OMRON

Light convergent reflective type sensor

B5W-LB series

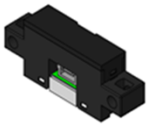
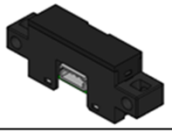
User's Manual

Light convergent reflective type sensor

E592-E1-02

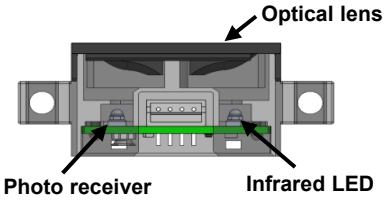
1 Outline

This user manual describes usage guidance and special matters regarding the light convergent reflective sensor; B5W-LB series. This document makes supplementary statements to the data sheet and the product specification sheet. Therefore, please read this manual in order to effectively use the sensors within your actual application.
The following table shows the product line of the B5W-LB series. The digital output models are easy to use sensors that can operate with 24 volts and can be connected to a PLC. The analog output model can be directly connected to an A/D input terminal of a microcomputer. It is good to use for applications which require threshold level adjustment.

	B5W-LB11series		B5W-LB21 series		
Output method	Digital output		Digital output		Analog output
Figure	Super miniature type 		Miniature type 		Miniature type 
Sensing distance (White paper)	2 to 10 mm		10 to 55 mm		10 to 55 mm
Supply voltage	24 VDC +/- 10%		24 VDC +/- 10%		5 VDC +/- 10%
Output configuration	Light ON	Dark ON	Light ON	Dark ON	-
Operation indicator lamp	Available	Not available	Available	Not available	-

2 Construction

The B5W-LB series consists of an optical lens (with visible light cutting filter), an infrared LED, a light receiver, and an analog circuit, as shown below.



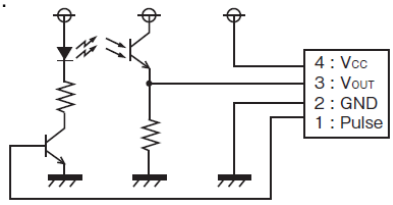
Note: A variable resister is mounted in the analog output model. Since it is for Omron's internal use only, it should not be touched. Otherwise the sensor will not meet the product specification sheet.

2.1 Analog output model

The internal circuit of B5W-LB2101 is shown in the upper-right figure.

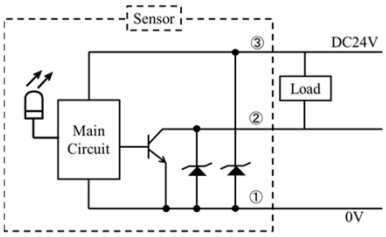
- The LED device should be driven with a pulse signal from an external circuit.
- The threshold level for the output voltage should be properly set according to application details such as sensing distance, objects sensed, and so on.

Regarding recommended pulse signal and external disturbing light canceling processing method, please refer to page 6. Usage guidance (Circuit).



2.2 Digital output model

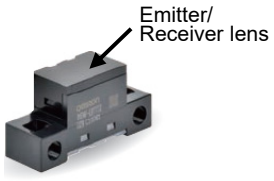
The internal circuit of B5W-LB2114 is shown in the lower-right figure. The digital output model includes an LED pulse-driven circuit and its threshold level is fixed. The model has an NPN open collector output. Only sensor with operation indicator lamp types lights.



3 Outline dimensions

The outline dimensions of the B5W-LB series are shown below. Please refer to the data sheet for more details.

(1) Super miniature type: B5W-LB11 series



Size: 26mm X 8.4mm X 13mm

(2) Miniature type: B5W-LB21 series

Size: 40mm X 8.4mm X 15.9mm

For wiring, connector with cable: EE-5002 1M can be provided as an optional accessary.

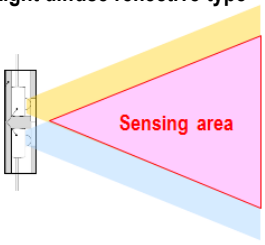
* This wire harness assembly is available only for the digital output models (3-pin), not for the analog output model.

