Optex FA website full of sensor information

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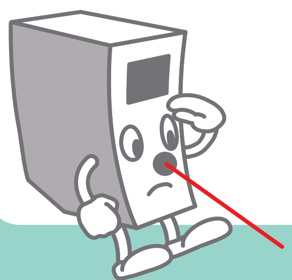
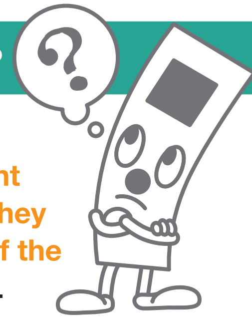
Photoelectric Sensor Handbook

OPTEX FA CO., LTD.

Contents

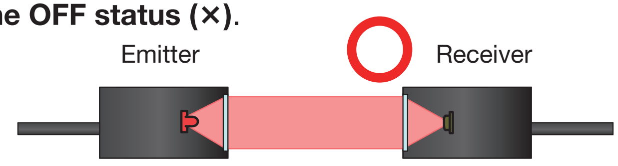


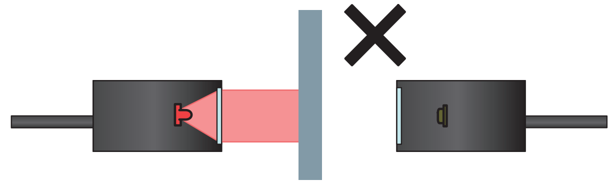
1. What is a Photoelectric Sensor?



Photoelectric sensors **use the receiving light level (or the shade level) of the light that they themselves emit to detect the presence of the detection target in a non-contact manner**.

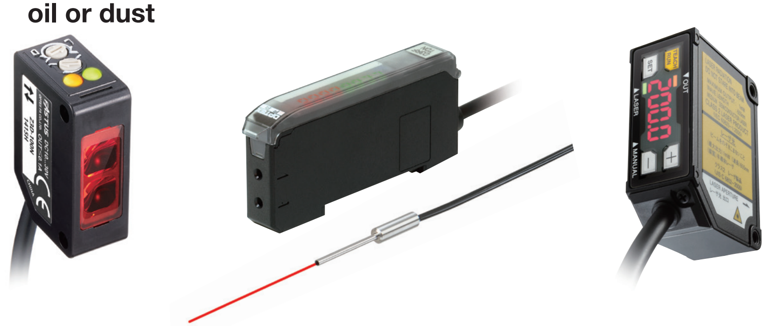
In the following diagram, the light from the left unit (the emitter) being received by the right unit (the receiver) is judged as being **the ON status (○)**. This light not being received is judged as being **the OFF status (×)**.





Photoelectric sensor characteristics

○ Performs detections in a non-contact manner
○ Long sensing distance
○ Small object detection
○ Fast response
○ Can detect most objects
× Susceptible to the lens getting dirty such as with oil or dust



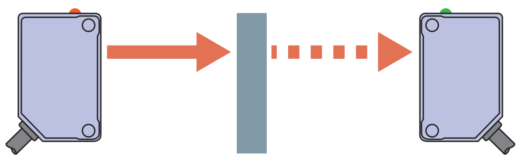
2. Detection Type

There are many types of photoelectric sensors, which all use different detection types. This section explains the main detection types.

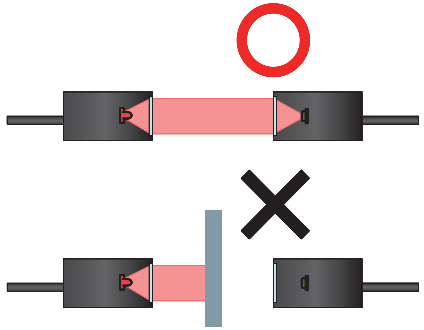
2-1. Through-beam

This is a type in which the **emitter and the receiver are separate**. Detections are performed by checking whether the light is blocked, so **stable detections are possible regardless of the color or shape of the object to detect**.

Through-beam type sensor



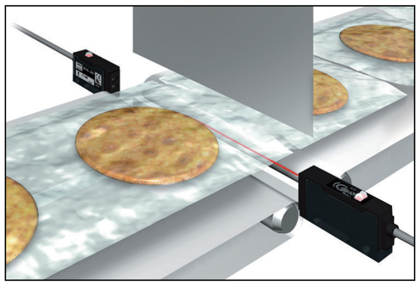
- The sensor switches between **ON (○)** and **OFF (×)** depending on whether the light from the emitter is received by the receiver or the light is blocked by the object to detect, respectively.
- This sensor is resistant to effects such as ambient reflections and is also highly resistant to the effects of dirt and dust, so it can perform stable detections.
- This sensor's characteristic is its ability to perform long-distance detections, but two units must be installed, resulting in higher prices.
- By using a specialized slit, this sensor can also detect small objects.



Application

Detection of stuck items

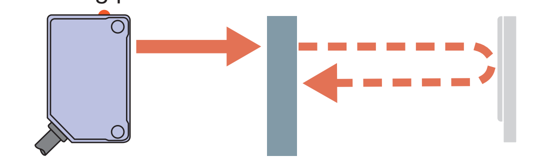
When sealing crackers in their packages, the sensor detects whether the cracker is in the position that will be sealed. The light passes through the film but is blocked if a cracker is present. The sensor uses this to determine whether a cracker is present. To make the light pass through the film, it is effective to use a sensor that uses infrared light, which has good transmission properties.



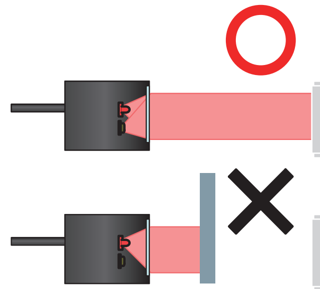
2-2. Retro-reflective (Reflex)

The sensor head (emitting/receiving part) and the **reflector** are used as a set. The recognizing of the object to detect blocking the light between the sensor and the reflector is the same as the through-beam type, but there is only one sensor, so **only one sensor needs to be wired** (the installation requires a location for the sensor and a location for the reflector).

