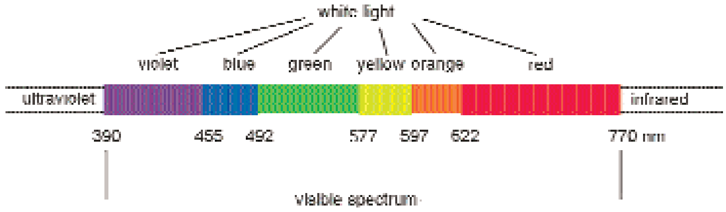
Basic theory

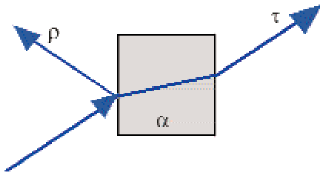
LIGHT

Visible light is an electromagnetic radiation with a wavelength between 390 and 770 nm. White light is composed of all the visible spectrum components in equal quantity; the predominance of a specific wavelength determines the colour of the light. Light Emitting Diode (LED) is the most used in optoelectronics. LEDs for all the emission colours and for white light are available today; as well as for the invisible infrared (over 770 nm) and ultraviolet (under 390 nm) radiations.



Transmission, Absorption, Reflexion

When light hits an object three phenomenons take place contemporarily: Reflection (ρ), Absorption (α), Transmission (τ); with parameters and ratios that vary according to objects, differentiated by material, surface, thickness or colour, and that can be consequently detected using a photoelectric sensor.



PHOTOELECTRIC SENSORS

A photoelectric sensor (also denominated optoelectronic sensor or more simply photocell) consists basically in the following elements:

a) a photo-emitter converts a modulated electric signal into luminous energy pulses, that can be distinguished from other light sources;

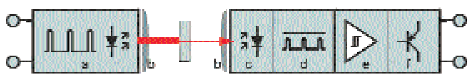
b) an optic system connects the emitter and the receiver by means of a light beam; whose variations are elaborated to detect the objects

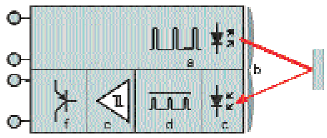
c) a photo-receiver converts the received luminous energy into an electronic signal;

d) a demodulator-amplifier extracts and amplifies the part of the signal originated by the modulated light emitter;

e) a comparator compares the received signal with a switching threshold

f) a transistor or relay power output drives an external actuator or directly the load.

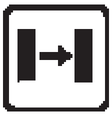




UNIVERSAL PHOTOELECTRIC SENSORS

'***Universal sensors***' include all sensors with basic optic functions that can be used for common object detection, in very vast and differentiated applications. The basic optic functions are through beam, retroreflex and proximity. The various series of universal sensors differ principally for housing shape and dimensions, which condition the performances such as operating distances.

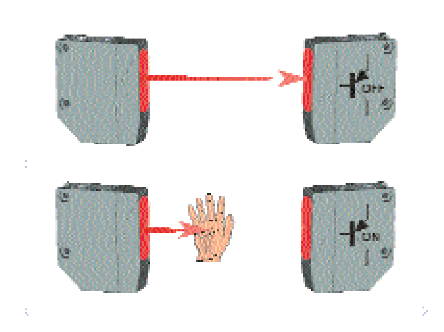
*Please refer to **S2**, **S3**, **S5**, **S6**, **S10**, **S12M**, **S18**, **S20**, **S30**, **S40**, **S41**, **S50**, **S51**, **S60**, **S7**, **S80**, **S90**, **SDS10**, **SDS5**, **SL5**, **SM**, **TED** series.*



Through beam

In these photoelectric sensors, the light emitter and receiver are contained in two different housings, that are mounted one in front of the other. The light beam emitted by the emitter directly hits the receiver; each object that interrupts the beam is thus detected. This system is used to obtain large signal differences (when the light directly hits the receiver and when the object interrupts the beam) with the highest Excess Gain and the largest operating distance reaching up to 50 m. Moreover, these sensors can operate in the harshest environmental conditions, such as in presence of dirt or dust. The disadvantage consists mainly in having to wire two different emitter and receiver units. The through beam optic function operates typically in the dark mode: the output is activated when the object interrupts the beam between the emitter and receiver.