形EE-5002 1M

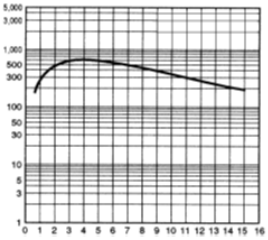
4 Product features

Reflective optical sensors can generally be categorized into two types; light diffuse reflective and light convergent reflective. The optical paths of both the emitter and the receiver in the light convergent type are narrower and more angular than those of the light diffuse type. This optical convergent design can enhance its sensing ability for low-reflective objects because of its high density light beam. The sensing area of the convergent type is thereby limited as shown by the figures below.

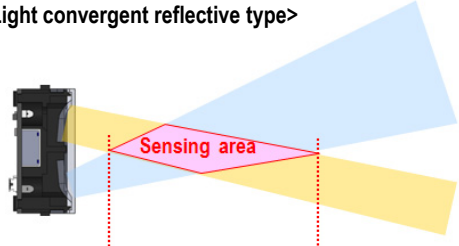
<Light diffuse reflective type>



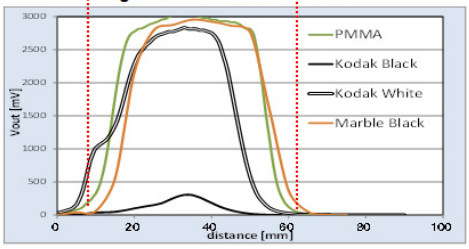
<Sensing distance Characteristics>



<Light convergent reflective type>

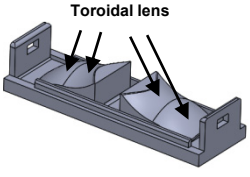


<Sensing distance Characteristics>



The B5W-LB series is composed of light convergent reflective type sensors utilizing Omron's original optical lenses which are combined with 4-toroidal lens designs. These sensors can provide stable sensing with a small amount of reflected light, and even black paper and transparent plates can be detected in its wide sensing range. Furthermore, the B5W-LB series will not detect any highly reflective background that is positioned beyond the sensor's sensing area.

Toroidal lens



5 Usage guidance (Detection)

Analog and digital output models are lined up in the miniature type B5W-LB series. Both models have the same optical characteristics. In order to provide a better understanding of B5W-LB series, the analog output model will be explained first.

5.1 Analog output model

The table “Electrical and Optical Characteristics” mentioned in the data sheet of B5W-LB2101 is shown below. The sensor can be used in any application which requires detection of a wide variety of objects. However, within the table, only white and black papers are used to specify the sensing distance characteristics. (See explanation, below).

● **Electrical and Optical Characteristics (Ta= 25°C, Vcc= 5.0 V)**

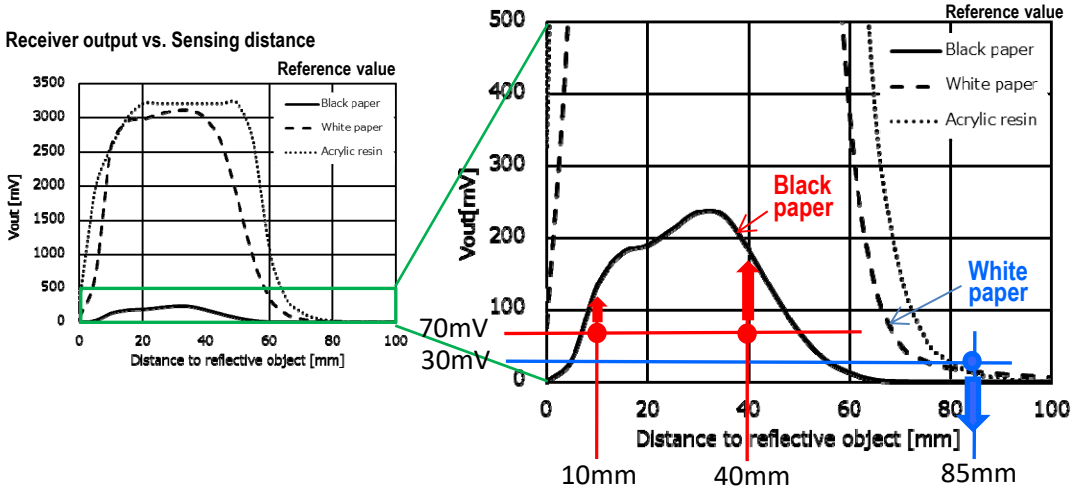
Item	Symbol	Value			Unit	Condition
		MIN.	TYP.	MAX.		
Operating voltage	Vcc	4.5	5.0	5.5	V	---
Maximum output voltage Forward voltage	Vomax	---	3.3	---	V	---
Sensing distance (Black paper)	Lrange	10	---	40	mm	Black paper, Vo≥70 mV
Sensing distance (White paper)	Lrange	10	---	55	mm	White paper, Vo≥70 mV
Non-sensing distance (White paper)	L	85	---	---	mm	White paper, Vo<30mV

