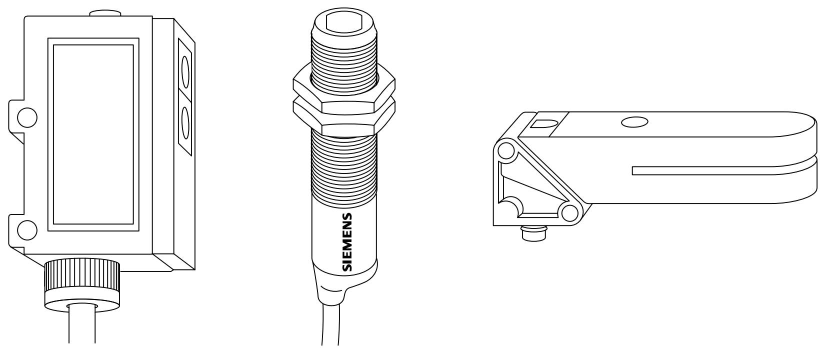
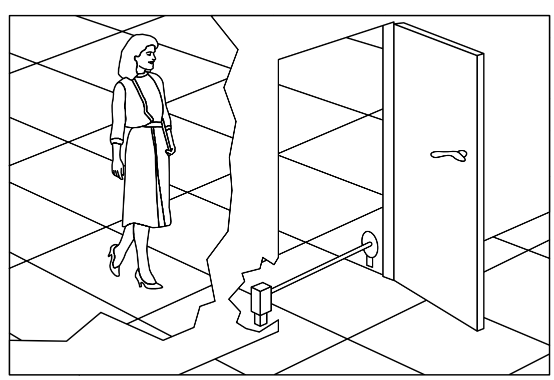
Photoelectric Sensors Theory of Operation

A photoelectric sensor is another type of position sensing device. Photoelectric sensors, similar to the ones shown below, use a modulated light beam that is either broken or reflected by the target.

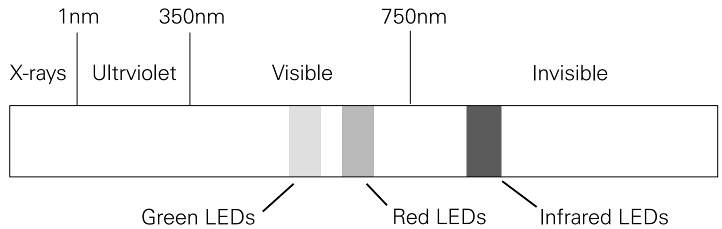


The control consists of an emitter (light source), a receiver to detect the emitted light, and associated electronics that evaluate and amplify the detected signal causing the photoelectric's output switch to change state. We are all familiar with the simple application of a photoelectric sensor placed in the entrance of a store to alert the presence of a customer. This, of course, is only one possible application.



Modulated Light

Modulated light increases the sensing range while reducing the effect of ambient light. Modulated light is pulsed at a specific frequency between 5 and 30 KHz. The photoelectric sensor is able to distinguish the modulated light from ambient light. Light sources used by these sensors range in the light spectrum from visible green to invisible infrared. Light-emitting diode (LED) sources are typically used.



Clearance

It is possible that two photoelectric devices operating in close proximity to each other can cause interference. The problem may be rectified with alignment or covers. The following clearances between sensors are given as a starting point. In some cases it may be necessary to increase the distance between sensors.

Sensor Model	Distance
D4 mm / M5	50 mm
M12	250 mm
M18	250 mm
K31	250 mm
K30	500 mm
K40	750 mm
K80	500 mm
L18	150 mm
L50 (Diffuse)	30 mm
L50 (Thru-Beam)	80 mm

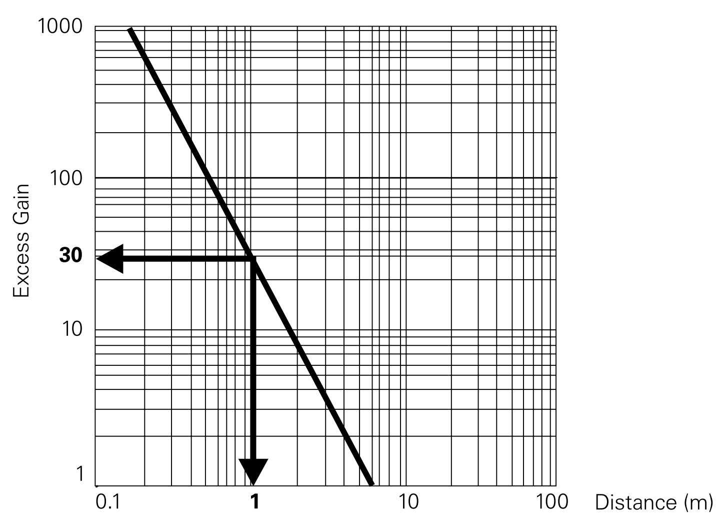
Excess Gain

Many environments, particularly industrial applications, include dust, dirt, smoke, moisture, or other airborne contaminants. A sensor operating in an environment that contains these contaminants requires more light to operate properly. There are six grades of contamination:

1. Clean Air (Ideal condition, climate controlled or sterile)
2. Slight Contamination (Indoor, nonindustrial areas, office buildings)
3. Low Contamination (Warehouse, light industry, material handling operations)
4. Moderate Contamination (Milling operations, high humidity, steam)
5. High Contamination (Heavy particle laden air, extreme wash down environments, grain elevators)
6. Extreme/Severe Contamination (Coal bins, residue on lens)

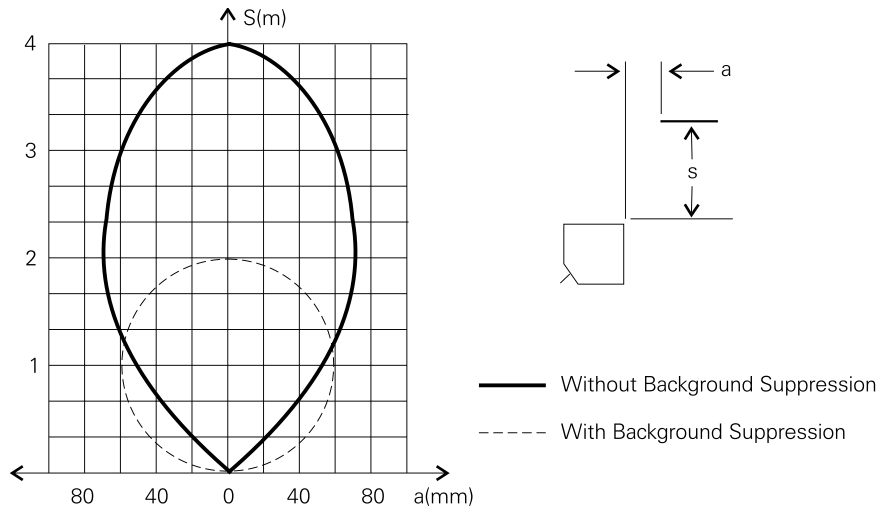
Excess gain represents the amount of light emitted by the transmitter in excess of the amount required to operate the receiver. In clean environments an excess gain equal to or greater than 1 is usually sufficient to operate the sensor's receiver. If, for example, an environment contained enough airborne contaminants to absorb 50% of the light emitted by the transmitter, a minimum excess gain of 2 would be required to operate the sensor's receiver.

Excess gain is plotted on a logarithmic chart. The example shown below is an excess gain chart for an M12 thru-beam sensor. If the required sensing distance is 1 m there is an excess gain of 30. This means there is 30 times more light than required in clean air hitting the receiver. Excess gain decreases as sensing distance increases. Keep in mind that the sensing distance for thru-beam sensors is from the transmitter to the receiver and the sensing distance for reflective sensors is from the transmitter to the target.



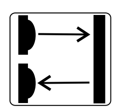
Switching Zones

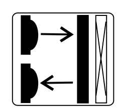
Photoelectric sensors have a switching zone. The switching zone is based on the beam pattern and diameter of the light from the sensor's emitter. The receiver will operate when a target enters this area.

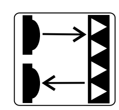


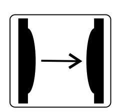
Symbols

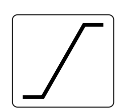
Various symbols are used in the Sensor catalog (SFPC-08000) to help identify the type of photoelectric sensor. Some symbols are used to indicate a sensor's scan technique, such as diffuse, retroreflective, or thru beam. Other symbols identify a specific feature of the sensor, such as fiber-optics, slot, or color sensor.