Please refer to models with the following optic function codes: _F_ for receiver and _G_ for emitter.



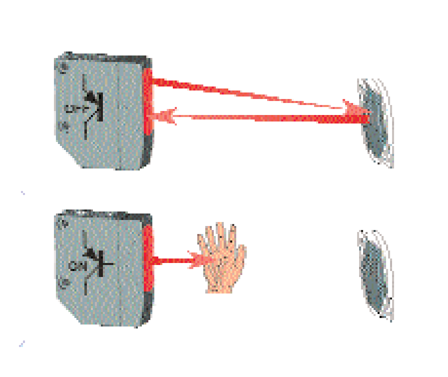
Through beam retroreflex in the DARK operating mode

Basic theory

Retroreflex

Photoelectric sensors with this optic function present both the emitter and receiver inside the same housing. The emitted light beam is reflected on the receiver thanks to a prismatic reflector; an object is thus detected when it interrupts the beam. With respect to the through beam optic function, the signal difference is reduced (when the light is freely reflected by the reflector and when an object interrupts the beam) so the Excess Gain is reduced and the maximum operating distance reaches 12 meters. Moreover it is necessary to operate in clean environments without dirt or dust. A retroreflex sensor typically operates in the dark mode: the output is activated when an object interrupts the light beam between the sensor and reflector.

*Please refer to models with the _**A**_ optic function code.*

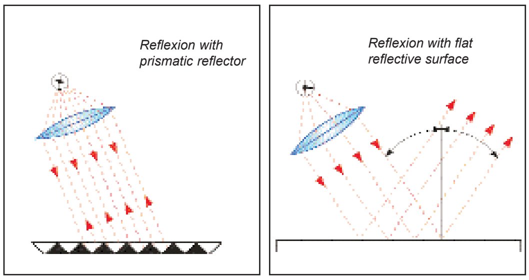


Retroreflex in the DARK operating mode

Prismatic reflector

The prismatic reflector is able to reflect the incident light in a parallel manner, with a reflection coefficient higher than any other object for angles inferior to 15°. Typically the operating distance proportionally increases according to the reflector's dimensions. The reflector can rotate the incident light's polarisation plane at 90°.

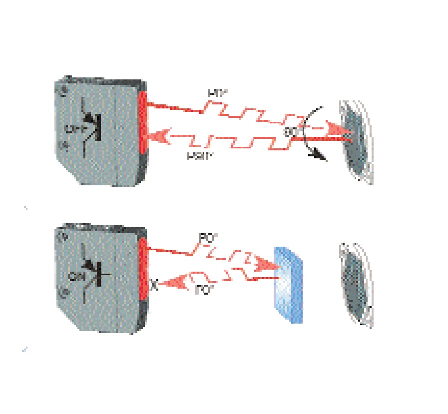
*Please refer to **R** series reflectors.*



Polarised retroreflex

In presence of critical detection of objects with very reflective surfaces, such as shiny metals or mirrored glass, retroreflex sensors with polarised filters have to be used. In the polarised retroreflex sensors, the emission light is polarised on a vertical plane, while the reception is obtained only through a polarised filter on a horizontal plane. The prismatic reflector rotates the light plane at a right angle, while the light reflected from the object maintains the polarisation plane unvaried and is blocked by the filter placed on the receiver. Consequently, only the light reflected by the prismatic reflector is received.