The sensing capability of a sensor can be verified with the graph “Receiver output vs. Sensing distance characteristics”. The graph of B5W-LB2101 is shown below.
The sensing distance with black paper can be read as follows;

-Sensing distance (Black paper):
The output voltage should be 70 mV or more in the distance range of 10 to 40 mm.

The non-sensing distance with white paper is read as follows;

-Non-sensing distance (White paper):
The output voltage should be 30 mV or less in the distance range of 85 mm or more.



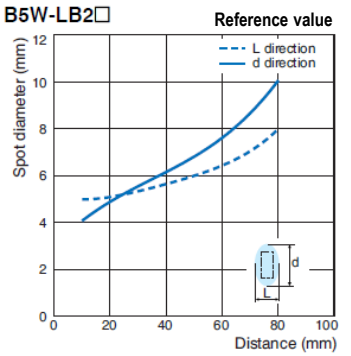
When designing your actual application, the sensing distance should be properly determined by first referencing the graph of “Receiver output vs. Sensing distance.” In the case that the sensing object position does not fluctuate, the sensing distance is recommended to be set at the peak of the graph’s curve.
As previously stated, commercially available white and black papers are used to specify the characteristics values in the product specification sheet. However the sensed objects are typically not black or white papers in actual applications. Therefore it is necessary to measure “Output voltage-sensing distance” with the actual objects to be sensed. It is essential to set a proper threshold level according to the evaluation test data obtained for the considerable worst case conditions, in order to achieve long term stable sensing in your applications. Additionally, it is ideal to test as many samples as possible to consider individual differences of sensors. The recommended minimum threshold is 40 mV, but this depends on the actual environmental noise situation.

In the case of detecting small objects, or background objects existence:

Ideally, the size of the actual object to be sensed must be bigger than the emitter's lighting spot. Since the B5W-LB series carries an infrared LED, the light spot is invisible. However the size of the spot can be checked according to “Spot diameter-distance characteristics” (reference value) or “Operating range” (reference value).

When any background objects which B5W-LB should not detect are located in the sensing area, the objects should be ideally eliminated from the area to achieve a stable sensing. For example, the background objects/plates might be partially cut off, considering the size of the sensing spot location.

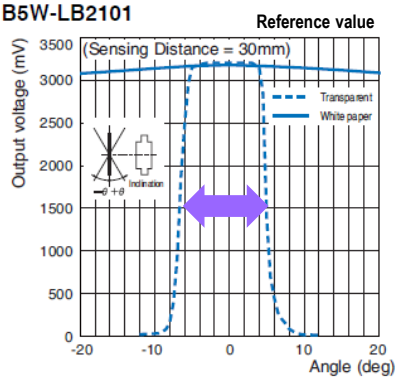
Spot diameter - distance characteristics



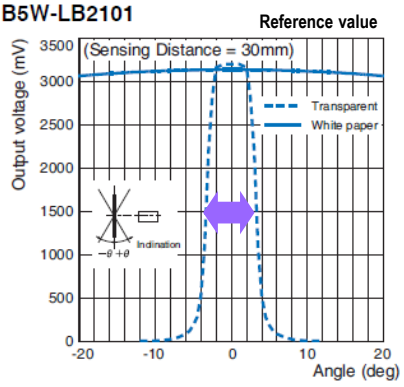
In the case that the sensing objects have a glossy surface (mirror, glass plates, etc.);

