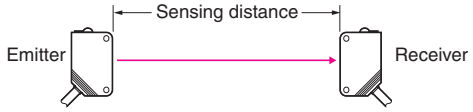
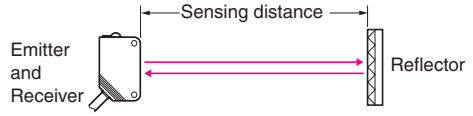
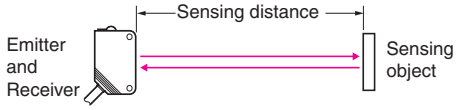
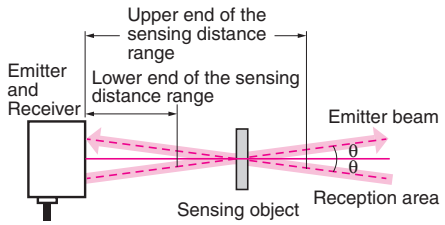
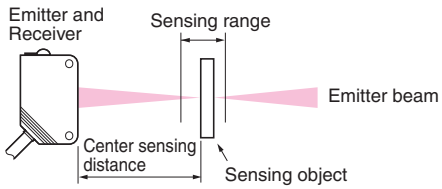
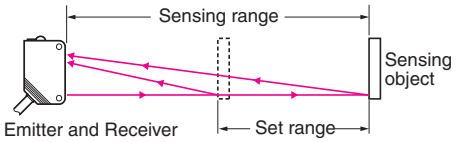
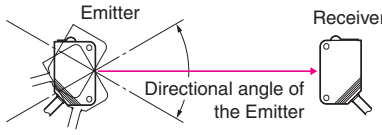
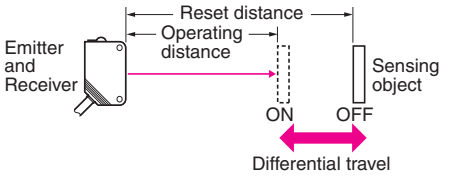
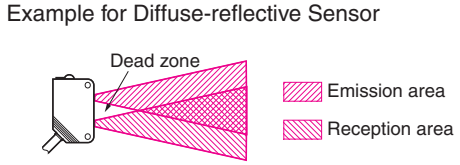
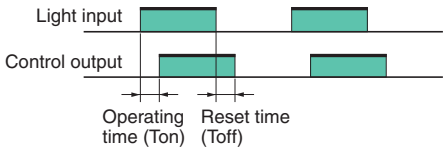
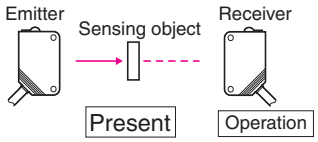
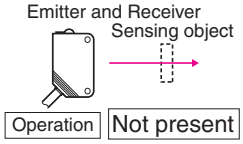
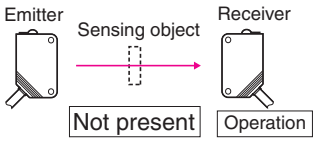
Explanation of Terms

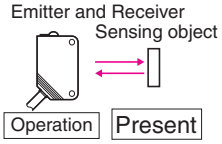
Item		Explanatory diagram	Meaning
Sensing distance	Through-beam Sensors		The maximum sensing distance that can be set with stability for Through-beam and Retro-reflective Sensors, taking into account product deviations and temperature fluctuations. Actual distances under standard conditions will be longer than the rated sensing distances for both types of Sensor.
	Retro-reflective Sensors		
	Diffuse-reflective Sensors		The maximum sensing distance that can be set with stability for the Diffuse-reflective Sensors, taking into account product deviations and temperature fluctuations, using the standard sensing object (white paper). Actual distances under standard conditions will be longer than the rated sensing distance.
	Limited-reflective Sensors		As shown in the diagram at left, the optical system for the Limited-reflective Sensors is designed so that the Emitter axis and the Receiver axis intersect at the surface of the detected object at an angle θ. With this optical system, the distance range in which regular-reflective light from the object can be detected consistently is the sensing distance. As such, the sensing distance can range from 10 to 35 mm depending on the upper and lower limits. (See page 7.)
	Mark Sensors (Contrast scanner)		As shown in the diagram of the optical system at the left, a coaxial optical system is used that contains both an emitter and a receiver in one lens. This optical system provides excellent stability against fluctuations in the distance between the lens and the sensing object (i.e., marks). (With some previous models, the emitter lens and receiver lens are separated.) The sensing distance is specified as the position where the spot is smallest (i.e., the center sensing distance) and the possible sensing range before and after that position.
Set range/ Sensing range	Distance-settable Sensors		Limits can be set on the sensing position of objects with Distance-settable Sensors. The range that can be set for a standard sensing object (white paper) is called the "set range." The range with the set position limits where a sensing object can be detected is called the "sensing range." The sensing range depends on the sensing mode that is selected. The BGS mode is used when the sensing object is on the Sensor side of the set position and the FGS mode is used when the sensing object is on the far side of the set position. (See page 6.)
Directional angle			Through-beam Sensors, Retro-reflective Sensors The angle where operation as a Photoelectric Sensor is possible.
Differential travel			Diffuse-reflective and Distance-settable Sensors The difference between the operating distance and the reset distance. Generally expressed in catalogs as a percentage of the rated sensing distance.
Dead zone			The dead zone outside of the emission and reception areas near the lens surface in Mark Sensors, Distance-settable Sensors, Limited-reflective Sensors, Diffuse-reflective Sensors, and Retro-reflective Sensors. Detection is not possible in this area.
Response time			The delay time from when the light input turns ON or OFF until the control output operates or resets. In general for Photoelectric Sensors, the operating time (Ton) ≈ reset time (Toff).

