparency; recommended wall thickness: 1 mm)		E32-L25T	10 mm
Free-cut Tube-mounting type; unlimited tube diameter; minimal influence from bubbles and water drops		E3X-MDA	Applicable tube: Transparent tube Tube diameter: No restriction (Tube must be FEP or material with equivalent transparency)		E32-D36F	4 mm

Mapping Sensors (Through-beam)

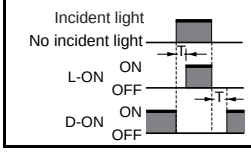
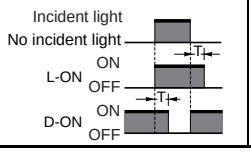
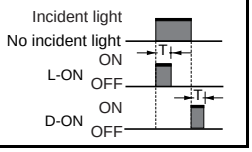
Features	Appearance	Applicable Amplifier Unit	Sensing distance (mm)	Standard object (min. sensing object: Gold wire)	Model	Permissible bending radius
Free-cut Super-narrow vision field; side-view; opening angle: 1.5°; simple adjustment		E3X-MDA		2-mm dia. (0.1-mm dia.)	E32-A03	1 mm
Free-cut Super-narrow vision field; small; side-view; opening angle: 3°; simple adjustment		E3X-MDA		1.2-mm dia. (0.1-mm dia.)	E32-A04	10 mm

Output Circuits

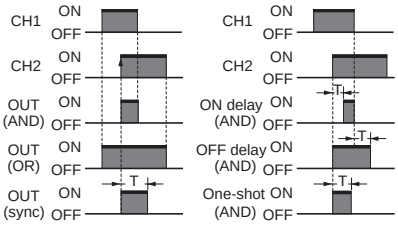
NPN Output

Model	Mode selector	Timing chart	Mode selector	Output circuit
E3X-MDA11 E3X-MDA6	LIGHT ON (L/ON)	CH1/CH2: Incident light / No incident light Operation indicator (orange): ON / OFF Output transistor: ON / OFF Load (relay): Operate / Release (Between brown and black)	Light ON	
	DARK ON (D/ON)	CH1/CH2: Incident light / No incident light Operation indicator (orange): ON / OFF Output transistor: ON / OFF Load (relay): Operate / Release (Between brown and black)	Dark ON	

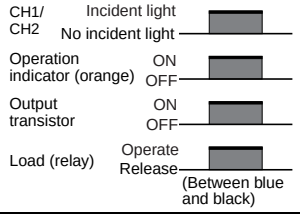
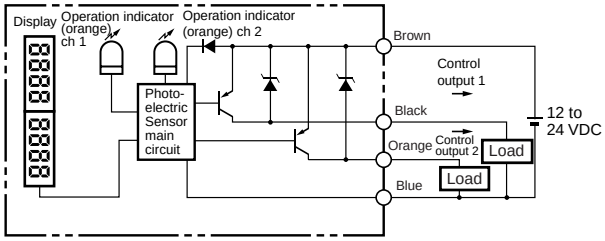
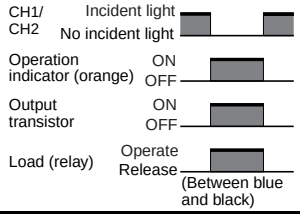
Note 1. Time Charts for Timer Settings (T: Set Time)

ON delay	OFF delay	One-shot
		

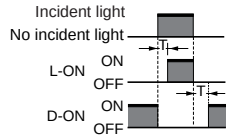
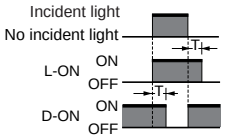
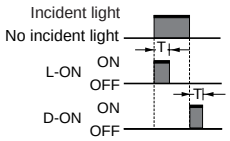
2. Control Output (AND, OR, Sync) and Time Chart for Timer Settings (T: Set Time)



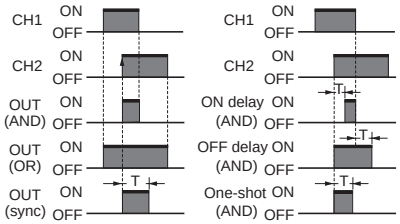
PNP Output

Model	Mode selector	Timing chart	State of output transistor	Output circuit
E3XMDA41 E3X-MDA8	LIGHT ON (L/ON)		Light ON	
	DARK ON (D/ON)		Dark ON	

Note 1. Time Charts for Timer Settings (T: Set Time)

ON delay	OFF delay	One-shot
		

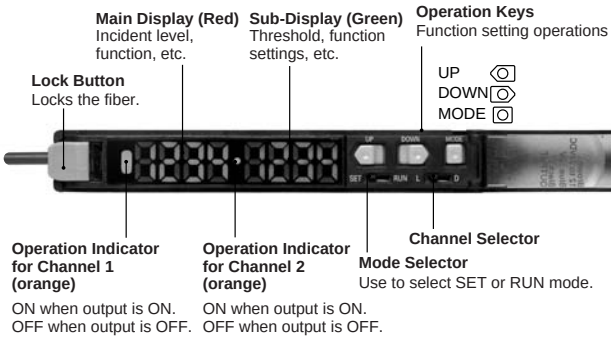
2. Control Output (AND, OR, Sync) and Time Chart for Timer Settings (T: Set Time)



Nomenclature

■ Amplifier Units

E3X-MDA□



Adjustment Methods

1. Setting the Operation Mode

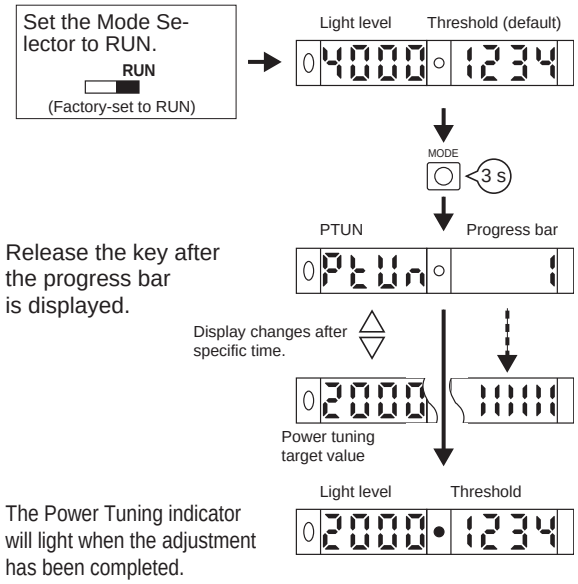
The operation mode is set in SET mode. Refer to *5. Setting Functions in SET Mode* on page 21.