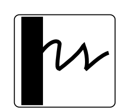

Diffuse Sensor

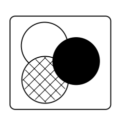

Diffuse Sensor with Background Supression

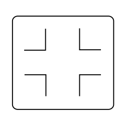

Retroreflective Sensor

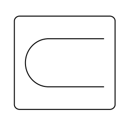

Thru-Beam Sensor


Diffuse Sensor with Analog Output


Sensors for Fiber-Optic Conductors


Color Sensor


Color Mark Sensor


Slot Sensor

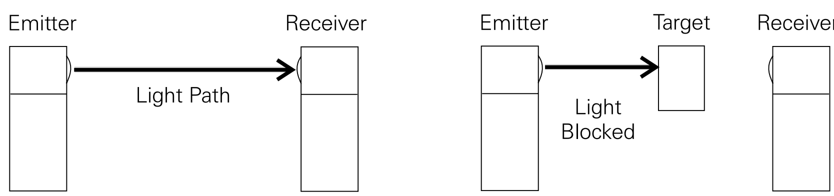
Scan Techniques

A scan technique is a method used by photoelectric sensors to detect an object (target). In part, the best technique to use depends on the target. Some targets are opaque and others are highly reflective. In some cases it is necessary to detect a change in color. Scanning distance is also a factor in selecting a scan technique. Some techniques work well at greater distances while others work better when the target is closer to the sensor.

Thru-Beam

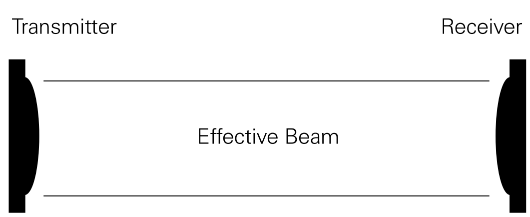
Separate emitter and receiver units are required for a thru-beam sensor. The units are aligned in a way that the greatest possible amount of pulsed light from the transmitter reaches the receiver. An object (target) placed in the path of the light beam blocks the light to the receiver, causing the receiver's output to change state. When the target no longer blocks the light path the receiver's output returns to its normal state.

Thru-beam is suitable for detection of opaque or reflective objects. It cannot be used to detect transparent objects. In addition, vibration can cause alignment problems. The high excess gain of thru-beam sensors make them suitable for environments with airborne contaminants. The maximum sensing range is 300 feet.



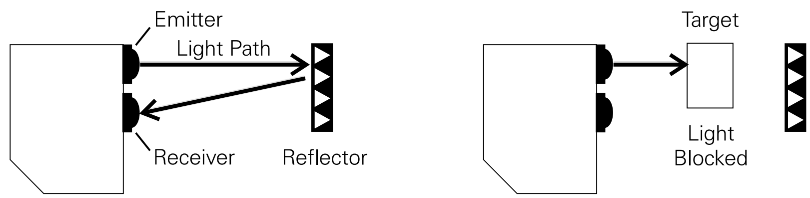
Thru-Beam Effective Beam

The effective beam of a photoelectric sensor is the region of the beam's diameter where a target is detected. The effective beam on a thru-beam sensor is the diameter of the emitter and receiver lens. The effective beam extends from the emitter lens to the receiver lens. The minimum size of the target should equal the diameter of the lens.



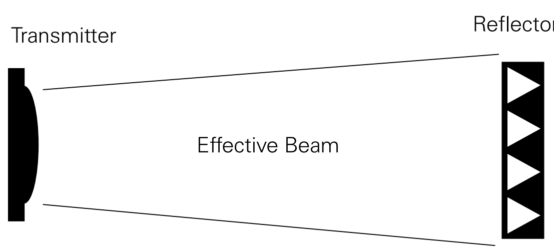
Reflective or Retroreflective Scan

Reflective and retroreflective scan are two names for the same technique. The emitter and receiver are in one unit. Light from the emitter is transmitted in a straight line to a reflector and returns to the receiver. A normal or a corner-cube reflector can be used. When a target blocks the light path the output of the sensor changes state. When the target no longer blocks the light path the sensor returns to its normal state. The maximum sensing range is 35 feet.



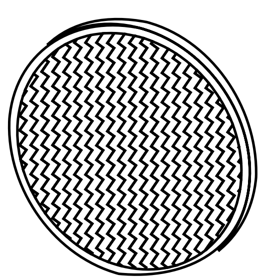
Retroreflective Scan Effective Beam

The effective beam is tapered from the sensor's lens to the edges of the reflector. The minimum size of the target should equal the size of the reflector.



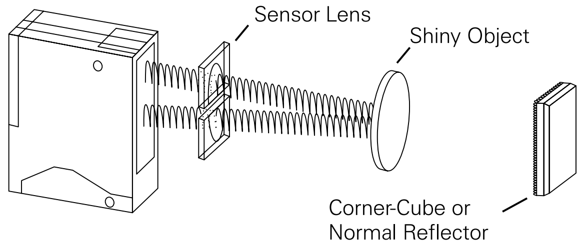
Reflectors

Reflectors are ordered separately from sensors. Reflectors come in various sizes and can be round or rectangular in shape or reflective tape. The sensing distance is specified with a particular reflector. Reflective tape should not be used with polarized retroreflective sensors.



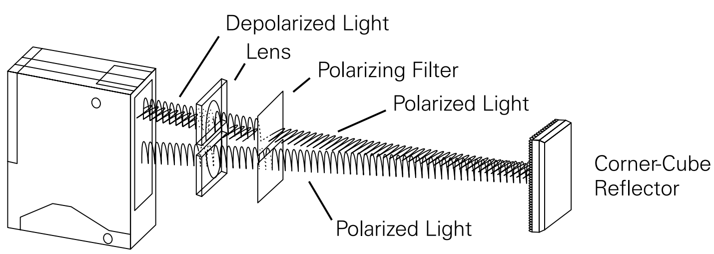
Retroreflective Scan and Shiny Objects

Retroreflective scan sensors may not be able to detect shiny objects. Shiny objects reflect light back to the sensor. The sensor is unable to differentiate between light reflected from a shiny object and light reflected from a reflector.



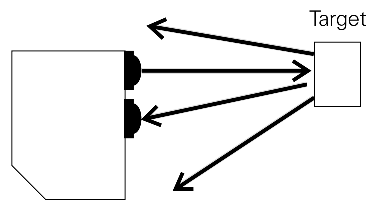
Polarized Retroreflective Scan

A variation of retroreflective scan is polarized retroreflective scan. Polarizing filters are placed in front of the emitter and receiver lenses. The polarizing filter projects the emitter's beam in one plane only. This light is said to be polarized. A corner-cube reflector must be used to rotate the light reflected back to the receiver. The polarizing filter on the receiver allows rotated light to pass through to the receiver. In comparison to retroreflective scan, polarized retroreflective scan works well when trying to detect shiny objects.



Diffuse Scan

The emitter and receiver are in one unit. Light from the emitter strikes the target and the reflected light is diffused from the surface at all angles. If the receiver receives enough reflected light the output will switch states. When no light is reflected back to the receiver the output returns to its original state. In diffuse scanning the emitter is placed perpendicular to the target. The receiver will be at some angle in order to receive some of the scattered (diffuse) reflection. Only a small amount of light will reach the receiver, therefore, this technique has an effective range of about 40."



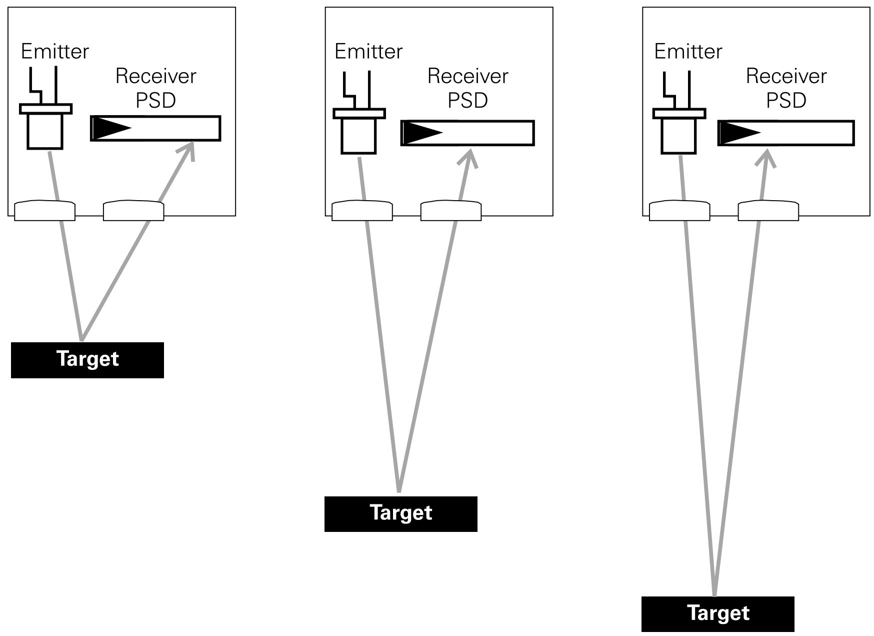
Diffuse Scan Correction Factors

The specified sensing range of diffuse sensors is achieved by using a matte white paper. The following correction values may be applied to other surfaces. These values are guidelines only and some trial and error may be necessary to get correct operation.