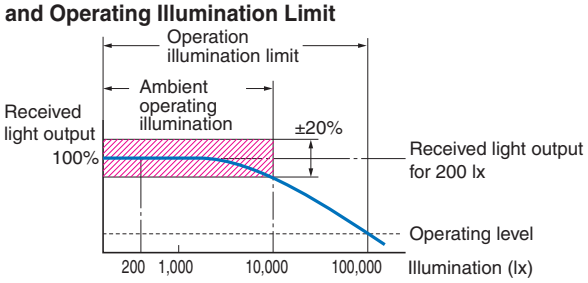
<table>
<tr><th>Item</th><th>Explanatory diagram</th><th>Meaning</th></tr>
<tr><td>Dark-ON operation (DARK ON)</td><td>
Through-beam, Retro-reflective Sensors


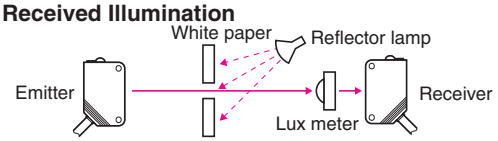
Diffuse-reflective Sensors


</td><td rowspan="2">The "Dark-ON" operating mode is when a Through-beam Sensor produces an output when the light entering the Receiver is interrupted or decreases.

The "Light-ON" operating mode is when a Diffuse-reflective Sensor produces an output when the light entering the Receiver increases.</td></tr>
<tr><td>Light-on operation (LIGHT ON)</td><td>
Through-beam, Retro-reflective Sensors


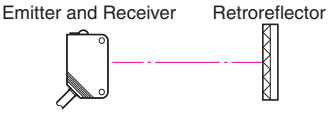
Diffuse-reflective Sensors


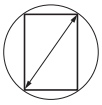
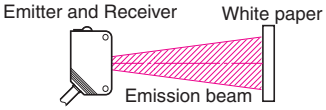
</td></tr>
<tr><td>Ambient operating illumination</td><td>
Difference between Ambient Operating Illumination and Operating Illumination Limit


Received Illumination


</td><td>The ambient operating illumination is expressed in terms of the Receiver surface illuminance and is defined as the illuminance when there is a ±20% change with respect to the value at a light reception output of 200 lx. This is not sufficient to cause malfunction at the operating illuminance limit.</td></tr>
<tr><td>Standard sensing object</td><td>
Through-beam Sensors

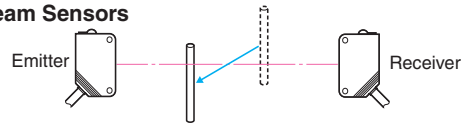
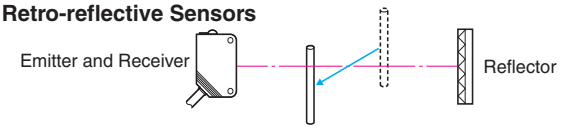
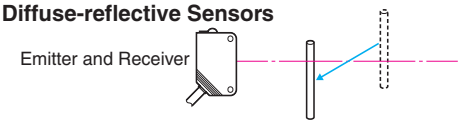
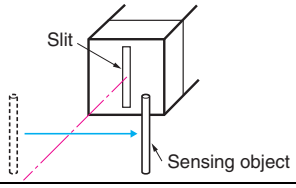


The length of the diagonal of the Emitter lens or Receiver lens
Retro-reflective Sensors



The length of the diagonal of the Reflector
Diffuse-reflective Sensors



A bigger piece of blank paper than the diameter of the Emitter beam
</td><td>The standard sensing object for both Through-beam Sensors and Retro-reflective Sensors is an opaque rod with a diameter larger than the length of a diagonal line of the optical system. In general, the diameter of the standard sensing object is the length of the diagonal line of the Emitter/Receiver lens for Through-beam Sensors, and the length of a diagonal line of the Reflector for Retro-reflective Sensors.

Size of Standard Sensing Object Using Reflector
<table>
<tr><th>Reflector models</th><th>Diagonal line of optical system</th><th>Sensing object</th></tr>
<tr><td>E39-R1/R1S/R1K</td><td>72.2 mm</td><td>75-mm dia.</td></tr>
<tr><td>E39-R2</td><td>100.58 mm</td><td>105-mm dia.</td></tr>
<tr><td>E39-R3</td><td>41.44 mm</td><td>45-mm dia.</td></tr>
<tr><td>E39-R4</td><td>26.77 mm</td><td>30-mm dia.</td></tr>
<tr><td>E39-R6</td><td>56.57 mm</td><td>60-mm dia.</td></tr>
<tr><td>E39-R9</td><td>43.7 mm</td><td>45-mm dia.</td></tr>
<tr><td>E39-R10</td><td>66.47 mm</td><td>70-mm dia.</td></tr>
<tr><td>E39-RS1</td><td>36.4 mm</td><td>40-mm dia.</td></tr>
<tr><td>E39-RS2</td><td>53.15 mm</td><td>55-mm dia.</td></tr>
<tr><td>E39-RS3</td><td>106.3 mm</td><td>110-mm dia.</td></tr>
<tr><td>E39-R37</td><td>13.4 mm</td><td>15-mm dia.</td></tr>
</table>
For Diffuse-reflective Sensors, the standard sensing object is a sheet of white paper larger than the diameter of the emitted beam.
</td></tr>
</table>

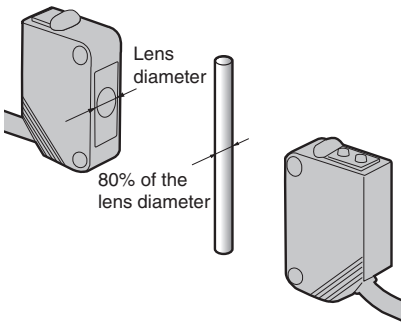
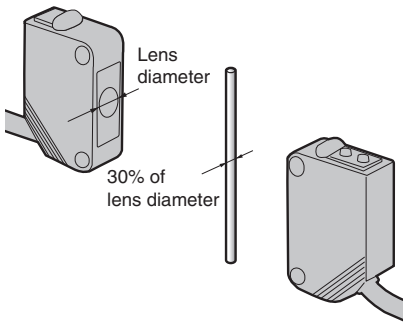
Item	Explanatory diagram	Meaning
Minimum sensing object	**Through-beam Sensors**  **Retro-reflective Sensors**  **Diffuse-reflective Sensors** 	Typical examples are given of the smallest object that can be detected using Through-beam and Retro-reflective Sensors with the sensitivity correctly adjusted to the light-ON operation level at the rated sensing distance. For Diffuse-reflective Sensors, typical examples are given of the smallest objects that can be detected with the sensitivity set to the highest level.
Minimum sensing object with slit attached		Through-beam Sensors Typical examples are given of the smallest object that can be detected using Through-beam Sensors with a Slit attached to both the Emitter and the Receiver as shown in the figure. The sensitivity is correctly adjusted to the Light-ON operating level at the rated sensing distance and the sensing object is moved along the length and parallel to the slit.