Set the Channel Selector to the desired channel before making any adjustments or settings. This is true for all adjustments and settings.

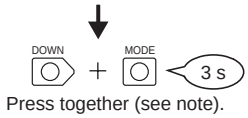
2. Adjusting the Power (RUN Mode)

The current incident light level can be adjusted to near the power tuning target value (default: 2,000).

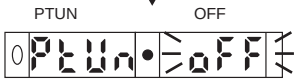
Confirm that the MODE key setting is PTUN (power tuning). The default setting is PTUN. Refer to *5. Setting Functions in SET Mode* on page 21.



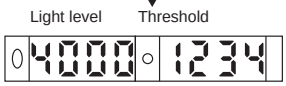
To restore the default power settings:



"OFF" will flash twice.



The Power Tuning indicator will go out when the default setting has been restored.



*** Setting Errors**

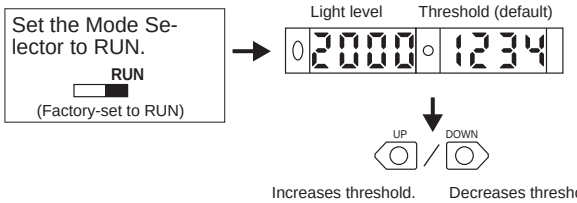
An error has occurred if one of the following displays appears after the progress bar is displayed.

Display	Error	Action
Flashes twice PtUn ouEr PTUN OVER	**Over Error** The incident light level is too low for the power tuning target value.	The power will not be tuned. The power can be increased up to approximately 5 times the incident light value.
Flashes twice PtUn botn PTUN BOTM	**Bottom Error** The incident light level is too high for the power tuning target value.	The power will be tuned to the minimum level. The power can be decreased down to approximately 1/25th the incident light value.

Note: Press the DOWN key right after pressing the MODE key.

3. Setting Thresholds Manually (RUN Mode)

A threshold can be set manually. A threshold value can also be fine-tuned using manual setting after teaching.



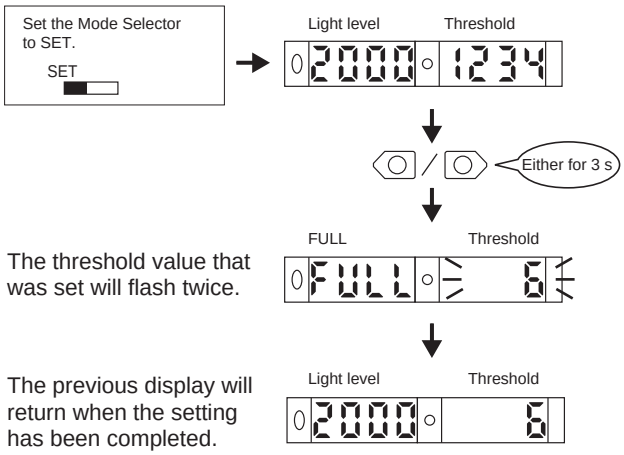
***** Even if the display method for display switching is changed, the threshold will appear on the sub-display when the key is pressed.

4. Teaching the Threshold Value (SET Mode)

* There are four methods that can be used for teaching, as described below. Use the method most suitable for the application.
* An error has occurred if OVER, LO, or NEAR is displayed on the sub-display. Repeat the operation from the beginning.

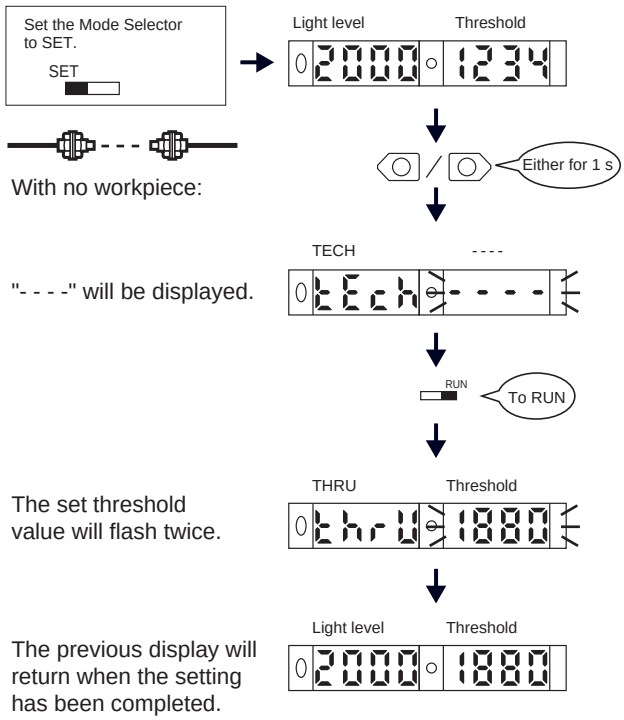
4-1. Setting the Threshold at Maximum Sensitivity

The threshold can be set at the maximum sensitivity. This method is ideal when using a Through-beam Fiber Unit to detect workpieces so that detection is not influenced to any great degree by dust and other environmental factors.