Test Card (Matte White)	100%
White Paper	80%
Gray PVC	57%
Printed Newspaper	60%
Lightly Colored Wood	73%
Cork	65%
White Plastic	70%
Black Plastic	22%
Neoprene, Black	20%
Automobile Tires	15%
Aluminum, Untreated	200%
Aluminum, Black Anodized	150%
Aluminum, Matte (Brushed Finish)	120%
Stainless Steel, Polished	230%

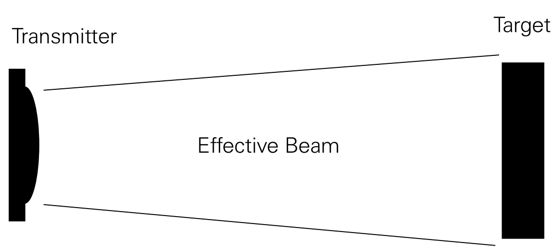
Diffuse Scan with Background Suppression

Diffuse scan with background suppression is used to detect objects up to a certain distance. Objects beyond the specified distance are ignored. Background suppression is accomplished with a position sensor detector (PSD). Reflected light from the target hits the PSD at different angles, depending on the distance of the target. The greater the distance the narrower the angle of the reflected light.



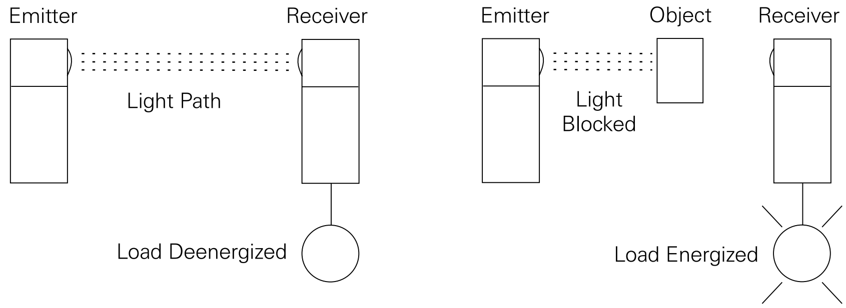
Diffuse Scan Effective Beam

The effective beam is equal to the size of the target when located in the beam pattern.

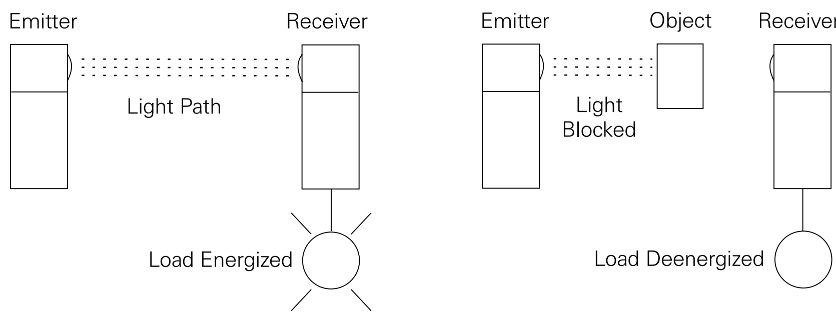


Operating Modes

There are two operating modes: dark operate (DO) and light operate (LO). Dark operate is an operating mode in which the load is energized when light from the emitter is absent from the receiver.



Light operate is an operating mode in which the load is energized when light from the emitter reaches the receiver.

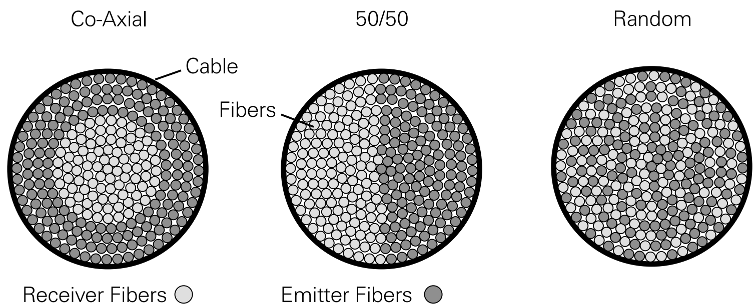


The following table shows the relationship between operating mode and load status for thru, retroreflective, and diffuse scan.

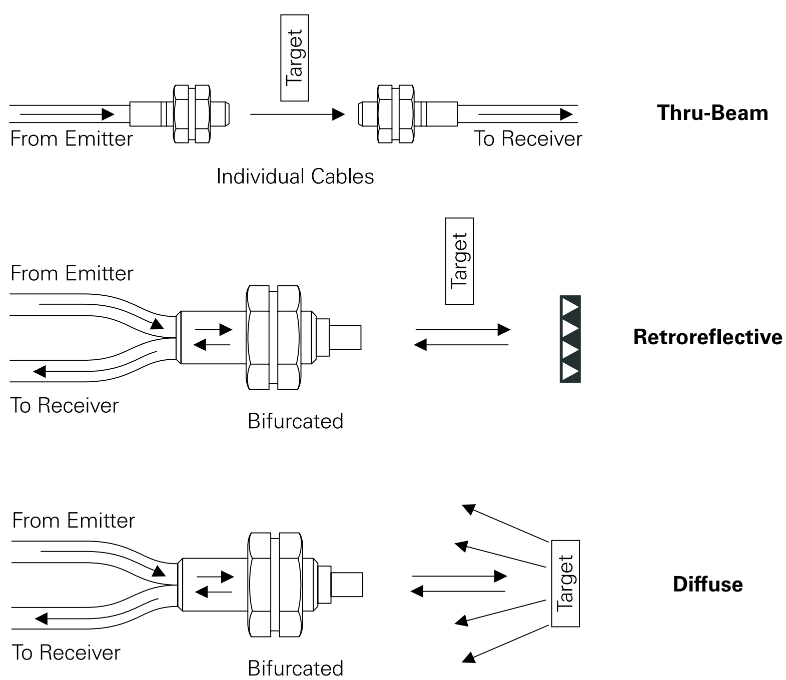
Operating Mode	Light Path	Load Status	
		Thru San and Retroreflective	Diffuse
Light Operate (LO)	Not Blocked	Energized	Deenergized
	Blocked	Deenergized	Energized
Dark Operate (DO)	Not Blocked	Deenergized	Energized
	Blocked	Energized	Deenergized

Fiber Optics

Fiber optics is not a scan technique, but another method for transmitting light. Fiber optic sensors use an emitter, receiver, and a flexible cable packed with tiny fibers that transmit light. Depending on the sensor there may be a separate cable for the emitter and receiver, or it may use a single cable. When a single cable is used, the emitter and receiver use various methods to distribute emitter and transmitter fibers within a cable. Glass fibers are used when the emitter source is infrared light. Plastic fibers are used when the emitter source is visible light.



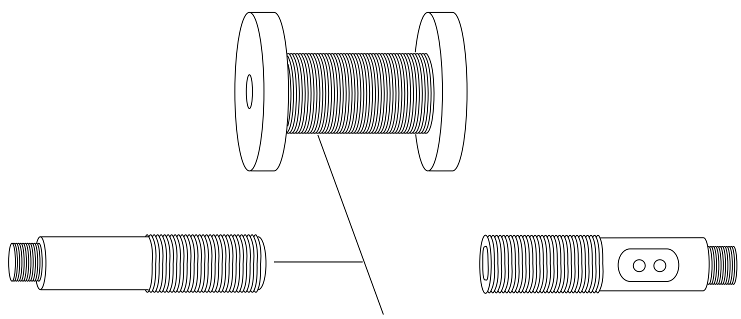
Fiber optics can be used with thru-beam, retroreflective scan, or diffuse scan sensors. In thru beam light is emitted and received with individual cables. In retroreflective and diffuse scan light is emitted and received with the same cable (bifurcated). Fiber optics is ideal for small sensing areas or small objects. Fiber optics have a shorter sensing range due to light losses in the fiber optic cables.



Lasers

Lasers are sometimes used as sensor light sources. Siemens uses Class 2 lasers which have a maximum radiant power of 1 mW. Class 2 lasers require no protective measures and a laser protection officer is not required. However, a warning notice must be displayed when laser sensors are used.

