Vishay Infrared Receivers for Presence Sensor Applications

By Dr. Sebastian Schäfer

INTRODUCTION

The presence detection function utilized in such applications as smart bins, gate access, soap dispensers, and parking lot sensors is often based on optical sensors in a reflection geometry design (Fig. 1). These sensors usually contain an IR emitter and a photodetector mounted side by side in a common housing facing in the same direction (Fig. 2, Left). The light transmitted from the emitter can only return to the detector if it is reflected on the surface of an obstacle. In the simplest kind of presence detection, the output state of the receiver will indicate only if an obstacle is in front of the sensor or not.

Fig. 1 - Examples of Reflective Sensor Applications

The signal strength at the receiver is not only a function of the distance to the object, but it also depends on the properties of the object, such as size, shape, color, and surface roughness (Fig. 2, Right). The ability to reflect light or radiation can also be expressed in units of reflectivity. The reflectivity of the object is a crucial point, since in many applications the target objects are diverse and not well defined.

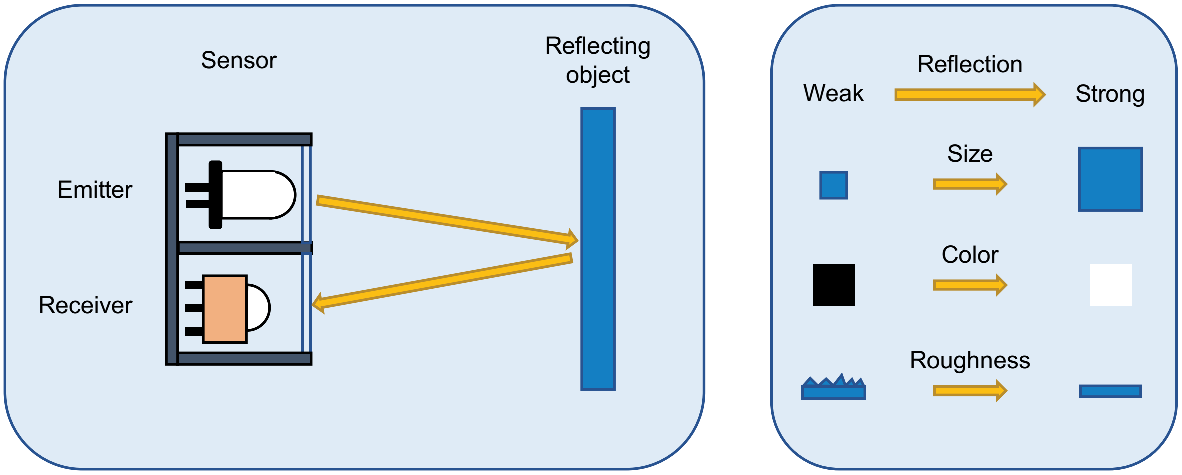

Fig. 2 - Left: Reflective Sensor With Emitter and Receiver in a Common Housing,
Right: Object Properties That Influence the Reflected Signal Strength

Vishay Infrared Receivers for Presence Sensor Applications

For example, a toilet flush sensor must react to all kinds of textiles, light or dark, with rough or smooth surfaces, but a rough dark textile will reflect less light than a smooth light one and this will affect the detection range of the sensor (Fig. 2). It is therefore beneficial to regard the extreme cases when the detection range of a sensor is considered. Table 1 shows the relative collector current of a reflective sensor to various tested materials as guidance for the reader.

TABLE 1 - RELATIVE COLLECTOR CURRENT

KODAK NEUTRAL CARD		**PLASTICS, GLASS**	
White side (reference medium)	100 %	White PVC	90 %
Gray side	20 %	Gray PVC	11 %
PAPER		Blue, green, yellow, red PVC	40 % to 80 %
Typewriting paper	94 %	White polyethylene	90 %
Drawing card, white (Schoeller Durex)	100 %	White polystyrene	120 %
Card, light gray	67 %	Gray partinax	9 %
Envelope (beige)	100 %	**FIBER GLASS BOARD MATERIAL**	
Packing card (light brown)	84 %	Without copper coating	12 % to 19 %
Newspaper paper	97 %	With copper coating on the reverse side	30 %
Pergament paper	30 % to 42 %	Glass, 1 mm thick	9 %
BLACK ON WHITE TYPEWRITING PAPER		Plexiglass, 1 mm thick	10 %
Drawing ink (Higgins, Pelikan, Rotring)	4 % to 6 %	**METALS**	
Foil ink (Rotring)	50 %	Aluminum, bright	110 %
Fiber-tip pen (Edding 400)	10 %	Aluminum, black anodized	60 %
Fiber-tip pen, black (Stabilo)	76 %	Cast aluminum, matt	45 %
Photocopy	7 %	Copper, matt (not oxidized)	110 %
PLOTTER PEN		Brass, bright	160 %
HP fiber-tip pen (0.3 mm)	84 %	Gold plating, matt	150 %
Black 24-needle printer (EPSON LQ-500)	28 %	**TEXTILES**	
Ink (Pelikan)	100 %	White cotton	110 %
Pencil, HB	26 %	Black velvet	1.5 %

