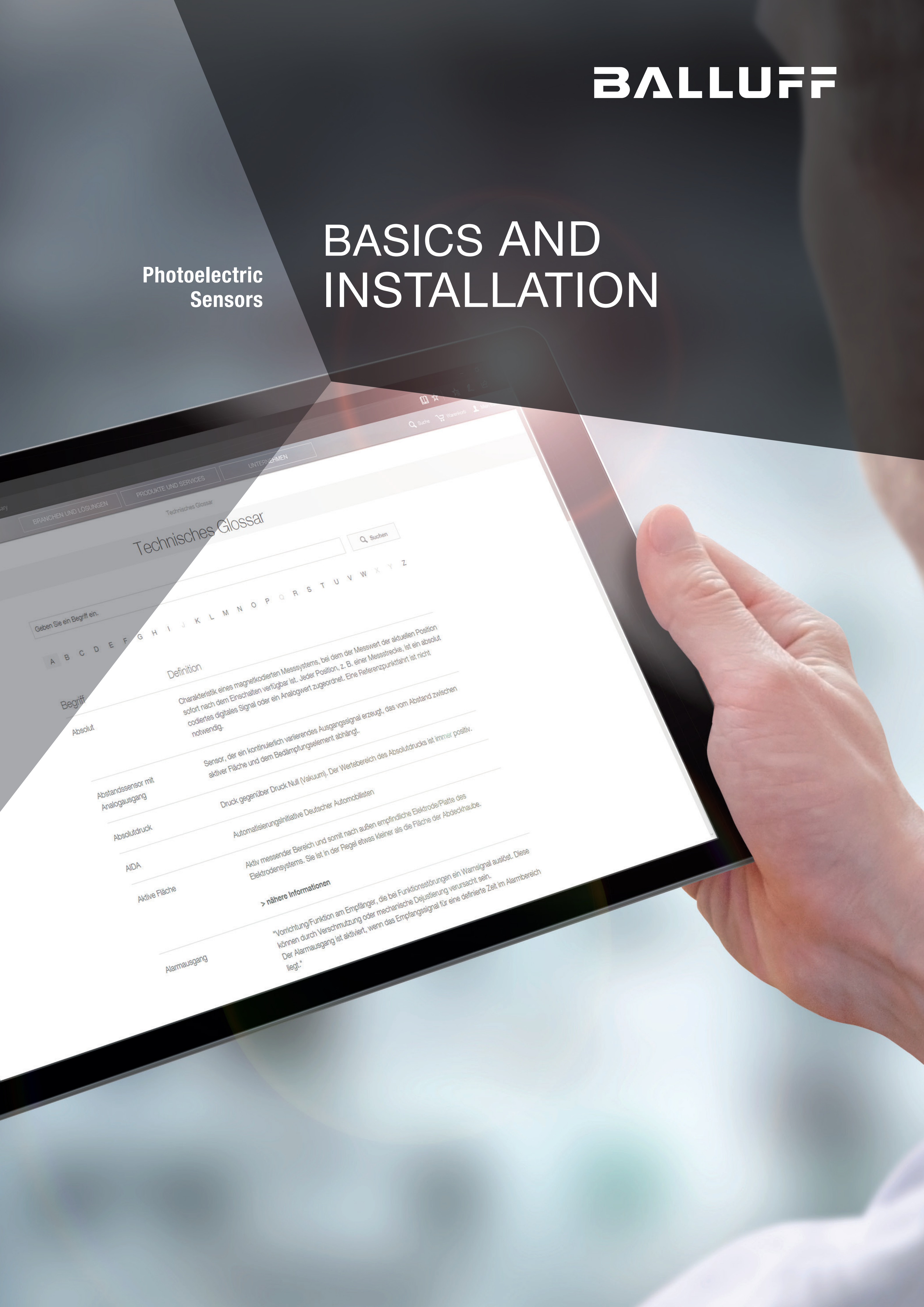
BALLUFF

Photoelectric Sensors

BASICS AND INSTALLATION



PHOTOELECTRIC SENSORS

Ambient light

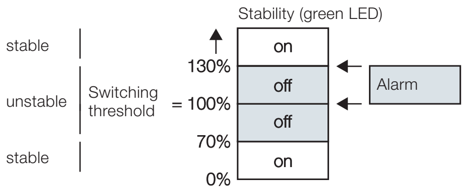
The portion of light which is picked up by the receiver, but does not originate from the emitter.