Application and Data

(1) Relationship of Lens Diameter and Sensitivity to the Smallest Detectable Object

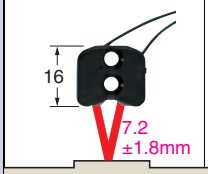
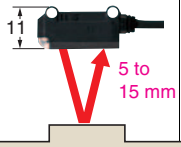
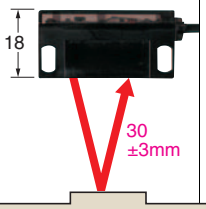
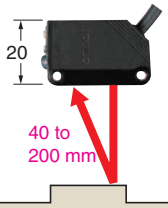
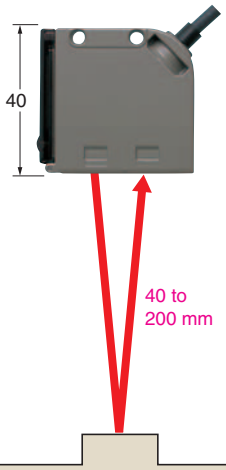
- With a Through-beam Sensor, the lens diameter determines the size of the smallest object that can be detected.
- With a Through-beam Sensor, a small object can be more easily detected midway between the Emitter and the Receiver that it can be off center between the Emitter and Receiver.
- As a rule of thumb, an object 30% to 80% of the lens diameter can be detected by varying the sensitivity level.
- Check the ***Ratings and Specifications*** of the Sensor for details.

The size given for the smallest object that can be detected with a Reflective Photoelectric Sensor is the value for detection with no objects in the background and the sensitivity set to the maximum value.

Maximum sensitivity	Adjusted sensitivity
	
Detects objects 80% of the lens diameter.	Detects objects up to 30% of the lens diameter.

(2) Detecting Height Differences

Selecting Sensors Based on Detectable Height Differences and Set Distances (Typical Examples)

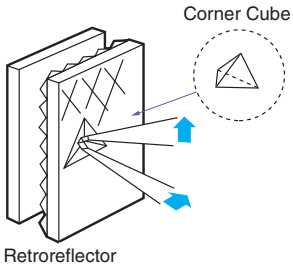
Appearance					
	0.27 to 0.45 mm	2mm	0.8 to 1.0 mm	4 to 20 mm min.	0.8 to 4 mm
Features	Optical Fiber Sensors	• Built-in Amplifier Sensors • Microsensors	Separate Amplifier Sensors	Built-in Amplifier Sensors	Built-in Amplifier Sensors
Model	E32-L25L	E3T-SL1□	E3C-LS3R	E3Z-LS	E3S-CL1

(3) MSR (Mirror Surface Rejection) Function

[Principles]

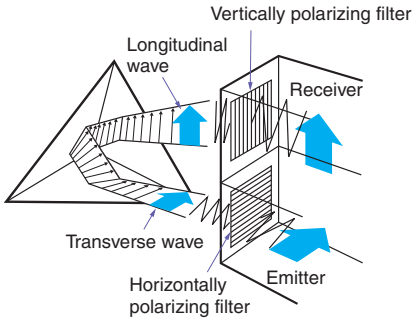
This function and structure uses the characteristics of the Retroreflector and the polarizing filters built into the Retro-reflective Sensors to receive only the light reflected from the Retroreflector.

- The waveform of the light transmitted through a polarizing filter in the Emitter changes to polarization in a horizontal orientation.
- The orientation of the light reflected from the triangular pyramids of the Retroreflector changes from horizontal to vertical.
- This reflected light passes through a polarizing filter in the Receiver to arrive at the Receiver.



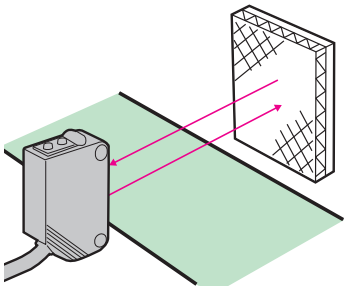
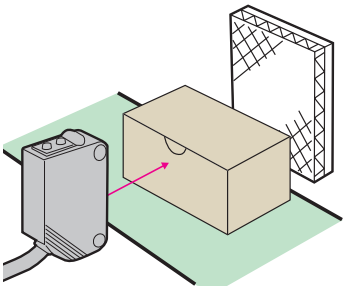
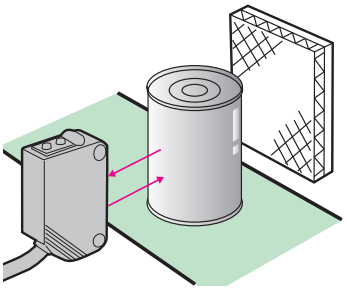
[Purpose]

This method enables stable detection of objects with a mirror-like surface.
Light reflected from these types of objects cannot pass through the polarizing filter on the Receiver because the orientation of polarization is kept horizontal.



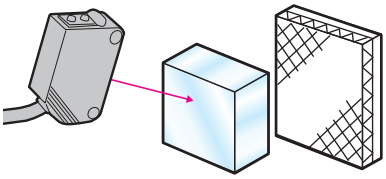
[Examples]

A sensing object with a rough, matte surface (example (2)) can be detected even without the MSR function. If the sensing object has a smooth, glossy surface on the other hand (example (3)), it cannot be detected with any kind of consistency without the MSR function.

(1) No Object	(2) Non-glossy Object	(3) Object with a Smooth, Glossy Surface (Example: battery, can, etc.)
The light from the Emitter hits the Reflector and returns to the Receiver.	Light from the Emitter is intercepted by the object, does not reach the Reflector, and thus does not return to the Receiver.	Light from the Emitter is reflected by the object and returns to the Receiver.
		