Note
- Relative collector current of a reflective sensor to various tested materials; the wavelength is 950 nm

Vishay Infrared Receivers for Presence Sensor Applications

DETECTION RANGE CONSIDERATIONS

The needed detection range is one of the most important criteria to keep in mind when choosing the right components for a sensor system. In a simple design, where the receiver and the emitter are facing each other (Fig. 3), a first approximation of the sensing range can be determined by the ratio of the receiver sensitivity and the emitter intensity. Under the assumption that the emitter behaves like a point source, the detection range *d* can simply be estimated by the inverse square law:

$$d = \sqrt{\frac{I_e}{E_{e\ min.}}}$$

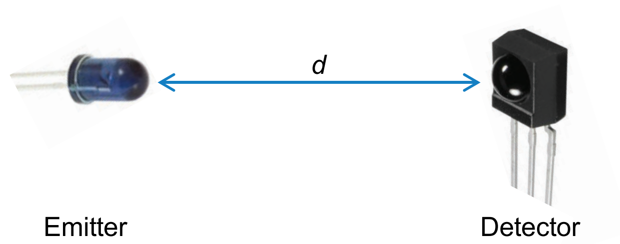

Fig. 3

where I_e denotes the intensity of the emitter and $E_{e\ min.}$ is the minimum irradiance necessary to trigger the output of the IR receiver. Both values can be found in the datasheet (see Table 2 and Table 3). A frequently used system of emitter and receiver is the TSSP4038 receiver with 0.4 mW/m^2 minimum irradiance and a TSAL6200 IR emitter with an intensity of 72 mW/sr at 100 mA. This results in a typical receiving range of

$$d = \sqrt{\frac{72\ \text{mW/sr}}{0.4\ \text{mW/m}^2}} = 13.4\ \text{m}$$

TABLE 2 - TSSP4038 DATASHEET
ELECTRICAL AND OPTICAL CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply current (pin 3)	E_v = 0, V_S = 5 V	I_{SD}	0.55	0.7	0.9	mA
	E_v = 40 klx, sunlight	I_{SH}	-	0.8	-	mA
Supply voltage		V_S	2.5	-	5.5	V
Transmission distance	E_v = 0, test signal see Fig. 1, IR diode TSAL6200, I_F = 50 mA	d	-	12	-	m
Output voltage low (pin 1)	I_{OSL} = 0.5 mA, E_e = 2 mW/m^2, test signal see Fig. 1	V_{OSL}	-	-	100	mV
Minimum irradiance	Pulse width tolerance: $t_{pi} - 5/f_0 < t_{po} < t_{pi} + 6/f_0$, test signal see Fig. 1	$E_{e\ min.}$	-	0.4	0.7	mW/m^2

Vishay Infrared Receivers for Presence Sensor Applications

TABLE 3 - TSAL6200 IR EMITTER DATASHEET
BASIC CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Forward voltage	I_F = 100 mA, t_p = 20 ms	V_F	-	1.35	1.6	V
	I_F = 1 A, t_p = 100 μs	V_F	-	2.2	3	V
Temperature coefficient of V_F	I_F = 1 mA	TK_{VF}	-	-1.8	-	mV/K
Reverse current	V_R = 5 V	I_R	-	-	10	μA
Junction capacitance	V_R = 0 V, f = 1 MHz, E = 0	C_j	-	40	-	pF
Radiant intensity	I_F = 100 mA, t_p = 20 ms	I_e	40	72	200	mW/sr
	I_F = 1 A, t_p = 100 μs	I_e	340	600	-	mW/sr

In most home applications, reflections from nearby walls tend to increase the transmission distance, which leads to an underestimation of the above formula. Fig. 4 shows a comparison between transmission distances in free air and in a corridor to show this effect. The transmission distance given in the datasheets takes these reflections into account and therefore deviates from the simple inverse square law results. Nevertheless, the formula is a useful tool to get a rough estimate of the receiving range to be expected with a given emitter receiver pair. It is also worth mentioning that the point source approximation used in this formula is not applicable in the near field of the emitter, since here the angular intensity profile becomes more significant.