*Please refer to models with the _**B**_ optic function code.*

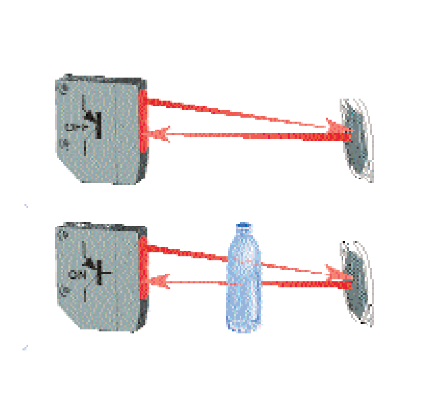


Polarised retroreflex in the DARK operating mode

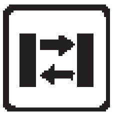
Retroreflex for transparents

For the detection of transparent objects, such as PET bottles or Mylar sheets, a particular low-hysteresis retroreflex version (capable of detecting small signal differences) can be used. These sensors elaborate the very small signal difference that the light undergoes when it passes through the transparent object.

*Please refer to models with the _**T**_ optic function code.*



Retroreflex for transparents in the DARK operating mode

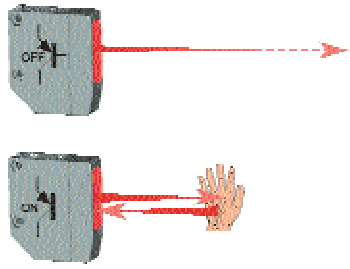


Diffuse proximity

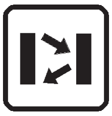
Photoelectric sensors with this optic function present both the emitter and receiver inside the same housing. The light beam emitted is reflected on to the receiver directly by the object, which is detected without the need of prismatic reflectors. The proximity sensors represent the most economic and fastest mounting solution. However, they work with weaker signals compared to the retroreflex sensors and so the Excess Gain is reduced and the operating distance, depending on the object's reflection degree, reaches 2 meters.

A proximity sensor normally operates in a light mode: the output is activated when an object enters the detection area and reflects the light emitted by the sensor.

*Please refer to models with the following optic function codes: _**C**_ (long distance) and _**K**_ (short distance).*



Diffuse proximity in the LIGHT operating mode

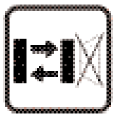


Fixed focus proximity

The fixed focus proximity sensor offers a simple fixed background suppression distance beyond which no object is detected. The fixed triangulation of the optics greatly reduces the detection distance of reflective objects. The visible red emission facilitates sensor installation.

*Please refer to models with the _**D**_ optic function code.*

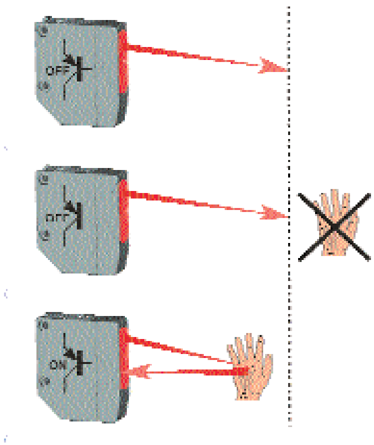
Fixed focus proximity in the LIGHT operating mode



Background suppression proximity

The background proximity function allows the operator to precisely fix the maximum detection distance. The operating distance adjustment is not based upon the receiver's sensitivity, but is obtained through optic triangulation, mechanically acting on the lenses or photoelements angle or electronically using PSD (Position-Sensitive Detectors) receiving systems. Consequently the detection of an object is independent of other objects lying behind (or in the background), which are suppressed. Moreover, thanks to this adjustment method, all objects can be detected almost at the same distance independent of their colour.