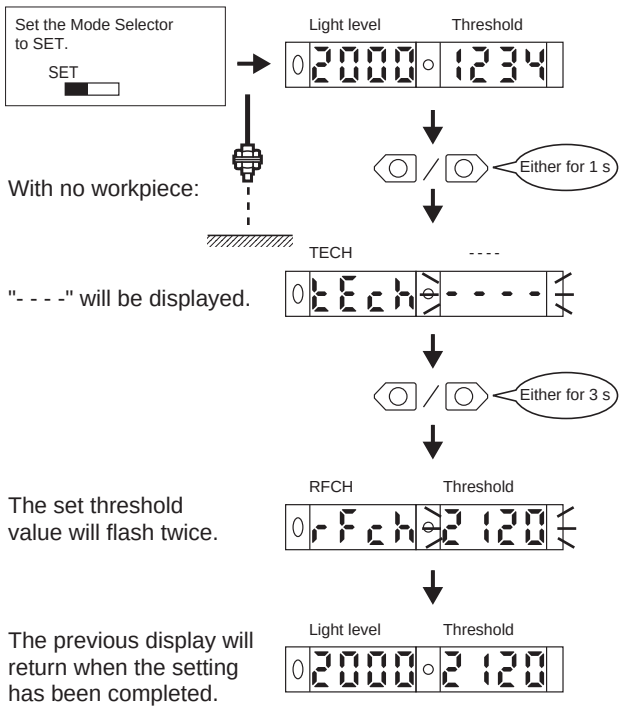
4-2. Teaching a Through-beam Fiber Unit without a Workpiece

A value about 6% less than the incident light level can be set as the threshold value. This method is ideal when detecting very small differences in light level, such as when detecting very fine workpieces or transparent workpieces like transparent fibers.



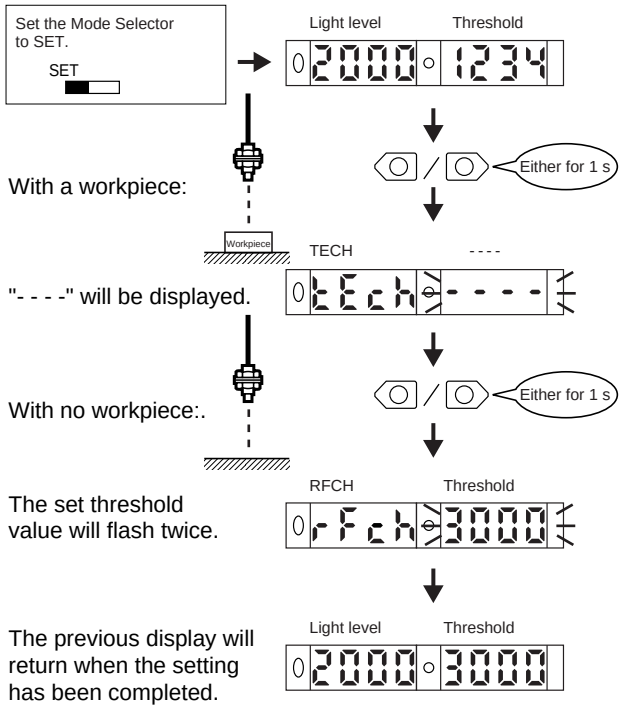
4-3. Teaching a Reflective Fiber Unit without a Workpiece

A value about 6% greater than the incident light level can be set as the threshold value. This method is ideal when using a Reflective Fiber Unit to detect workpieces so that detection is not influenced to any great degree by dust and other environmental factors.



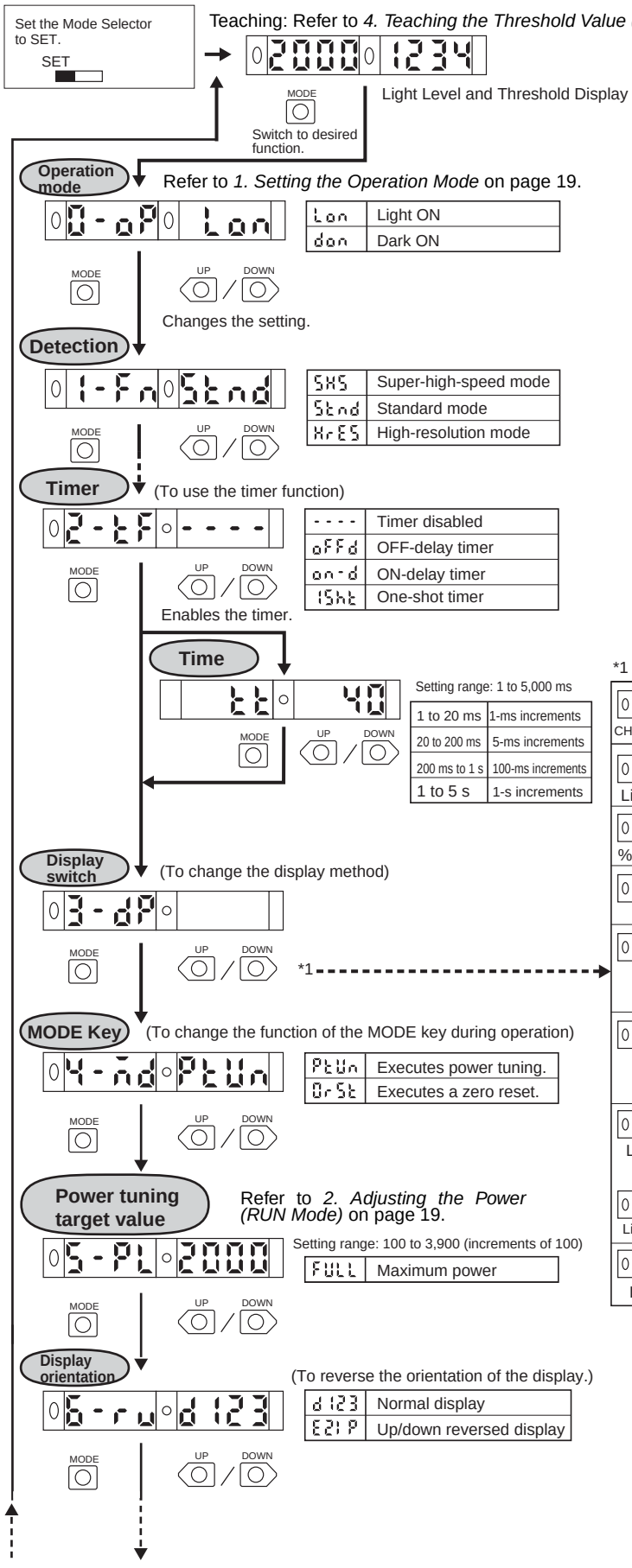
4-4. Teaching With and Without a Workpiece

Teaching can be performed twice, once with and once without a workpiece, and the value between the two measured value can be set as the threshold.