It is necessary to consider the mounting position of the sensor with respect to the angular position of the sensed object, in both the vertical and horizontal planes. This is because the output voltage will greatly depend on the angle, due to the optical design of B5W-LB. For glossy objects, the sensor should essentially be mounted at a right angle to the objects. Please refer to “Angular characteristics” (reference value) in the data sheet. According to the data, mounting the sensor vertically, instead of horizontally, will be preferable if angular fluctuations of the glossy objects occur.

Angle characteristics (Up and down)



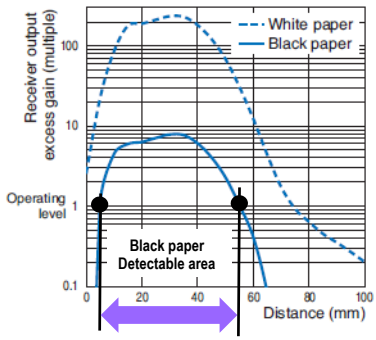
Angle characteristics (Left and right)



5.2 Digital output model

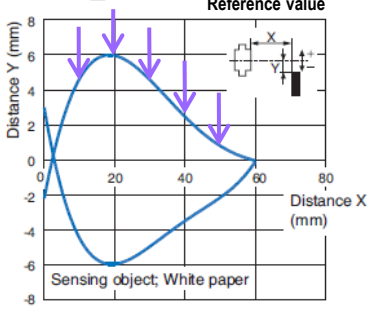
"Receiver output – Sensing distance characteristics" is the most suitable graph to understand the sensing ability of optical sensors. The vertical axis of this graph shows excess gain of receiver output. Excess gain 1 is equal to the threshold level of the sensor.
According to the graph of B5W-LB21, the detectable area for black paper is the distance from the crossing point of excess gain 1 and the characteristic curve to the other crossing point.
When the sensing ability is verified in your actual application, it is important to use testing objects which have lower reflective characteristics or are smaller than the actual objects for long term and stable sensing.

Receiver output – sensing distance characteristics
B5W-LB2112/LB2122 Reference value

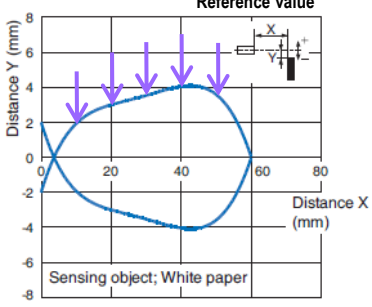


Please see "Operating range characteristics" (reference value) below. The curve in this graph shows operating points (turn OFF to ON with Light –ON type) when an object to be sensed travels in the arrow's direction for each sensing distance.

Operating range (Up and down)
B5W-LB2□ Reference value



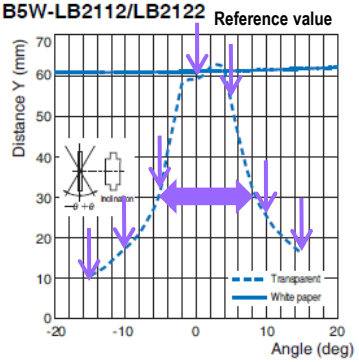
Operating range (Left and right)
B5W-LB2□ Reference value



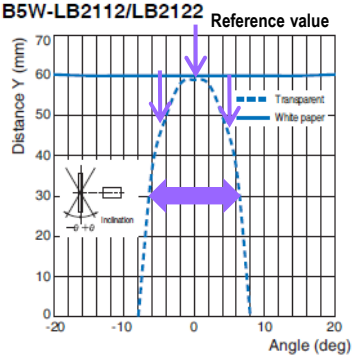
In the case of detecting moving objects, a reflective type sensor is generally mounted vertically to the surface on which the light emitting axis and the light receiving axis are crossing (equal to "Left and right" direction) .