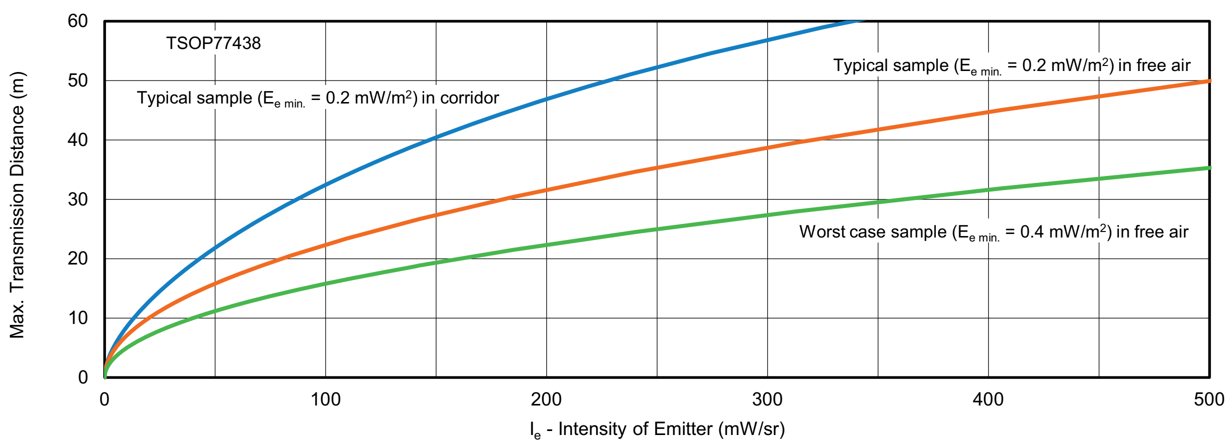

Fig. 4 - Comparison of the Transmission Distance in Free Air and a Long Corridor

A reasonable criterion requires that the distance between the emitter and detector be at least 10 times larger than the dimensions of the light source.

Furthermore, part to part tolerances should be considered when a minimum receiving range is required. A good practice here is to take the minimum value of the emitter intensity and the maximum value of the receiver threshold irradiance to compute the worst-case transmission range.

If the IR signal is reflected from an obstacle before it reaches the receiver, the calculation of the detection distance becomes more complex. It is still possible to calculate the irradiance at the surface of the object with the inverse square law, but when the light travels back to the receiver the reflector acts as a second light source, which requires a different mathematical approach.

Vishay Infrared Receivers for Presence Sensor Applications

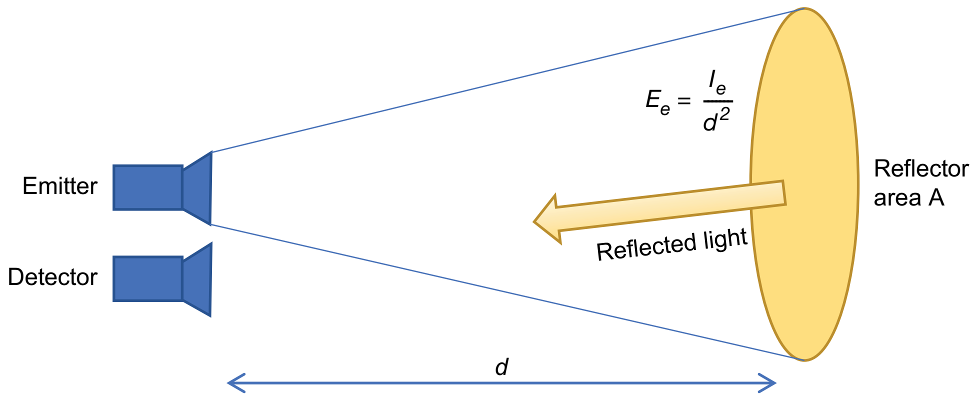

Fig. 5 - Illustration of the Light Path in a Reflective Sensor

Since the reflector is usually an extended obstacle, it cannot be assumed as a point source but must be handled as an extended area light source (Fig. 5).

Most objects that need to be detected with a sensor have rather rough surfaces with mostly diffuse reflections, such as clothes and skin. In a first-order approximation they can be treated as Lambertian surfaces, where the reflected radiance L_e is the same in all directions. The radiance of such an illuminated diffuse surface is given as:

$$L_e = \frac{\rho E_e}{\pi}$$

Here ρ denotes the reflectivity of the object and E_e is the irradiance approaching on the reflector surface originating from the emitter. As indicated above, the irradiance at the reflector can be derived from the inverse square law $E_e = I_e/d^2$. Plugging this into the radiance equation yields:

$$L_e = \frac{\rho I_e}{\pi d^2}$$

If the radius of the reflector is small relative to the distance d, the irradiance on the detector E_d can be determined by the following basic relation:

$$E_d = \frac{L_e A}{d^2} = \frac{\rho I_e A}{\pi d^4}$$

where A is the area of the reflector.

The resulting equation for the irradiance E_d at the detector depends on the size and reflectivity of the reflecting object and decays with the fourth power of the distance (as also known from the radar equation). The reflector area A must be fully illuminated by the transmitter and normal incidence of radiation is assumed. This requires that the distance between emitter and receiver is small relative to the distance to the target.