Retro-reflective type sensor



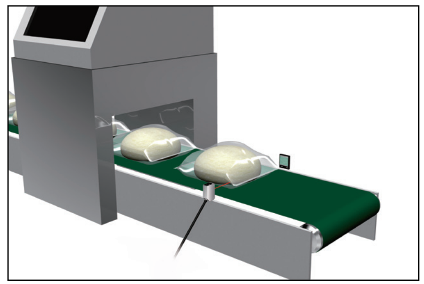
- The same as the through-beam type, the sensor switches between **ON (○)** and **OFF (×)** depending on whether the light from the emitting part is received by the receiving part or the light is blocked by the object to detect, respectively.
- This sensor is resistant to effects such as ambient reflections, so it can perform stable detections.



Application

Checking for the insertion of targets into inspection devices

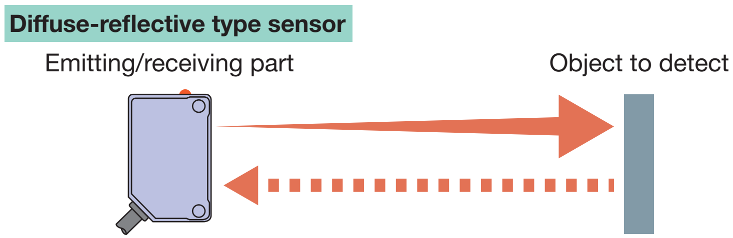
The sensor checks whether the inspection target has entered the inspection device. The inspection is performed after the inspection target enters the inspection device, so inspections can be performed automatically.



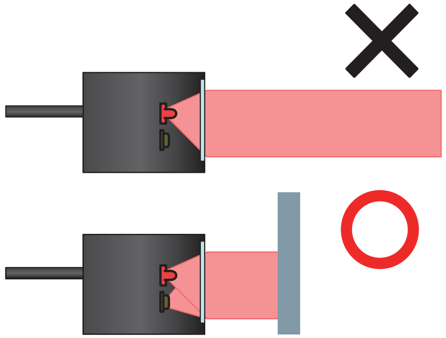
2. Detection Type

2-3. Diffuse-reflective (Energetic)

With this type, only a sensor head (emitting/receiving part) is used. **Detections are performed according to the amount of light reflected from the object to detect**. Because only a single sensor is used, **all the wiring and installation that needs to be performed is that for one unit**. However, the reflection status of the target changes depending on its reflectance (color) and tilt, so performing stable detections may be difficult. As such, caution is required when using this sensor.



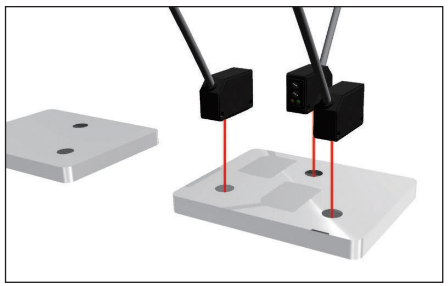
- Different from retro-reflective types, diffuse-reflective types detect the object by receiving its reflected light.
- Installation is simple, but the reflected light level varies depending on factors such as the target's reflectance (color), distance, and tilt. Therefore, in order to perform stable detections, it is necessary to verify whether the reflected light level is stable.



Application

Presence of drilled holes

The sensor is used to confirm the machining of metal parts. The light is no longer reflected from areas where holes have been drilled. This makes it possible to confirm whether machining has been performed. Only the sensor needs to be installed, so it is easy to start these systems.

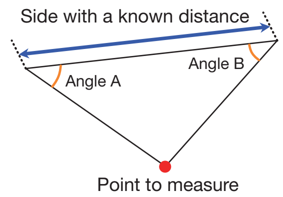


2-4. BGS (Background Suppression)

With this type, **"distance," not "the amount of light," is used to determine whether to turn the signal ON or OFF**. These sensors are **barely affected by the "target reflectance (color),"** which is a disadvantage of diffuse type photoelectric sensors.
However, the sensing distance is shorter than diffuse-reflective types.
BGS stands for "**B**ack**g**round **S**uppression."

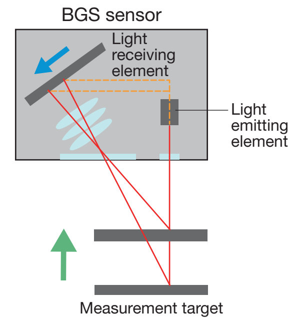
What is triangulation, the principle of the BGS type?

Triangulation is a method for measuring the distance to a separate point by using the principles of triangles.
As shown in the diagram on the right, if the accurate distance between two points is known, the distance to a position separate from these two points (the red circle, ●) can be found so long as the angles from these two points are known.



Measurement method

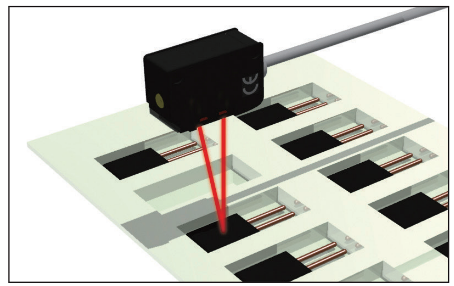
- A triangle is created between the light emitting element, light receiving element, and measurement target. Then, the distance to the measurement target is found.
- If the distance to the target changes (green⬆), the position of the light on the light receiving element changes (blue⬅). In other words, the distance to the target can be measured from the position of the light on the light receiving element.



Application

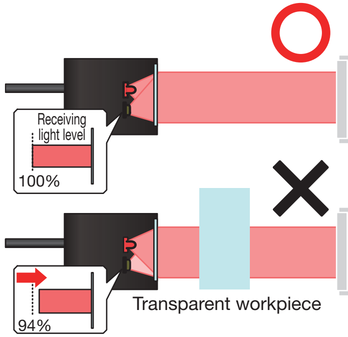
Part presence confirmation

The sensor is used to check for the presence of parts in a tray. Because detections are performed according to the height, detections can be performed without any readjustments even if the color of the part changes.



2-5. Transparent Object Detection

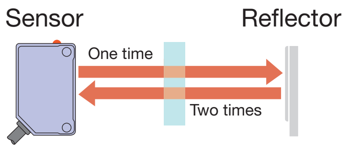
This is a type of retro-reflective sensor. Because transparent objects transmit light, detection is not possible with a normal retro-reflective type sensor. Transparent object detection type sensors **use reduced hysteresis (see page 20) to detect transparent objects**. However, because simply reducing hysteresis increases the likelihood of chatter (repetitions of the signal turning ON/OFF) and of malfunctions arising due to noise, optical system and circuit design improvements are required for transparent object detection.