[Caution]

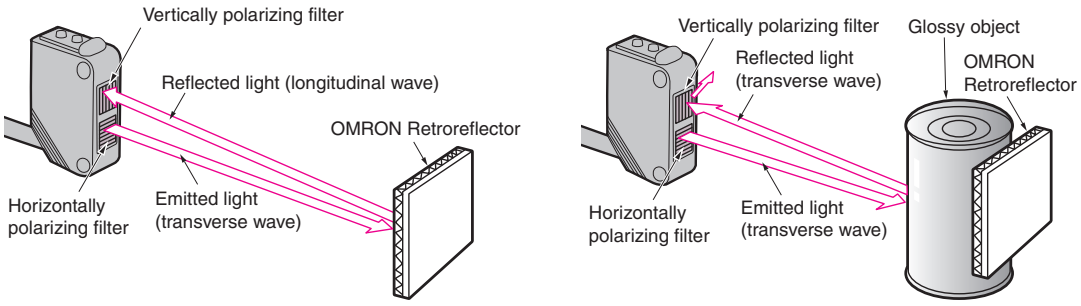
Stable operation is often impossible when detecting objects with high gloss or objects covered with glossy film. If this occurs, install the Sensor so that it is at an angle off perpendicular to the sensing object.



Retro-reflective Sensors with MSR function

Retro-reflective Sensors with MSR function	
Classification by Configuration	**Model**
Optical Fiber Sensors	E32-R21, E32-R16
Built-in Amplifier Sensors	E3Z-R61/R66/R81/R86
	E3ZM-R61/R66/R81/R86/B61/B66/B81/B86
	E3ZM-CR61(-M1TJ)/CR81(-M1TJ)
	E3S-CR11(-M1J)/CR61(-M1J)
Separate Amplifier Sensors	E3C-LR11/LR12
Built-in Power Supply Sensors	E3JM-R4□4(T), E3JK-R2M□/R2S3

Note: When using a Sensor with the MSR function, be sure to use an OMRON Reflector



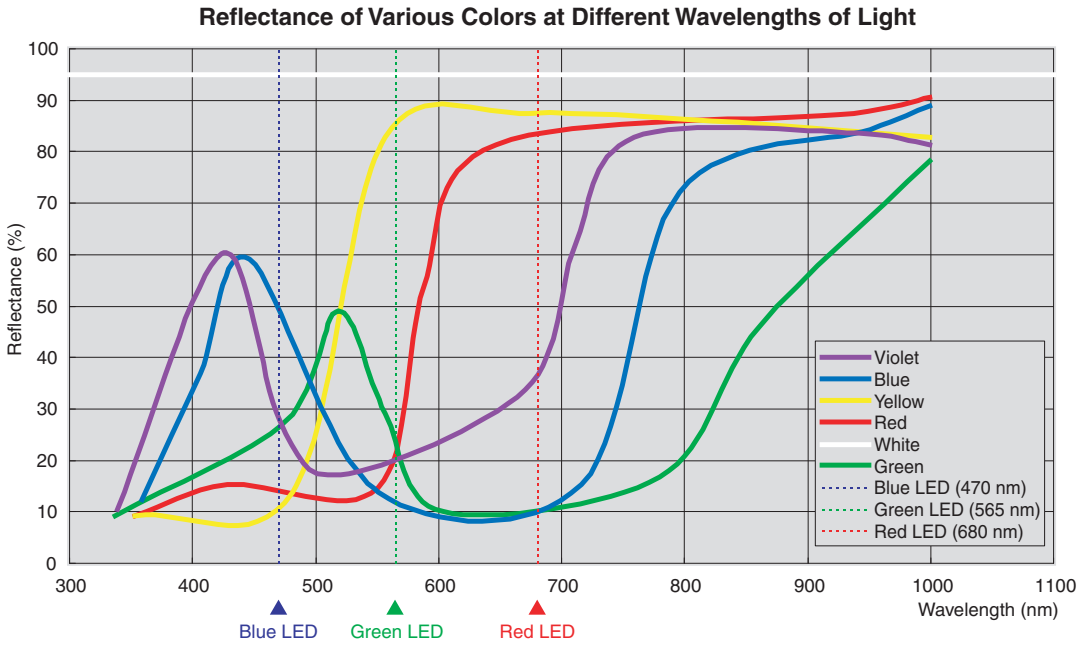
Retro-reflective Sensors without MSR Function

When detecting a glossy object using a Retro-reflective Sensor without the MSR function, mount the Sensor diagonally to the object so that reflection is not received directly from the front surface.

Retro-reflective Sensors without MSR Function	
Classification by Configuration	**Model**
Transparent Object Sensors	E3Z-B61/B62/B66/B67/B81/B82/B86/B87

(4) Surface Color and Light Source Reflectance

Surface Color Reflectance



Identifiable Color Marks

Sensor Light Color : Blue

	White	Red	Yellow	Green	Blue	Violet	Black
White		5	5	3		3	8
Red	5				3	2	
Yellow	5			2	4	2	
Green	3		2		2		3
Blue		3	4	2			6
Violet	3	2	2				4
Black	8			3	6	4	

Sensor Light Color : Green

	White	Red	Yellow	Green	Blue	Violet	Black
White		8			3	5	10
Red	8		5	5	3		
Yellow		5				3	6
Green		5				3	6
Blue	3	3					4
Violet	5		3	3			3
Black	10		6	6	4	3	

Sensor Light Color : Red

	White	Red	Yellow	Green	Blue	Violet	Black
White				5	6	3	9
Red				4	4	2	7
Yellow				5	5	3	8
Green	5	4	5			2	
Blue	6	4	5			2	
Violet	3	2	3	2	2		4
Black	9	7	8			4	

The numbers express the degree of margin (percentage of received light for typical examples).
Models with an RGB light source support all combinations.

Sensor light color	Product classification	Model
Red light source ●	Optical Fiber Sensors	E3X-HD
		E3X-SD
		E3X-NA
		E3X-DA-S
		E3X-MDA
	Separate Amplifier Sensors	E3C-VS3R E3C-VM35R E3C-VS7R
Blue light source ●	Optical Fiber Sensors	E3X-DAB-S
Green light source ●	Optical Fiber Sensors	E3X-DAG-S
		E3X-NAG
	Separate Amplifier Sensors	E3C-VS1G
White light source ● ● ●	Optical Fiber Sensors	E3X-DAC-S

(5) Self-diagnosis Functions

The self-diagnosis function checks for margin with respect to environmental changes after installation, especially temperature, and informs the operator of the result through indicators and outputs. This function is an effective means of early detection of product failure, optical axis displacement, and accumulation of dirt on the lens over time.

