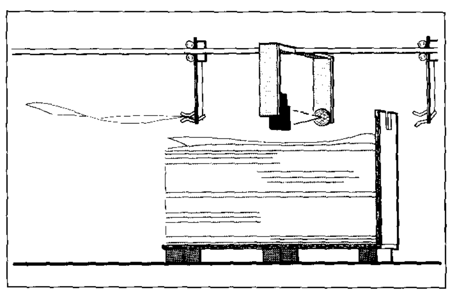
Retro-reflective sensors

With the emitter and receiver in the same housing this sensor transmits a pulsed infrared or red light beam which is reflected back from a "triple prism" reflector or reflective tape.

The sensor switches when the light beam is interrupted.

These devices recognize objects independent of their surface qualities, as long as they are not too shiny.



Features

Large sensing range

Matte finished objects are recognized independent of their surface properties.

Typical applications

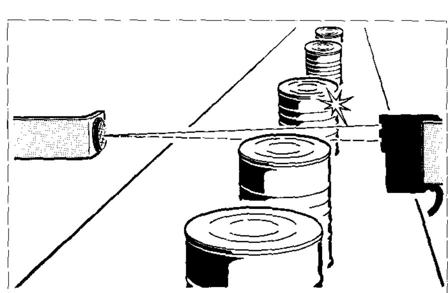
Height detection of stacked objects.

Control of randomly positioned objects on a conveyor.

Retro-reflective sensors with polarization filter

Retro-reflective sensors with polarization filters correctly recognize highly reflective objects.

The polarizing filter prevents false switching with shiny objects. Only the stray and unpolarized light from the reflector actuates the sensor.



Features

Similar to retro-reflective sensors, but with the added advantage of being able to accurately distinguish shiny objects.

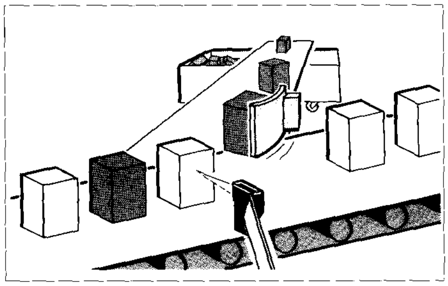
Typical Applications

Monitoring shiny cans on a conveyor belt.

Introduction to the world of photo electric sensors

Diffuse sensors

The emitter and receiver are in the same housing. The emitter sends out a beam of pulsed red or infrared light which is reflected directly by the target. When the beam of light hits the target (at any angle), it is diffused in all directions and some light is reflected back. The receiver sees only a small portion of the original light, switching the sensor when a target is detected within the effective scan range.



Features

The sensing range depends largely on the reflective properties of the target's surface.

Suitable for distinguishing between black and white targets.

Relatively large active range.

Positioning and monitoring with only one sensor.

Typical applications

Distinguishing and sorting of objects according to their volume or degree of reflection.

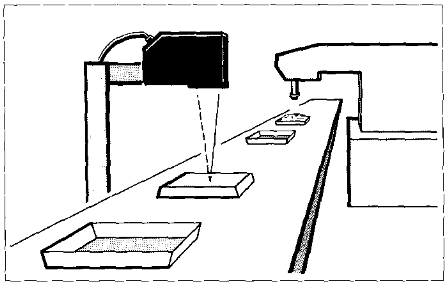
Counting of objects.

Presence detection of boxes.

Diffuse sensors with background suppression

A special development of the diffuse sensor.

The beam of light is closely focused, therefore able to distinguish a target within a precisely defined scan range and ignore targets outside the range.



Features

Sensing range largely independent of the color and surface of the target.

Detects small objects.

Typical applications

Sorting objects without concern for the background color, purely on their distance from the sensor.

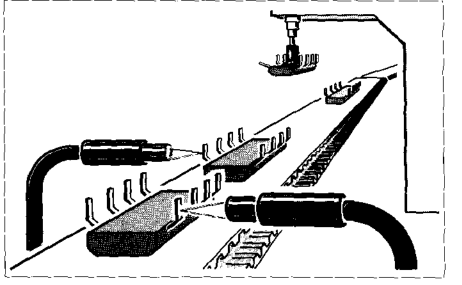
Sensing contents within transparent packaging.

Fiber optics

The application possibilities of some standard diffuse sensors can be enhanced with screw-on type fiber optic cables.

Fiber optic cables are available in both Diffuse and Through beam configurations.

