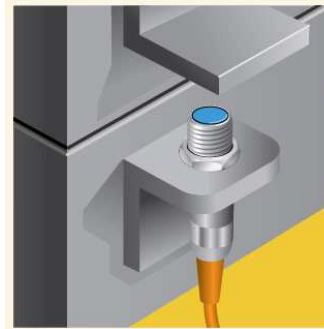
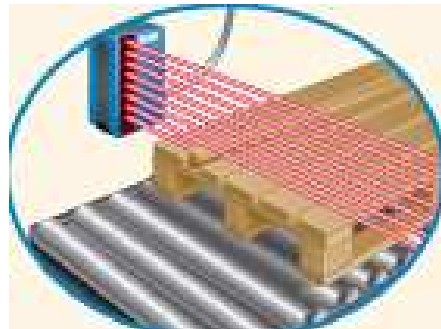
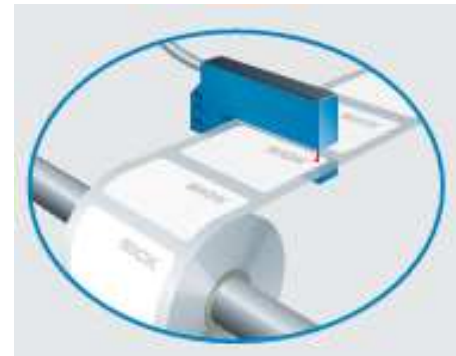
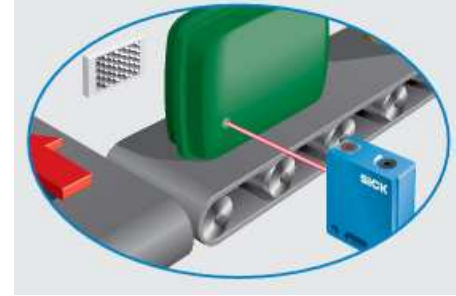




: Choose the Right Object Detection Sensor

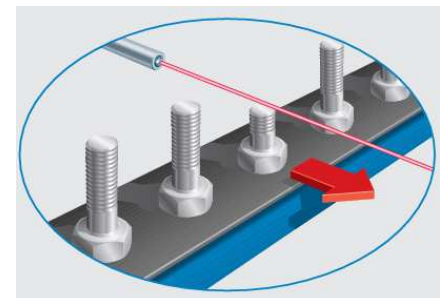
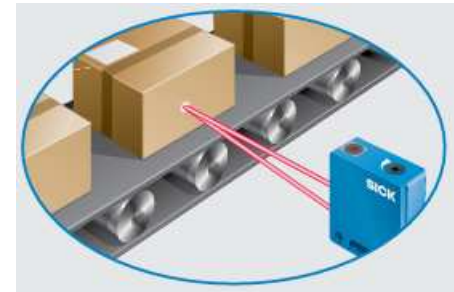
Rolf Agner, Sr Corp Trainer

- : Selecting an industrial sensor can be daunting. With so many different sensing technologies and the endless variety of products in the market, how is it possible to find that one ideal sensor for any given application? It's not really so much a process of selecting the right sensor . . . it's really about eliminating all the wrong choices. And, there probably isn't going to be just the "ideal" sensor, but a choice of more than one that'll get the job done.
- : We will define a step by step method of determining the best sensor(s) for an application.



Step 1: Determine Type of Sensing

- Does the sensor determine a process parameter (e.g. temperature, pressure, flow, torque . . .), the presence of an object, the distance to a target, or the position of an object or mechanism? Let's focus on detecting an object for this discussion.
 - If the job is to detect presence of an object, then we are probably going to select some kind of proximity sensor
 - Sometimes called “presence sensors” or “object detection sensors”
 - There are several kinds of sensor technologies that can detect the presence (or absence) of an object:
 - Inductive, photoelectric, capacitive, magnetic, bar code reader, RFID and ultrasonic sensors are all possible candidates
 - If the job is to detect presence of a **particular** object, then we are probably going to select multiple of the above sensors arranged to define a particular profile/shape, material, color or other unique characteristic of an object, or some form of ID (bar code or RFID) or vision system



: What material composition is the object?