Ambient temperature T_a

The maximum permissible temperature range at which a sensor may be operated while ensuring reliable functioning of the sensor.

Alarm output

Device/function on the receiver which generates a warning signal when there is a malfunction. This can be caused by contamination or mechanical maladjustment. The alarm output is activated if the received signal lies in the alarm range for a defined amount of time.



Amplifier

Amplifiers prepare signals from sensor heads or fiber optics and convert them into a switching or analog signal.

Autocollimation

Principle of reflection in which the light beam striking a reflector is reflected back to itself in parallel. The emitter and receiver use the same optical lens, so that the emitted light and the light beam reflected back from the reflector lie on the same optical axis. The advantage compared with the dual lens principle is that there is no dead zone in front of the sensor and that the switching response does not depend on the approach direction.

Background suppression (BGA)

Procedure for reliably distinguishing an object against its background. Can be done nearly regardless of the color and surface of the object. A reflecting background has no effect. Sensors with background suppression consist of a light emitter and several light receivers. By means of triangulation the position of an object can be determined. Depending on this position the switching distance can be set and the object thereby distinguished from the background.

Beam shape

Focused
With a focused light beam the emitter light is bundled at a certain distance into a minimum diameter. This location is referred to as the point of focus. At this point small parts detection and switching accuracy are at their greatest.

Collimated
With a collimated light beam the light emitted is radiated out in parallel. This means the size of the light spot remains virtually unchanged over the entire working range of the sensor. This allows distance-independent yet precise object detection.

Divergent
In a divergent light beam the light spot created by the emitter becomes larger with increasing object distance. In the case of through-beam sensors a divergent light beam makes possible simple alignment with the reflector or receiver.

Blind zone

Area between the active surface and minimum switching distance within which a target cannot be detected.

Color sensor

Photoelectric sensor for detecting and evaluating colors.

Contamination

Dirt and dust particles which collect on a sensor and reduce the range of photoelectric sensors and fiber objects compared with pure air. Deposits on the lens reduce its light transmission. The light is absorbed and scattered in the beam path. An oil-free source of compressed air can be used to prevent the effects of dirt and contamination due to impure air.

Correction factors (for diffuse sensors)

Values for determining the range of a sensor which is dependent on the differing reflection properties of an object. For example the range of the sensor is reduced with darker objects due to the greater light absorption.

For objects with different reflective properties the following correction factors can be applied (see table).

Correction factor	Object, surface
1	Paper, white, matte 200 g/m²
1.2...1.6	Metal, shiny
1	Styrofoam, white
0.6	Cotton fabric, white
0.5	PVC, gray
0.4	Wood, rough
0.3	Cardboard, black, shiny
0.1	Cardboard, black, matte

Dark switching

Type of photoelectric sensor in which the output becomes active when there is no light at the receiver.

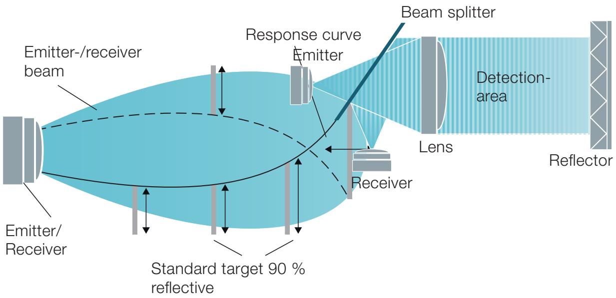
Light receiver	Amplifier	Consumer
Non-illuminated	Fully modulated	Switched on
Illuminated	Not fully modulated	switched off

Detection range

Range in which the switching distance of a sensor from the standard target can be adjusted.