Vishay Infrared Receivers for Presence Sensor Applications

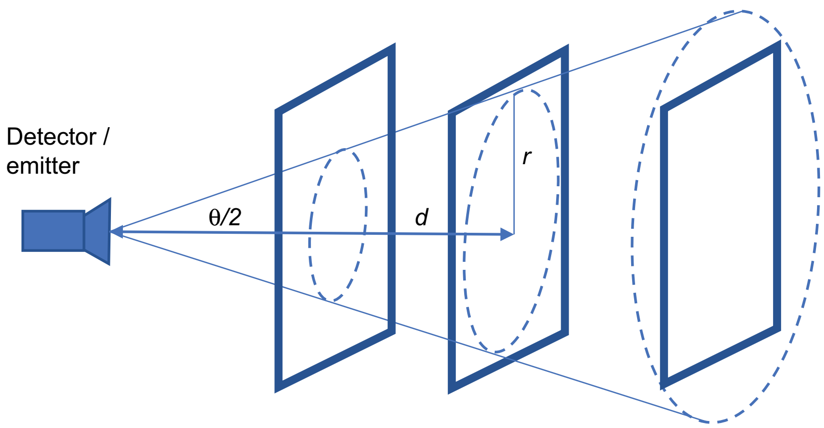

Fig. 6 - Illustration of how the Fraction of the Radiating Reflector Area Seen by the Detector Increases With the Distance *d* Until the Receiver's Field of View Becomes Larger Than the Reflector Size

At short distances and with large reflecting objects, an interesting effect can lead to a different behavior and thus to a new distance law. As illustrated in Fig. 6, in close proximity to the detector the illuminated object might extend over the detector's field of view θ. Consequently, the circular radiating area seen by the detector increases with increasing distance to the reflector. The increasing area compensates the intensity loss due to the inverse square law, and the irradiance of the back reflected light no longer falls off as predicted by the $1/d^2$ law. In this case the irradiance of the circular Lambert reflector can be expressed as:

$$E_d = \pi\, L_e \sin^2 \frac{\theta}{2}$$

For the radiance L_e in the above equation we can use again the expression $L_e = \frac{\rho I_e}{\pi d^2}$ which yields:

$$E_d = \frac{\rho I_e}{d^2} \sin^2 \frac{\theta}{2}$$

In most cases the above formula holds only for short distances and rather large objects, whereas the $1/d^4$ law becomes applicable when the distance to the object increases. The transition between $1/d^2$ and $1/d^4$ behavior happens at the distance where the receiver's field of view equals the size of the reflecting object. For this reason, the transition distance d_t depends on the receiver's viewing angle and the radius *r* of the reflector:

$$d_t = \frac{r}{\tan \frac{\theta}{2}}$$

However, in cases where the viewing angle of the transmitter is tighter than the receiver's viewing angle, the transmitter turns out to be the limiting factor. In this situation a similar effect can be observed. The transmitter spot size on the reflector increases with increasing distance until it extends over the reflector size. The increasing spot size compensates again the inverse square law, and the emitter viewing angle can be plugged in for θ in the above expressions.

Special attention must be paid at short distances to the reflector, where the assumption of a homogeneously illuminated reflector becomes increasingly inaccurate and the distance between emitter and receiver starts to play a role. This leads to a decreasing accuracy of the above relation.

Vishay Infrared Receivers for Presence Sensor Applications

THE CHOICE OF AN APPROPRIATE EMITTER

The range equations given above can be used for a rough estimate of the emitter intensity needed for a given range requirement. However, ambient lighting conditions and nearby reflecting walls can have a major impact on the receiving range. It is therefore recommended to perform range testing under real application conditions. A few examples of appropriate emitters are listed in Table 4. These emitters have a peak intensity between 940 nm and 950 nm, which fits the peak sensitivity of the IR receivers at 940 nm.

TABLE 4 - IR EMITTERS WITH 940 nm TO 950 nm WAVELENGTH COMPATIBLE WITH THE IR RECEIVER PEAK SENSITIVITY

PART NUMBER	PACKAGE	PACKAGE DIMENSIONS (mm)	ANGLE OF HALF INTENSITY (± °)	INTENSITY (mW/sr)	$1/d^2 \rightarrow 1/d^4$ TRANS. DISTANCE FOR 200 mm TARGET (m) (1)	ESTIMATED RANGE FOR 200 mm DIAMETER TARGET WITH ρ = 0.8 (m) (2)
VSLY5940	T1¾	5	3	600	1.91	1.81
TSAL6102	T1¾	5	10	220	0.57	1.45
TSAL6100	T1¾	5	10	170	0.57	1.36
TSAL6200	T1¾	5	17	72	0.33	1.10
VSLY3943	T1	3	17	70	0.33	1.09
VSLB3940	T1	3	22	65	0.25	1.07
CQY37N	T-¾	1.8	12	5	0.47	0.56
VSMY2941GX01	Gullwing	2.3 x 2.3 x 2.8	8	160	0.71	1.34
VSMY2943SL	Side-view lens	2.3 x 2.55 x 2.3	28	50	0.19	1.00
VSMY1940X01	0805	2 x 1.25 x 0.85	60	6	0.06	0.59