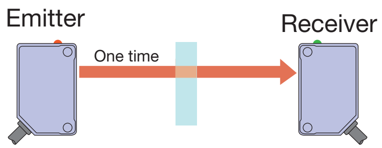
Why use a retro-reflective type?

With a retro-reflective type, the light passes through the workpiece twice, so it is easy for there to be a difference in the receiving light levels. However, with a through-beam type, the light passes through the workpiece only once, so it is more difficult for the receiving light level to be attenuated in comparison with retro-reflective types. This is the reason why retro-reflective types are used.
If the attenuation when the light passes through the workpiece is 3%, the light is attenuated by 6% with a retro-reflective type but is only attenuated by 3% with a through-beam type.

With a retro-reflective type



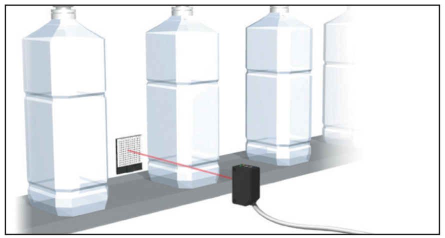
With a through-beam type



Application

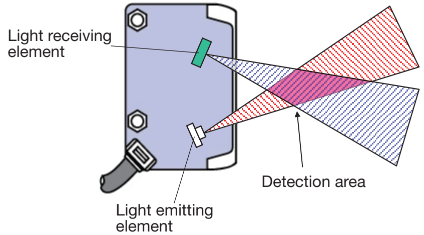
Detection of plastic bottle passage

The sensor accurately detects the passage of transparent bottles. It is difficult to detect glass and bottles, which cannot be detected with photoelectric sensors or proximity sensors. Furthermore, bottles are becoming thinner, which makes mechanical detections difficult. As such, the importance of inexpensive transparent object detection type sensors is increasing.



2-6. Limited Diffuse Reflective/Wide Angle Diffuse Reflective

Limited diffuse reflective type

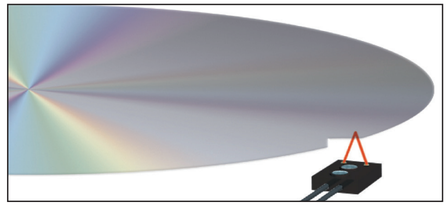


These are types of reflective sensors, but their optical systems have been modified and they have been designed so that they **only respond to a specific detection area**. They are used when checking the presence of workpieces in only a specific area within complicated devices. They are less accurate than BGS sensors, but their simple structure makes them inexpensive. Furthermore, this method is used with fiber sensors because it cannot be done structurally with BGS sensors.

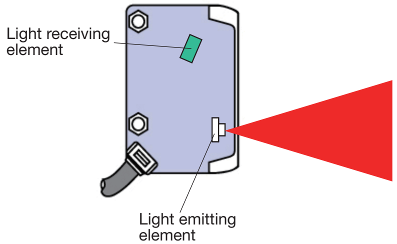
Application

Wafer notch detection

The sensor detects the orientation of the wafer. Even in a narrow device, detections are performed by limiting the distance, so mistaken detections of the background do not occur.



Wide angle diffuse reflective type

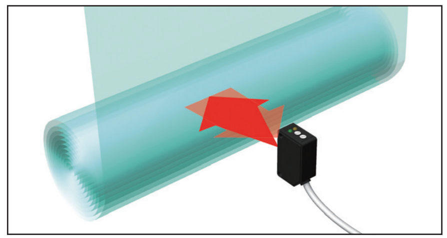


With general sensors, the light spot is narrowed, but this sensor behaves in the opposite manner: **the spot is widened**. Because the aperture is wide, this sensor type is used in applications where the signal turning ON/OFF is unstable with a small spot such as transparent objects and workpieces that have holes. Because the spot is not narrowed, the sensing distance is short.

Application

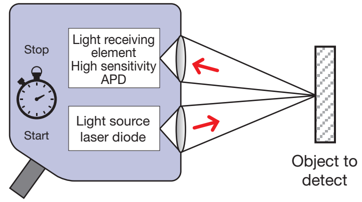
End detection for transparent film

The sensor detects the end (the end of the wound film on a roll) of transparent film. The spot light is large, so detections that are highly resistant to the effect of wrinkles and vibration in the film are possible even without using a reflector.



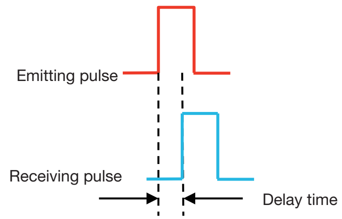
2-7. TOF (Time-Of-Flight)

TOF is an abbreviation for **"Time-Of-Flight."** In this measurement method, the time that it takes for a laser emitted from the sensor in pulses to come back to the light receiving element within the sensor is measured, and this time is then converted into distance.



Emitting pulse and receiving pulse

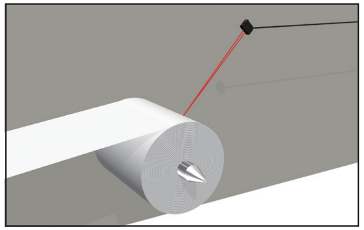
For example, assume that the waveform delay time between the emitting pulse and the receiving pulse is 10 nanoseconds. Because the speed of light is 300,000 km/s, 10 nanoseconds (0.00000001 s) × 300,000 km = 3 m. Therefore, the distance from the sensor to the target is 3 m.



Characteristics of TOF

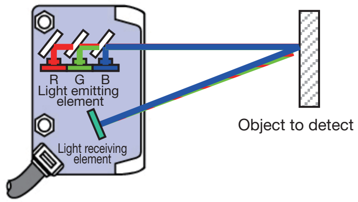
With the triangulation method of the BGS type, which determines whether to turn the signal ON or OFF according to distance just like the TOF method, detections can be performed with high accuracy at short distances but become rough at long distances. The accuracy of the TOF method is not as high as BGS, but it can perform long-distance detections with only a minor drop in accuracy.