[Principles]

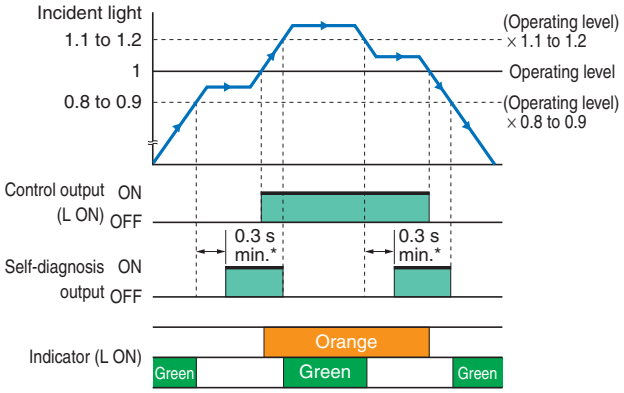
These functions alert the operator when the Sensor changes from a stable state to an unstable state. The functions can be broadly classified into display functions and output functions.

Display function

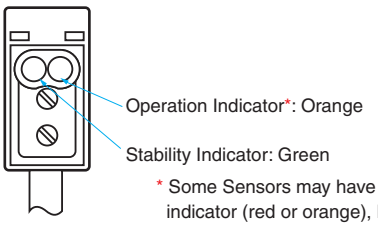
- Stability Indicator (green LED)
  The amount of margin with respect to environmental changes (temperature, voltage, dust, etc.) after installation is monitored by the self-diagnosis function and indicated by an indicator. (Illuminates steadily when there are no problems.)
- Operation Indicator (Orange LED)
  Indicates the output status.

Output function

The margin is indicated by an indicator light, and the state is output to alert the operator.



* If the moving speed of sensing object is slow, the Sensor may output a self-diagnosis output. When using the Photoelectric sensor, please install an ON-delay timer circuit etc..

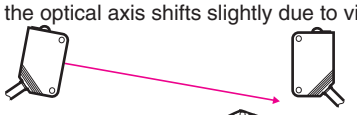
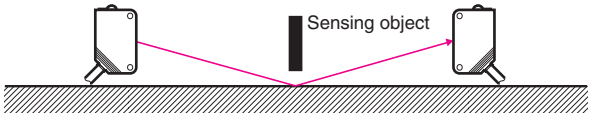
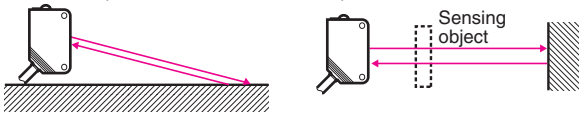
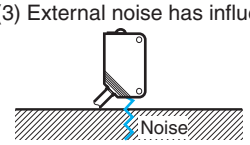


* Some Sensors may have an incident light indicator (red or orange), but it depends on the model.

[Purpose]

Self-diagnosis functions are effective in maintaining stable operation, alerting the operator to displacement of the optical axis, dirt on the lens (Sensor surface), the influence from the floor and background, external noise, and other potential failures of the Sensor.

Example: Light-ON Operation

Indicator state	Light-ON/Dark-ON indicated by the orange indicator	Degree of margin with respect to temperature changes indicated by the green indicator	Self-diagnosis output	Example of diagnosed condition
Stability indicator / Operation indicator (Green / Orange) **Operating level x 1.1 to 1.2**	Light Incident (orange indicator ON)	Stable use is possible. (Margin of 10% to 20% or higher) (Stability indicator: ON)	---	---
Stability indicator / Operation indicator (Green / Orange) **Operating level**	Light Incident (orange indicator ON)	The margin is not sufficient. (Green indicator: OFF)	When this state continues for a certain period of time, an output alerts the operator.	• Example: Incident light becomes unstable. (1) When the optical axis shifts slightly due to vibration.  (2) When the lens became dirty from adhesion of dust. 
Stability indicator / Operation indicator (Green / Orange) **Operating level x 0.8 to 0.9**	Light Interrupted (orange indicator OFF)			• Example: Operation is unstable when light is interrupted. (1) Light has leaked around the sensing object (Through-beam Sensors or Retro-reflective Sensors).  (2) Reflected light from the floor or the background has been received (Diffuse-reflective Sensor).  (3) External noise has influenced operation. 
Stability indicator / Operation indicator (Green / Orange)		Stable use is possible. (Margin of 10% to 20% or higher) (Stability indicator: ON)	---	---

<Applicable Models>

Classification by Configuration	Models	Self-diagnosis function	
		Display function	Output function
Optical Fiber Sensors	E3X-DA-S	Digital display	●
	E3X-MDA	Digital display	---
	E3X-NA	●	---
Separate Amplifier Sensors	E3C-LDA	Digital display	●
	E3C	●	●(E3C-JC4P)
Built-in Amplifier Sensors	E3Z	●	---
	E3ZM(-C)	●	---
	E3T	●	---
	E3S-C	●	---
	E3S-CL	●	---

Safety Standards for Laser Beams

● Safety Standards for Laser Beams

The laser beams that are emitted from lasers have a high power density and can cause damage to the human body, even if the quantity of light is small. In Japan, in order to prevent injury to users of laser products, a Japanese Industrial Standard, Radiation Safety Standards for Laser Products (JIS C 6802), has been established. It is based on the corresponding International Electrotechnical Commission (IEC) standard.
The JIS C 6802 standard divides laser products into different classes according to the degree of the hazard, and specifies the required safety measures for each class.
An overview of the classifications is given on the right.