T1¾ T1 T-¾ Gullwing Side-view lens 0805

Notes

(1) The transistion distance was estimated by using the expression: d = reflector diameter/(2 x tan(angle of half intensity))

(2) Calculated for a threshold irradiance $E_{e\ min.}$ = 0.4 mW/m^2

The second to last column contains estimated transition distances, where the $1/d^2$ law merges into the $1/d^4$ law for a 200 mm target and indicates which distance law must be applied. This transition is not abrupt, but rather smooth and extends over a finite range. The resulting receiving range for a diffuse reflecting planar object with a diameter of 200 mm and reflectivity of 80 % is shown in the last column. The goal is to provide designers with a rough idea of which emitter will best fit their applications. A fine tuning of the detection range can then be achieved by adjusting the forward current of the emitter, which scales linearly with the intensity over a large range of forward currents. For details on emitter driving circuits and thermal management, please contact technical support at IRR@vishay.com.

Vishay Infrared Receivers for Presence Sensor Applications

THE CHOICE OF THE IR RECEIVER

Vishay's TSOP series remote control receivers use an automatic gain control (AGC) feature to suppress interference signals from ambient light sources such as compact fluorescent lamps (CFLs) and display lighting. The AGC can discriminate between data signals and interference and reduces the sensitivity of the receiver to such an extent that the disturbance signal stays below the detection threshold. Although this feature is very useful in remote control applications, it is often not welcome in sensor applications where a fixed detection distance is required.

Vishay's TSSP series receivers with AGC 0 are designed for sensor applications and do not change their sensitivity in response to ambient light. Once the system parameters are fixed (emitter radiance, detection distance, aperture size), the constant gain response will be stable and repeatable under all lighting conditions. Due to their ability to receive continuous modulated signals of 38 kHz or 56 kHz, their reaction time of approximately 300 μs is considerably shorter than that for TSOP receivers, which makes them ideal for fast applications.

The fixed gain IR receivers can be ordered in a variety of package forms, SMD as well as leaded devices. A few of them are listed in Table 5. Their sensitivity level was chosen below standard remote control receivers to protect them from interference. Most TSSP receivers have a threshold irradiance of $E_{e\ min.}$ = 0.7 mW/m^2, which makes them robust for standard indoor lighting levels. Nevertheless, when the receiver is exposed to direct sunlight or very strong CFLs, spurious pulses can occur at the output. In this case, the receiver should be protected with an external attenuator, as explained in the section "Outdoor Applications".

TABLE 5 - TSSP-FIX GAIN RECEIVERS FOR SENSOR APPLICATIONS

PART NUMBER	PACKAGE	PACKAGE DIMENSIONS (mm)	CARRIER FREQUENCY (kHz)	HALF VIEWING ANGLE (± °)	$E_{e\ min.}$ (mW/m^2)	ESTIMATED RANGE FOR 200 mm DIAMETER TARGET WITH ρ = 0.8 (m) (1)
TSSP57038	Belobog	3.95 W x 3.95 H x 0.8 D	38	75	0.7	0.9
TSSP57038H	Belobog shield	3.95 W x 3.95 H x 1.0 D	38	75	0.7	0.9
TSSP95038	Heimdall	6.8 W x 3.0 H x 3.2 D	38	50	0.7	0.9
TSSP96038	Panhead	7.5 W x 5.3 H x 4.0 D	38	50	0.7	0.9
TSSP98038	Minicast	5.0 W x 6.95 H x 4.8 D	38	45	0.7	0.9
TSSP93038DF1P	Minimold SMD	5.4 W x 6.35 H x 4.9 D	38	45	0.4	1.1
TSSP4038	Mold	6.0 W x 6.95 H x 5.6 D	38	45	0.4	1.1
TSSP94038Z3	Mold	6.0 W x 6.95 H x 5.6 D	38	45	0.1	1.5
TSSP4038SS1XB	Mold	6.0 W x 6.95 H x 5.6 D	38	45	7.0	0.5

Belobog　Belobog shield　Heimdall　Panhead　Minicast　Minimold SMD　Mold

Notes

(1) Calculated for VSLB3940 with an Intensity of I_e = 65 mW/sr

Another possibility is to use a low sensitivity receiver, such as the TSSP4038SS1XB, which offers advantages in short distance applications and under harsh environmental lighting conditions.

The TSSP94038Z3 has a sensitivity similar to remote control receivers, which makes it ideal for use behind low transmitting panel windows or for long range applications. Of course, precautions are needed to protect the receiver from ambient light, because even low light levels might trigger the output.