Laser sensors are available in thru-beam, diffuse scan, and diffuse scan with background suppression versions. Lasers have a high intensity visible light, which makes setup and adjustment easy. Laser technology allows for detection of extremely small objects at a distance. The Siemens L18 sensor, for example, will detect an object of 0.03 mm at a distance of 80 cm. Examples of laser sensor applications include exact positioning, speed detection, or checking thread thickness of 0.1 mm and over.



Review 7

1) Modulated light of a Siemens photoelectric sensor is pulsed at a frequency between ___________ and _________ KHz.

2) Excess ___________ is a measurement of the amount of light falling on the receiver in excess of the minimum light required to operate the sensor.

3) ___________ is a scan technique in which the emitter and receiver are in one unit. Light from the emitter is transmitted in a straight line to a reflector and returned to the receiver.

4) Polarizing filters on a retroreflective scan sensor orientate planes of light ___________ degrees to one another.

5) The correction factor for diffuse scan of cork with a photoelectric sensor is ___________ %.

6) ___________ operate is an operating mode in which the load is energized when light from the emitter of a photoelectric sensor is absent from the receiver.

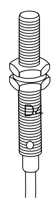
7) Fiber optics is a scan technique.

   a. true
   b. false

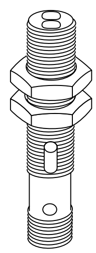
8) Siemens laser photoelectric sensors use Class ___________ lasers.

Photoelectric Family of Sensors

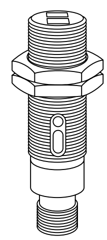
Siemens offers a wide variety of photoelectric sensors, including thru-beam, retroreflective scan, and diffuse scan sensors. There are many photoelectric sensors to choose from. Choice depends on many factors such as scan mode, operating voltage, environment, and output configurations. Most of these sensors can be used with some or all scan techniques. In addition, specialized sensors such as fiber optic, laser, and color sensors are available. To help simplify the process of determining the right sensor selection guides are provided. These guides do not list all the features of a given sensor. For a more detailed description refer to the appropriate catalog.



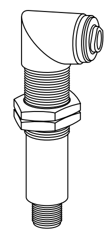
D4



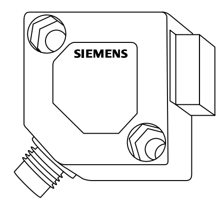
M12



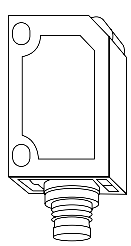
M18



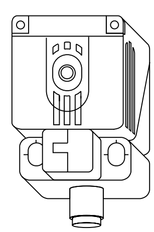
L18



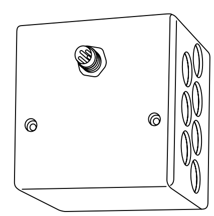
K40



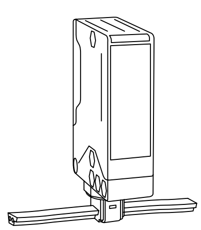
K20



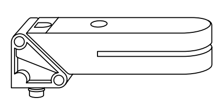
C40



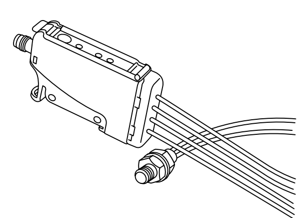
Light Array



K80 with AS-i Cable



G20



CL40

Thru-Beam Sensors

Sensor	Range	Voltage	Output			Mode		Connection					Housing
			PNP	NPN	Relay	DO	LO	AS-i	M8	M12	Cable	Terminals	
D4/M5	250 mm	10-30 VDC	X	X			X		X		X		Metal
M12	4 m	10-30 VDC	X	X		X	X			X	X		Metal
M18	6 m	10-36 VDC	X	X		X	X			X	X		Metal
M18M	12 m	10-30 VDC	X	X		X	X			X	X		Metal
M18P	12 m	10-30 VDC	X	X		X	X			X	X		Plastic
K30	12 m	10-36 VDC	X	X		X	X		X		X		Plastic
K35	5 m	10-30 VDC	X	X		X	X		X		X		Plastic
K40	15 m	10-36 VDC	X	X		X	X		X	X	X		Plastic
K50	5 m	10-30 VDC 15-264 VAC	X	X	X	X	X	X		X	X		Plastic
K65	50 m	10-30 VDC	X	X		X	X			X	X		Plastic
K80	50 m	10-36 VDC 20-320 VAC	X	X	X	X	X	X		X		X	Plastic
L18 (Laser)	50 m	10-30 VDC	X			X	X			X	X		Metal

Retroreflective Sensors

Sensor	Range	Voltage	Output			Mode		Connection					Housing
			PNP	NPN	Relay	DO	LO	AS-i	M8	M12	Cable	Terminals	
M12	1.5 m	10-30 VDC	X	X		X	X			X	X		Metal
M18	2 m	10-36 VDC	X	X		X	X			X	X		Metal
M18M	2 m	10-30 VDC	X	X		X	X			X	X		Metal
M18P	2 m	10-30 VDC	X	X		X	X			X	X		Plastic
K20	2.5 m	10-30 VDC	X	X		X	X		X		X		Plastic
K30	4 m	10-36 VDC	X	X		X	X		X		X		Plastic
K35	2.5 m	10-30 VDC	X	X		X	X		X		X		Plastic
K40	6 m	10-36 VDC	X	X		X	X		X	X	X		Plastic
K50	4 m	10-30 VDC 15-264 VAC	X	X	X	X	X	X		X	X		Plastic
K65	8 m	10-30 VDC	X	X		X	X			X	X		Plastic
K80	6 m	10-36 VDC 20-320 VAC	X	X	X	X	X	X		X		X	Plastic
L50 (Laser)	12 m	10-30 VDC	X	X		X	X			X	X		Metal
Light Array	1.4 m	12-36 VDC	X			X			X				Plastic
C40	6 m	10-36 VDC	X	X		X	X			X			Plastic

Diffuse Sensors

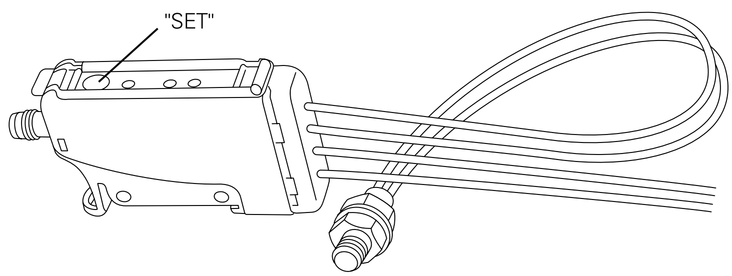
Sensor	Range	Voltage	Output			Mode		Connection					Housing
			PNP	NPN	Relay	DO	LO	AS-i	M8	M12	Cable	Terminals	
D4/M5	50 mm	10-30 VDC	X	X			X		X		X		Metal
M12	30 cm	10-30 VDC	X	X		X	X			X	X		Metal
M18	60 cm	10-36 VDC	X	X		X	X			X	X		Metal
M18M	30 cm	10-30 VDC	X	X		X	X			X	X		Metal
M18P	30 cm	10-30 VDC	X	X		X	X			X	X		Plastic
K20	30 cm	10-30 VDC	X	X		X	X		X		X		Plastic
K30	1.2 m	10-36 VDC	X	X		X	X		X		X		Plastic
K35	50 cm	10-30 VDC	X	X		X	X		X		X		Plastic
K40	2 m	10-36 VDC	X	X		X	X		X	X	X		Plastic
K50	90 cm	10-30 VDC 15-264 VAC	X	X	X	X	X	X		X	X		Plastic
K65	2 m	10-30 VDC	X	X		X	X			X	X		Plastic
K80	2 m	10-36 VDC 20-320 VAC	X	X	X	X	X	X		X		X	Plastic
C40	2.5 cm	10-30 VDC	X	X		X	X			X			Plastic

Diffuse Sensors with Background Suppression

Sensor	Range	Voltage	Output			Mode		Connection					Housing
			PNP	NPN	Relay	DO	LO	AS-i	M8	M12	Cable	Terminals	
M18	120 mm	10-36 VDC	X	X		X	X			X	X		Metal
M18P	100 mm	10-30 VDC	X	X		X	X			X	X		Plastic
K20	100 mm	10-30 VDC	X	X		X	X		X		X		Plastic
K50	25 cm	10-30 VDC 15-264 VAC	X	X	X	X	X	X		X	X		Plastic
K65	50 cm	10-30 VDC	X	X		X	X			X	X		Plastic
K80	1 m	10-36 VDC 20-320 VAC	X	X	X	X	X	X		X		X	Plastic
L50 (Laser)	150 mm	10-30 VDC	X	X		X	X			X	X		Metal
C40	2.5 cm	10-30 VDC	X	X		X	X			X			Plastic