Class	Overview of hazard evaluation
Class 1	Laser products that are safe under any reasonably foreseeable operating conditions, even when viewed with loupes, binoculars, or other optical viewing instruments. Laser products that emit visible light may still produce dazzling visual effects.
Class 1M	Laser products that are safe under any reasonably foreseeable operating conditions when viewed with the naked eye. Under certain conditions, the use of optical instruments may result in eye injury.
Class 2	Laser products that are normally safe for momentary exposure due to the protection afforded eyes by aversion reactions, such as blinking, but that can be dangerous if someone deliberately looks into the beam. Caution is required for visual impairments caused by residual images or reflection actions caused by surprise.
Class 2M	Same as Class 2 for the naked eye: Laser products that are normally safe for momentary exposure due to the protection afforded eyes by aversion reactions, such as blinking, but that can be dangerous if someone deliberately looks into the beam. Caution is required for visual impairments caused by residual images or reflection actions caused by surprise. Under certain conditions, the use of optical instruments may result in eye injury.
Class 3R	The risk of injury is less than Class 3B for direct intrabeam exposure. Intentional ocular exposure is dangerous. Caution is required for visual impairments caused by residual images or reflection actions caused by surprise.
Class 3B	Even accidental short-term ocular exposure to the beam is normally dangerous. Under certain conditions, minor skin injury or combustion of flammable materials is possible.
Class 4	Intrabeam viewing and skin exposure are dangerous. There is also a risk of fire.

● Laser Classifications

The safety standards for laser beams are different for each country and region. The definitions for laser classifications in Europe and the United States are described below.

Europe (EN 60825-1)

The classification standards set forth in European Standard EN 60825-1:2007 is consistent with the JIS standard C6802:2011.
You should always check the original text of the standard when trying to attain conformance.

USA

✻ The following information was edited by OMRON based on the actual standard. OMRON assumes no responsibility for this information. You should always check the original text of the standard before implementing an actual application.
✻ Filing is required for laser products for the USA. Select products that have been filed with the FDA (U.S. Food and Drug Administration).
✻ Currently the USA is preparing to adopt the IEC 60825-1 2007 international standard, which was harmonized between the EU and JIS. During the provisional period, the classifications and labeling of IEC will be approved (Laser Notice 50). For details refer to Laser Notice 50 and to the IEC Standards.
Some OMRON products are classified by the standards given in Laser Notice 50. Others are classified by the FDA standards.

	Description of FDA classification definition
Class I	Considered nonhazardous.
Class IIa	Products that have emissions in the visible spectrum (400 to 710 nm) and that are nonhazardous for viewing durations up to 1,000 s. Viewing for longer than 1,000 s presents the risk of chronic visual impairment.
Class II	Products that have emissions in the visible spectrum and that have an emission power of more than 1 mW for continuous discharge of more than 0.25 s. Viewing the laser beam presents the risk of chronic visual impairment.
Class IIIa	Products that have emissions in the visible spectrum and that have an emission power of more than 5 mW for continuous discharge of more than 0.38 ms. Irradiance presents the risk of acute or chronic visual impairment resulting from viewing the beam. Directly viewing the laser beam with an optical instrument presents the risk of acute visual impairment.
Class IIIb	Products that emit laser beams of any wavelengths, for example products that emit visible light with an emission power of 5 to 500 mW. Direct contact with the light beam presents the risk of acute visual impairment or skin damage.
Class IV	Products that exceed the limits of Class IIIb and that present a risk for visual impairment or skin damage for scattered (diffuse) reflection as well as for direct exposure.

● Measures for the Prevention of Damage due to Laser Beams

Regarding labor using lasers, the Industrial Safety and Health Law sets out specific details of safety measures for laser equipment that are classified as Class 3R or higher in Measures for the Prevention of Damage due to Laser Beams. The following table gives the criteria for the measures by each class.

Measure (item only)			Measure	Class of laser equipment				
				4	3B	3R	2M	1M
Appointment of a laser device manager			Appoint an individual with sufficient knowledge and experience regarding the prevention of damage due to laser beams and the handling of laser equipment.	Yes	Yes	Yes		
Controlled area (signs and restricted area)			Partition from other areas, indicate the partition with signs, and prohibit entry to unauthorized personnel.	Yes	Yes			
Laser equipment	Path of laser beam	Position of path	Avoid eye level of the operator.	Yes	Yes	Yes	Yes	Yes
		Appropriate design and blocking of path	Keep the path as short as possible, minimize the number of bends, avoid intersections of light with pathways, and block light paths as much as possible.	Yes	Yes	Yes		
		Proper termination	Terminate with diffuse reflection objects or light absorbing objects that have appropriate reflectance and heat resistance.	Yes	Yes	Yes	Yes	Yes
	Key control		Use a construction where operation is enabled by key or similar means.	Yes	Yes			
	Emergency stop switches, etc.	Emergency stop switches	Provide an emergency stop switch that can be used to immediately stop laser-beam emission.	Yes	Yes			
		Warning system	Provide a warning system with features that allow easy confirmation, such as indicators that light automatically.	Yes	Yes	Yes		
		Shutter	Provide the emission aperture with a shutter to prevent accidental emission.	Yes	Yes			
	Interlock system, etc.		Ensure that laser-beam emission is stopped automatically when the controlled area becomes accessible or the beam patch is unblocked.	Yes	Yes			
	Indication of emission aperture		Indicate the laser-beam emission aperture.	Yes	Yes	Yes		
Work management, etc.	Operating position		Perform control of laser equipment from a position as far away as possible form the laser-beam path.	Yes				
	Adjustment of optical system		Use the minimum amount of power that is required when adjusting the optical system.	Yes	Yes	Yes	Yes	Yes
	Protective equipment	Protective glasses	Wear protective glasses appropriate for the type of laser used.	Yes	Yes	Yes		
		Protective clothing	Wear clothing that allows only minimum skin exposure.	Yes	Yes			
		Use of flame-retardant materials	Wear clothing made of flame-retardant materials. Synthetic fibers that melt and become sphere-shaped are unsuitable.	Yes				
	Inspections and maintenance		Perform inspections before operation and regular inspections and adjustments at fixed intervals.	Yes	Yes	Yes	Yes	Yes
	Safety and health education		Provide training when taking on new personnel, and when changing the work procedure or the laser equipment.	Yes	Yes	Yes	Yes	Yes
	Healthcare	Examinations of anterior ocular segment	Administer cornea and lens examinations together with eyesight examinations when taking on or transferring personnel.	Yes	Yes	Yes		
		Examinations of the ocular fundus	Administer ocular-fundus examinations together with eyesight examinations when taking on or transferring personnel.	Yes				
Others	Notification	Supervisor's name	Provide notification of the laser-equipment supervisor's name.	Yes	Yes	Yes		
		Level of the hazard indication	Provide notification regarding the risks and harmful effects of laser beams, as well as handling precautions in an obvious location.	Yes	Yes	Yes	Yes	Yes
		Installation	Provide signs that indicate the presence of laser-equipment.	Yes	Yes			
	High voltage display		Provide indication of high voltages and implement measures for preventing electric shock.	Yes	Yes	Yes	Yes	Yes
	Prohibition of hazardous objects	In controlled areas	Prohibit explosive and flammable substances.	Yes				
		Close to path of laser beam	Prohibit explosive and flammable substances.	Yes	Yes			
	Hazardous gases and dusts		Implement the measures prescribed by the Industrial Safety and Health Law.	Yes	Yes			
	Examination and treatment of personnel with suspected laser-related injury by medical professional		Make it possible for personnel with suspected laser-related injury to be examined and treated quickly by a medical professional.	Yes	Yes	Yes	Yes	Yes

