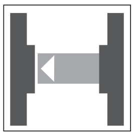
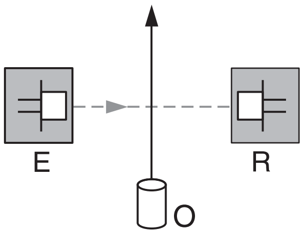
Overview of functional principles

The type, size, shape and surface characteristics of the objects to be recorded, the distance between the sensor and the object, and the environmental conditions determine the design of the system and the selection of suitable sensor types.

1 Thru-beam sensor



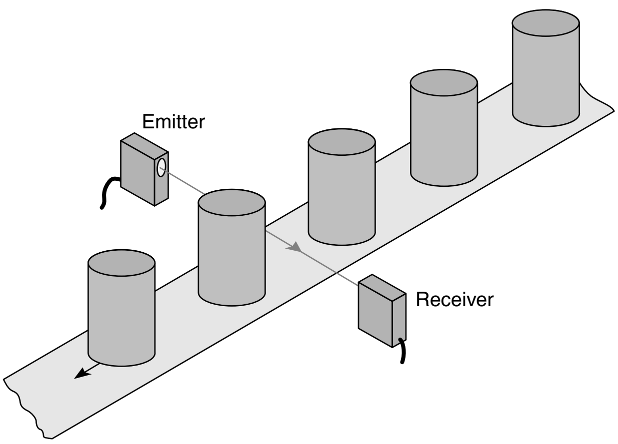
The transmitter and receiver of the thru-beam sensor are housed in different cases that are separated from each other. The Emitter (E) transmits directly to the receiver (R). If an object (O) interrupts the light beam, the receiver voltage drops and the switching function is initiated.



Characteristics:

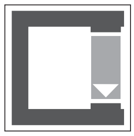
- Detects opaque and reflecting objects.
- Large operating range and high stability control, since the light beam only covers the signal path once.
- Not significantly affected by interference, and therefore suitable for application in difficult conditions, for example applications outside of buildings or in dirty environments.
- Additional installation expense, since both units need to be mounted and wired.

Typically, thru-beam sensors are used to monitor production and packaging lines (see fig.) to measure full state in transparent containers or as a safety measure for doors and hazardous areas. The last-named area of application is a domain of thru-beam systems.

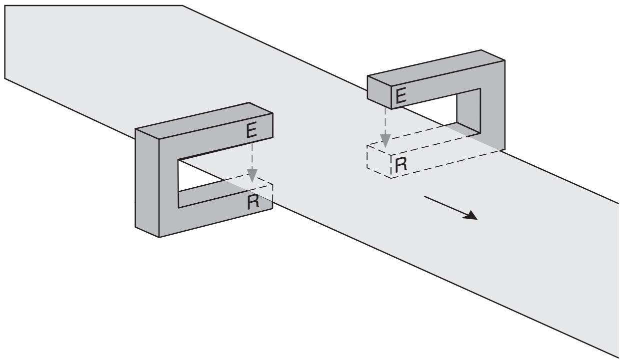


Special versions of thru-beam sensors

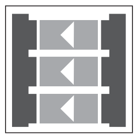
1.1 Fork type sensor



If there is only a small distance in space to cover - a few millimeters or centimeters (available up to 220 mm) - the two can be arranged in a u-shaped housing one next to the other. Fork type sensors (see figure) have the advantage in comparison to normal thru-beam sensors of a simpler electrical installation, since cabling is only required for one device. In addition, there is no need to adjust the optical axis.

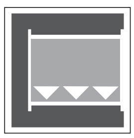


1.2 Light grid



Especially in safety applications, the task at hand often involves monitoring a large surface. The easiest way to achieve this is by arranging a number of thru-beam sensors parallel to each other. In a light grid of this type, all transmitters are combined together in a single housing. This also applies to all receivers whose switch outputs are logically connected. This reduces the time and expense required for installation in comparison to a corresponding number of thu-beam sensors. The distances between the individual beams of the grid can be selected specifically for the application.

1.3 Slot grid sensor



Slot grid sensors are designed for filling and counting objects with feed devices. Unlike standard fork type sensors, there is an entire field available for object detection with a maximum response speed of 100 ms and a minimum object size of 1 mm. Slot light grid sensors are available in 4 sizes with an active range of 34 mm x 50 mm to 142 mm x 150 mm. Dynamic mode can be used to detect moving objects.