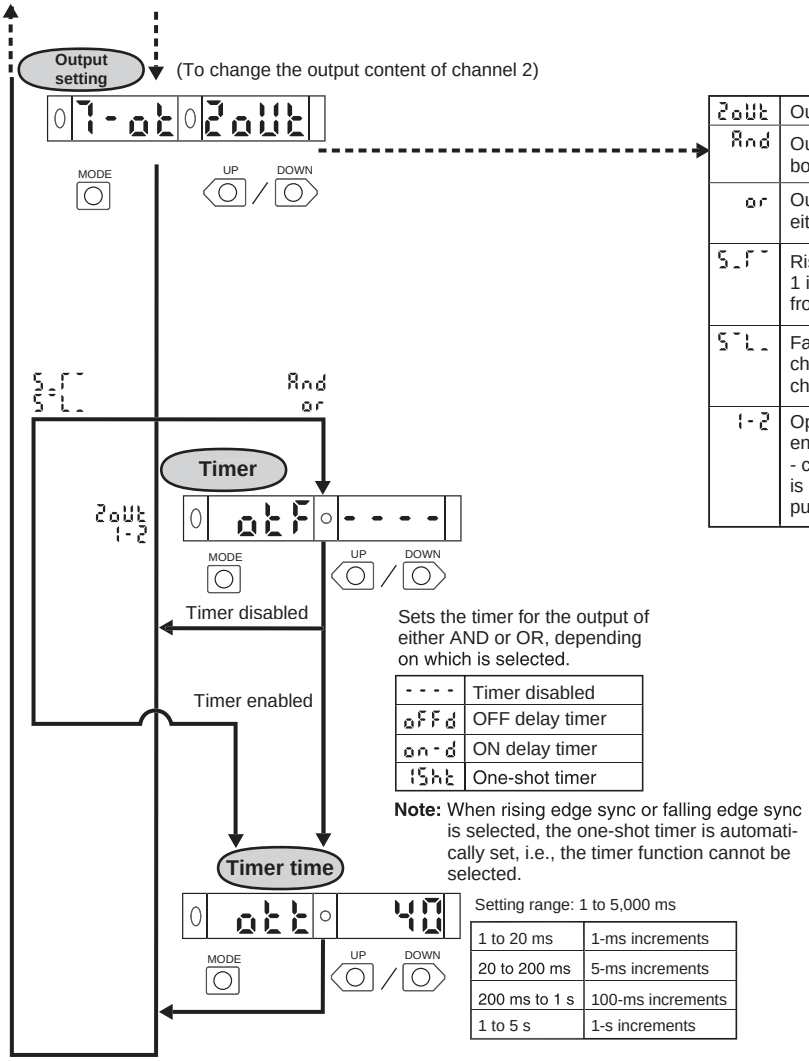
5. Setting Functions in SET Mode

***** The default settings are shown in the transition boxes between functions.



*1 The display will be switched as shown below.

3112 3112 CH1 light level CH2 light level	Light levels for channels 1 and 2
3112 2000 Light level Threshold	The incident light level and the threshold value.
P123 2000 % light level Threshold	The incident light level as a percentage of the threshold value and the threshold value.
L-PE d-bt L-PE D-BT	The incident light peak level and no incident light bottom level. (Refreshed when output turns ON or OFF.)
L-bt d-PE L-BT D-PE	The min. incident light peak level and max. incident light bottom level, showing min. width of light level change. (Refreshed when output turns ON/OFF ten times.)
0 1111111 Detection status	Analog bar display. The current detection status is displayed as an analog bar. The bar will lengthen from the right as ON status is reached. (ON: Red; OFF: Green)
3112 PEAK Light level PEAK ▲ Fixed interval ▼ 3112 3800 Light level Peak light level	The current incident light level and the peak incident light level.
3112 2ch Light level Channel	The incident light level and the channel.



2out	Output for each channel
And	Output when the output is ON for both channels 1 and 2.
or	Output when the output is ON for either channel 1 or channel 2.
S_r	Rising edge sync. Output if channel 1 is ON when channel 2 changes from OFF to ON.
S_L	Falling edge sync. Output if channel 1 is ON when channel 2 changes from ON to OFF.
1-2	Operates according to the difference between channels (channel 1 - channel 2). The difference value is used for both threshold and output judgement execution.

Sets the timer for the output of either AND or OR, depending on which is selected.

----	Timer disabled
oFFd	OFF delay timer
on-d	ON delay timer
1Sht	One-shot timer

Note: When rising edge sync or falling edge sync is selected, the one-shot timer is automatically set, i.e., the timer function cannot be selected.