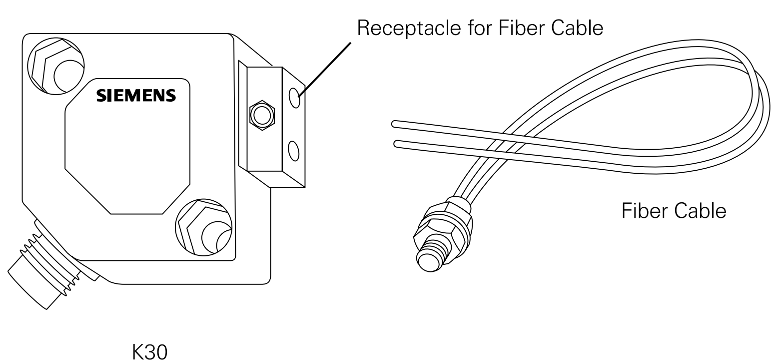
Teach In

Some of the following sensors, such as the CL40, have a feature known as Teach In. This feature allows the user to teach the sensor what it should detect. An object to be detected is placed in front of the sensor so that it knows what the accepted reflected light is. The sensor is then programmed to respond only to this light. The CL40 uses a "SET" button to Teach In. Other sensors have different methods to Teach In. Teach In can be used to detect a specific color, for example. Teach In also works to detect transparent objects.



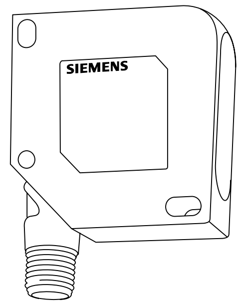
Fiber Optic Sensors

The basic operation is the same for optical fibers made of glass or plastics. Optical fibers are fitted in front of the transmitter and receiver and extend the "eye" of the sensor. Fiber optic cables are small and flexible and can be used for sensing in hard to access places.



Laser Diffuse Sensor with Analog Output

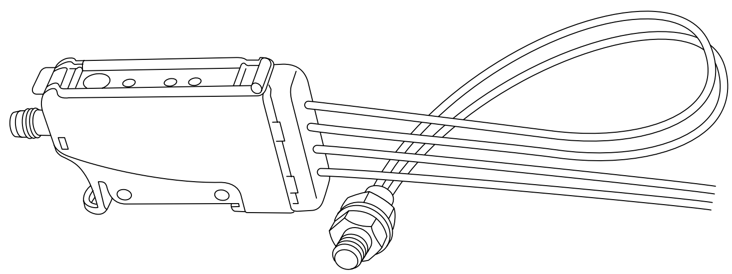
The analog laser sensor is able to measure the exact distance of an object within its sensing range. This sensor uses a visible laser light with a highly accurate and linear output.



L50

Color BERO

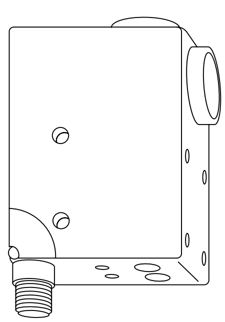
The color BERO uses 3 LEDs with the colors red, green, and blue. Light is emitted to the target and can detect a specific color of reflected light. This sensor uses Teach In to set the color to be detected. The CL40 is also a fiber optic device.



CL40

Color Mark BERO

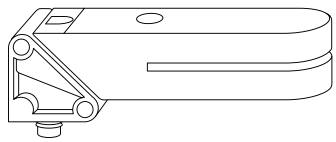
The color mark BERO is also used to detect specific colors. This sensor works differently from the CL40. The color mark BERO uses green or red light for the emitter. The color is selected dependent on the contrast of the target. The target and background color can be set separately.



C80

Slot BERO

The target is placed inside the slot of the sensor. Emitted light passes through the object. Different contrast, tears, or holes in the target will vary the quantity of light reaching the receiver. This sensor uses Teach In. It is available with infrared or visible red/green light



G20

Selection Guide

Sensor Type	Sensor	Range	Voltage	Teach In	Output		Mode		Connection			Housing
					PNP	NPN	DO	LO	M8	M12	Cable	
Fiber Optic	K35	75 mm	10-30 VDC		X	X	X	X	X		X	Plastic
	KL40	280 mm	10-30 VDC	X	X	X	X	X	X		X	Plastic
	K30	120 mm	10-36 VDC		X	X	X	X	X		X	Plastic
	K40	150 cm	10-36 VDC		X	X	X	X	X	X	X	Plastic
Laser Diffuse Analog Output	L50	45-85 mm	18-28 VDC								X	Plastic
Color BERO	CL40	15 mm	10-30 VDC	X	X	X	X	X	X		X	Plastic
Color Mark BERO	C80	18 mm	10-30 VDC	X	X		X	X		X	X	Metal
Slot BERO	G20	2 mm	10-30 VDC	X	X	X	X	X	X			Metal

Review 8

1) The maximum sensing range of a K80, thru scan, photoelectric sensor is ___________ m.

2) ___________ is an example of a photoelectric sensor with Teach In.

   a. D4
   b. K50
   c. CL40
   d. K30

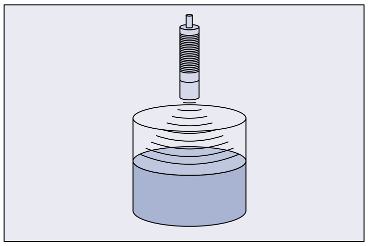
3) A ___________ is a photoelectric sensor that has a slot where the target is placed.

4) The maximum sensing range of a Color Mark BERO C80 is ___________ mm.

Sensor Applications

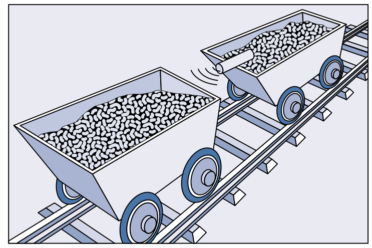
There are any number of applications where sensors can be utilized, and as you have seen throughout this book there are a number of sensors to chose from. Choosing the right sensor can be confusing and takes careful thought and planning. Often, more than one sensor will do the job. As the application becomes more complex the more difficult it is to choose the right sensor for a given application. The following application guide will help you find the right sensor for the right application.

Ultrasonic Sensors



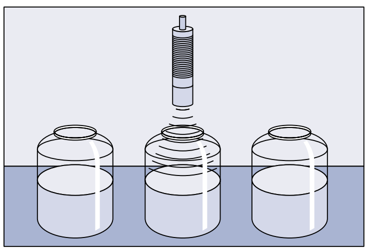
Application
Level Measurement in Large Vessels (Tanks, Silos)

Sensor
3RG61 13
Compact Range III



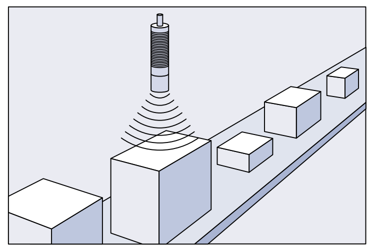
Application
Anti-Collision

Sensor
3RG60 14
Compact Range I



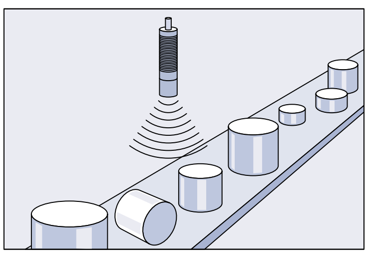
Application
Level Measurement in Small Bottles