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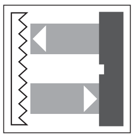
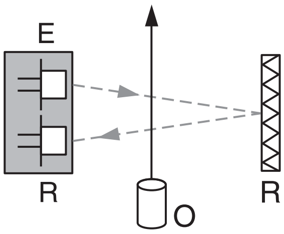
2 Retro-refective sensor

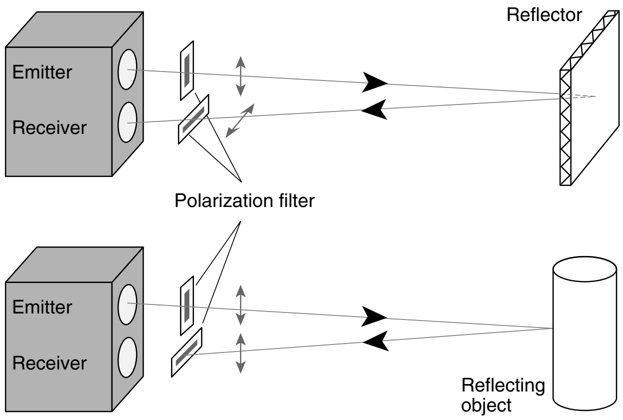


The retro-reflective sensor contains the emitter and receiver in a single housing. The light from the transmitter is beamed back from a reflector to the receiver. If the beam of light is interrupted, the switching function is initiated.



2.1 Retro-reflective sensor with polarization filter

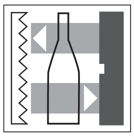
The problem that typically arises for retro-reflective systems, that glossy and reflective objects cannot be reliably detected, can be eliminated by using a polarization filter. To do this, a linear polarization filter is placed in front of the transmitter and receiver of the light barrier. The polarization planes of the filter are perpendicular to each other (see fig.). These filters determine two polarization planes offset to each other by 90°. In this manner, only light beams from the triple reflector reach the receiver, since the reflector modifies the polarization plane of the light in such a manner that it can pass through the filter in front of the receiver unhindered.



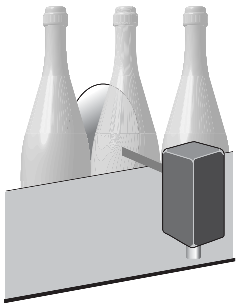
Characteristics:

- Detects opaque objects even with glossy and reflective surfaces.
- It is also possible to detect clear glass with special sensors (G-version).
- Minimal time and expense for installation since the electrical connection is only necessary on the light beam switches side.

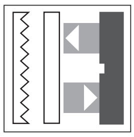
2.2 Retro-reflective sensor for clear glass detection



Retro-reflective sensor with reduced stability control are used for the special application of clear glass detection. This results in increased switching sensitivity with only minor absorption through the glass.

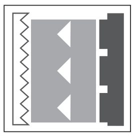


2.3 Retro-reflective sensor with foreground suppression



These retro-reflective sensor ignore all signals from reflectors and high-gloss reflective objects that are closer to the sensor than the adjusted minimum detection range.

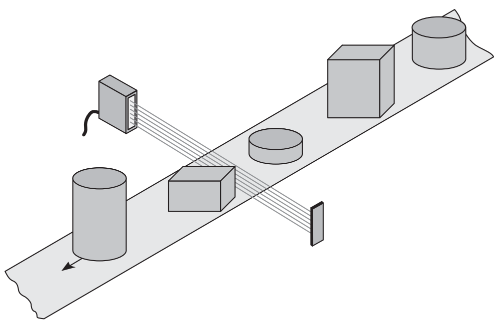
2.4 Retro-reflective area sensor



A retro-reflective area sensor contains several transmitters and receivers in one enclosure with a reflector positioned opposite forming a continuous wide or high detection area over the relevant sensing range.

When the light beams in the detection area are interrupted by an object, the switching function is triggered.

These photoelectric sensors are suited for reliable and consistent object recognition without incorrect switching, regardless of object shape, surface, or position. The sensors do not need to be realigned in should the object shape or position change.



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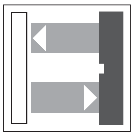
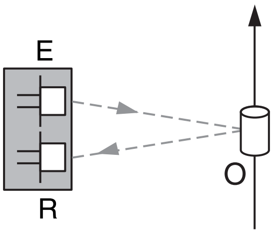
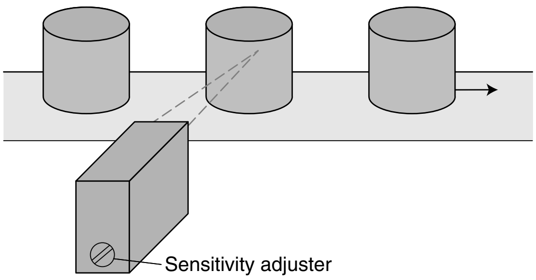
3 Diffuse mode sensor



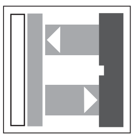
The structure of the diffuse mode sensor is based on the same principle as a retro-refective sensor. It does not have a reflector, however. Instead, the light reflected from the recorded object is evaluated by the receiver.