As described in section 5.1 analog output model, it is important to consider the mounting direction of the sensor when detecting glossy objects. Please refer to "Angle characteristics" of the digital output models below.
The characteristic curves show operating points (turn OFF to ON with Light –On type) when a tilted object is traveling to the sensor.

Angle characteristics (Up and down)
B5W-LB2112/LB2122 Reference value



Angle characteristics (Left and right)
B5W-LB2112/LB2122 Reference value

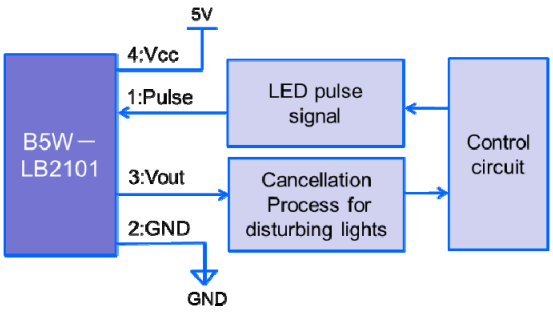


6 Usage guidance (external circuit)

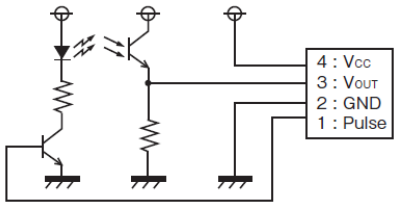
6.1 Analog output model

The B5W-LB series is designed to detect dark colored objects with a relatively greater LED current. Therefore, the LED should be driven by a pulsed current in order to minimize the stress imposed on the LED and to increase the life of the LED. Additionally the pulsed LED circuit can be used for a cancellation process (with external circuit), alleviating the effects of external light interference.

The connection diagram and the internal circuit of B5W-LB2101 are shown below:

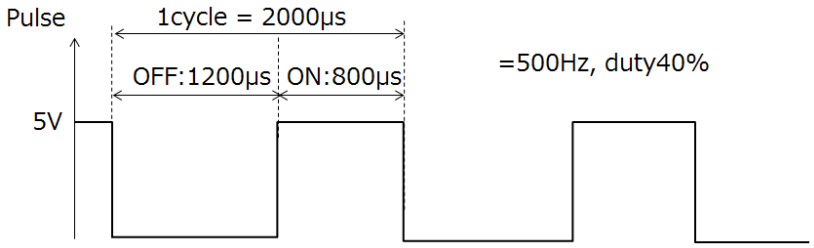


B5W-LB2101 Internal circuit



(1) LED pulse signal input

The recommended pulse signal into the terminal (Connector pin: #1) is shown below.



Notes: *On time (Pulse width): When pulsing the LED, the output becomes stable within 400 micro sec., max. Therefore 800 (>> 400) micro sec. of on time is recommended, to ensure proper operation.

**Duty cycle: According to the LED characteristics, duty cycle should be 40% or less.

(2) Sampling timing for sensor output

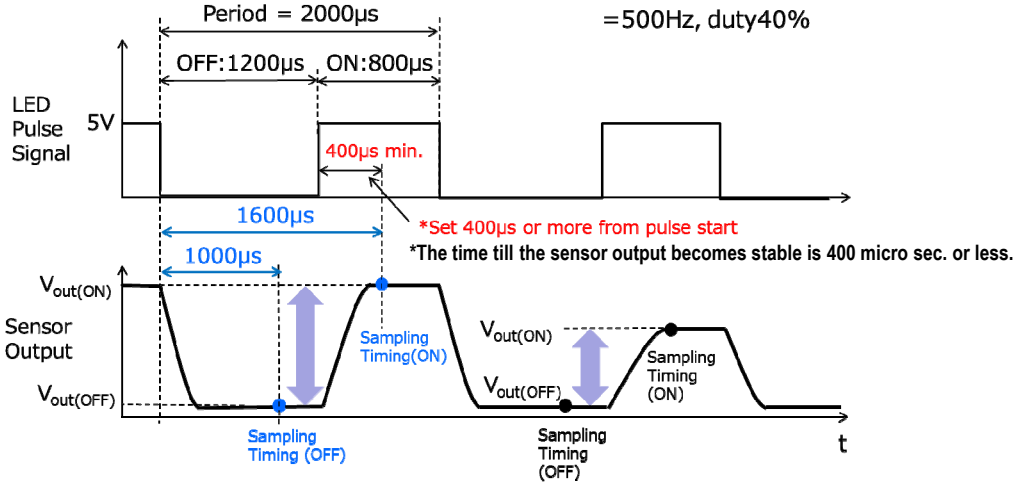
Considering the sensor response time, the recommended sampling timing of sensor output is shown below;