*Please refer to models with the _**M**_ optic function code.*

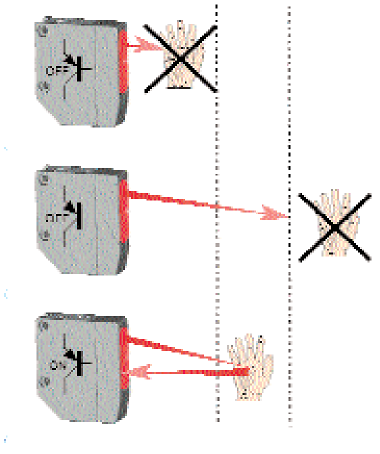


Background suppression proximity in the LIGHT operating mode

Basic theory

Foreground-background suppression proximity

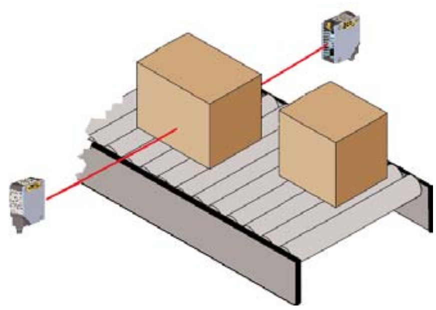
The foreground-background proximity function allows the operator to precisely fix the minimum and the maximum detection distance. Consequently an object is detected only inside a given area, avoiding the interference of objects lying before (foreground) or behind (background), which are suppressed.
With this function it is possible to suppress the detection of a box edges and bottom, detecting only the eventual presence of contained goods.
Otherwise it is possible to set the sensor for a conveyor's plane detection, using the normally closed output to detect the objects lying in the foreground, without any risk of false commutation even in presence of very reflective and corrugated surfaces.
*Please refer to models with the **_N_** optic function code.*



Foreground-background suppression proximity in the LIGHT operating mode

Distance sensors

Distance sensors supply an analogue signal on a 0-10V or 4-20mA output proportional to the measurement of the distance between the emitting optics and the target.
The main technologies that lie at the basis are optic triangulation and time of flight. The first suits very precise measurements on short distances, while the second is ideal for medium and long distances.
*Please refer to models with the **_Y_** optic function code.*



Time of flight technology (T.O.F.)

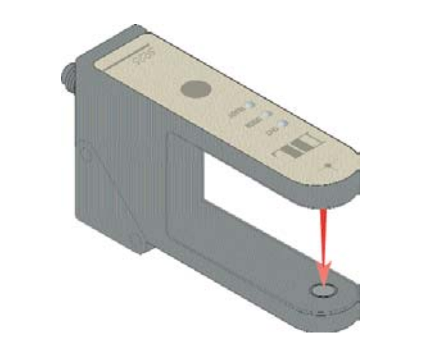
APPLICATION PHOTOELECTRIC SENSORS

'Application' sensors are photocells that, due to technical particulars or optic function specialisation, can be used only in some specific applications.

Slot sensors

A slot sensor is a particular version of the through beam retroreflex sensor, where the emitter and receiver are placed opposite each other on the internal sides of an U-shaped housing. Any target that passes through the internal slot interrupts the beam and is detected. Due to the particular construction, slot sensors are limited to applications with operating distances of some centimeters. The most typical slot sensor applications are hole or teeth detection on wheels, label detection on thin supports, or the control of edge and continuity of sheets or tapes. The emission is generally infrared light; however visible red or green emission versions are available, able to detect references such as registration marks, that present colour contrasts on translucid films.

*Please refer to **SR21, SR31, SRF** slot sensor series.*



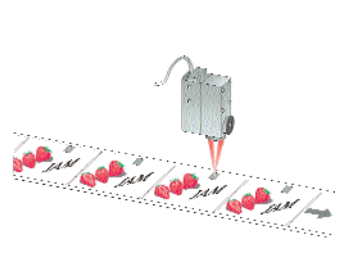
Slot sensor

Contrast sensors

Contrast sensors (also defined colour mark readers, according to the most popular application) present a proximity function but, instead of detecting only the presence or absence of an object, they are able to distinguish two surfaces according to the contrast produced by the different reflection degree. In this manner a dark reference mark (low reflection) can be detected thanks to the contrast with a lighter surface (high reflection), or viceversa. In presence of coloured surfaces, the contrast is highlighted using a LED with coloured light emission, typically a selectable red or green LED.