Setting range: 1 to 5,000 ms

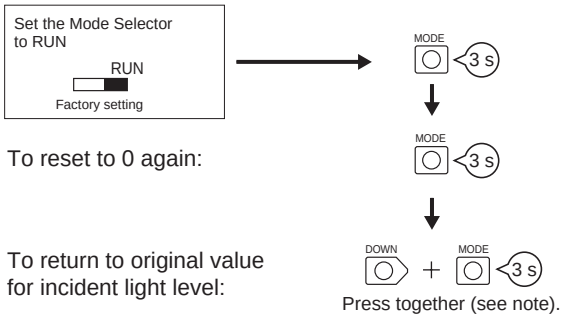
1 to 20 ms	1-ms increments
20 to 200 ms	5-ms increments
200 ms to 1 s	100-ms increments
1 to 5 s	1-s increments

6. Convenient Functions

6-1. Zeroing the Digital Display

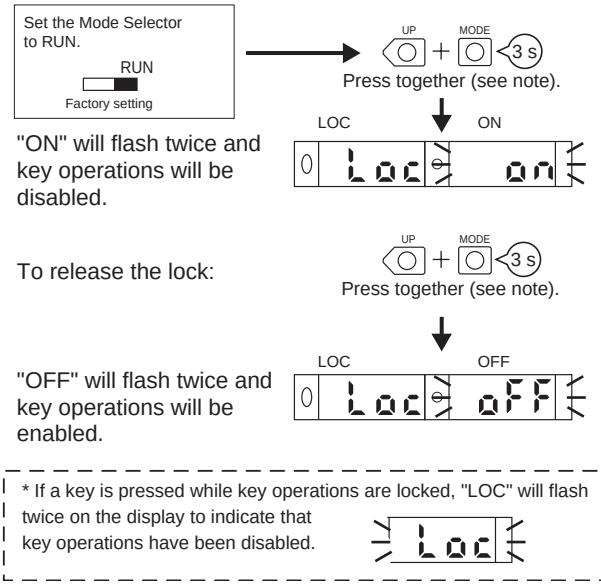
The incident light level on the digital display can be set to 0.

* Change the function to ᴅ-5ᴇ (zero reset) with the MODE key. The default setting is PTUN.



6-2. Locking the Keys

All key operations can be disabled.

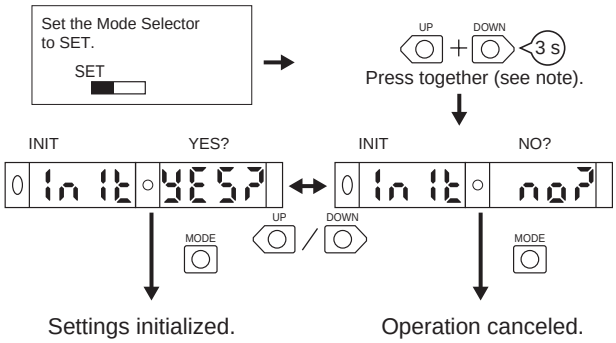


* If a key is pressed while key operations are locked, "LOC" will flash twice on the display to indicate that key operations have been disabled.

Note: Press the DOWN or UP key right after pressing the MODE key.

6-3. Initializing Settings

All settings can be returned to their original default settings.



Safety Precautions

Note: In addition to the following precautions, please read and observe the common precautions for the instructions included with the product.

■ Precautions for Correct Use

Amplifier Unit

Installation

● Operation after Turning Power ON

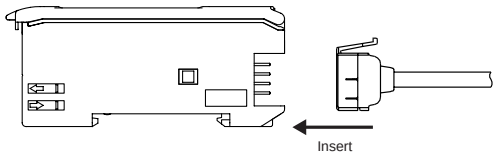
The Amplifier Unit is ready to operate within 200 ms after the power supply is turned ON. If the Sensor and load are connected to power supplies separately, be sure to turn ON the power supply to the Sensor first.

Mounting

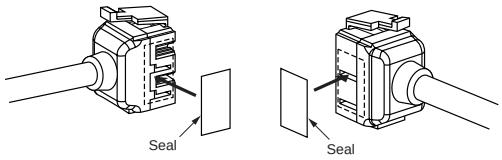
● Connecting and Disconnecting Connectors

Mounting Connectors

1. Insert the Master or Slave Connector into the Amplifier Unit until it clicks into place.



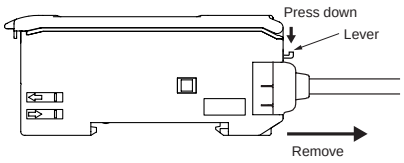
2. Attach the protector seals (provided as accessories) to the sides of master and slave connectors that are not connected.



Note: Attach the seals to the sides with grooves

Removing Connectors

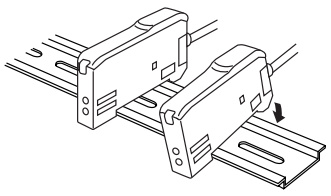
1. Slide the slave Amplifier Unit(s) for which the Connector is to be removed away from the rest of the group.
2. After the Amplifier Unit(s) has been separated, press down on the lever on the Connector and remove it. (Do not attempt to remove Connectors without separating them from other Amplifier Units first.)



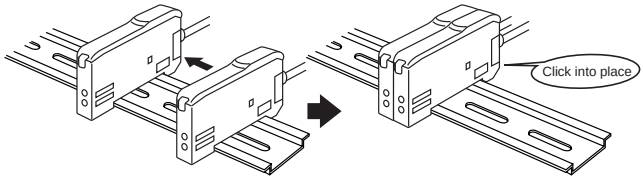
● Joining and Removing Amplifier Units

Joining Amplifier Units

1. Mount the Amplifier Units one at a time onto the DIN track.



2. Slide the Amplifier Units together, line up the clips, and press the Amplifier Units together until they click into place.



Separating Amplifier Units

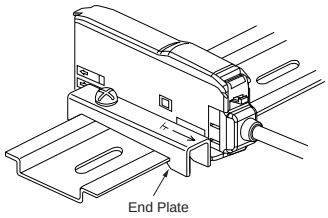
Slide Amplifier Units away from each other, and remove from the DIN track one at a time. (Do not attempt to remove Amplifier Units from the DIN track without separating them first.)

Note 1. The specifications for ambient temperature will vary according to the number of Amplifier Units used together. For details, refer to *Ratings/Characteristics*.

2. Always turn OFF the power supply before joining or separating Amplifier Units.

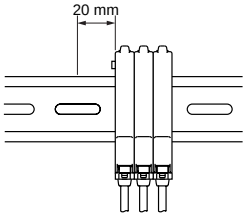
● Mounting the End Plate (PFP-M)

An End Plate should be used if there is a possibility of the Amplifier Unit moving, e.g., due to vibration. If a Mobile Console is going to be mounted, connect the End Plate in the direction shown in the following diagram.