Sensor
3RG61 12
Compact Range III



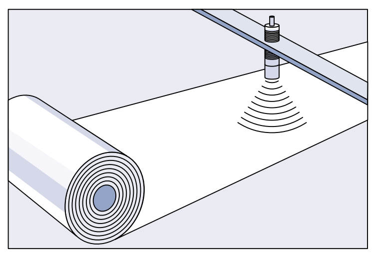
Application
Height Sensing

Sensor
3RG60 13
Compact Range II



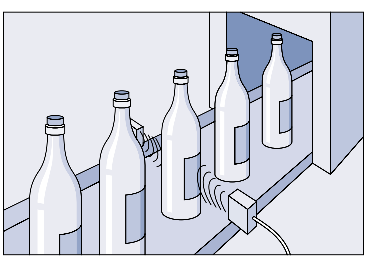
Application
Quality Control

Sensor
3RG61 12
Compact Range III



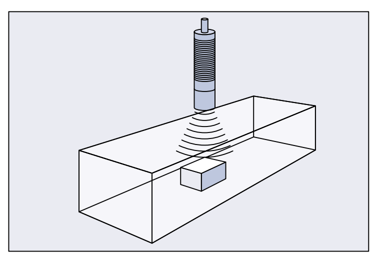
Application
Breakage Sensing

Sensor
3RG61 12
Compact Range I



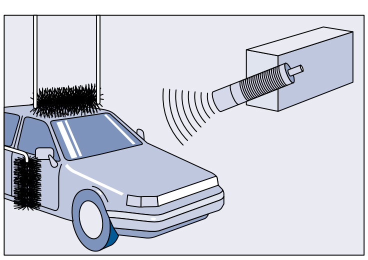
Application
Bottle Counting

Sensor
3RG62 43
Thru Beam



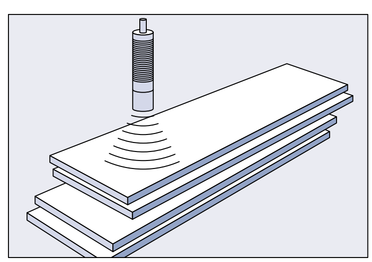
Application
Object Sensing

Sensor
3RG60 12
Compact Range II



Application
Vehicle Sensing and Positioning

Sensor
3RG60 14
Compact Range III

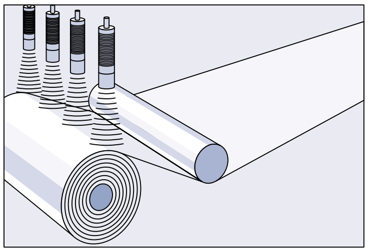


Application
Stack Height Sensing

Sensor
3RG60 13
Compact Range II

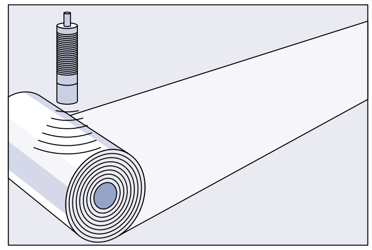
For further application assistance contact your local sales office. Call (800) 964-4414 for nearest office.

Ultrasonic Sensors



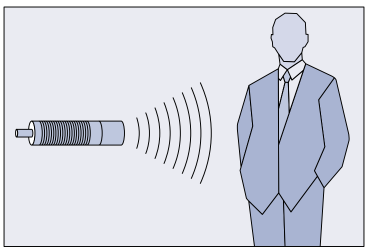
Application
Contour Recognition

Sensor
3RG61 13
Compact Range III



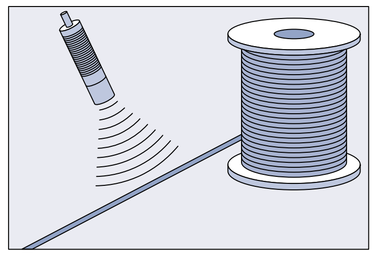
Application
Diameter Sensing and
Strip Speed Control

Sensor
3RG61 12
Compact Range III



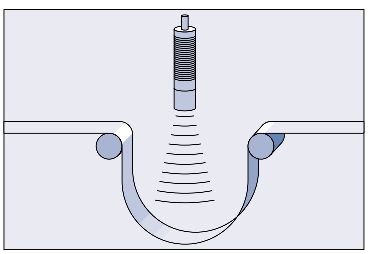
Application
People Sensing

Sensor
3RG60 12
Compact Range II



Application
Wire and Rope
Breakage Monitoring

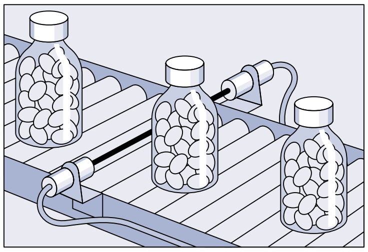
Sensor
3RG60 12
Compact Range I



Application
Loop Control

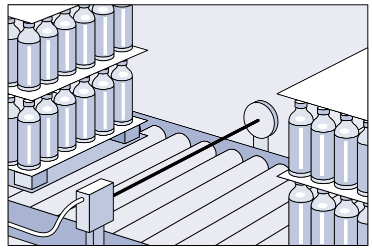
Sensor
3RG60 15
Compact Range II

Photoelectric Sensors



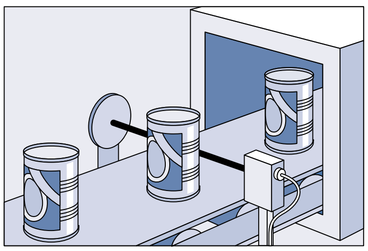
Application
Verifying Objects in Clear Bottles

Sensor
M12 Thru Beam



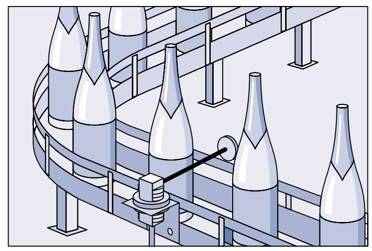
Application
Flow of Pallets Carrying Bottles

Sensor
K40 Retroreflective



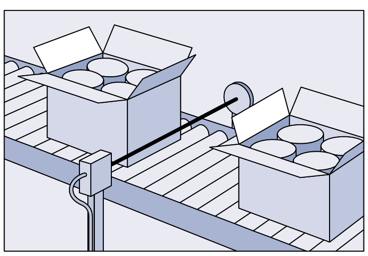
Application
Counting Cans

Sensor
K50 Polarized Retroreflective



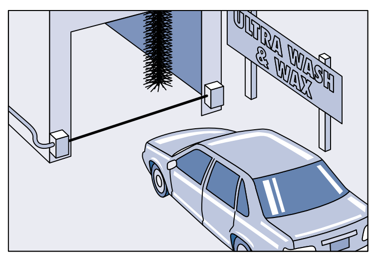
Application
Counting Bottles

Sensor
SL18 Retroreflective



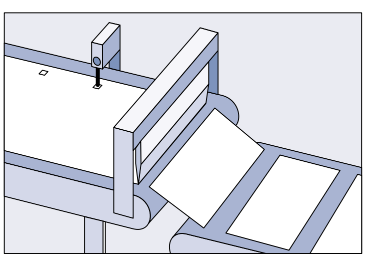
Application
Counting Cartons

Sensor
K65 Retroreflective



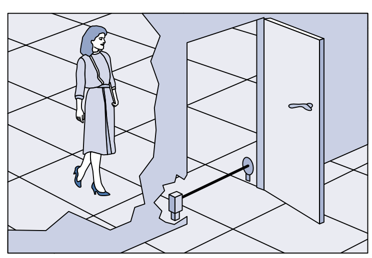
Application
Car Wash

Sensor
SL Thru Beam



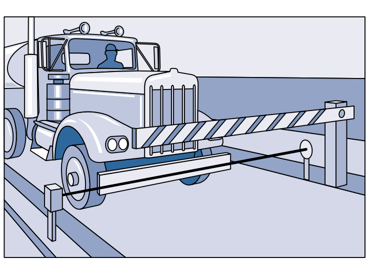
Application
Reading Reference Marks for Trimming

Sensor
C80 Mark Sensor



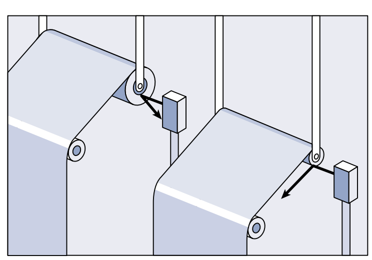
Application
Detecting Persons

Sensor
K50 Retroreflective



Application
Controlling Parking Gate

Sensor
SL Retroreflective

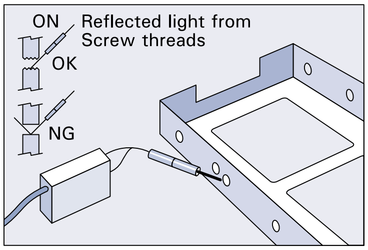


Application
End of Roll Detection

Sensor
K31 Diffuse

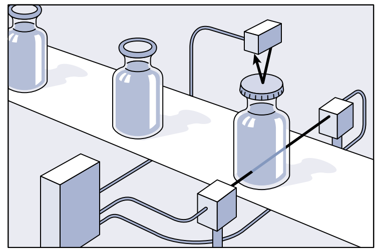
For further application assistance contact your local sales office. Call (800) 964-4414 for nearest office.