- Metallic
- Non-metallic
- Magnetic
- Solid
- Liquid
- Granular
- Bulk
- Hard
- Porous
- Opaque
- Clear
- Shiny
- Remission
- Irregular shape
- Uniform in color

These object physical characteristics plus others, and combinations of these, will affect your choice of sensor

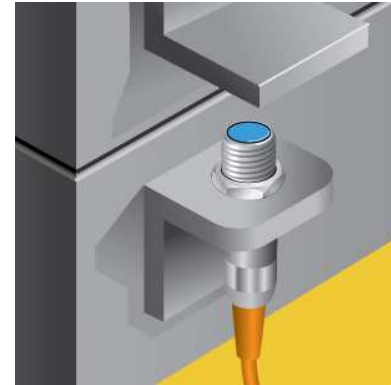


- ⋮ If target object is metal, any of these common technologies could work:
 - Inductive
 - Photoelectric
 - Capacitive
 - Ultrasonic
 - Vision Sensor
- ⋮ Therefore, to narrow our selection, we need to examine the application some more



Step 3: Distance to Target Object

- How far away from the object the sensor be mounted?
- Example: If the application is modern, compact automation machinery, where things are close together, and the sensor is installed close to a metallic object target that passes at a consistent short distance, an inductive proximity sensor would be the first choice. Inductive sensors have short sensing distances (a few millimeters), but compared to other sensing technologies, they have some advantages:
 - Inductive proximity sensors ignore all materials except metal
 - Inductive proximity sensors are very reliable and predicable
 - Inductive proximity sensors are not affected by contamination (as long as contamination is non-metallic)
 - Industry standard sizes are readily available from multiple sources (8, 12, 18, 30 mm)
 - Inductive proximity sensors are inexpensive compared to other sensing technologies



Step 3: Distance to Target Object

- What if distance is beyond an inductive sensor's capability? We are left with the following choices:
 - Photoelectric
 - Capacitive
 - Ultrasonic
 - Vision Sensor
- One can usually rule out capacitive switch technology because it, too, has very limited range. (Capacitive switches are often chosen, however, to sense bulk materials or liquids in vessels.)
- If the application is dusty or dirty, ultrasonic technology is very well suited. Vision sensors and photoelectric sensors should be avoided for very dirty applications.
 - Ultrasonic sensors are available with ranges over 20 ft, but keep in mind that the detection focus spot can be very large at longer distances
 - Caution: electrical and audio noise can affect ultrasonic sensors, too.
 - Ultrasonic sensors are also affected by humidity



Step 3: Distance to Target Object

- ⋮ What if the distance is just beyond the range of typical inductive switches?
- ⋮ This is where magnetic switches are “attractive” (Sorry!)
 - Magnetic switches of similar size as inductive switches (12 – 18 mm) can have a range of 2-3 inches, depending on the magnet used
 - Magnetic switches are often used to identify a specific target object having a magnet
 - Magnetic switches are often used on machinery where target position cannot be well controlled or position tolerances are larger

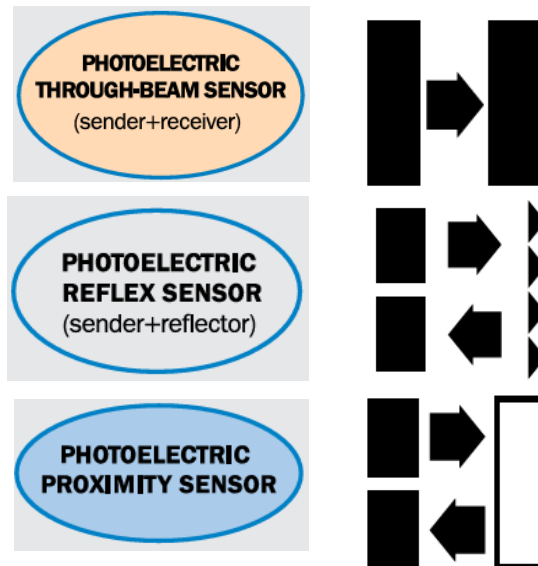


Step 3: Distance to Target Object

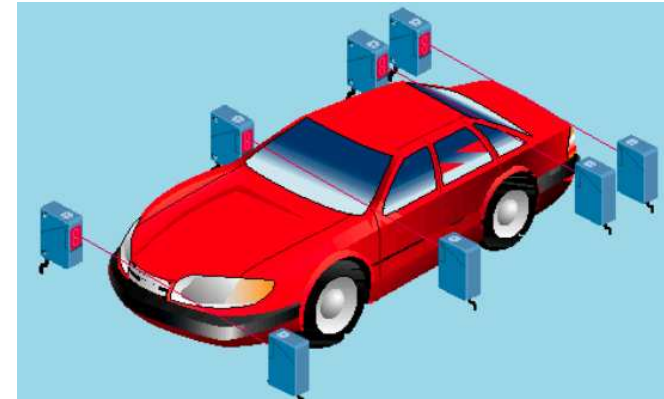
- : What if the target object is beyond the range of an inductive switch and beyond magnetic switch capability, we need more precise switching than what might be available with an ultrasonic, and the environment is relatively clean?
- : This where photoelectric switches “shine” (Sorry, again!)
- : Photoelectric sensors are used in a wide variety of applications:
 - Presence detection
 - Positioning
 - Sorting
 - Counting
 - Etc . . .