Diffuse sensors

Photoelectric sensor in which the emitter and the receiver are in one housing. The alignment to a detection object is largely uncritical. A target object (e. g. a standard target which is 90 % reflective) bounces a part of the light from its surface back to the receiver. If the standard target reaches the response curve, the output signal will change. The sensing distance depends on the size, shape, color and properties of the reflective object surface. Using a Kodak gray card with 90 % reflectivity (like white paper), distances of up to 2 m can be obtained.



Distance sensor with analog output

A sensor which generates a continuously varying output signal which is a function of the distance between the sensing surface and the target point. It generates a linear output signal within a certain range (measuring range).

Fiber optics

Optical fiber made of glass or plastic with a diameter of down to 50 µm, consisting of several hundred individual fibers. Extremely flexible. The optical properties are not affected by moisture or aggressive media.

Fork sensors

U-shaped housing style of through-beam sensors with the emitter and receiver facing each other. Advantage: Ease of installation, alignment and simple electrical connection.

Gray value shift

The switching distance difference when calibrating using different object reflectivities. The sensor is calibrated for a distance using a Kodak gray card with 90 % reflection. A Kodak gray card having 18 % Reflexion is used and the resulting distance measured. The difference between these two switchpoints in % is referred to as the gray value shift. The smaller the gray value shift, the more color-independently the sensor operates.

Hysteresis

Signal difference resulting for measurement sensors when a mechanically prescribed position is approached from one side, then crosses this point and afterwards approaches this same position from the other direction. Position difference between switching point (object approaches) and switch-back point (object travels away) for switching sensors.

Lasers, laser class

Designation both for a physical effect as well as a device used to generate laser beams. Laser stands for "light amplification by stimulated emission of radiation". Laser beams are electromagnetic waves. The purpose of laser protection classes is to protect persons from laser radiation by specifying limit values. Based on this, the lasers used are classified according to a scale reflecting the degree of hazard. The calculations and associated limit values relevant for the classification are described in the standard EN 60825-1:2001-11. The grouping is based on a combination of output power and wavelength, taking into account emission duration, number of pulses and angle extension.

Balluff sensors have the following laser protection classes:
Class 1: Non-hazardous, no special caution.
Class 2: Low power, eyelid closing reflex is sufficient.

Light

The medium with which photoelectric sensors operate. In the sensor there is a change in the light intensity on an optical path (between emitter and receiver) caused by a target object. This change is evaluated by the sensor. Depending on the properties of this object and the characteristics of the optical beam, the light beam is either interrupted, reflected or scattered. The emitter usually consists of high-power red light LEDs and laser LEDs, with photodiodes or CCD (charge coupled devices) used as the receiver. Red light LEDs are used because the light beam and the detection point can be measured visually and can be adjusted more easily. In the case of laser sensors the light spot is usually more sharply delineated and is highly visible. Even over great distances.

Light band sensor

LED light band sensor
Photoelectric sensor with LEDs consisting of multiple emitters and receivers in a row in separate housings. The close arrangement of the optical components means the emitter generates a light band is generated and the entire light intensity measured at the facing receiver side.

Laser light band sensor
Photoelectric laser sensor in which a laser beam is refracted on the emitter side over a prism at a sharp angle for generating a homogeneous light band. The receiver contains a CCD (charge coupled device) used for precisely detecting edges, even at up to 2 m of distance. A CCD consists of very precisely arranged light-sensitive cells whose charge is measured and processed by the electronics.

Light grids

Photoelectric sensor in which the emitter and the receiver are located in separate housings. By placing individual emitter and receiver elements in a row a large area can be monitored. As soon as an object enters this area, a switching signal is triggered. Light grids with analog output also tell you the object location or its size.

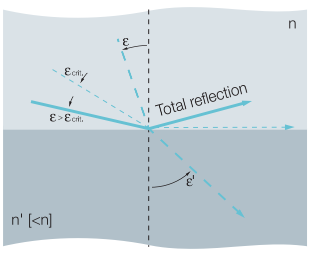
Light-on switching

Type of photoelectric sensor in which the output becomes active when there is light at the receiver.