Photoelectric Sensors



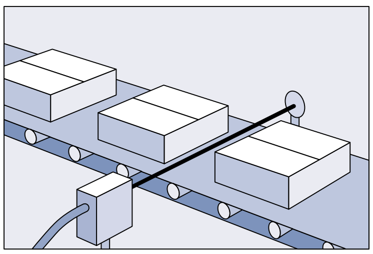
Application
Detecting Tab Threads

Sensor
KL40 Fiber Optic



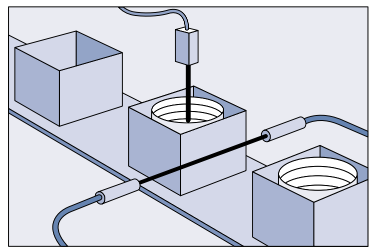
Application
Detecting Caps on Bottles

Sensor
K20 Diffuse with Background Suppression and K31 Thru Beam



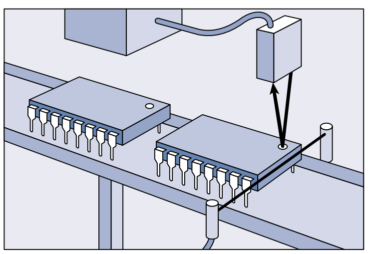
Application
Counting Packages

Sensor
K80 Retroreflective



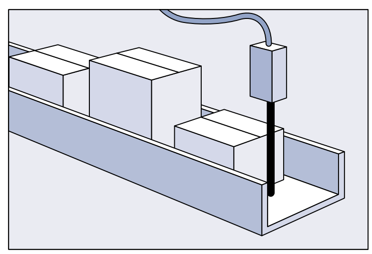
Application
Detecting Components Inside Metal Can

Sensor
K50 Background Suppression



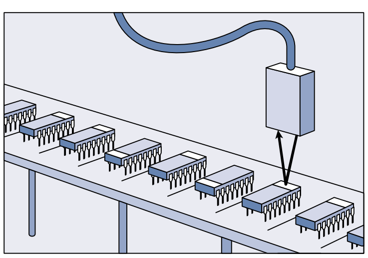
Application
Determining Orientation of IC Chip

Sensor
L50 Laser with Background Suppression



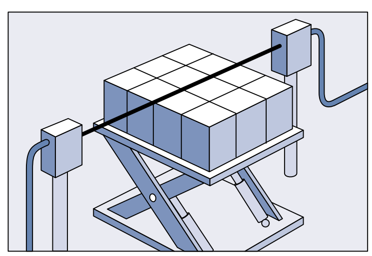
Application
Detecting Items of Varying Heights

Sensor
K80 Background Suppression



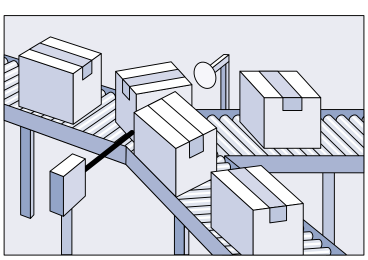
Application
Detecting Orientation of IC Chip

Sensor
Color Mark or Fiber Optic



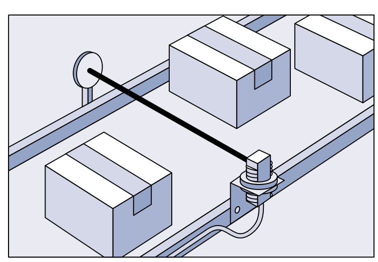
Application
Controlling Height of a Stack

Sensor
SL Thru Beam



Application
Detecting Jams on a Conveyor

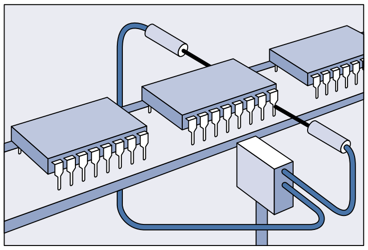
Sensor
K50 Retroreflective



Application
Counting Boxes Anywhere on a Conveyor

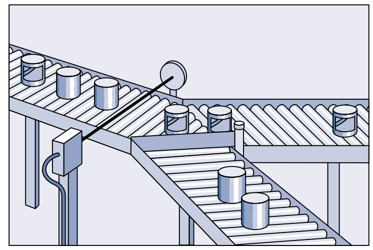
Sensor
SL18 Right Angle Retroreflective

Photoelectric Sensors



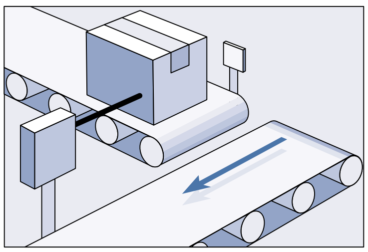
Application
Counting IC Chip Pins

Sensor
KL40 Fiber Optic



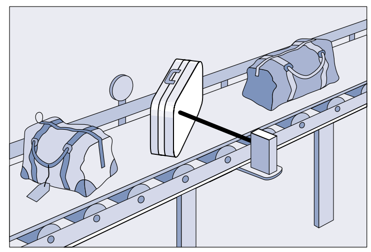
Application
Batch counting and Diverting Cans Without Labels

Sensor
K40 Polarized



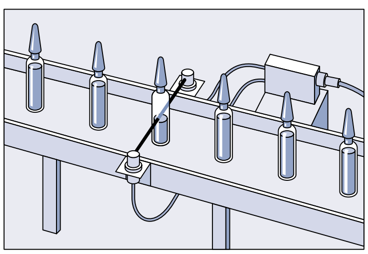
Application
Detecting Presence of Object to Start a Conveyor

Sensor
K35 Retroreflective



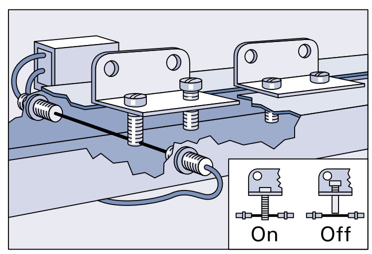
Application
Detecting Reflective Objects

Sensor
K80 Polarized Retroreflective



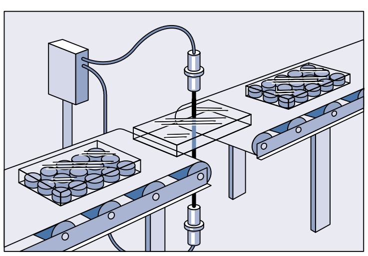
Application
Verifying Liquid in Vials

Sensor
K35 Fiber Optic



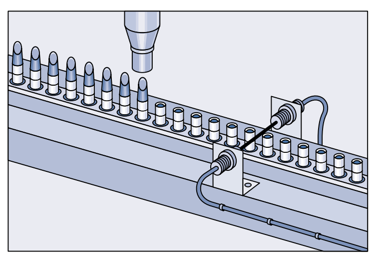
Application
Verifying Screws are Correctly Seated

Sensor
KL40 Fiber Optic



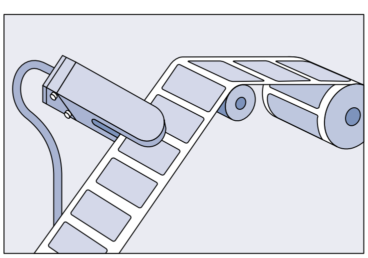
Application
Verifying Cakes are Present in Transparent Package

Sensor
KL40 Fiber Optic



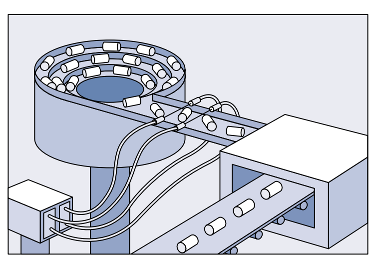
Application
Verifying Lipstick Height Before Capping

Sensor
M5 or M12 Thru Beam



Application
Detecting Labels with Transparent Background

Sensor
G20 Slot Sensor

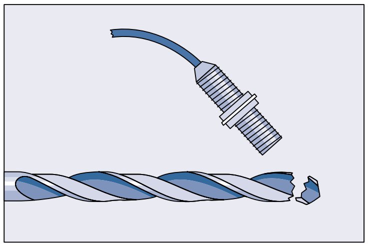


Application
Monitoring Objects as they Exit Vibration Bowl

Sensor
K35 Fiber Optic

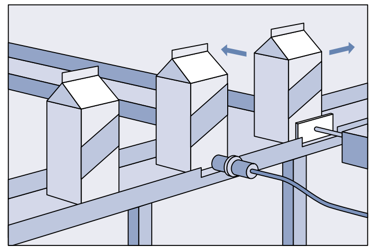
For further application assistance contact your local sales office. Call (800) 964-4414 for nearest office.