The attachment of fiber optic cables gives a shorter but more accurate sensing range, allowing the detection of small objects.

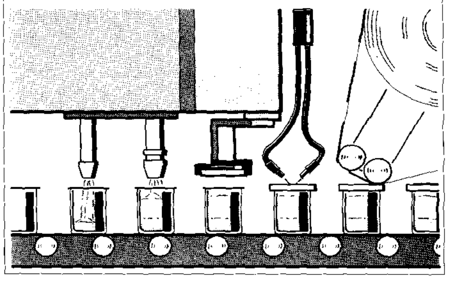


Typical applications

Detecting small objects.

Monitoring flow of bread in an oven.

Detecting absence/presence of lids on a process filling line.



Fiber optic devices with analog output

The complete range of fiber optics can be connected to amplifiers with analog outputs. Applying a cross section converter, as shown in the drawing, the output signal is proportional to the covered area of the fiber optic.

The height and therefore the orientation of a target can be simply monitored.

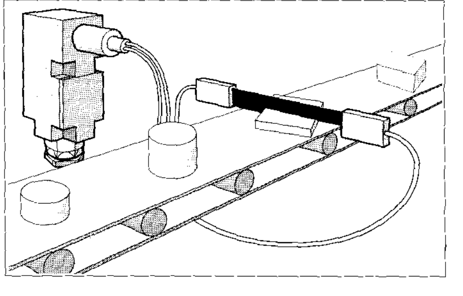
The slope and zero points of the output signal are adjustable by potentiometer.

Typical applications

Sorting various objects.

Measuring of diameters and heights.

Checking for double sheets.



Alignment aid and failure pre-warning

To keep a sensor operating for as long as possible in a dirty environment, a sufficient reserve signal is needed.

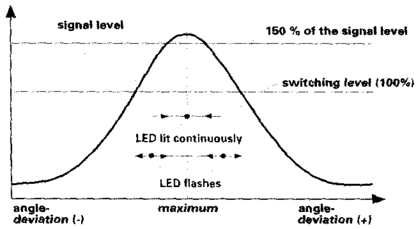
A slowly increasing dust layer, for example, should be detected before the system breaks down. This means that when the signal strength is reduced to a certain level, a prewarning should be activated. However the system must continue to provide an accurate output signal.

This is achieved with an alignment aid and soiled lens indicator.

A flashing LED indicates the signal strength (excess gain level) is in a range between 100% and 150%. Action should be taken to check the alignment or condition of the sensor. Above an excess gain of 150% the LED lights continuously when switched.

Alignment aid

The alignment aid helps the user to find the maximum signal strength and checks the signal reserve during setup. The LED starts to flash when the signal strength falls below the safe value. See drawing on the right.



The correct adjustment for maximum receiving signal is achieved by mounting the sensor between the two positions at which the LED starts to flash and adjusting the alignment.

Soiled lens indicator

Even if the sensor is adjusted perfectly, a growing dust layer on the lens or on the target, can decrease the signal strength below a 150% level of excess gain. The sensor continues to provide the correct output signal but the flashing LED indicates that the system needs attention.

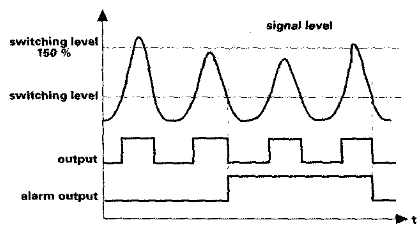
Alarm output

The degree of contamination can be monitored with the alarm output. It is activated immediately following a Light Operate switching, if the signal reserve is below the 150% required excess gain level.

The polarity of the alarm output corresponds to the sensor output, for example PNP if the sensor output is PNP.

The spare (unconnected) light/dark operate output connection is used for the alarm output, and therefore when ordering an alarm output, either a light operate or dark operate output function must be specified.

The values for both the average and peak maximum supply currents increase by 5 mA over a standard sensor when an Alarm output is specified.



The alarm output is activated as soon as the necessary signal level is not achieved. The alarm output is deactivated at the end of the light operate phase, if the signal strength has increased above the 150% excess gain level.