● Mounting the Mobile Console Head

Leave a gap of at least 20 mm between the nearest Amplifier Unit and the Mobile Console head.

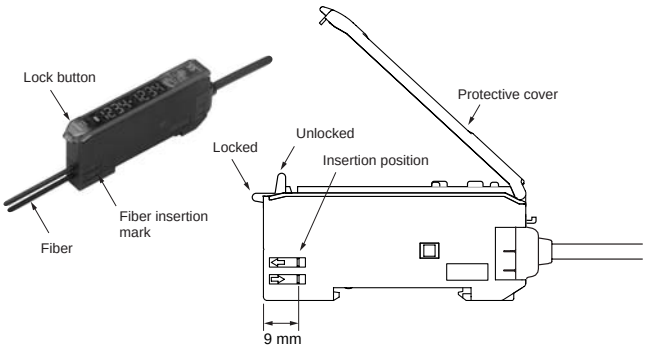


● Fiber Connection

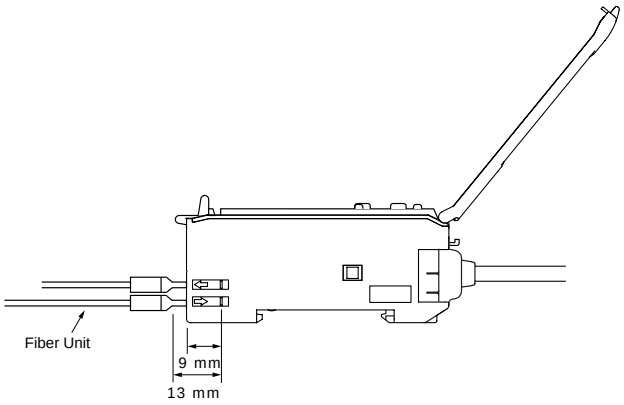
The E3X Amplifier Unit has a lock button for easy connection of the Fiber Unit. Connect or disconnect the fibers using the following procedures:

1. Connection

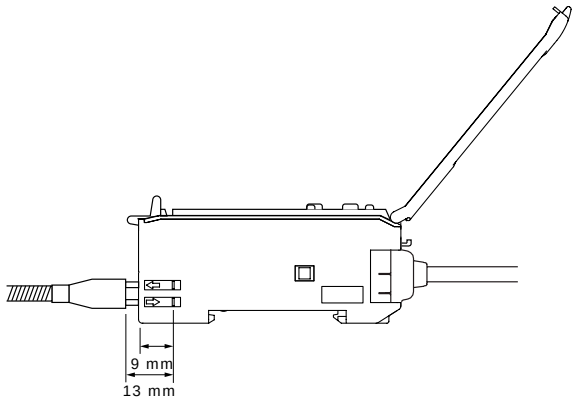
Open the protective cover, insert the fibers according to the fiber insertion marks on the side of the Amplifier Unit, and lower the lock button.



Fibers with E39-F9 Attachment

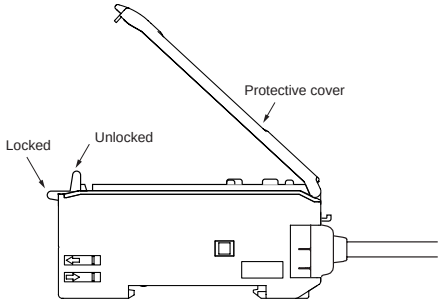


Fibers That Cannot Be Free-Cut (with Sleeves)



2. Disconnecting Fibers

Remove the protective cover and raise the lock button to pull out the fibers.



Note 1. To maintain the fiber properties, confirm that the lock is released before removing the fibers.

2. Be sure to lock or unlock the lock button within an ambient temperature range between –10°C and 40°C.

Adjustments

● Mutual Interference Protection Function

There may be some instability in the digital display values due to light from other sensors. If this occurs, decrease the sensitivity (i.e., decrease the power or increase the threshold) to perform stable detection.

● EEPROM Writing Error

If the data is not written to the EEPROM correctly due to a power failure or static-electric noise, initialize the settings with the keys on the Amplifier Unit. ERR/EEP will flash on the display when a writing error has occurred.

● Optical Communications

Several Amplifier Units can be slid together and used in groups. Do not, however, slide the Amplifier Units or attempt to remove any of the Amplifier Units during operation.

Other Precautions

● Protective Cover

Always keep the protective cover in place when using the Amplifier Unit.

● Mobile Console

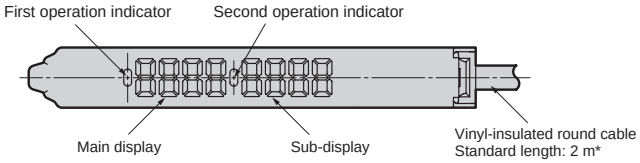
Use the E3X-MC11-S Mobile Console for the E3X-DA-S-series and the E3X-MDA series Amplifier Units. Other Mobile Consoles, such as the E3X-MC11, cannot be used.