Proximity Switches



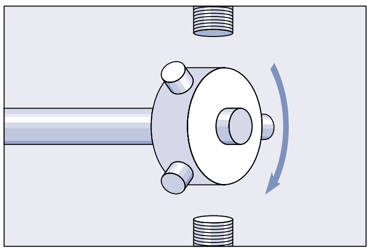
Application
Detecting the Presence of a Broken Drill Bit

Sensor
12 mm Normal Requirements



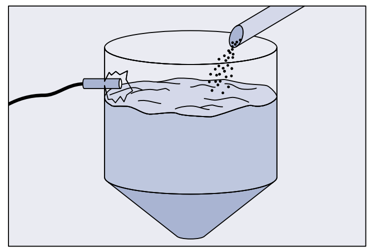
Application
Detecting Milk in Cartons

Sensor
Capacitive



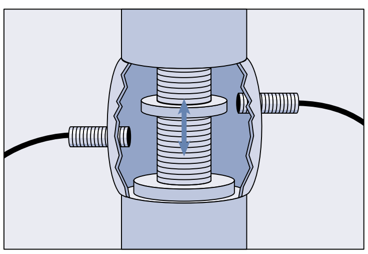
Application
Detecting Presence of Set Screws on Hub for Speed or Direction Control

Sensor
30mm Shorty



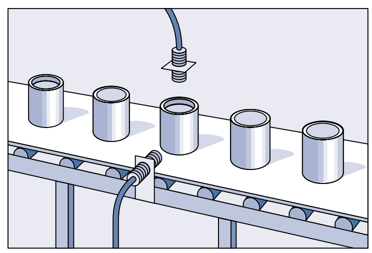
Application
Controlling Fill level of solids in a bin

Sensor
Capacitive



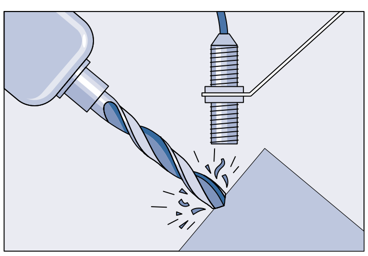
Application
Detecting Full Open or Closed Valve Postition

Sensor
12mm or 18mm Extra Duty



Application
Detecting Presence of Can and Lid

Sensor
30mm Normal Requirements or UBERO, 18mm Normal Requirements Gating Sensor



Application
Detecting Broken Bit on Milling Machine

Sensor
18 mm

Application Inquiry

Providing a sensing device solution requires both knowledge of the application and answers to specific questions to obtain key additional facts. This page is intended to be photocopied and used as a self-help guide in assessing the scope of sensor applications. The information recorded on this form may then be cross-checked with the product specifications found in our "BERO - Sensing Solutions" catalog to obtain a potential solution to your application. If your application involves machine guard safety interlocking, the use of standard position sensors could result in serious injury or death. Please contact SE&A Sensor Marketing for assistance at (630) 879-6000.

1. Target Material

___ Metal ___ Non-Metal
___ Ferrous ___ Non-Ferrous
___Transparent ___Translucent
___ Opaque

2. Target Description and Dimensions

Target Finish
(shiny/dull/matte, etc.) __________
Target Color __________
Target Texture __________

3. Target Orientation/Spacing

Describe position of target when sensed relative to immediate environment.

Number of Multiple Targets ____
Number of Targets Nested Together ___
Spacing Between Targets _______
Size of Target __________

4. Target Movement/Speed/Velocity

Describe how the target approaches the sensing area (Axial/Lateral).

Target Speed __________
Cycles per Second/Minute/etc ______
Hours machine is run? ________

5. Sensing Distance

From Target to Sensor __________
From Target to Background __________

6. Background Description

Describe the background conditions.

7. Physical/Mounting Criteria

Is target accessible from more than one side?

Space available to install sensor _____

Sensor Orientation Possibilities _____

____

8. Environment

___ Clean ___ Oily ___ Dusty
___ Humid ___ Outdoor ___ Indoor
___ Submersion ___ Wash down
Temperature ________
Temperature Variation ________

9. Load Requirements

Describe the Load _________________
Inductive: Inrush _____ Sealed _____

10. Control Voltage Supply

__________VAC __________VDC

11. Output Requirements

___ NPN ___ PNP ___ SCR ___ FET
___ Relay
___ Normally Open ___ Normally Closed
___ Complimentary _____ LO/DO

12. Connection Preference

___ Connector/Matching Cordset

Length of Sensor Prewired Cable
(2 Meters Standard) ________

___ AS-i Interface

Review Answers

Review 1	1) Limit switch; 2) d; 3) Pretravel; 4) operating position; 5) break-before-make; 6) Break; 7) 30; 8) operating head; 9) SIGUARD; 10) 6P
Review 2	1) inductive; 2) a; 3) 3; 4) 4; 5) steel; 6) 0.40; 7) 81%
Review 3	1) 10; 2) 20; 3) 265, 320; 4) IP; 5) 65; 6) UBERO
Review 4	1) electrostatic; 2) any; 3) dielectric; 4) b; 5) 20
Review 5	1) sound; 2) 6-80; 3) 5; 4) 60; 5) 3; 6) Diffuse
Review 6	1) Thru-Beam; 2) 5 to 40; 3) separate; 4) a; 5) SONPROG; 6) Modular; 7) b
Review 7	1) 5 and 30; 2) gain; 3) Retroreflective; 4) 90 degrees; 5) 65; 6) Dark; 7) b; 8) 2
Review 8	1) 50; 2) c; 3) G20; 4) 18

Final Exam

The final exam is intended to be a learning tool. The book may be used during the exam. A tear-out answer card is provided. After completing the final exam, mail in the answer card for grading. A grade of 70% or better is passing. Upon successful completion of the test a certificate will be issued.

Questions

1. The distance an actuator arm travels on a mechanical limit switch from the release position to the free position is known as ___________ .

   a. Overtravel b. Differential Travel
   c. Pretravel d. Release Travel

2. ___________ is a term that describes the load a mechanical limit switch can handle when the mechanical contacts close.

   a. Make b. Break
   c. Continuous d. Inductive

3. ___________ are the two product lines for Siemens mechanical limit switches.

   a. International and IEC
   b. International and North American
   c. North American and BERO
   d. International and BERO

4. ___________ is a type of sensor that can only detect metal.

   a. Photoelectric b. Ultrasonic
   c. Inductive d. Capacitive

5. When two or more shielded inductive proximity sensors are mounted opposite one another, they should be placed a distance of at least ___________ times the rated sensing range from each other.

   a. two b. three
   c. four d. six

6. A correction factor of ___________ is applied to an unshielded inductive proximity switch when the target is 50% smaller than the standard target.

a.	0.50	b.	0.73
c.	0.83	d.	0.92

7. ___________ is a type of Siemens inductive proximity switch that can detect all metal targets without a reduction factor.

   a. NAMUR
   b. UBERO
   c. Increased Operating Distance
   d. AS-i

8. When using a capacitive proximity sensor with a rated sensing distance of 10 mm to detect polyamide, the effective sensing distance is approximately ___________ mm.

a.	4	b.	6
c.	8	d.	10

9. ___________ proximity sensors develop an electrostatic field to detect the target.

a.	Inductive	b.	Ultrasonic
c.	Photoelectric	d.	Capacitive

10. The approximate angle of the main cone of an ultrasonic sensor is ___________ degrees.

a.	5	b.	10
c.	30	d.	45

11. A distance greater than ___________ cm should be left between two ultrasonic sensors mounted opposite each other with a rated sensing range of 20 - 130 cm.

a.	4000	b.	2500
c.	1200	d.	400

12. Coarse-grained materials can have as much as ___________ degrees angular deviation from the send direction of an ultrasonic sensor.

a.	3	b.	5
c.	45	d.	90

13. Sound velocity decreases ___________ % between sea level and 3000 m above sea level.

a.	0.17	b.	3.6
c.	5	d.	25 - 33

14. A signal evaluator is required for use with ___________ ultrasonic sensors.

a. Compact Range 0
b. Compact Range I
c. Compact Range III
d. Modular Range II

15. The maximum sensing distance of a Thru Beam ultrasonic sensor is 80 cm when ___________ .

a. X1 is open
b. X1 is connected to L+
c. X1 is connected to L-
d. X1 is closed

16. SONPROG can be used to adjust ___________ ultrasonic sensors.

a. Thru Beam
b. Compact Range 0 and Compact Range I
c. Compact Range I and Compact Range II
d. Compact Range II and Compact Range III

17. A 90° diverting reflector is available for use with ___________ ultrasonic sensors.

a. M30 spherical
b. Compact Range M18 spherical
c. Compact Range 0 with Integrated Transducer
d. Thru Beam

18. ___________ scan is a photoelectric scan technique in which the planes of emitter light and reflected light are orientated 90° to one another.

a. Polarized Retroreflective
b. Retroreflective
c. Diffuse
d. Thru

19. ___________ is a photoelectric sensor that use three LEDs with colors red, green, and blue and is can be used to detect a specific color of reflected light.

a. G20
b. K30
c. CL40
d. C80

20. The maximum sensing range of the L18 laser photoelectric sensor is ___________ .

a. 12 m
b. 50 m
c. 100 mm
d. 150 mm

Notes