Immunity to interference and error correction

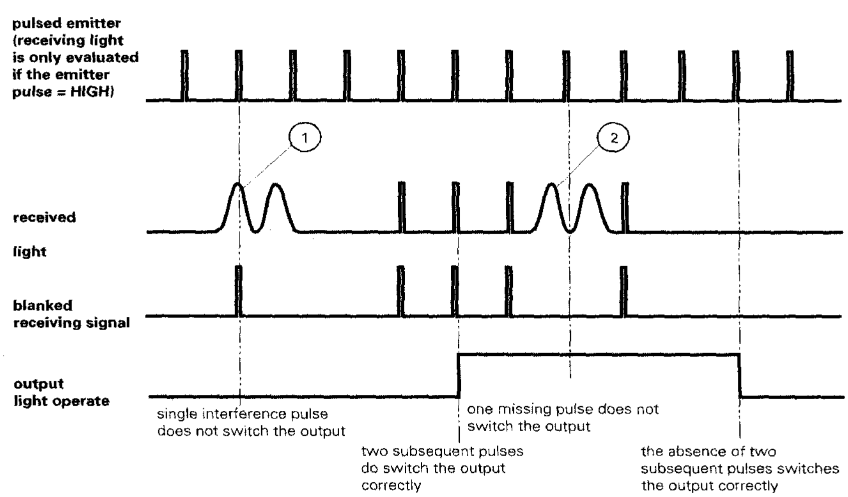
Baumer electric's photoelectric sensors are designed with features that enhance both reliability and longevity.

Blanking

The emitter sends a short pulsed signal with a relatively long pause between two pulses. The light energy of the LED can therefore be enormously increased. If emitter and receiver are mounted in the same housing, the receiver is clocked to the emitted pulse. Interference is therefore suppressed during 98% of the time.

Error correction

Fast changes in the ambient light (switching of fluorescent light, welding etc.) might interfere with the light signal. To suppress this disturbance an error correction circuit is built in. The receiver needs at least two consecutive pulses in order to activate; one pulse will not activate the sensor output.
Dropping a single pulse, due to interference, will not create a false output signal.



(1) first interference pulse generates a failure, while the emitter pulse is high; the second pulse is blanked

(2) first and second interference pulse are blanked, the low in between however results in a missing receiver pulse

The graphic shows a burst of noise, from which the positive part of the signal coincides with the emitted pulse. After blanking, only the first noise peak is left. The result is only one noise pulse, which is blanked with the error correction method.

A second burst of noise, from which the negative part coincides with the emitted pulse, results in only one missing receiving pulse after blanking. This inaccuracy is also blanked out with the error correction.

Test input

Function

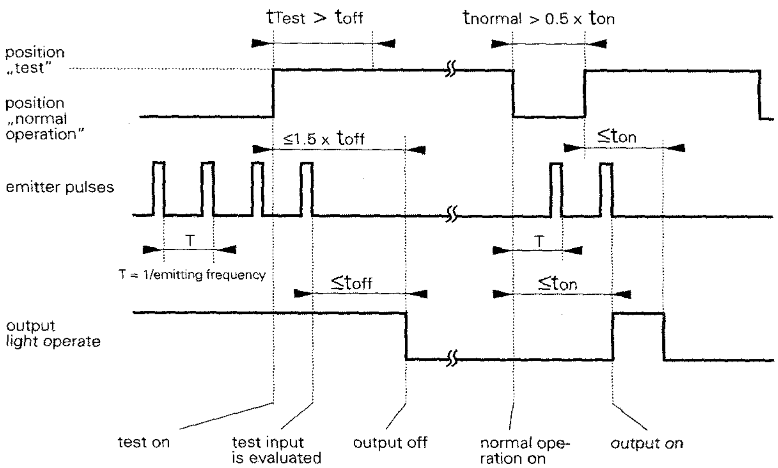
The function of the sensor can be monitored by an external controller through the use of the test input. The user can switch the emitter off using the test input and monitor the resulting change of output state. The whole system, from a soiled lens to the wiring, can be checked with this method. This is especially important for sensors which seldom change state, such as in a web break detection.

Without this test, the proper functioning of the sensor can not be guaranteed.

Test states

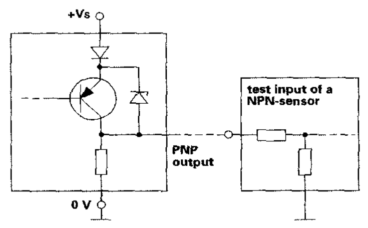
Activate
After the active edge of the test pulse one more emitter pulse is transmitted. After that the emitter is switched off. The result is that after max. 1,5 x t_{off} the output switches back to the dark operate state. To switch off the output, the status "Test" must have a longer duration than t_{off}.