Light receiver	Amplifier	Consumer
Illuminated	Fully modulated	Switched on
Non-illuminated	Not fully modulated	switched off

Light refraction

A change in direction of light rays at the interface between two optical media having different optical density (e.g. glass/air). The degree of refraction depends on the quotients of the optical densities of both media and on the angle of incidence ε to the optical axis.
If a light beam travels from a dense medium, n, into a thinner one, n', its course there will show a greater angle ε'. Above $\varepsilon_{crit.}$ (critical angle at which the refracted ray travels parallel to the interface). If however it again enters the medium having density n, the result is total reflection.



Light type

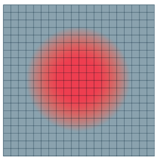
Photoelectric sensors make use of the differing wavelengths of light, with some using visible light in different colors and others using light invisible to the human eye. Photoelectric sensors use mainly the following light types:
Red light: Visible, easy to align, universal for many applications
Infrared light (IR): Invisible, essentially color-independent, ideal in dirty environments
Laser red light: Visible, physical properties of the laser make it ideal for small parts detection and for long ranges, high switching accuracy
White light: Visible, for special applications, e.g. contrast and color sensors
Ultraviolet light (UV): Hardly visible, ideal for luminescent marks

MICROmote

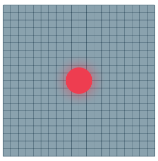
Photoelectric sensor system which combines an external processor unit (amplifier) with exceptionally small photoelectric sensor heads. This allows miniaturized sensor heads to be realized.

Microspot/Pin Point

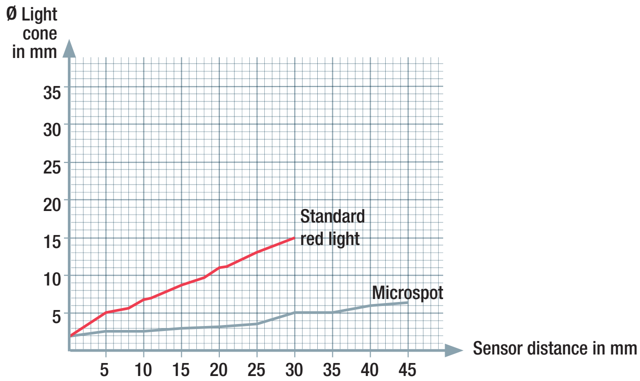
LEDs with opening angles of ≤3°. These are used where small, extremely sharp light spots are required.



Standard red light



Microspot

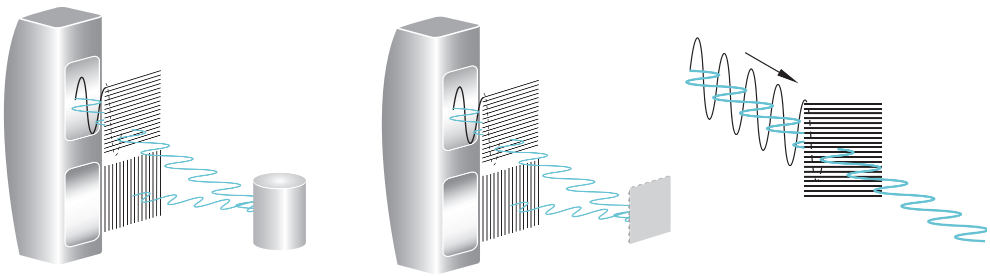


On delay

Time a sensor requires to be ready when an object enters the capture range.

Polarizing filter

Light filters which allow only a certain oscillation plane to pass and thereby effectively filters out scattered light: the light is polarized. Reduces reflections from metallic surfaces and reduces spurious switching. Also referred to as a polarizing filter.



Relative humidity

Ambient condition which can affect the sensor function. For example if the lens is subjected to high relative humidity.

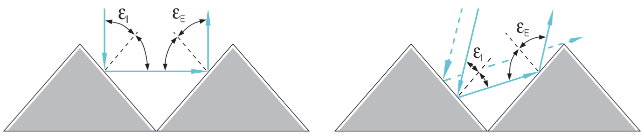
Reflector

Light beams extend to a straight line in free space. Upon striking an object, they are reflected. Depending on the surface properties of the object, we distinguish between the following reflection types: total reflection, retroreflection, and diffuse reflection.