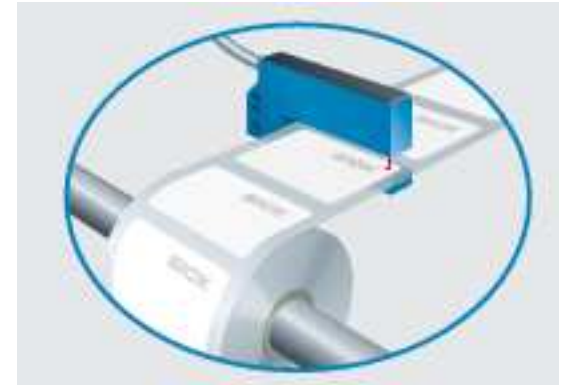
- : A photoelectric sensor responds to a change in the intensity or angle of the light received
- : Photoelectric sensing requires an emitter (to generate light) and a receiver (which "sees" the light from the emitter)
- : Different sensing arrangements exist based on the emitter and receiver's physical orientation to each other



- Through-beam photoelectric sensors are the first choice for the best performance, toughest applications and most consistent results
 - Advantages
 - Long operating range
 - Reliable detection in dusty and wet environments
 - Not easily fooled by shiny objects or materials
 - Detection of small sized objects with high repeatability
 - Limitations
 - More expensive than a reflex type
 - Two components
 - Higher mounting and installation costs required
 - Must mount both sender and receiver and run power to both
 - Must align both sender and receiver



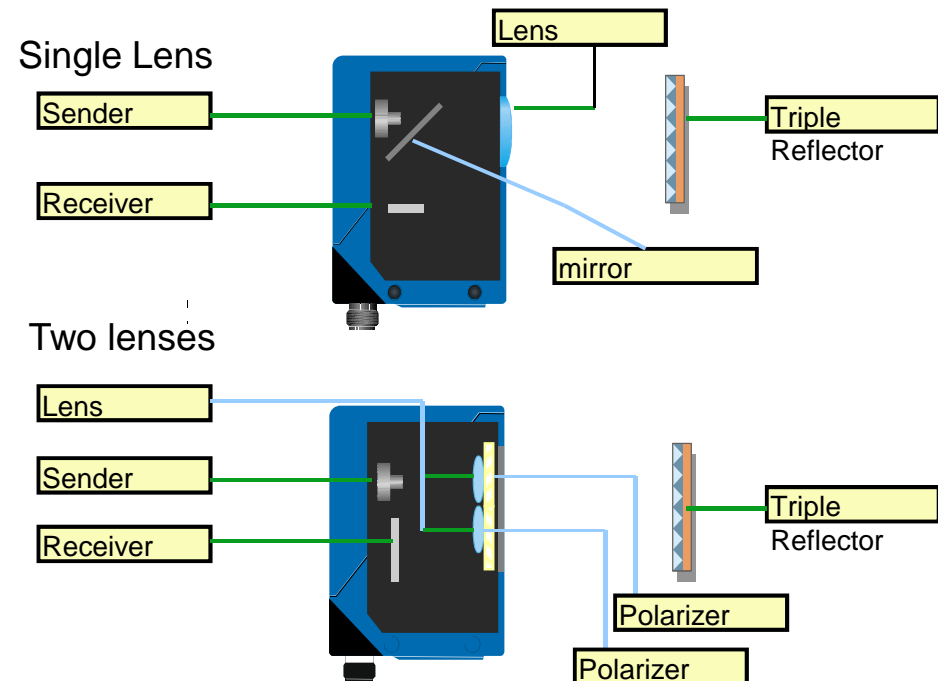
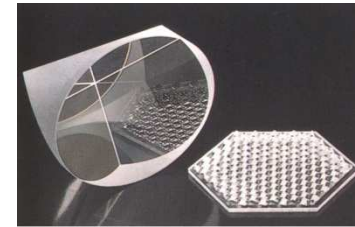
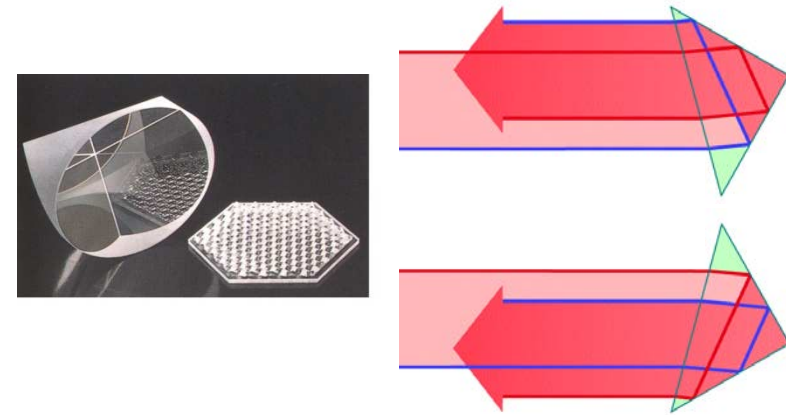
- : Trying to sense a label on backing material?
- : A special through-beam photoelectric sensor called fork sensor is a great choice
 - Both sender and receiver are in the same housing, but on opposite sides of the fork-like housing