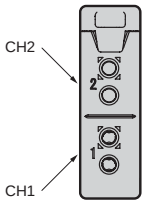
Dimensions

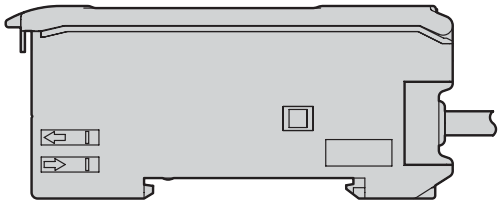
■ Amplifier Units

Amplifier Units with Cables

E3X-MDA11
E3X-MDA41



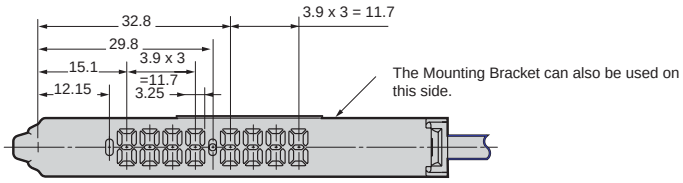


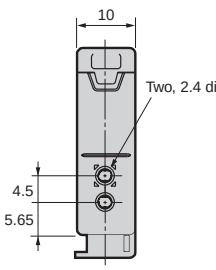


*Cable Specifications

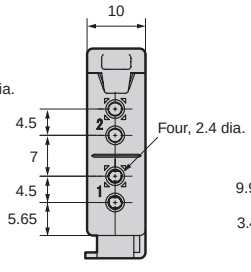
E3X-MDA11 MDA41	A 4-dia., 2-conductor (conductor cross-sectional area: 0.2 mm^2; insulation diameter: 1.1 mm)

With Mounting Bracket Attached

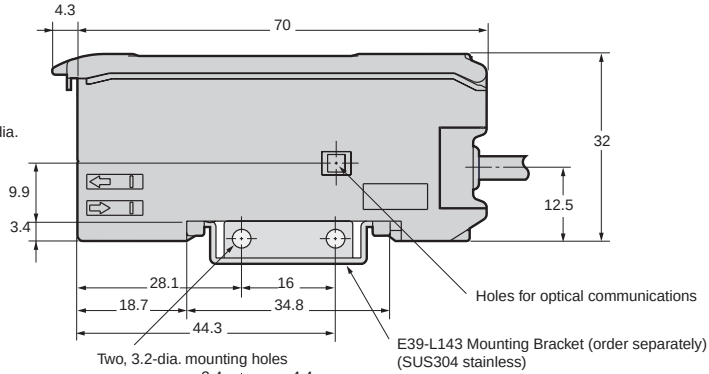


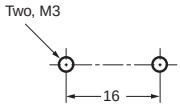


E3X-DA□-S

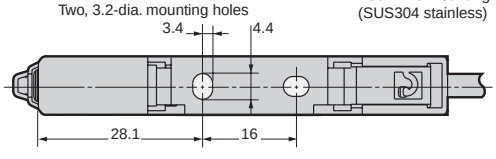


E3X-MDA□



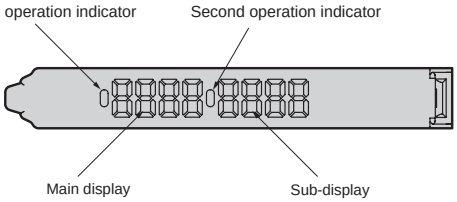


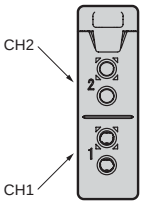
Mounting Holes

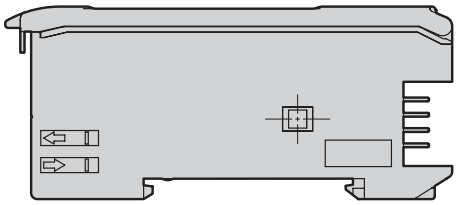


Amplifier Units with Connectors

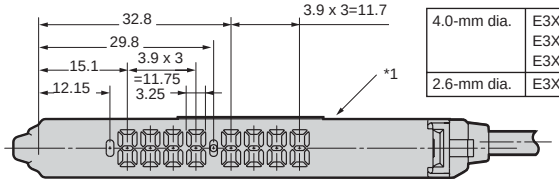
E3X-MDA6
E3X-MDA8





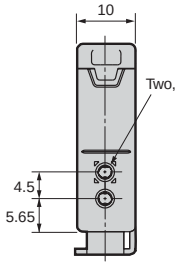


With Mounting Bracket Attached

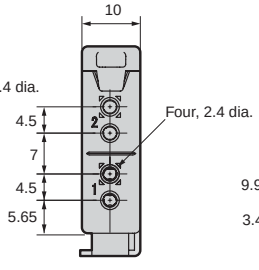


*1 The Mounting Bracket can also be used on this side.
*2 Cable Diameters

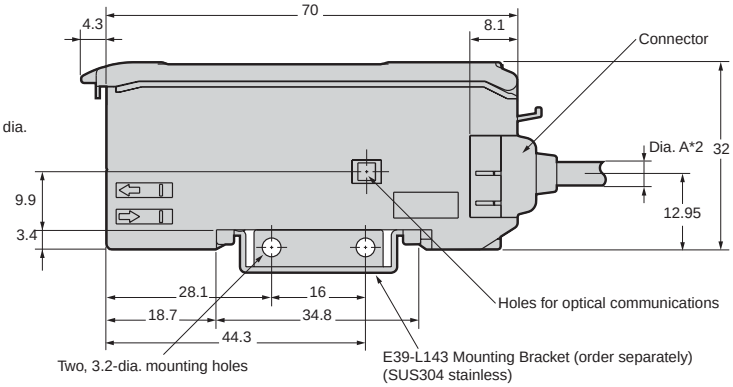
4.0-mm dia.	E3X-CN11 (3 conductors) E3X-CN21 (4 conductors) E3X-CN22 (2 conductors)
2.6-mm dia.	E3X-CN12 (1 conductor)