Measurement of remaining non-woven fabric amount



2-8. Color Detection

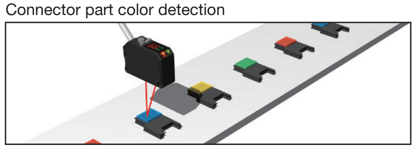
Three LEDs that emit light in the three primary colors of red, blue, and green are used, and **the color of the measurement target is identified** from the reflected light level of each color. The modes are used separately according to the application.



Color mode

RGB, the three primary colors, are emitted in order, and then the sensor identifies the color of the target. **In situations where various colors pass the sensor**, this makes it possible to detect a specific color with high accuracy.

Connector part color detection



Mark mode

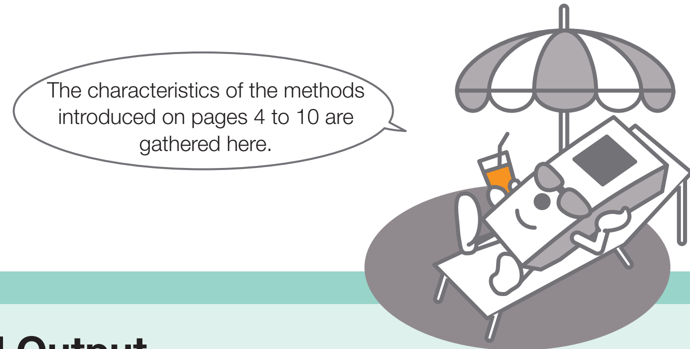
If the sensor is taught to recognize the mark and the base (2-point teaching), the sensor performs detection by automatically selecting the light source (the emitted color) that is optimal for the detection from RGB. In detections of registration marks and similar situations when **a specific color passes the sensor**, this enables high-speed and stable detections.

Tube registration mark color detection

Comparison of Different Methods

(Through-beam, retro-reflective, diffuse-reflective, BGS, TOF)

	Through-beam	Retro-reflective	Diffuse-reflective	BGS	TOF
Sensing distance	Very good	Good	Poor	Very poor	Good
Installation work and space	Poor	Good	Very good	Very good	Very good
Wiring work	Poor	Good	Good	Good	Good
Color effect resistance	Very good	Very good	Very poor	Good	Poor
Surface conditions	Very good	Very good	Very poor	Good	Poor
Background effect resistance	Very good	Very good	Very poor	Good	Poor

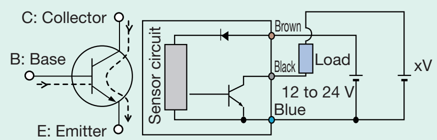


Control Output

NPN and PNP are the general transistor output types. The NPN output type is commonly used in Asia. The PNP output type is commonly used in Europe. These types differ in terms of the flow of transistor current within the sensor. In the case of the NPN output type, the current flows from the collector (C) to the emitter (E). The current flows in the opposite direction in the case of the PNP output type.

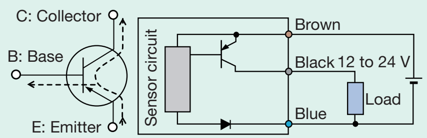
	Flow of current
NPN (Commonly used in Japan)	**Collector (C) → Emitter (E)**
PNP (Commonly used internationally)	**Emitter (E) → Collector (C)**

NPN



In the case of NPN, if the load is operated by the sensor's power supply, the power line can be made common with the sensor's power line. However, if the load is operated by a different voltage, this method can easily be used by preparing an external power supply.

PNP



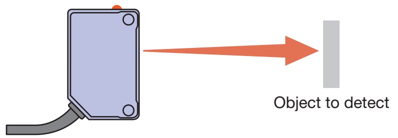
In the case of PNP, the power supply that moves the load must be common with the sensor's power supply. Therefore, this method is not as flexible as NPN.

3. Configuration

This section introduces sensors classified by unit configuration.
Photoelectric sensors are mainly composed of an optical unit and an amplifier unit.

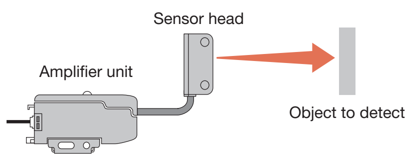
3-1. Built-in Amplifier

This is a type in which the optical unit, which performs the emitting and receiving, and the amplifier unit, which performs judgments and generates output, are included in the same device.
Because only one housing is used, this type is inexpensive.



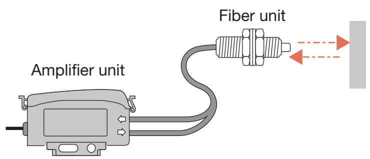
3-2. Amplifier Separate

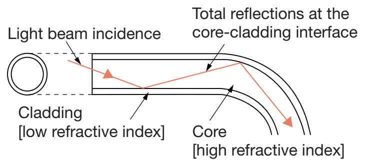
This is a type in which the head (just the optical unit) and the amplifier unit (which performs judgments and generates output) are separate. This is a product that was originally developed with the goal of miniaturization. However, as the performance of fiber sensors has increased, the main applications for this product in recent years have become long-distance detections and highly accurate discrimination using laser light.



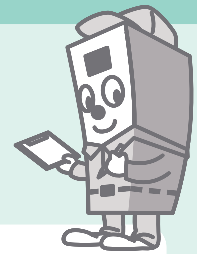
3-3. Fiber Sensor

This type is divided into a head and an amplifier, just like the amplifier separate type. However, **the light emitting element and the light receiving element are within the amplifier unit**. Light emitted from the amplifier unit passes through a fiber and shines from a fiber unit. The fiber unit only has a mounting part and a lens (many types do not even have a lens), so extremely compact fiber units can be made.





An optical fiber is composed of a core in its center and a layer of cladding, which has refractive index that differs from that of the core. Light moves along the fiber by way of repeated total reflections.



Connection Types

Cable type, connector type, and terminal block type are the three photoelectric sensor connection types.

Cable type

There is no need to prepare a separate cable. The standard cable length is 2 m. The cable can also be extended.

Connector type

Preparing a separate connector cable (optional) eliminates the need to perform wiring again when replacing the sensor. Most models have M8 connector specifications. (Some models have M12 specifications.)