Due to the diffuse reflection (re-emission) through the object, the detection range of the light sensor is reduced in comparison to the retro-reflective sensor. This is referred to as the detection range. The detection range means the maximum distance from the transmitter at which an object can still be reliably detected.

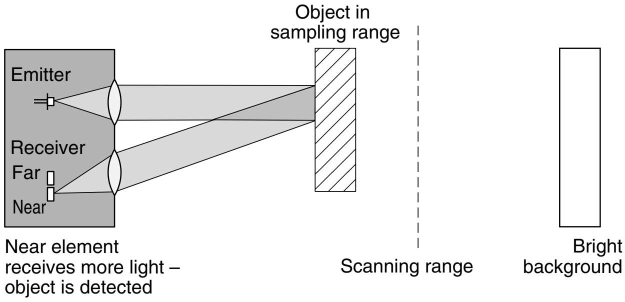


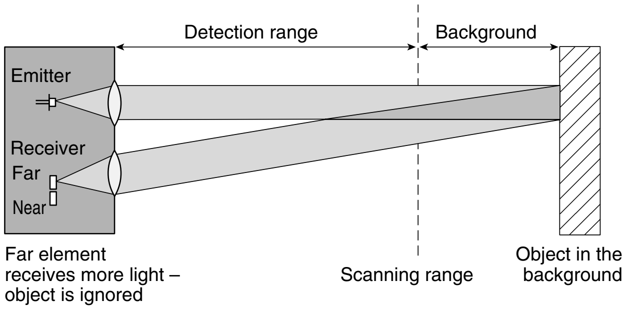
3.1 Background suppression sensor (HGA)



Background suppression sensor were developed to achieve a defined detection range with any objects - independent of its brightness, color or other properties such as the brightness of the background. The following illustration shows the functional principle of a background suppression sensor. The light emitted by the transmitter falls on the object, focused by the optics. If the object is located within the detection area, a part of the reflected light, focused by the receiver's lens, forms an image on the near element of the receiver (N); the scanner emits the signal "on".

As the distance from the object increases, this light spot moves in the direction of the far element (F). At the edge of the detection zone, half of the light spot lies on the near element, half on the far element, and the scanner emits an "off" signal. If the object recedes further, the light spot only falls on the far element, and the scanner continues to emit "off".



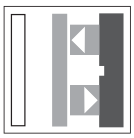


Characteristics:

- A nearly constant detection range on diffusely reflecting materials with sharply differing re-emission levels.
- Dark objects in front of a bright background are reliably recorded.
- Not sensitive to interfering reflections of objects outside the adjusted detection range.
- High stability control.
- Inexpensive installation since the sensor consists of only one unit and no reflector is required.

The principle of **foreground suppression** is similar to background suppression. Diffuse mode sensor of this type ignore all objects that are located closer to the sensor than a previously adjusted minimum detection range.

3.2 Convergent mode sensor (HGU)



A convergent mode sensor is a more efficient type of diffuse mode sensing. The emitter lens is focused to an exact point in front of the sensor and the receiver lens is focused to the same point. The range for a convergent mode sensor is fixed and defined as this focus point. The sensor is able to detect an object at the focus point, plus or minus some distance. Because all the emitted energy is focused to a single point, a high amount of excess gain is available. This excess gain enables the sensor to easily detect narrow or low reflectivity targets.

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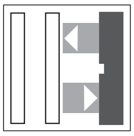
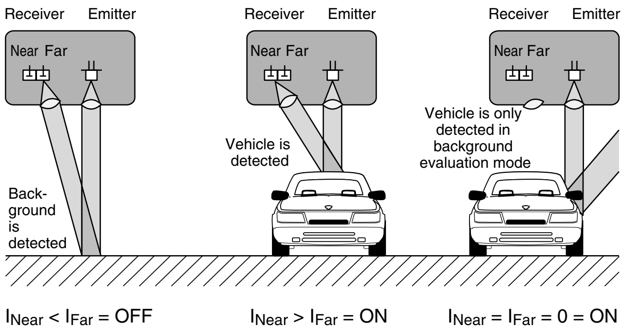
3.3 Background evaluation sensor (HW)

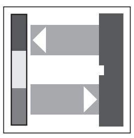


In addition to background suppression, a principle that is to a certain extent the opposite one is used for specific applications, namely background evaluation. While the first process ignores the background and only looks at objects within the detection zone, the other evaluates only the light reflected from the background; not the object, but the background, is the reference (see fig.). If an object interrupts the light path to the background, the sensor switches regardless of whether the reflected light has reached the receiver again, thus signaling or not signaling an object detected in front of the background - for example with reflecting objects.