- : What if the target object has an irregular shape?
- : Use a light grid for more consistent switching points
 - This application optimizes wrapping material consumption and allows closer spacing of products for higher volume by using a light grid as a target object sensor



- Corner cube or retro reflector is the basis of reflex photoelectric sensor technology
 - With a retro-reflector the light reflects back parallel to the direction it entered--it goes directly back to the source
- Good reflex photoelectric sensors use polarized light in order to discriminate between a true retro reflector and just a shiny or highly reflective object
- The best reflex photoelectric sensors use a single lens
 - Provides a more consistent switching point when objects are not always the same distance and provides extended in-close sensing distance



: Advantages

- Sender and receiver in same housing
- Operating range starts at zero (with one lens models)
- Only one part needs to be installed electrically
- Large operating ranges possible (up to 45 m)
- Simple adjustment mechanism
- Easy mounting
- Detection of all objects, including most objects with shiny surfaces

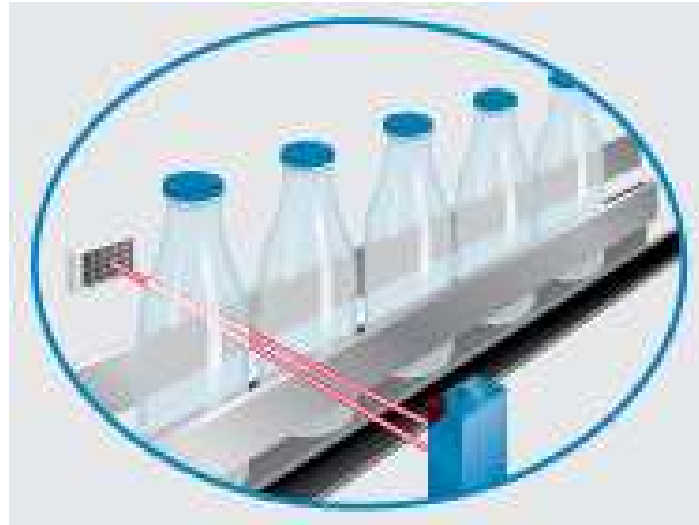
: Limitations

- Problems possible with very shiny irregular shaped objects
- Less reliable detection of small objects at large distance
- Problems possible in close range when using double lens models
- Shorter range than through-beam photoelectric sensors