A good compromise is offered by the Mold and Minimold receivers with $E_{e\ min.}$ = 0.4 mW/m^2. These receivers support a high range requirement as well as acceptable interference robustness.

Vishay Infrared Receivers for Presence Sensor Applications

SHORT DETECTION RANGES

Short detection ranges may require the same careful emitter choice as large ranges. This can be shown in the following example. A soap dispenser usually needs detection ranges of 10 cm to 15 cm for hand detection. If the designer uses a TSAL6200 emitter and a TSSP4038 for this application, the driving current of the emitter can be estimated in the following way:

Approximate size of a hand:

A = 10 cm x 15 cm = 150 cm^2 = 0.015 m^2

Assumed reflectivity of a hand: $\rho = 0.4$

Typical detection distance: ~ 12 cm

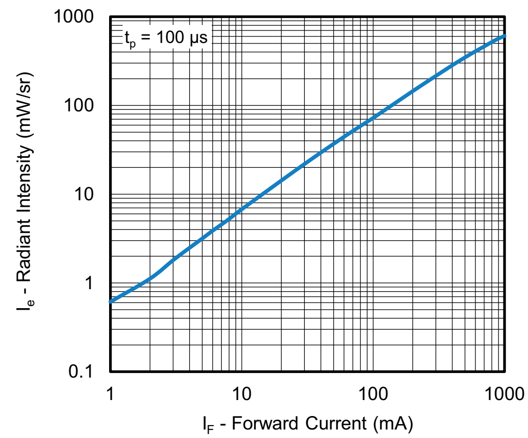

Fig. 7 - TSAL6200 Emitter Intensity vs. Forward Current

$1/d^2 \rightarrow 1/d^4$ transition distance for the TSAL6200 using the shortest dimension of the hand:

$$d_t = \frac{0.1\ m}{2 \times \tan 17°} = 0.16\ m$$

The result indicates that the $1/d^2$ distance law is appropriate to evaluate the required intensity:

$$I_e = \frac{E_d d^2}{\rho \sin^2\frac{\theta}{2}} = \frac{0.4\ mW/m^2 (0.12\ m)^2}{0.4 \sin^2(17°)} = \sim 0.2\ mW/sr$$

This is a quite low intensity, where the emitter must be driven at a low forward current.

The forward current for this intensity can be estimated from Fig. 7 in the datasheet of the TSAL6200. Unfortunately, the forward current turns out to be below 1 mA, which is beyond the x-axis scaling of Fig. 7. Such low currents are not shown because the intensity of IR emitters might not be strictly linear and reproducible in this current range. Therefore, it is not recommended to drive IR emitters at such a low forward current. This example shows that it might be beneficial to choose emitters with a low intensity, such as the CQY37N or the VSMY1940X01, for short range applications to avoid extremely low emitter forward currents.

LOW SENSITIVITY RECEIVERS

A second possibility to avoid low emitter forward currents is to use an IR receiver with low sensitivity.

The TSSP4038SS1XB contains a photodiode of reduced size in comparison to the standard TSSP4038. This increases the detection threshold to $E_{e\ min.}$ = 7 mW/m^2, which appears to be an extremely low sensitivity at first glance. However, in short range applications this can be an advantage because it makes the receiver very robust against any kind of interference, such as ambient lighting or EMI. A calculation of the required intensity for a short range of 12 cm yields:

$$I_e = \frac{E_d d^2}{\rho \sin^2\frac{\theta}{2}} = \frac{7\ mW/m^2 (0.12\ m)^2}{0.4 \sin^2(17°)} = \sim 2.9\ mW/sr$$

This level of intensity requires a forward current of approximately 4 mA for the TSAL6200, where a stable and reproducible intensity can be expected.

Vishay Infrared Receivers for Presence Sensor Applications

LONG RANGE APPLICATIONS

In long range applications, environmental conditions play a much more significant role than at short ranges. Any obstacle in the vicinity of the object to be detected might also be seen by the receiver. Serious problems arise if a small target object is detected in front of a large, highly reflective wall (Fig. 8). Although it's further away from the sensor than the target, the wall could generate a larger reflected signal than the target itself. In this case object detection is almost impossible, because a small signal must be detected over a large background signal. A possible solution to this problem could be a proximity sensor, where the back reflected signal strength can be measured. In this case the background signal could be subtracted to make the target signal visible.