Terminal block type

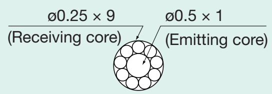
This type can support a wide variety of cables. The connections use cables having diameters ranging from 6 to 10 mm.

Fiber Sensor Terminology

[Flexible] This is a fiber unit that is suited to installation on moving parts that repeatedly bend the fiber. When using the fiber unit with something other than moving parts, [Flexible R1/R2] fiber units can be bent smaller.

[Free cut] This is a fiber unit whose fiber cable can be cut with the included fiber cutters. Using a free cut fiber makes it possible to cut unnecessary parts of the fiber in order to obtain clean wiring when the fiber cable is too long and is difficult to route.

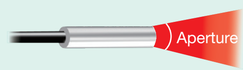
[Coaxial]
This is one type of diffuse type fiber unit. Multiple receiving cores are positioned around the emitting core. This fiber unit is used when it is necessary to perform detections with high detection positional accuracy. It is also possible to attach lenses that enable small object detection to some of these fiber units.



Detecting part detail

[Bending radius]
This radius indicates how small the fiber cable can be bent. Note that this is not the diameter. Note that bending the fiber cable smaller than the bend radius value will bend the core, which will shorten the sensing distance and make it impossible to perform detections.

[Aperture]
This is the emitting angle of the light that shines from the tip of the fiber. It is also the light receiving angle. With a normal fiber unit, the aperture is extremely wide at 60°. However, the narrow view type has a narrow aperture of 2° to 5°.

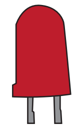


4. Light Source

Photoelectric sensors have two main types of light sources.

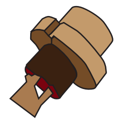
4-1. LED (Light Emitting Diode)

This is a light emitting diode. It is an **inexpensive** light source. It has poor directivity and low power, so it is not suited for the detection of small parts.



4-2. Laser (LD: Laser Diode)

This is a semiconductor laser diode. It is a **high-power** light source.
It has strong directivity and is bright, so narrowing the spot **makes it possible to detect small parts**.

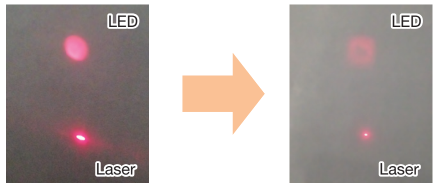


These photographs show a comparison of the laser and LED spots.

- With the laser, the spot can be narrowed.
- As the distance increases, the decrease in brightness is larger for the LED.

With an installation distance of 50 mm

With an installation distance of 300 mm



Comparison of Different Methods

The characteristics of each method are collected in the following table.

	LED type	Laser type
Price	Very good (inexpensive)	Poor
Sensing distance	Good	Very good (max. 70 m*)
Small object detection	Poor/very good (with lens)	Very good (approx. ø1 mm*)
Mutual interference	Poor	Good
Light leakage	Poor	Good
Easy alignment of light axis	Poor (The spot may be difficult to see at long distances.)	Very good
Stain resistance	Poor	Good
Durability (life/temperature)	Very good	Good

* Specifications of Optex FA products

Hazard Degrees by Laser Class

[Class 1]
By design, these lasers are inherently safe. Regardless of the optical method that is used to condense the light, the level is such that eye safety is ensured. No countermeasures are especially required.

[Class 1M]
The wavelength range is 302.5 to 4000 nm and the output is low. Using an optical method to observe the beam may be hazardous.

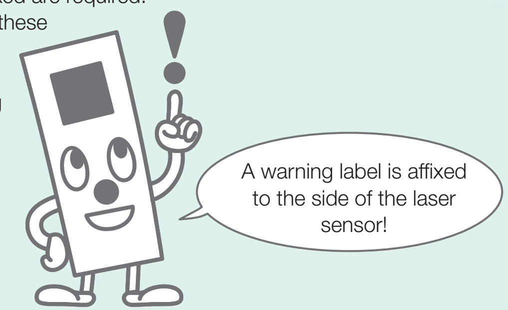
[Class 2]
The light is visible (the wavelength range is 400 to 700 nm) and the output is low. The eyes are protected by the blink reflex and other aversion responses.

[Class 2M]
The light is visible (the wavelength range is 400 to 700 nm) and the output is low. The eyes are protected by the blink reflex and other aversion responses. Using an optical method to observe the beam may be hazardous.

[Class 3R]
With these lasers, directly observing the beam is potentially hazardous, but the level of this hazard is lower than that of class 3B and higher lasers. The control countermeasures for manufacturers and users are more relaxed than those for class 3B lasers. The AEL (Accessible Emission Limit) is at maximum five times that of class 1 lasers for light other than visible light (wavelength: 302.5 nm or higher) and is at maximum five times that of class 2 lasers for visible light (wavelength range: 400 to 700 nm). These lasers do not require a key switch and an interlock system.

[Class 3B]
These lasers have an output of 500 mW or less. Observing the beam directly is hazardous. These lasers require a key switch and an interlock system. They also require a warning display or a similar device during use.

[Class 4]
These are high-output lasers that are hazardous even when viewing their dispersed light. They pose the risk of burns if they come into contact with the skin and the risk of fire if they come into contact with objects. Countermeasures such as ensuring that the emitted laser beam is blocked are required. It goes without saying that these lasers require a key switch and an interlock system. They also require a warning display or a similar device during use.

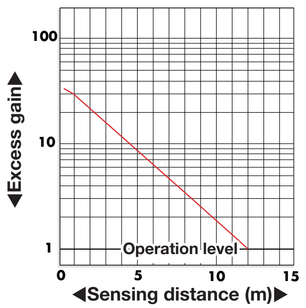


5. Characteristic Diagrams

This section explains the sensor characteristic diagrams that are included in catalogs.
The characteristic diagrams evaluate the capabilities of photoelectric sensors that cannot be expressed with specifications.

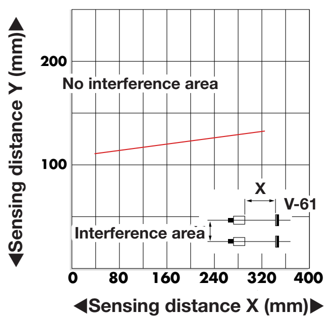
Excess gain

This indicates the amount of excess gain that is present in the received light output of the receiving part when the sensor is set to maximum sensitivity. After checking the distance on the horizontal axis, view the excess gain on the vertical axis to determine how much excess gain is present as a multiple of the operation level (excess gain 1).