In optical object detection and image processing retro-reflectors are often used. The retro-reflection is caused by two mirrors aligned vertically to each other. A light beam is again projected back through double reflection in the same direction. The angle of incidence can thus be altered in a relatively wide range. The two-dimensional principle of retroreflection can be carried over to a spatial system with three mirrors which are oriented at right angles to each other (one corner of a cube standing on its point). A light beam entering this system is totally reflected by all three surfaces and exits parallel to the incident beam.

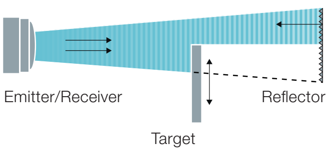
Retroreflection

A light beam which is again projected back through double reflection in the same direction. The angle of incidence can thus be altered in a relatively wide range. Is caused by two mirrors at vertical angles to each other.



Retroreflective sensor

Photoelectric sensor in which the emitter and the receiver are in one housing. A reflector on the opposite side of the beam bounces the emitter's light back to the receiver. A target object interrupts the reflected light beam and causes a change in the output signal. With reflective surfaces it is recommended that the light reflected from the object be filtered out using a polarizing filter in front of the receiver, in order to prevent any possible fault signals.



Reverse polarity protection

Also called polarity reversal protection. This sensor technology protects against reversal of the supply voltage (plus and minus) and reversal of the connection wires (brown and blue).

Sensor heads

Sensor heads consist of an emitter and receiver element. In through-beam sensors the emitter and receiver elements are housed in separate enclosures.

Short-circuit protection

Protective device for overload and short-circuit. Present in all our DC sensors. In the event of overload or short-circuit at the output, the output transistor is automatically switched off. As soon as the malfunction has been corrected, the output stage is reset to normal functioning.

Teach-in

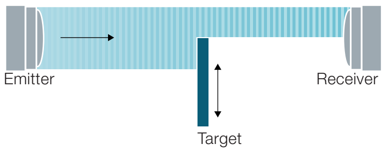
Method for setting sensors by pressing a button. No potentiometers or slide switches are used. Because there are defined setting increments, the advantage is that the sensor cannot be set in an unreliable range. The microcontroller also assumes control of the contamination indicator and the contamination output.

Test input

Input on a photoelectric sensor which enables function checking of the emitter and receiver by interrupting its light pulses. Contamination or maladjustment of the optical axis causes the emitter signal to reach the receiver only weakly, if at all. Therefore, the output will not switch, even though the test input is activated. The test function corresponds to a remote monitoring of the photoelectric sensor and enables a preventive system control.

Through-beam sensor

A photoelectric sensor consisting of separate emitter and receiver units which must be aligned on opposite sides of the sensing path. Long ranges of up to 50 m. When an object interrupts the light beam, the receiver switches, i.e. the output signal changes – regardless of the surface composition of the target. In unfavorable conditions (e.g. dust, moisture, oil), you achieve the best results with through-beam sensors.



Time-of-flight sensor

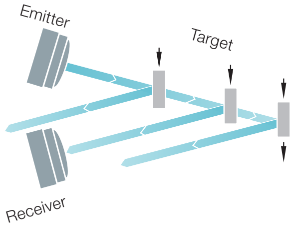
Photoelectric sensor in which the light time-of-flight between emitter, the object and the receiver is measured. The duration of this time-of-flight allows the distance to the object to be determined.

Transmission

Measure for the transparency of a medium. It is defined as the ratio of: – passed to – entering light (in %). Diffuse transmission is the term which is used when the light is partially or completely diffused.

Triangulation

Procedure whereby the light cones of the emitter and receiver lobe of a through-beam system intersect each other at a narrow angle. A target object is detected where the lobes overlap. The emitter light which is reflected or diffused from objects outside this limited zone cannot be registered by the photo-receiver. Benefit: With triangulation, relatively small changes in distance can be recognized (e.g. slots, offsets on shafts). Color and shape of the object have very little effect.



Turn-off time

The time a sensor requires to respond when the target leaves the detection range at a factor of 0.5 of the radiant power.

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