Sensors that evaluate the background have no blind area and are more especially suitable for recording difficult objects, especially those that are highly reflective. In addition, in contrast to systems with background suppression, they can be tested and can be designed to be self-monitoring.



Special versions of the diffuse mode sensors



The typical feature of the standard diffuse mode sensors, responding sensitively to the surface characteristics of the sensor material, is put to use with contrast sensors and color sensors.

3.4 Print mark contrast sensor

This scanners evaluates differences in brightness between the scanner material and the markings made on it. The color of the transmitted light or the color of the print marks must be selected in such a manner as to result in the greatest possible contrast. The scanner is built on the autocollimation principle, that is, transmitter and receiver are located on a single optical axis (one-eyed system).

3.5 Color sensor

While a standard contrast sensor evaluates only differences in brightness within a specific range of the spectrum determined by the light color of the sensor, the color sensor breaks up the light re-emitted from the object into several portions of the spectrum and returns an intensity value for each of these sub-spectra. The distribution of this value reflects the spectral properties - and thus the color - of the sensor material.

Visolux color sensors work according to the three-range procedure. A distinction is made here between the active and passive three-range procedure.

- Active three-range procedure:
  The sensor material is beamed sequentially with three transmitter colors (red, green and blue). The quantity of light reflected is measured individually for each color. The three colors that are obtained in this manner are used to unambiguously determine the color of the sensor object.
- Passive three-range procedure
  The sensor material is beamed with white transmitted light. The light source may be a white LED, for example. After this the red, green and blue portions of the reflected light are filtered out and the light quantity is determined for each one. Three receivers are used for this process. In this manner, the color of the sensor object is determined.

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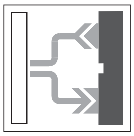
4 Fiber optics systems



The optical properties of an optical barrier correspond, depending on the design, to those of a thru-beam sensor or to those of a retrorefective sensor.

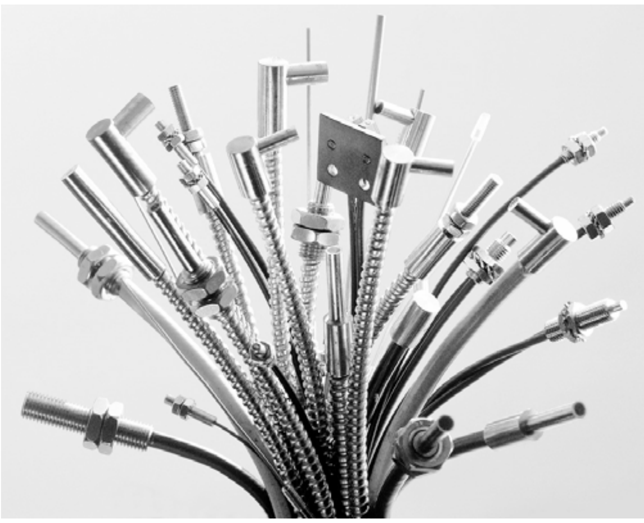
Thru-beam systems have one fiber optic each for transmitter and receiver. For reflection systems, the light is guided in a single fiber optics through separate transmitter and receiver fibers.

The transmitter and receiver are arranged together in a single housing. The optically active area is guided via flexible fiber optics made of glass or plastic optical fiber from the device to the sampling station. Due to their small optically active surfaces, fiber optics systems are also suitable for detecting small details in near applications. Special fiber optics with coaxial or mixed fiber arrangement and small fiber diameters (plastic optical fiber: several 100 µm, glass fibers: typically, 50 µm).

Due to the large opening angle of the light aperture of the optical fiber (about 70°), on the other hand, fiber optics are generally used for shorter distances than standard light beam switches or light scanners; these distances can be increased if necessary using suitable lens attachments.

Glass or plastic?

When choosing the right fiber optic, the user must decide between plastic or glass fibers. The characteristics of these two materials should be examined briefly at this point.