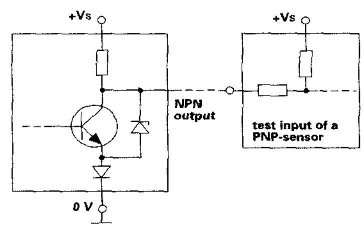
De-activate
After the transition from the test mode to the normal operating mode, the test input initiates an emitter pulse if a time (t) has elapsed. After a period of time t_{on} has elapsed, if the emitted light is recognized by the receiver, the output switches to the light operate state. Further emitter pulses follow, as long as the test input is in the "normal" mode. The output is only switched as long as the normal mode is longer than 0,5 x t_{on}.



The output is switched off a maximum 1.5 x Toff after the test input is activated. After de-activating the output switches on after a maximum period Ton.

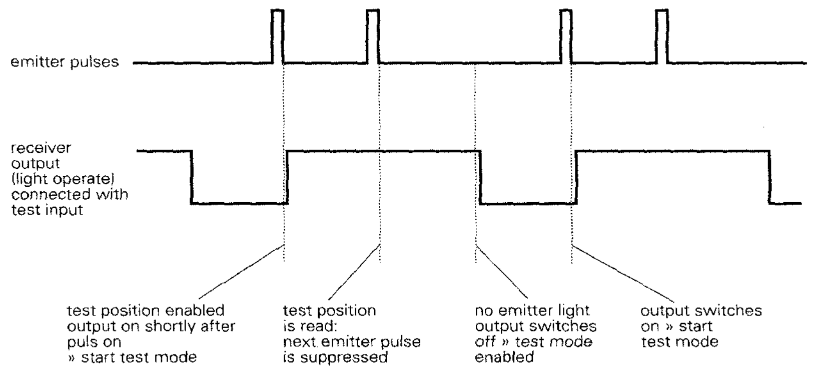
The polarity of the test input of retro-reflective and diffuse sensors is always the same as that of the specific output version for example if the sensor is PNP the test input is activated by closing the current circuit to +Vs (for NPN the circuit connects to ground, 0 V).





Self regulating system

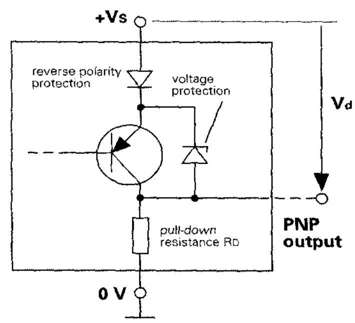
For applications where the light beam is normally broken (e.g. web break detection), an alternating output state can be obtained by connecting the test input with the light operate output.



By implementing this, the complete function of the sensor, emitter, receiver and output can be completely monitored. A system failure or an open light path has the same effect on the output state. The proper functioning of a system with a closed light beam, generates an alternating output signal with a defined pulse-pause length as shown in the diagram. Sufficient received signal strength is required to obtain a proper functioning system. Without excess gain near the threshold level, signal fluctuations or noise might lead to random output states.

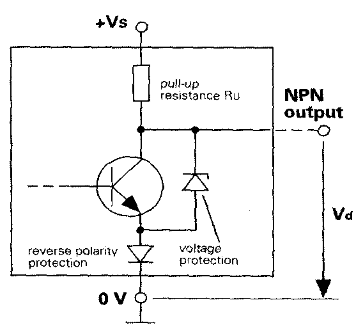
The electrical output

PNP-output



A PNP output acts as an electronic switch from +Vs to the output. The load is switched to 0 Volt. If the output is switched (if "light" is received in a light operate mode or "no light" in a dark operate mode) a current flows from +Vs via the reverse polarity protection diode and the output transistor, through the load to 0 Volt. The voltage between +Vs and the output is called the voltage drop. The voltage protection prevents damage to the output if spikes occur.

NPN-output



An NPN output acts as an electronic switch from the output to 0 Volt. The load is switched to +Vs. If the output is switched (if "light" is received in a light operate mode or "no light" in a dark operate mode) a current flows from +Vs through the load and via the output transistor and the reverse polarity protection diode to 0 Volt. The voltage between the output and 0 Volt is called the voltage drop. The voltage protection prevents damage to the output if spikes occur.

Parallel / Serial wiring

Parallel wiring

Sensors with identical outputs, PNP or NPN, may be wired in parallel as long as they are all using the same power supply. The maximum number of sensors depends on the load current and the internal pull up / pull down resistors; typically 3 mA per sensor. The sum of the load currents must be lower than the maximum sensor switching current of the power supply.