MARK COLOUR	*Red LED*	*Green LED*	*White LED*
Red	no	medium	medium
Orange	low	medium	medium
Yellow	low	low	medium
Green	high	no	medium
Blue	high	medium	high
Violet	medium	high	high
Brown	low	medium	high
Black	high	high	high
Grey	medium	medium	medium
White	no	no	possible

Contrast obtainable on white background



Contrast sensor

For general purposes a white light emission is used, which thanks to the full spectrum detects the majority of contrasts. The white light emission is obtained through lamps, or LEDs in the most recent sensors, enabling the detection of very slight contrasts due to different surface treatments, even of the same material and colour.

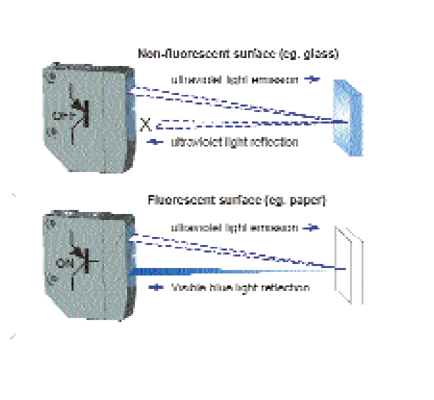
The contrast sensors are mainly used in automatic packaging machines for register mark detection to synchronise all the folding, cutting and welding phases.

*Please refer to **TL10**, **TL80**, **TLμ**, **S50**, **S60**, **S65**, **S90** contrast sensor series with the **_W_** optic function code.*

Luminescence sensors

'Luminescence' is defined as the visible light emission on the behalf of fluorescent or phosphorous substances, due to electromagnetic radiation absorption. Luminescence sensors emit ultraviolet light, which is reflected at a higher wavelength (minor energy) on the fluorescent surface, shifting into the visible light spectrum. The ultraviolet light emission is obtained using special lamps, or LEDs in the more recent sensors. The U.V. emission is modulated and the visible light reception is synchronised. The maximum immunity against external interferences, such as reflections caused by very shiny surfaces, is consequently obtained and fluorescent targets, invisible to the human eye, can be detected. Luminescence sensors are used in various industrial fields: pharmaceutical and cosmetic to detect labels on glass or mirrors; ceramic to select tiles marked with fluorescent signs; automatic packaging to detect paper of fluorescent glues; textile to distinguish cutting and sewing guides; mechanical to check fluorescent paints or lubricants.

*Please refer to **LDμ** luminescence sensors series.*

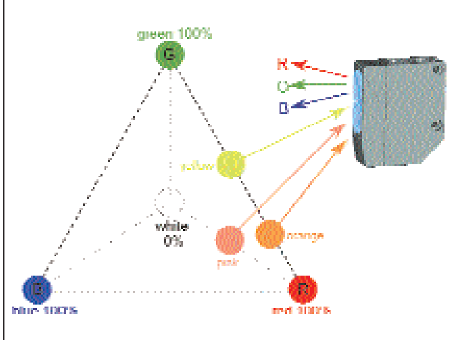


Luminescence sensor

Basic theory

Colour sensors

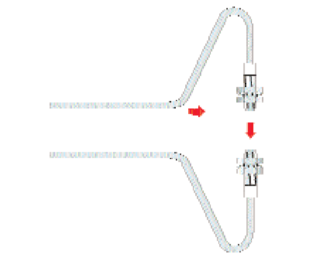
The colour of an illuminated object depends on all the colour components of the incident light which are reflected, eliminating those which are instead absorbed. The dominant colour is defined 'hue' and depends on the reflected light's wavelength; while the 'saturation' indicates the pureness percentage with respect to white that represents 0%. The hue and saturation are together defined 'chromaticity' or 'chromatism'.
Colour or chromatic sensors have a proximity function with generally a triple RGB LEDs light emission. The colour of an object is identified according to the different reflection coefficients obtained with the red (R), green (G) and blue (B) light emissions. More simply, yellow can be identified by R=50% G=50% B=0% reflections; orange by R=75% G=25% B=0% reflections; pink by R=50% G=0% B=0% reflections; but the combinations are practically infinite. Colour sensors operate only on reflection ratios and are not influenced by light intensity, defined instead 'brilliance 'or 'luminance'. The applications are extremely common in all fields, ranging from quality and process controls, or automatic materials handling for the identification, orientation and selection of objects according to the colour.
*Please refer to the **S65-V**, **TEC** colour sensor series.*