● Standards for Europe

Laser Classifications and Requirements

Europe (EN 60825-1)

✻ The following information was edited by OMRON based on the actual standard. OMRON assumes no responsibility for this information. You should always check the original text of the standard before implementing an actual application.

Requirement	Classification						
	Class 1	Class 1M	Class 2	Class 2M	Class 3R	Class 3B	Class 4
Description of hazard class	Safe under reasonably foreseeable conditions.	As for Class 1 except may be hazardous if user employs optics.	Low power; eye protection normally afforded by aversion responses.	As for Class 2 except may be hazardous if user employs optics.	Direct intrabeam viewing may be hazardous.	Direct intrabeam viewing normally hazardous.	High power; diffuse reflections may be hazardous.
Protective housing	Required for build-in laser products.	Required for each laser product; limits access except when necessary for performance of functions of the products.					
Access panel safety interlock	Designed to prevent removal of the panel until accessible emission values are below that for Class 3R.				Designed to prevent removal of the panel until accessible emission values are below that for Class 3B or 3R.		
Remote interlock connector	Not required.					Permits easy addition of external interlock in laser installation.	
Manual reset	Not required.						Manual reset is required when power is interrupted or a remote interlock is activated.
Key control	Not required.					Laser inoperative when key is removed.	
Laser emission warning	Not required.				Gives audible or visible warning when laser is switched on or if capacitor bank of pulsed laser is being charged. For Class 3R only, applies if invisible radiation is emitted.		
Beam stop or attenuator	Not required.					Gives means to temporarily block beam.	
Controls	Not required.				Controls so located that there is no danger of exposure to accessible emission limit above Class 1 or 2 when adjustments are made or operation is performed.		
Viewing optics	Not required.		Emissions from all observation system must be below the accessible emission limits of Class 1M.				
Scanning safeguard	Lasers must not exceed their assigned laser class even if scan failures occur.						
Class label	Required wording.		Figures A and B and required wording.				
Aperture label	Not required.				Specified wording required.		
Service entry label	Not required.	Required as appropriate to the class of accessible radiation.					
Labels for safety interlocked panels	Required under certain conditions as appropriate to the class of laser used.						
Warning for visible and invisible laser radiation	Required for certain wavelength ranges.						
Information for the user	Operation manuals must contain instructions for safe use. Additional requirements apply for Class 1M and Class 2M.						
Purchasing and servicing information	Promotion brochures must specify product classification; service manuals must contain safety information.						

Note: 1. The above table is a summarization of the basic requirements. You should always check the original text of the standard to understand and apply the actual standards.

2. Laser equipment used for healthcare applications are subject to IEC 60601-2-22.

3. Refer to IEC TR 60825-14 for a user's guide for laser products.

Sign and boundary: black
Background: yellow

Figure A. Warning Label - DANGER Symbol

Indication and boundary: black
Background: yellow

Figure B. Explanatory label

● Standards for the USA

Laser Manufacturer Requirements

Conformance Guide for FDA Laser Products (April 2013)

(If you file with the FDA based on Laser Notice 50, implement measures according to the IEC standards (same as the EN standards) and not according to the standards in this table.)

✻ The following information was edited by OMRON based on the actual standard. OMRON assumes no responsibility for this information. You should always check the original text of the standard before implementing an actual application.

Requirement	Laser Class (See note 1.)					
	Class I	Class IIa	Class II	Class IIIa	Class IIIb	Class IV
Capability (all laser products)						
Protective housing	Required. (See note 2.)	Required. (See note 2.)	Required. (See note 2.)	Required. (See note 2.)	Required. (See note 2.)	Required. (See note 2.)
Safety interlocks	Required. (See notes 3 and 4.)	Required. (See notes 3 and 4.)	Required. (See notes 3 and 4.)	Required. (See notes 3 and 4.)	Required. (See notes 3 and 4.)	Required. (See notes 3 and 4.)
Location of controls	Exception	Required.	Required.	Required.	Required.	Required.
Limits on optics for observation	Required.	Required.	Required.	Required.	Required.	Required.
Scanning safeguard	Required.	Required.	Required.	Required.	Required.	Required.
Operation and performance (laser system)						
Remote interlock connector	Exception	Exception	Exception	Exception	Required.	Required.
Key control	Exception	Exception	Exception	Exception	Required.	Required.
Laser radiation emission indicator	Exception	Exception	Required.	Required.	Required. (See note 10.)	Required. (See note 10.)
Beam attenuator	Exception	Exception	Required.	Required.	Required.	Required.
Manual reset mechanism	Exception	Exception	Exception	Exception	Exception	Required. (See note 13.)
Operation and performance (products for a specific purpose)						
Medical laser products	Same requirements as other products in same class.	Same requirements as other products in same class.	Same requirements as other products in same class.	Same requirements as other products in same class (See note 8).	Same requirements as other products in same class (See note 8).	Same requirements as other products in same class (See note 8).
Surveying, leveling, and alignment laser products	Same requirements as other products in same class.	Same requirements as other products in same class.	Same requirements as other products in same class.	Same requirements as other products in same class.	Prohibited.	Prohibited.
Demonstration laser products	Same requirements as other products in same class.	Same requirements as other products in same class.	Same requirements as other products in same class.	Same requirements as other products in same class.	Same requirements as other products in same class (See note 11).	Same requirements as other products in same class (See note 11).
Labelling (all laser products)						
Tests for determination of compliance	Required.	Required.	Required.	Required.	Required.	Required.
Protective housing	Depends on the internal radiation level (see note 5).	Required. (See note 5.)	Required. (See note 5.)	Required. (See note 5.)	Required. (See note 5.)	Required. (See note 5.)
Aperture	Exception	Exception	Required.	Required.	Required.	Required.
Class warning	Exception	Required. (See note 6.)	Required. (See note 7.)	Required. (See note 9.)	Required. (See note 12.)	Required. (See note 12.)
Information (all laser products)						
Information for the user	Required.	Required.	Required.	Required.	Required.	Required.
Product documentation	Exception	Required.	Required.	Required.	Required.	Required.
Servicing information	Required.	Required.	Required.	Required.	Required.	Required.