Serial wiring

Relay output sensors may be connected in serial. Due to the short circuit protection on all transistorized output photoelectric sensors, PNP and NPN sensors may not be wired in serial.

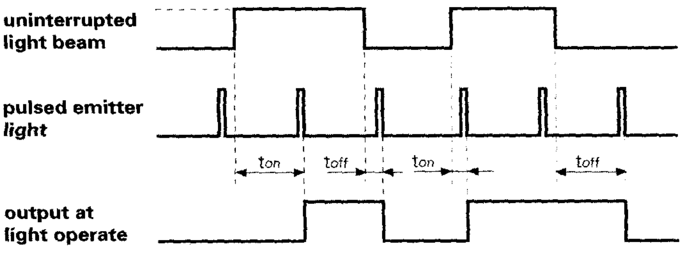
Technical definitions

Response / release time

The response time is the time taken from completing the light beam between emitter and receiver, until the output switch changes state. The release time is the time taken between interrupting the light beam and changing the output switch state.

The response/release time may vary because the emitter is pulsed and the movement of the object is not synchronized with it.

Completing the light beam immediately after the end of the previous emitter pulse results in a longer t_{on}, compared with completing the light beam immediately before the next emitter pulse. Similary the release time T_{off} may also vary. Because the user cannot synchronize the object movements with the emitter pulse, a certain random variation of the response/release time is inevitable. The maximum is specified in the technical data for each sensor. The diagram shows a simplified timing sequence. In reality there are at least two subsequent pulses needed to switch the output, due to the error correction circuit design.



Suppressing pulses during switching on

Initializing the electronics during power up takes some time and the output state is not defined. This could lead to faulty output states, so a built in suppression circuit blocks all outputs during the first ≤ 75 milliseconds after power up. After this period a stable condition of the sensor's output state is reached. The electronics are initialized and the output state reflects the true condition of the sensor.

Electro magnetic interference

The receiver amplifies the frequency of the emitted pulses while all other frequencies are attenuated. The emitter and receiver are gated so that while the emitter is in the off state, the receiver is also inactive. A metal foil is wrapped around the sensor's internal electronics for shielding. A high degree of EMI rejections is achieved by these measures. The basic requirements for EMI noise are defined in the European standards 89/336/EWG. The European standards EN 50081 and EN 50082 define the final standards. Baumer electric checks all new sensors to EN 55022 (for emission) and IEC 801 (for immunity).

Signal strength indicator

The LED is continuously on provided the light beam between emitter and receiver is unbroken and the signal strength is 150% or more of the required value. If the signal strength is between 100% and 150% the LED starts flashing. The LED serves as an alignment aid and soiled lens indicator.

Technical definitions

Sensitivity adjustment

Many applications for diffuse or reflective sensors require a reduction of the sensitivity.

There may be a background behind the target which could reflect light and falsely switch the sensor if the sensitivity were not reduced.

To distinguish between dark and light objects with a diffuse sensor, the sensitivity must also be adjustable.

In through beam sensor applications a transparent target might not block enough light to reduce the excess gain below the switching threshold.

For this reason most photo electric sensors feature a potentiometer for sensitivity adjustment.

Glass cover

Glass covers may protect a sensor against mechanical or chemical damage, such as welding sparks or strong solvents.

All 35 series sensors have a glass cover for installation in rugged industrial environments. With the 08, 15, 16 and 26 series, glass lenses are an option.

The tubular 18 and 30 series can be after-market equipped with lenses that screw on to the sensor.

Light / dark operate

Light operate or dark operate defines whether the output switch state is "On" or "Off" as a function of the received light.

Light operate means that the output switches if the light beam between emitter and receiver is not interrupted. This is the standard mode for diffuse sensors, where the output switches when the target reflects the light.

Dark operate means, that the output switches if the light beam between emitter and receiver is interrupted. This is the standard with retro-reflective and through beam sensors.

Short circuit and reverse polarity protection

All photo electric sensors have reverse polarity protection. All sensors have short circuit protection. In case of a short circuit or overload, the output switches off immediately. After a short duration (30 ms) the output is tested again for overload. If there is still a short circuit condition, the output is switched off within microseconds to protect it against damage. If the overload disappears the output is switched on again after the test.

Reflector

The "Triple Reflector" has a honeycomb pattern. Due to the design of its reflecting surfaces, the received light is reflected to the emitter at the same angle as the angle of incidence.