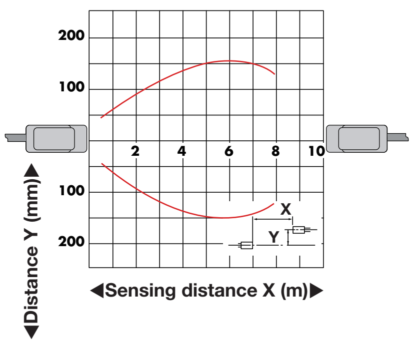
Interference area

This indicates how far apart sensors need to be installed so that interference does not occur when sensors are being used in a line. After checking the distance on the horizontal axis, view the distance between the centers of the sensors on the vertical axis to determine how far apart the sensors need to be installed.



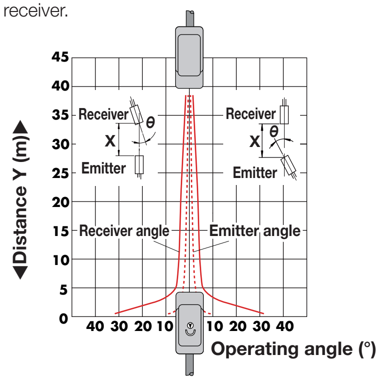
Sensing area

This indicates the degree to which the light spreads when a through-beam type sensor is set to maximum sensitivity. After checking the distance on the horizontal axis, view the spread of the light on the vertical axis to determine to what degree the light axis can be misaligned with detection still being possible.



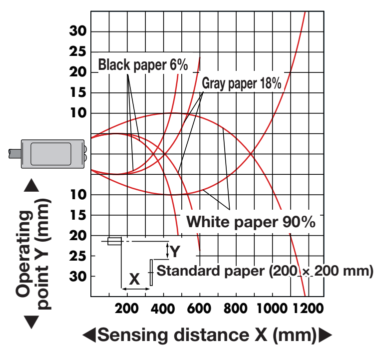
Angular deviation

This indicates to what degree the sensor or reflector can be tilted when using a through-beam type or retro-reflective type sensor. After checking the distance on the vertical axis, view the angle on the horizontal axis to determine how many degrees the sensor can be tilted with the light axis still reaching the receiver.



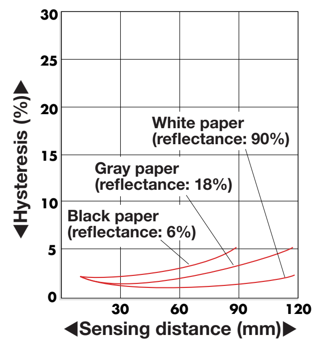
Sensing area

This indicates the area that is detected when a retro-reflective type or diffuse type sensor is set to maximum sensitivity. After checking the distance on the horizontal axis, view the spread of the light on the vertical axis to determine the workpiece detection position from the horizontal direction (the mirror position for retro-reflective types).



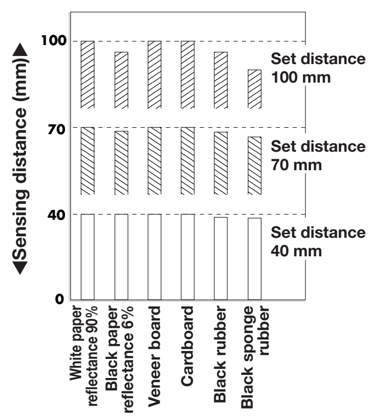
Hysteresis

This indicates how much a diffuse type sensor can differentiate height differences according to the color of the object to detect. After checking the color of the object to detect and the distance on the horizontal axis, calculate distance × hysteresis on the vertical axis to determine how much the sensor can differentiate height differences.



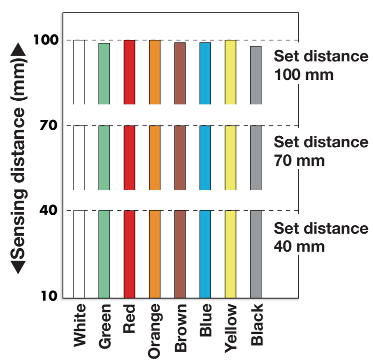
Material response

This indicates the degree to which a BGS type or TOF type sensor is affected by the material of the object to detect. After checking the material of the object to detect, view the distance on the vertical axis to determine how much of an error will occur for a white workpiece.



Color response

This indicates the degree to which a BGS type or TOF type sensor is affected by the color of the object to detect. After checking the color of the object to detect, view the distance on the vertical axis to determine how much of an error will occur for a white workpiece.



6. Sensor Selection

This section introduces key points for sensor selection in three steps.

Step 1 Checking detection details

First check the detection conditions. The general items that need to be checked are shown below.

Workpiece (Object to detect)

Color	Are there variations from color (reflectance) to color?
Size	Does the size vary from one workpiece to another?
Shape	Are there variations in tilt and shape?
Gloss	• Is the surface glossy? • If the surface is glossy, is the environment one in which ambient light enters the sensor?

Background (No object present)

Distance to the workpiece	If the workpiece and the background are close, it is difficult for there to be a difference between the reflected light levels. → It is difficult to perform detections with diffuse types, so consider detection with a through-beam type or a BGS type.
Color	Is the color difference with the workpiece sufficient? → If the workpiece is black and the background is white, the reflected light level may be equivalent.
Gloss	Is the surface glossy or made of stainless steel? If the surface is glossy, is the environment one in which ambient light enters the sensor?

Step 2 Considering detection type

Consider the stable detection type that gives the largest difference with the background (the OFF status) when a workpiece is present (the ON status).

Consider the detection type.

Consider the sensor type.
The normal detection stability order among the different type is shown below. (The type with the highest stability is shown on the left.)

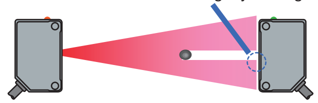
Through-beam > Retro-reflective > BGS/TOF > Diffuse-reflective

Consider the safest method.