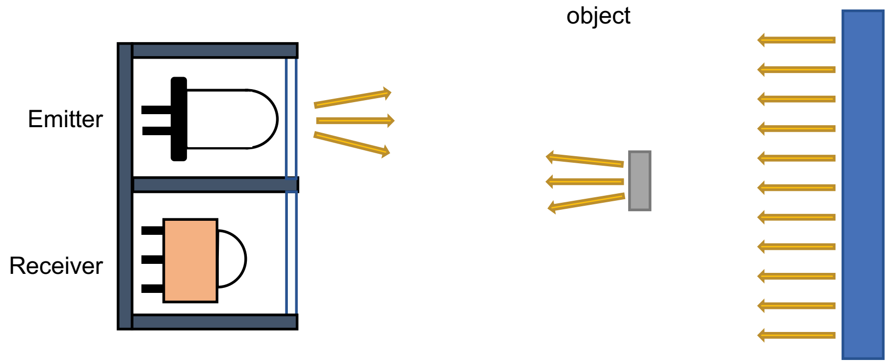

Fig. 8 - Detection of a Small Object in Front of a Large Strongly Reflecting Wall

In an IR receiver sensor this requires such techniques as a variation of the emitter intensity or modulation frequency; application examples are demonstrated in the TSSP sensor kit. To avoid these problems, there should be no large reflecting obstacles in the vicinity of the target. Also, a very narrow emitting transmitter can help to avoid background signals from nearby obstacles.

Long ranges require a high emitter intensity as well as a high receiver sensitivity. Table 4 shows that a well-reflecting target with a diameter of 200 mm requires a 600 mW/sr emitter intensity to be detected at a distance of 1.8 m. Longer ranges are possible, but they require some design enhancements.

For example, the emitter intensity can be further enhanced by using either higher forward currents or several emitters, as indicated in Fig. 9. But the most efficient way to enhance the detection range is by using optical lenses.

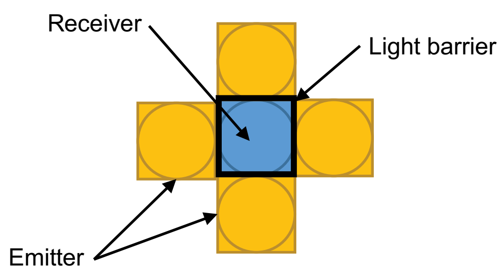

Fig. 9 - Sensor Example With Four Emitters Surrounding one Receiver Separated With an Optical Barrier

Vishay Infrared Receivers for Presence Sensor Applications

For example, plano-convex lenses shown in Fig. 10 can be used in front of the emitter as well as the receiver. The lens in front of the receiver may enhance the sensitivity significantly, since it increases the effective detection area.

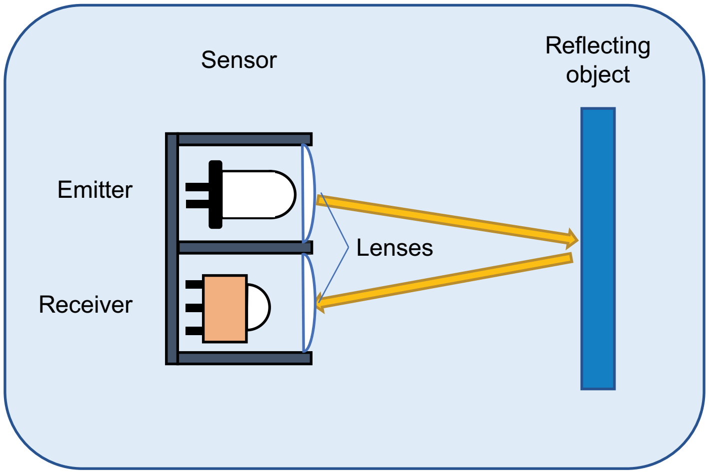

Fig. 10 - Sensor Example With Plano-Convex Lenses

Lenses in front of the transmitter will redirect the emitted light in the forward direction and thus increase the intensity. Since most emitter and receiver parts already use lenses integrated in the packages, the efficiency of external lenses always depends on how well they match with the integrated lenses.

Crosstalk can be efficiently avoided when using a light tight housing with separated lenses for emitter and detector, as shown in Fig. 10. Fig. 11 shows a simple solution for a light tight housing using the TSSP-HA. It can be used with 3 mm emitter packages and Mold receivers.

Fig. 11 - TSSP-HA Housing

CROSSTALK

To avoid crosstalk, a light blocking material should be placed between the emitter and the receiver. Using two separated panel windows instead of a common one prevents that light from the emitter from being reflected to the detector and causing offset signals. As indicated in Fig. 12, light can travel from the emitter to the receiver in various direct and indirect ways. A light barrier between emitter and receiver can block the direct reflection path between them but cannot stop multiple reflections in the common panel window or the PCB. For this reason, it is recommended to use separate panel windows or lenses in the sensor housing and, if possible, to also use separate PCBs.