Note: 1. Depends on the maximum possible exposure level during operation.
2. Required for human exposure to laser radiation exceeding Class I other than radiation required for product functions.
3. Required of a protective structure that can be opened during operation or maintenance when human exposure is never necessary while the structure is open.
4. Interlock requirements depend on the internal emission class.
5. The warning text depends on the laser emission level within the structure and on the wavelengths.
6. Label with warning text.
7. Logotype for CAUTION.
8. An instrument to measure the laser emission level for intentional human radiation.
9. "CAUTION" for 2.5 mW/cm^2 and "DANGER" for over 2.5 mW/cm^2.
10. A time delay is required between emission display and emission.
11. Variance (21 CFR 1010.4) approval is required for demonstration lasers or light shows for Class IIIb or IV.
12. DANGER logotype.
13. Required from August 20, 1986.

● Main Laser Sensor Classifications

(As of April 2014)

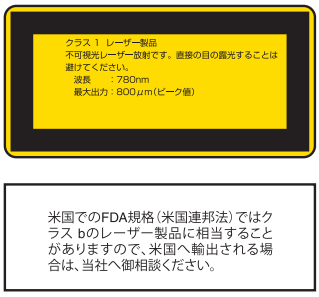
JIS/IEC/EN	FDA	Product name	Model
Class category	Class category		
Class 1	Class 1 (Laser Notice 50)	Laser-type Smart Sensors	ZX2-LD50V
	Class II		ZX-LT001/030
	Class II		ZX-LT005/010
	Class 1 (Laser Notice 50)	CMOS Laser Sensors with Built-in Digital Amplifiers	ZX0-LD50A□L/LD100A□L/LD300A□L/LD600A□L
	Class 1 (Laser Notice 50)	CMOS Laser Displacement Sensors with Built-in Digital Amplifiers	ZX1-LD50A□L/LD100A□L/LD300A□L/LD600A□L
	Class II	Photoelectric Sensors with Separate Digital Amplifiers (Laser-type Amplifier Units)	E3C-LR12
	Class 1 (Laser Notice 50)	Photoelectric Sensors with Built-in Amplifiers (Laser-type Amplifier Units)	E3Z-LR
			E3Z-LT
			E3Z-LL
	Class II	Smart Laser CCD Micrometer Sensors	ZX-GT□□S
	Class 1 (Laser Notice 50)	CMOS-type Smart Laser Heads	E3NC-SH100/250
		Smart Laser Heads	E3NC-LH01
			E3NC-LH02
			E3NC-LH03
	Class I	Safety Laser Scanners	OS32C
Class 2	Class II	Laser-type Smart Sensors	ZS-HLDS□
	Class II	Smart Sensors (2D CMOS Laser Type)	ZS-LD□□
	Class 2 (Laser Notice 50)	Laser-type Smart Sensors	ZX2-LD□/ZX2-LD□L
	Class II		ZX-LD□
	Class 2 (Laser Notice 50)	CMOS Laser Sensors with Built-in Digital Amplifiers	ZX0-LD50A□/LD100A□/LD300A□/LD600A□
		CMOS Laser Displacement Sensors with Built-in Digital Amplifiers	ZX1-LD50A□/LD100A□/LD300A□/LD600A□
	Class II	Photoelectric Sensors with Separate Digital Amplifiers (Laser-type Amplifier Units)	E3C-LD11/21/31
	Class II		E3C-LR11
	Class 2 (Laser Notice 50)	CMOS-type Smart Laser Heads	E3NC-SH250H
	Class 2 (Laser Notice 50)	Laser-type Installed Bar Code Readers	V500-R521□□
	Class 2 (Laser Notice 50)	Laser-type Bar Code Readers	V500-R2□□
	No application filed.	Laser Micrometers	3Z4L-S5□□RV3
	Class II	Smart 2D Profile Measurement Sensors	ZG2-WDS3V
	Class II	Laser Pointers	F39-PTJ/PTR
Class 2M	Class IIIb	Smart 2D Profile Measurement Sensors	ZG2-WDS70/WDS22/WDS8

✻ For details, refer to your OMRON website.

● Precautions for Safe Use of Laser Beams

(1) Ensure that the laser beam does not enter the eye either directly or by reflection off a mirror surface.

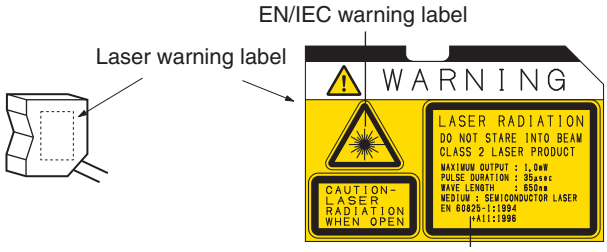
(2) Labels of the type shown below are attached to Sensors that use lasers. (These are typical examples.) Observe the instructions given on the labels when handling the Sensors.

Class 1 Labels	Class 2 Labels	Class 3B Labels
		

(3) Adjust the optical axis with an IR scope or a fluorescent plate that converts infrared rays into visible light.

When exporting products to the EU or USA, attach the following labels, which are packed with the products. US FDA labels are included only with products that have been filed and registered with the FDA.

Europe (EN Standard)



USA (FDA)