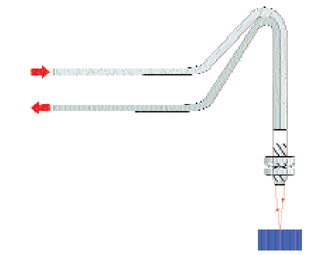


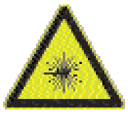
Colour sensor

Fibre optic sensors

All the universal optic functions of through-beam and proximity, as well as the application functions ranging from contrast and luminescence to colour detection, can be obtained using fibre optic sensors. The optic fibres can be considered as cables that transport light and can be used to dislocate the sensor's optics in small spaces, or to detect very small objects. An optic fibre is composed of a cylindrical glass or plastic core, surrounded by a Teflon or Silicon cladder. The difference between the core and the cladder refraction indexes allows the light to be diffused inside the fibre in a guided manner. The cladding is covered by a plastic or metal sheath, which has an exclusively mechanical protection function. The fibres with a glass core and metal sheath are suitable for very high temperature uses, or for particular mechanical requirements. The plastic fibres, offering great adaptability, are the most diffused in all applications. The plastic optic fibres have a standard 2.2 mm external diameter and generally end with a cylindrical threaded metal head, useful for mechanical mounting. The fibre lengths reach commonly 1 and 2 meters; performance reductions become significant with lengths over 5 meters. Plastic optic fibres can be shortened using a special fibre-cutting tool, to be used only for limited times; cutting the fibre with a non-sharp or non-perpendicular blade will produce a consistent reduction of the operating distance. High temperature, extra-flexible or high efficiency versions are present amongst plastic optic fibres range.
*Please refer to **OF** series fibre optics; **S3**, **S5**, **S7** universal sensor series with **_E_** optic function; **TED, TL80**, **TLμ** contrast sensor series; **LDμ** luminescence sensor series; **TEC** colour sensor series.*


Through beam fibres


Proximity fibres



LASER sensors

A LASER (Light Amplification by Stimulated Emission of Radiation) is an electronic device, such as a diode, that converts energy source into a very thin and concentrated light beam, suitable to detect very small objects or to reach very high operating distances. With reference to the safety of the laser radiation, according to the EN 60825-1 European standard, class 1 requires that the laser device is safe under reasonably foreseeable conditions of operations, not being dangerous for people in any situation; while class 2 states that the eye is normally protection afforded by aversion responses including the blink reflex, thus precautions must be adopted to avoid staring into beam.

*Please refer to **S40**, **S50**, **S60**, **S80**, **S90**, **SL5**, sensor series with LASER emission.*

REFERENCE STANDARDS

All Datasensor SpA products with CE marking comply with the European Directives relative to Electromagnetic Compatibility (EEC 89/336 and successive 92/31 and 93/68) and Low Voltage (LVD 73/23 and successive 93/68) and corresponding European standards for industrial environment use.

Photoelectric sensors refer to the EN 60947 European standard for Low Voltage Switchgear and Controlgear; Part 1: General rule; Part 5: Control Devices and Switching Elements, Section 2: Proximity Switches.

Note: these photoelectric sensors are not suitable as safety components according to the 89/392/EEC machinery directive and successive 91/368/EEC and 93/44/EEC amendments; please refer to light beam devices under the ‘Safety Devices’ section.