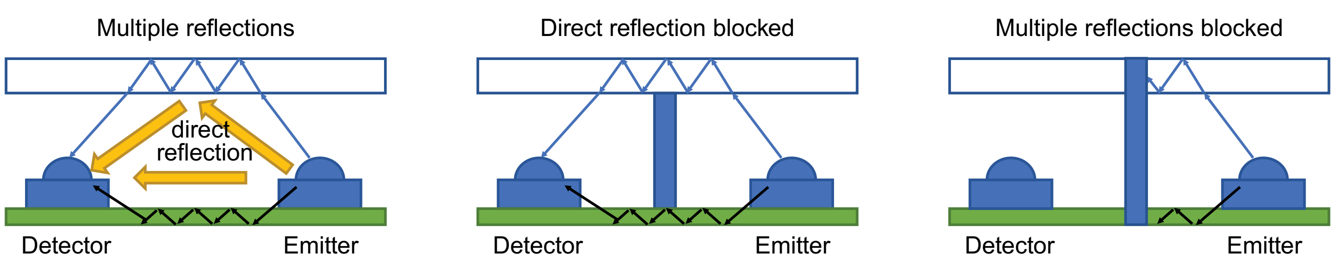

Fig. 12 - Various Light Paths Causing Crosstalk and Solutions to Block Them

Vishay Infrared Receivers for Presence Sensor Applications

OUTDOOR APPLICATIONS (DIRECT SUNLIGHT)

In outdoor applications the sensor may be exposed to strong ambient lighting levels such as direct sunlight. Vishay's TSOP remote control receivers are equipped with an AGC feature that can adjust the sensor's sensitivity according to ambient lighting conditions to protect the receiver from unwanted output pulses. This is not possible with TSSP series receivers because their sensitivity is fixed.

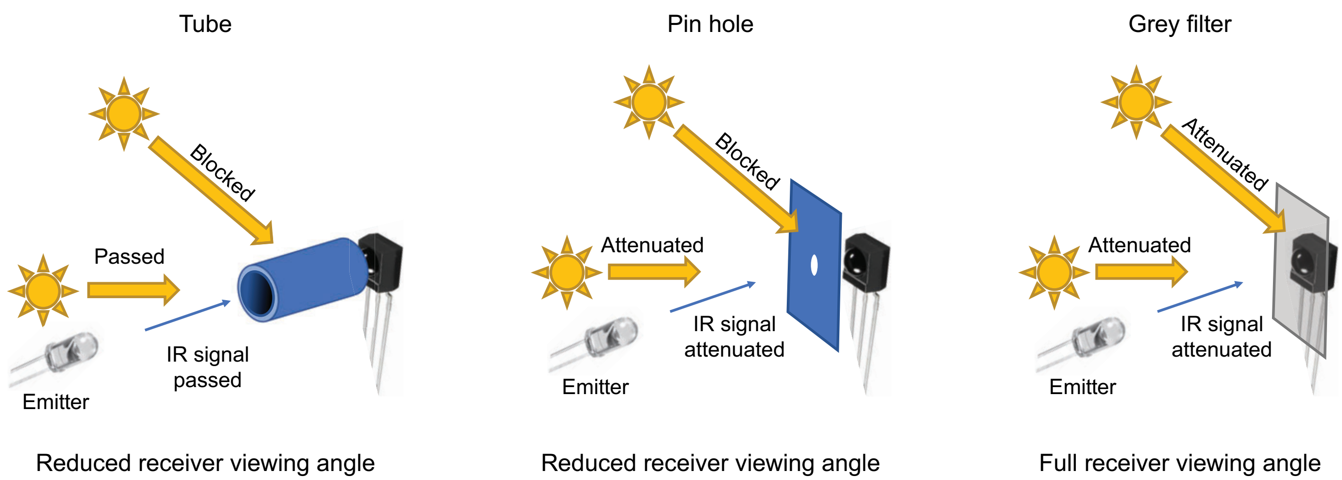

Fig. 13 - Various Methods for Sunlight Protection
Left: Tube, Middle: Pinhole, Right: Grey Filter

For this reason, the TSSP receivers have a lower sensitivity than their remote-control counterparts to make them robust against ambient light. The standard detection threshold of $E_{e\ min.} = 0.7\ mW/m^2$ protects the receiver well from typical indoor lighting levels. However, in outdoor applications this level can easily be exceeded, which may provoke an unwanted response of the receiver.

There are several ways to attenuate the incoming light level, such as a neutral (grey) filter or with a tube or pinhole (Fig. 13). The tube solution is an advantage if the receiver is not facing the sun directly, because the receiver will see most of the IR signal from the emitter but block the sunlight. This is similar with a pin hole of sufficient size, whereas a small pin hole can also attenuate the sunlight if the receiver is facing the sun directly. In this case both the field of view and the IR signal strength will be reduced. If the receiver's field of view needs to be preserved, a grey filter makes sense, but the grey filter will reduce the signal strength to the same level as the sunlight and thus requires a stronger emitter signal.

As always, the choice of solution will depend on the type of application and its specific requirements.