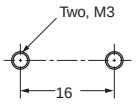


E3X-DA□-S

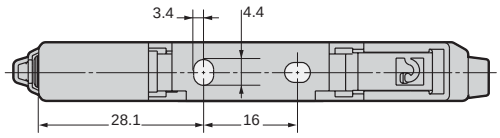


E3X-MDA□





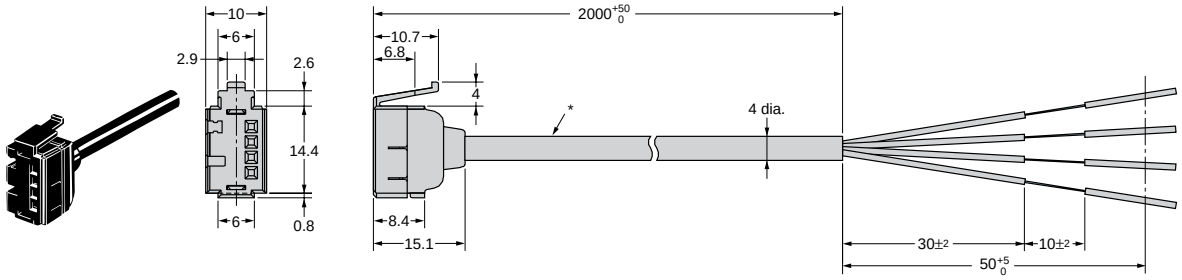
Mounting Holes



■ Amplifier Unit Connectors

Master Connectors

E3X-CN11
E3X-CN21

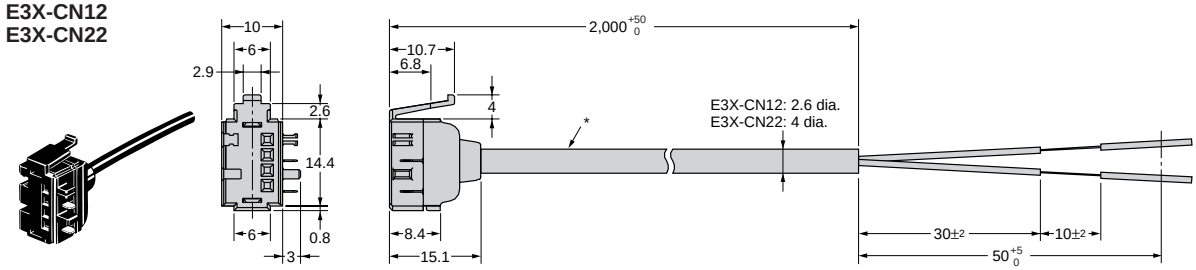


*E3X-CN11: A 4-dia., 3-conductor, vinyl-insulated round cable (conductor cross-sectional area: 0.2 mm^2; insulation diameter: 1.1 mm) is used.

E3X-CN21: A 4-dia., 4-conductor, vinyl-insulated round cable (conductor cross-sectional area: 0.2 mm^2; insulation diameter: 1.1 mm) is used.

Slave Connectors

E3X-CN12
E3X-CN22

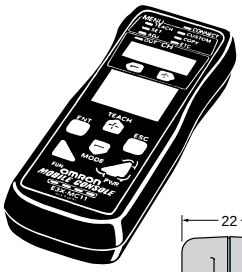


*E3X-CN12: A 2.6-dia., single-conductor, vinyl-insulated round cable (conductor cross-sectional area: 0.2 mm^2; insulation diameter: 1.1 mm) is used.

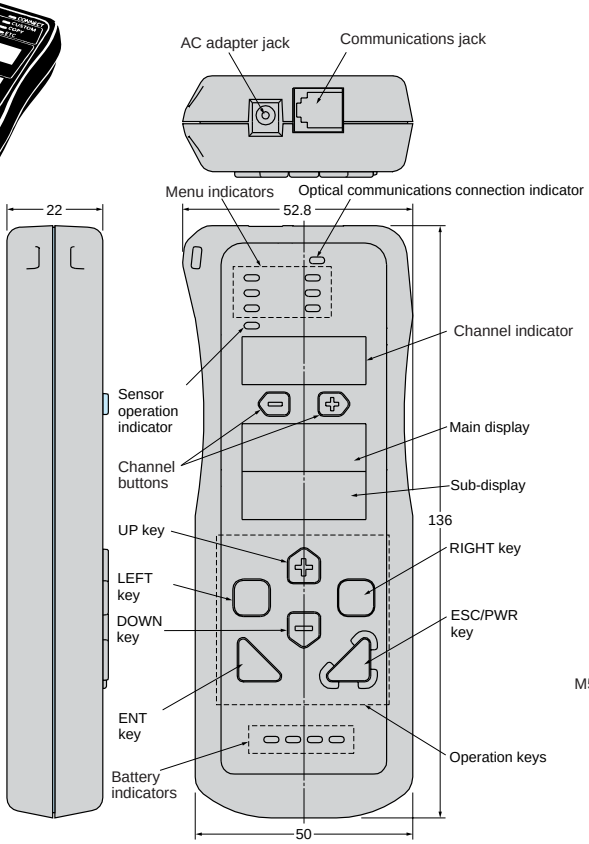
E3X-CN22: A 4-dia., 2-conductor, vinyl-insulated round cable (conductor cross-sectional area: 0.2 mm^2; insulation diameter: 1.1 mm) is used.

■ Mobile Console

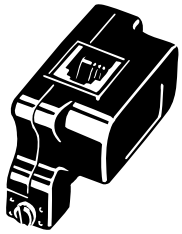
E3X-MC11-S

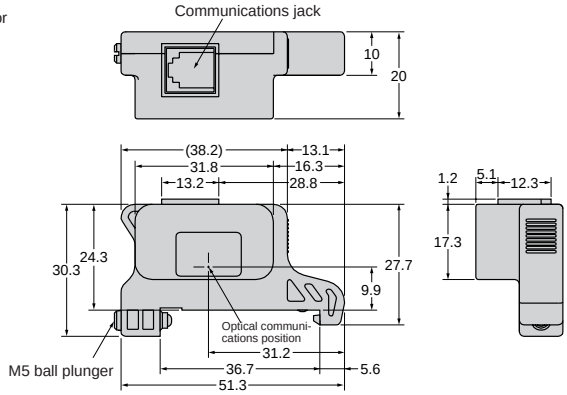


Mobile Console



Mobile Console Head





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- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this document.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

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Performance data given in this document is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased products.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this document has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

ALL DIMENSIONS SHOWN ARE IN MILLIMETERS.
To convert millimeters into inches, multiply by 0.03937. To convert grams into ounces, multiply by 0.03527.

Cat. No. E340-E1-03

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

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