Consider the method that has the largest difference between when the workpiece is present and not present and that can perform stable detections.
For example, when detecting a small workpiece like that shown below, using a fiber sensor leads to 100% of the light being blocked when the workpiece is present, which enables stable detection.

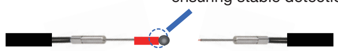
✕ Bad example

Light is not completely blocked. Workpieces may not be detectable if slightly misaligned.



○ Good example

The narrow effective light axis means light is completely blocked, ensuring stable detection.



Step 3 Verifying other conditions

Even if detection is possible, you have to exercise caution in checking whether a sensor can be used with the actual line.
The points that cause problems with actual lines are shown below.
Be sure to check these points before using a sensor.

Checking the line speed (response time)

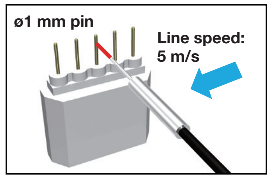
Check the takt and the line speed. With high-speed lines, perform tests using the actual line whenever possible. Exercise caution especially when using a fiber sensor to detect small workpieces because the detection time is short and a fast response is required.

<Calculation example>

Response time calculation method

$$\text{Response time} = \frac{\text{Size of the object to detect}}{\text{Movement speed}}$$

When detecting a pin with a diameter of 1 mm on a line that moves at a speed of 5 m/s, what should the response time be of the sensor that you select?



$$= \frac{1\ (\text{mm})}{5\ (\text{m})} = \frac{1\ (\text{mm})}{5{,}000\ (\text{mm})}$$

$$= 0.0002\ (\text{s}) = 0.2\ \text{ms}\ (200\ \mu\text{s})$$

A. You should select a sensor with a response time of 0.2 ms or less.

Ambient environment

Check whether the ambient environment can be used according to the sensor specifications.

Temperature

Sensors cannot be used in environments that are outside of their ambient temperature range. In high-temperature applications such as those inside of furnaces, use heat-resistant fibers.

Oil

Even if a sensor has a degree of protection (IP), oil will still penetrate into the sensor, so oil cannot be used. Sensors may be degraded by volatile oil in the air such as that generated by machine tools.

Water/dust

The water and dust resistance is prescribed by the degree of protection (IP). However, even with a rating of IEC: IP67, a sensor cannot be used if it is submerged under water at all times. The IP indicates the water resistance against temporary water such as that during cleaning.

Noise

It is extremely rare for a sensor to be damaged by noise. However, strong noise may lead to signals turning ON and OFF being detected in a manner that is different than what it should be. Motors and inverters are sources of strong noise, so consider countermeasures such as changing the installation position and using shielding to block the noise if you suspect that noise is a problem.

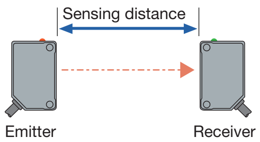
7. Terminology

This section introduces the minimal amount of terminology that you should remember when handling photoelectric sensors.

[Sensing distance]

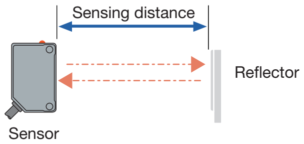
Through-beam type

This is the distance from the emitter to the receiver.



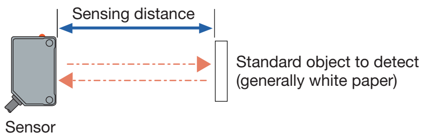
Retro-reflective type

This is the distance between the sensor and the reflector.



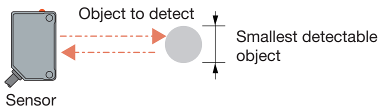
Diffuse type

This is the distance from the sensor to the standard object to detect.



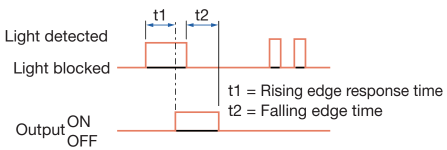
[Smallest detectable object]

This is the size of the object that can be detected with the settings configured to detect small objects most easily.



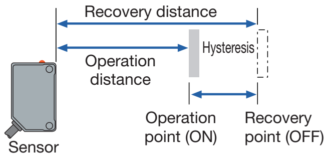
[Response time]

This is the time during which the sensor can judge that the object to detect is present.



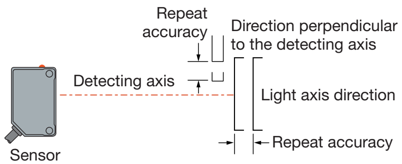
[Hysteresis]

This is the difference between the distances to the position at which the diffuse type sensor turns ON when approaching an object to detect from the front and the position at which the diffuse type sensor turns OFF when moving away from the above position.



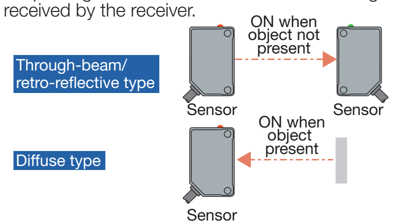
[Repeat accuracy]

This is the amount of variation in the positions that cause the sensor to turn ON.



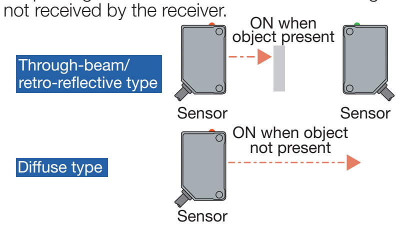
[Light ON]

Output is generated when a fixed amount of light is received by the receiver.



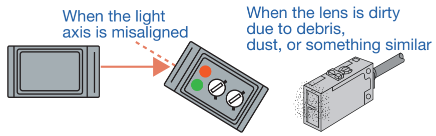
[Dark ON]

Output is generated when a fixed amount of light is not received by the receiver.



[Self-diagnosis output]

This function outputs an alarm without stopping the control output when the receiving light level is unstable due to light axis misalignment or a dirty lens surface.

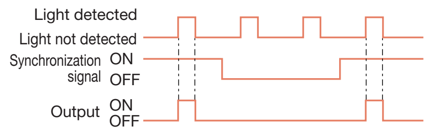


[Test input/laser OFF input]

An external signal can be used to stop the emission of light from the light source, which makes it possible to electrically create a state in which the light is not detected. This function can be used to perform operation inspections without causing the photoelectric sensor to operate with an object to detect.