-**Vout(OFF)**: Output voltage when LED is turned off

*The sampling timing for Vout(OFF) : 1,000 micro sec. after the end point of LED pulse

-**Vout(ON)**: Output voltage when LED is turned on

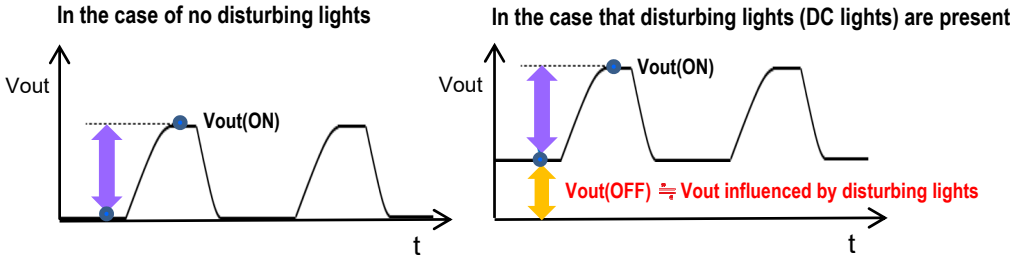
*The sampling timing for Vout(ON): 1,600 micro sec. after the end point of LED pulse



(3) Cancellation processing for external disturbing light interference (DC lights)

Next procedure is to calculate the difference of the two output voltage (Vout(ON) and Vout(OFF)) in order to cancel the influence of external disturbing lights. This voltage difference can be regarded as the voltage generated by sensing the object, in the absence of external disturbing lights.

Radical output voltage without disturbing lights = Vout(ON) - Vout(OFF)



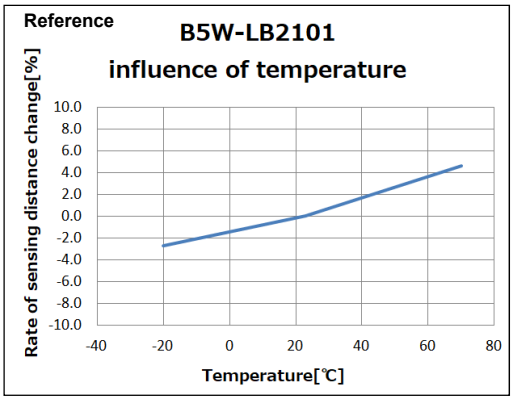
(4) Optimum threshold level setting

The analog output model of the B5W-LB series detects objects using the above recommended external circuits. In order to stably detect the objects to be sensed, proper evaluation should be performed considering the potential worst case conditions of the actual application. For example, the threshold level should be properly set using actual object samples that have the lowest reflection factor out of all of the actual objects to be sensed. Worst case design methods considers all factors that will change the sensor output voltage, such as; variations in sensing distance, angle, size, surface conditions of objects, and ambient temperature. If there are any objects or background surfaces which should not be detected in the sensing area, then the proper threshold level should be set, considering the potential influence they'll have on the output voltage.

(4) Others, reference data

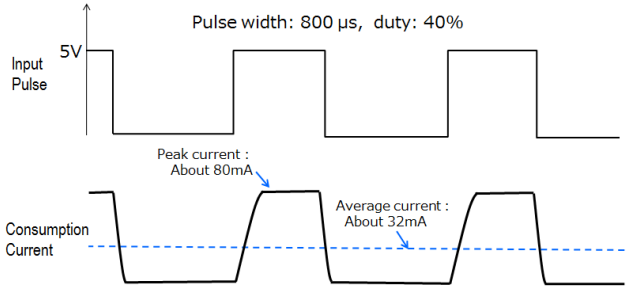
The influence to sensing distance by ambient temperature:

The sensing distance of B5W-LB will be changed by ambient temperature. The reference data is shown below.