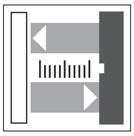


Plastic fiber optics
consist of a single fiber which is enclosed in a PVC cladding. The low weight and high flexibility of the fiber optic material enable applications, for instance, in moving machine parts. Customization of the fibers is a particular advantage. The standard length is 2 m. Using a cutter included in the scope of delivery, the fiber optic can easily be shortened to the length required in your application. Two different fiber diameters and many different heads are available. You will find the appropriate type for your application here.

Glass fiber optics
consist of many individual fibers with a diameter of about 50 µm each. Depending on the application, mantles of stainless steel, PVC, metallic silicon, or silicon can be selected. Due to the low optical damping of glass fibers in comparison with plastic fibers, larger ranges are possible. The robust mechanical design of the stainless steel mantle allows application in high temperatures up to 300 °C. When choosing a head, in combination with the corresponding mantle material, you will find a solution for any application.

The fiber optic types corresponding to the individual sensor types, in order to simplify your selection, are listed at the end of the sensor data in the "Fiber optics devices" section.

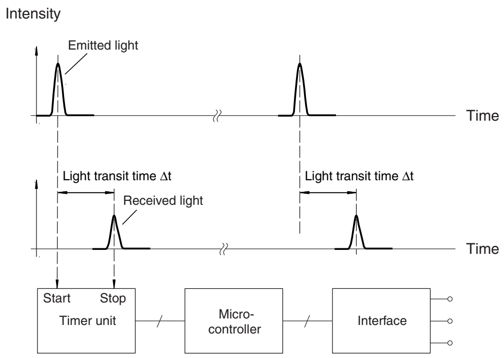
5 Distance Measurement Devices



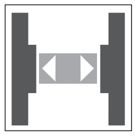
The echo time for a beam of light over the distance from transmitter to object to receiver is a dimension for the distance to the object.

5.1 Pulse Ranging Technology (PRT):

The Pulse Ranging Technology represents a direct method of measuring distance. The distance is determined from a time interval Dt between a transmitted and reflected light pulse.A sequence of very short laser pulses is generated by the transmitter. These pulses propagate at the speed of light and are reflected at a specific point in time after they are transmitted on an object or retroreflector. After the optical distance is traversed again, the reflected light pulses are registered by the receiver (see Figure). The following timer unit together with a microcontroller returns an output signal that is proportional to distance.

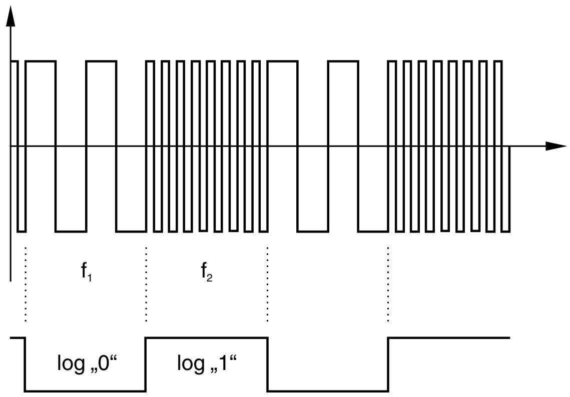


6 Optical data coupler



Optical data coupler are used to transmit information from a point A to another point B without the use of cables. Typically, one of the two optical data couplers can be moved in the axial direction. The FSK procedure (frequency shift keying) is used for transmission over the optical route. In other words, the bit information is coded in the carrier frequency.

The receiver now filters frequencies f1 and f2 from the received signal by means of switches designed with very narrow bands and converts them into a bit sequence. This prevents interference from superimposed signals (for example light flashes from fluorescent lamps) that would cause the transmitted information to be incorrect. In addition, this procedure has very low sensitivity to a fluctuating signal level (amplitude).



Our product selection includes optical data coupler with different interface types.

- Parallel data transfer:
  An optical data coupler can transfer 8 bits bidirectionally. To do this, the signals in the device are converted into a serial bit sequence. The data is then applied to the parallel outputs in the receiver. FSK modulation, which is noise-resistant, is used to transfer the binary signals.
- Serial data transfer (RS 232):
  Our serial optical data coupler also use the FSK procedure. The data that is available at the interface is transferred without the use of a protocol and is then exported again at the serial interface.

  Many devices with a serial interface are also available in a version with a red transmitter light. These devices are always used when the structure must consist of parallel transfer routes and the possibility of mutual influence with the adjacent infrared route must be excluded.
- PROFIBUS DP, RS 422

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