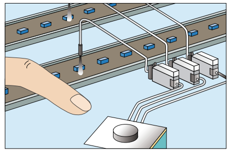
[Synchronous input]

This function operates the sensor with the required timing by applying a synchronization signal.



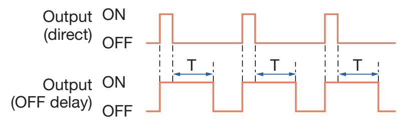
[Teach input]

This is a function for adjusting the threshold externally without pressing any buttons on the sensor.

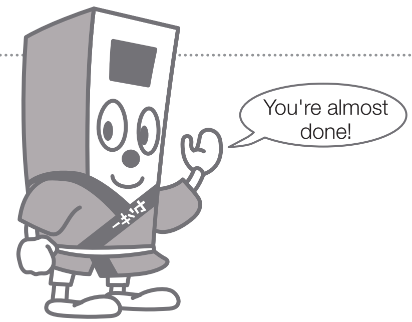


[OFF delay timer]

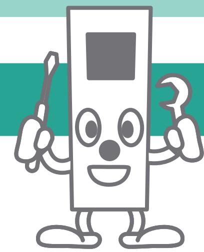
This is a timer function that delays the time when the output is turned OFF. Use it when applying input to machines that are slow in capturing this input.



* OFF delay timer with time set to T



8. Precautions



This section contains precautions that you should read before installing a photoelectric sensor.

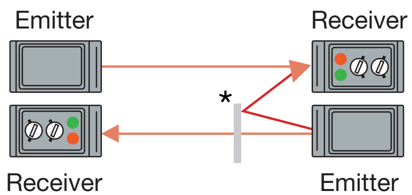
1. General notes

- When using a switching regulator for the power supply, be sure to ground the frame ground terminal.
- Avoid use in the transient state while the power is on (approximately 700 ms to 2 s depending on the model).
- Avoid wiring in parallel with or in the same wiring piping as high-voltage wires or power lines.
  These situations may lead to malfunctions due to induction.

2. Mutual interference

When sensors are installed in a line, operation may become unstable due to the effect of the light from another sensor. In this situation, use the following methods to prevent mutual interference.

(1) Use inter-connection type fiber amplifiers.
(2) Refer to the interference area characteristic diagram and remove the devices to a distance where interference does not occur.
(3) When using a through-beam type, equip it with a slit or a polarizing filter.
(4) When using through-beam types and retro-reflective types, install them in alternating order.
(* Exercise caution to prevent the light from the adjacent sensor reflecting off of the object to detect and being received by the receiver.)



3. Ambient illuminance and the effect of noise

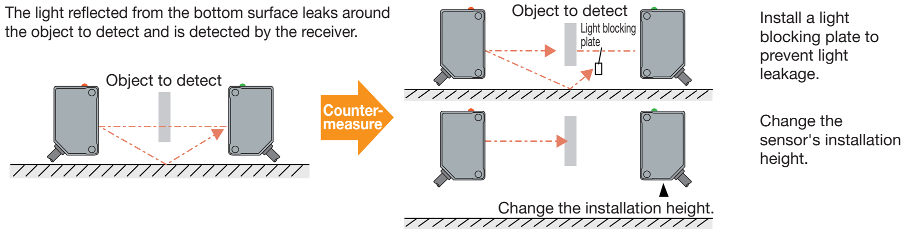
Because photoelectric sensor light is modulated, it is difficult for these sensors to be affected by ambient light. However, high-frequency fluorescent light or sunlight entering the receiver directly through its front may lead to malfunctions. In these situations, prevent the effect of ambient light by implementing countermeasures such as changing the installation angle and installing a light blocking plate.

Illuminance guidelines

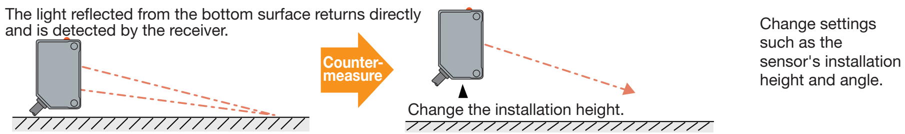
- Sunlight at midday on a clear day .... 100,000 lx
- Factory/office .... 400 to 1,500 lx
- Sunlight at midday on a cloudy day .... 30,000 lx

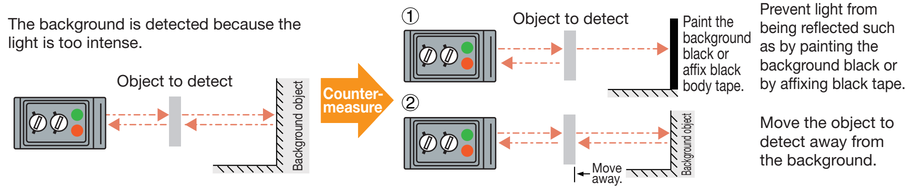
4. Effect of other objects in the installation area

Through-beam type



Diffuse type

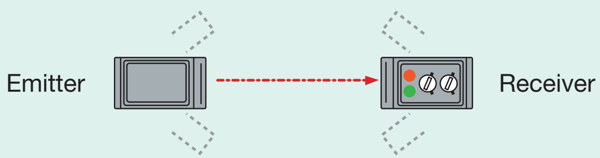


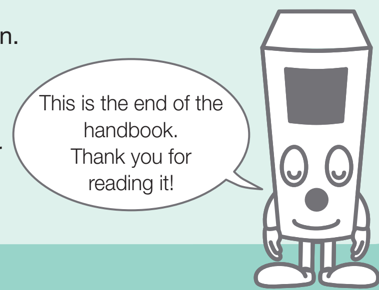


③ Change the model to the BGS series (distance setting type sensor).

Light Axis alignment

(1) Place the emitter and receiver in a straight line so that they face each other.
(2) Pan the emitter to the left and right and check the range that will be used for the light detection operation while viewing the operation indicator. Install the emitter in roughly the center of this range.
(3) Pan the receiver to the left and right and check the range that will be used for the light detection operation while viewing the operation indicator. Install the receiver in roughly the center of this range.
(4) Perform the same adjustment in the vertical direction.





8. Precautions