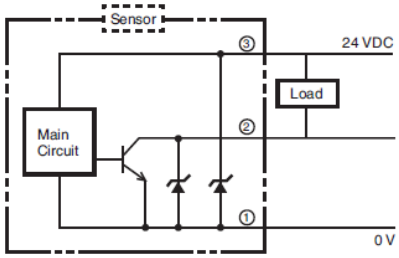
The average consumption current:

In the case that this sensor is operated with the recommended input pulse, the average current consumption is approximately 32 mA.



6.2 Digital output model

The digital output model contains an LED driving circuit and a dedicated photo IC (with fixed threshold level). As shown below, the output of the Main Circuit is routed through an NPN open collector transistor (Both, internal to the sensor). Regarding the wiring, please refer to the data sheet or “Precautions for use” in the product specification sheet.



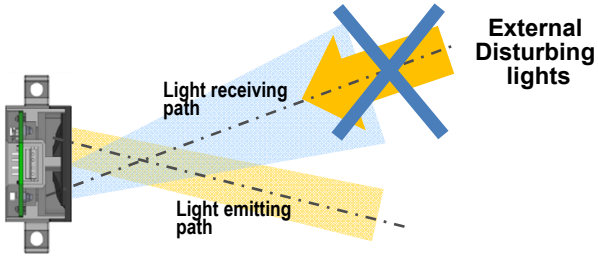
The digital output model has a fixed threshold level internally. If there is any object/background which should not be detected in the sensing area, the mechanical design should be modified to avoid detecting those objects. Alternatively, please try to use the analog output model with proper threshold level setting.

7 Mounting instruction

1. The B5W-LB series can be mounted in 2 potential ways (X,Y direction). Please refer to the data sheet for further detail.

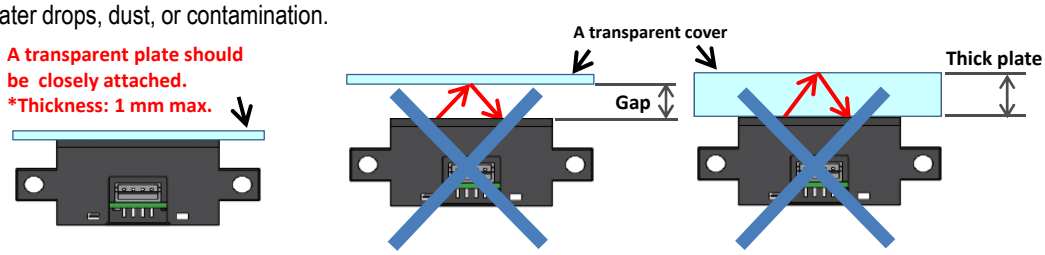
   * Please use M3 screw, spring washer, and flat washer with tightening torque of 0.54 N-m.

2. The B5W-LB series contains a special circuit that reduces the influence of external light interference. However, it is recommended that designers create proper equipment design in which any direct or indirect external disturbing light does not hit the sensor. In the case that the sensing surface must be exposed to ambient light, please mount the sensor as shown below. Since the B5W-LB series has a narrow path angle of light receiving, the sensor should be mounted in a direction which prevents external light from entering the light receiver.

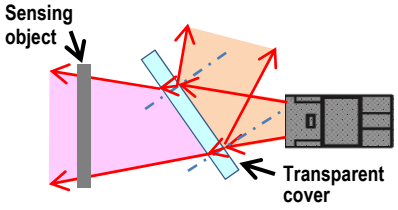


3. In the case of attaching a transparent cover on the sensor for water/dust prevention purpose, the plate must be closely attached to the sensing surface of the device. Depending on the thickness of the cover plate, the reflected light at the inside surface of the plate will reach the sensor receiver. Therefore, proper evaluation should be performed, especially for the super compact type which has a short sensing distance and a fixed threshold level.