This reflector can be tilted up to 15 ° off the angle of incidence, without any distortion of the reflective signal strength.

If the target and distance are large, then a large reflector should be specified.

A smaller reflector should not be bigger when sensing a smaller target. Sensing distance decreases as a function of reflector size and it is important that the reflector should not be bigger than the target.

Ripple

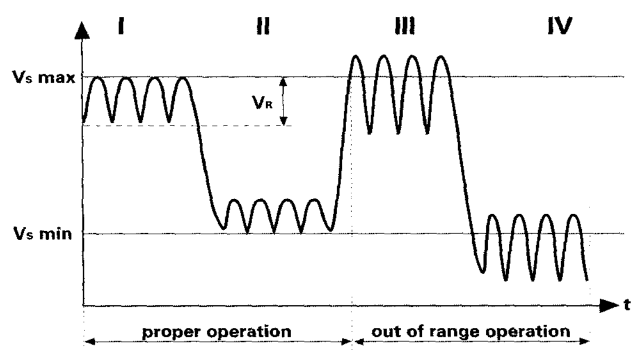
The voltage supplied to the sensor should always be within the specified range for proper operation. Within this range a 10% ripple (V_R) is allowed. The graphic shows the operating voltage in four critical areas:

I. Proper operation in the upper limit range: The upper peak value should never exceed V_S max.

II. Proper operation in the lower limits: The lower peak value should never fall below V_S min. In both cases the ripple is below 10% of the mean value.

III. The out of range area above the upper limits: The upper peak value exceeds V_S max. regularly. The built-in overvoltage protection will be activated. This can lead to an overload of the sensor or the voltage supply.

IV. The lower peak value is regularly below the lower limits of V_S max. Proper function of the sensor is not guaranteed. A typical case is insufficient voltage smoothing.



Supply current

The peak supply current is the maximum value during the power on time (< 1 msec). After this time, the average current is not exceeded at any time. To calculate the power supply required, sum the average currents for the installation. Users should ensure that the power supply can handle the peak current for ≥ 1 msec.

For an AS-i System with Baumer electric modules, the average currents are valid.

Protection class

IP 65: protects against dust and accidental contact. It also protects against a water jet coming from any direction.

IP 67: protects against dust and accidental contact. It also protects against water, if the housing is dipped in fresh water under defined time and pressure conditions.

Signal strength for red light emitters

The emitted pulse length is decreased as soon as the required signal strength for retro-reflective and diffuse sensors exceeds 150 % of the necessary value.

The advantages are:
The durability and longevity of the LED are increased. In the case of a visible red LED, the reflection of the beam on the target surface shows the signal strength. The user can see the switch state by looking at the face of the sensor, without having to see the output state LED. This is especially useful when there is limited access to the sensor.

Technical definitions

Test voltage

This is a value for isolation tests and is the maximum voltage that may be applied between the sensor housing and wiring for guaranteed isolation:

- For all DC-types 1kV
- For AC-types 2,5kV (synthetic and metal housing grounded)
- For AC-types 5kV (metal housing not grounded)

Ambient light

By using pulsed infrared light, interference from ambient light is eliminated. The receiving signal passes a band filter, whose frequency is tuned to the emitter pulse frequency. The receiver is synchronized with the emitter. Except for the short emitting pulse, the receiver is switched off (blanking).

A daylight filter is mounted before the lens, in order to further reduce the influence of the ambient light.

Overvoltage protection

All our optic sensors are equipped with an overvoltage protection. Spikes on the operating voltage as well as spikes generated by inductive loads are suppressed.

Time delay

A time delay is used to delay the output of the sensor. There is a response as well as a release delay.

The response time delay changes the time period between closing the light beam and the output switching.

The release time delay enlarges the time between interrupting the light beam and the output switching.

The following are examples of using intelligence in the sensor, such as time delays, without the additional cost of setting up and wiring separate external units:

A diffuse sensor monitors objects passing by in regular intervals on a conveyor belt. The device must switch as soon as one of the objects is missing. The release time of the sensor output can be adjusted using the potentiometer provided. Every time an object passes, it resets the timer. If an object is missing on the conveyor, then the timer will not be reset on time. The sensor gives an output. The output changes state as soon as the time elapsed between two successive objects exceeds the set time t_{off}.

On-delay should be chosen if a through beam or retro-reflective sensor is used in the application.

Series 26 and 35 are available with relay output and integrated t_{on}/t_{off} timer, replacing external relays and timers.