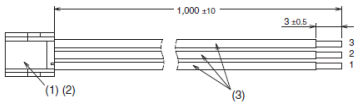
   For example: variation of clearance gap, sensor's individual difference, and contamination of the cover, such as by water drops, dust, or contamination.



4. In the case that a transparent cover is required to be located away from the sensor, try to check the possibility of tilting the cover. This design can eliminate the reflected light from the cover to the sensor (see the figure below). However, this way may make the sensor always turn on when the conditions of the cover surface is compromised, due to scratches, water drops, dust or contamination. Sufficient evaluation for proper threshold level will be required by checking the sensor output voltage with the analog output model.



4. Regarding wiring, please refer the followings. The wire harness of EE-5002 1M is provided for the digital output models. It can not use for analog output model.



Wiring

Connector circuit number	Lead-wire color
1	Blue
2	Black
3	Brown

No.	Name	Model/ Specifications	Quantity	Manufacturer
(1)	Connector, HS for 101-150 harness	GHR-03V-S	1	JST
(2)	Connector, CT for 101-150 harness	SSHL-002TP0.2	3	JST
(3)	Lead wires	UL1061 AWG26	3	—

The wire length should be basically designed 2 m max. In the case of longer wiring, please put a capacitor more than 10 micro F (ex. Aluminum electrolytic one) within 2 m. Please see data sheet for more details.

8 Frequently asked questions

Question: Can the analog output type distinguish between different kinds of objects?
Answer : The B5W-LB series has a special optical design which can detect a variety of objects in the sensing area. However, the sensors can not distinguish between the kinds of objects that are sensed, using the difference in the reflection factors of the objects. Please, refer to 4 - Product features.

Question: The analog output type has a variable resistor. Can it adjust the sensor's sensitivity?
Answer : This variable resistor is used only for our internal inspection. You should not alter its position, which is set by the factory. Otherwise the sensor will not meet Omron's guaranteed product specifications. Instead, please set a threshold level for your specific application, using actual objects to be sensed. Regarding the threshold level setting, please, refer to 6 - Usage guidance (external circuit).

Question: What is the minimum size of object to be sensed?
Answer : The object should be larger than the emitter's light spot, which varies with distance. Since the B5W-LB series uses an infrared LED, the light spot is invisible. So please refer to "Spot diameter-distance characteristic" or "Operating range" on the data sheet. Please, refer to 5 - Usage guidance (Detection) .

Question: What is the procedure when the sensor is influenced by external disturbing light interfernce?
Answer : The digital output type of B5W-LB contains a special circuit that minimizes the influence of disturbing lights. However please implement a mechanical design which prevents any external disturbing light from penetrating into the light receiving surface of the sensor. In the case of that the sensor must be exposed to ambient lights, please refer to 7 - Mounting instruction (No.2).

Question: Can this sensor detect reflective objects (mirror, glass plate) inclined at varying angles?
Answer : B5W-LB series has a special optical design which has a narrow and strong light beam. If a reflective object is tilted against the light receiving surface of the sensor, the specular light will not return to the sensor. So in the case of detecting glossy objects, the objects should be set parallel to the sensor. For further details, please see 5 - Usage guidance (Detection).

Question: Is it possible to put a transparent cover in front of the sensor for dust/water prevention purpose?
Answer : The B5W-LB series will detect a transparent plate. It is better to avoid using covers. When absolutely necessary, the transparent cover should be closely attached on the sensor. For details, please see 7 - Mounting instructions (No.3).

Question: Is the wire harness for B5W-LB series commercially available?
Answer : A wire harness (with 1 m long wires) for the digital output types is available. The part number is EE-5002 1M. However a wire harness for the analog output types is not available. The datasheet provides information about the mating connectors you would use for connection to your circuit.

Question: How long can the connecting wires be extended?
Answer : We recommend that the longest wire length should be no more than 2m. If longer wires are necessary, please use capacitors according to the instructions described on the product specification sheet.

9 Warranty, Limitations of Liability

9.1 Warranty, Limitations of Liability

Warranties

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Programmable Products

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