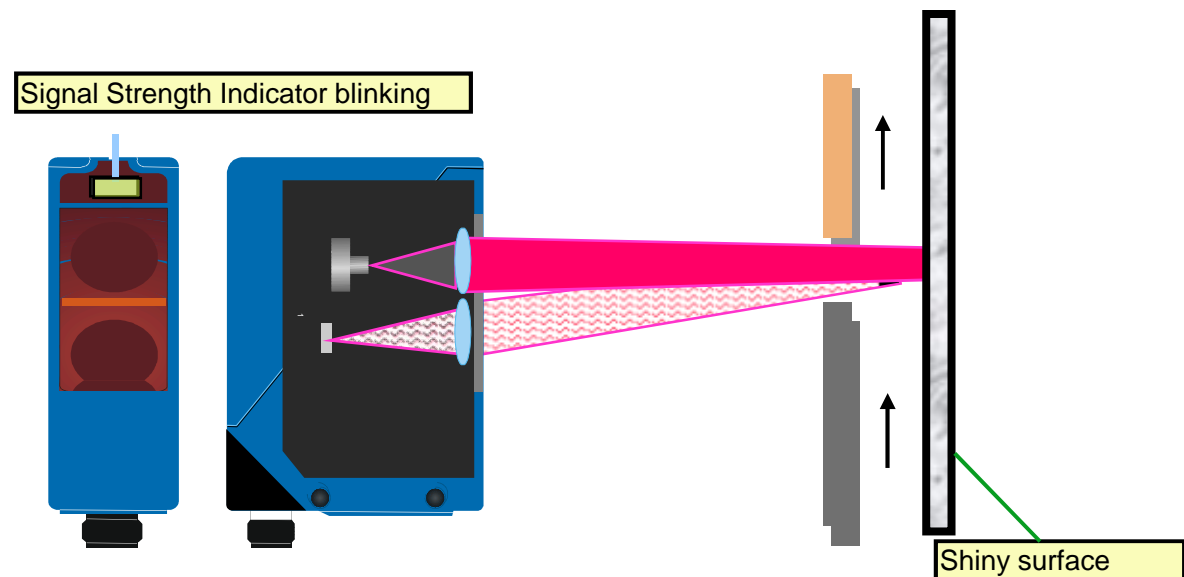
- : Recommendation: Use only the highest quality reflectors for best performance



- : Is the target object made of clear material?
- : Use reflex models especially designed for these difficult applications



- : Both sender and receiver in same housing
- : If emitted light received back from target object exceeds threshold, target object is sensed
- : Oops! Beware of shiny, bright or light colored objects too close in the background. Proximity (energetic) sensors can be fooled by a background that is too close to target range sensitivity setting



: Advantages

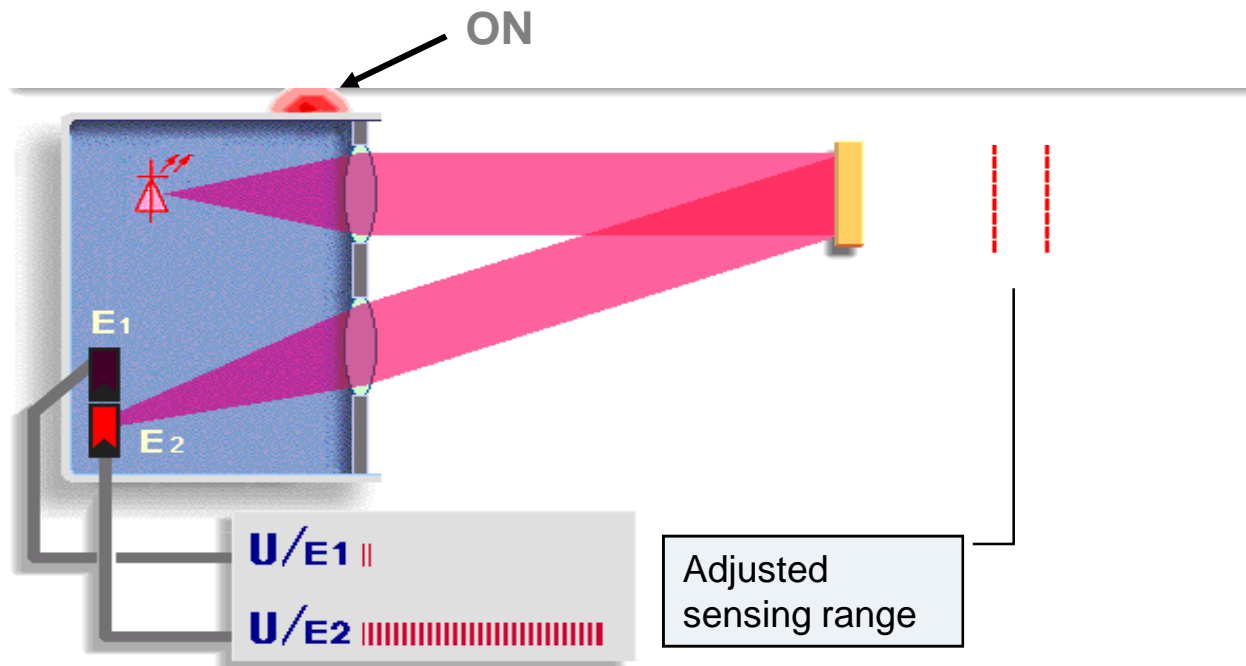
- No Reflector needed
- Low priced proximity switch
- Consistant detection of bright surfaces in front of a dark background

: Limitations

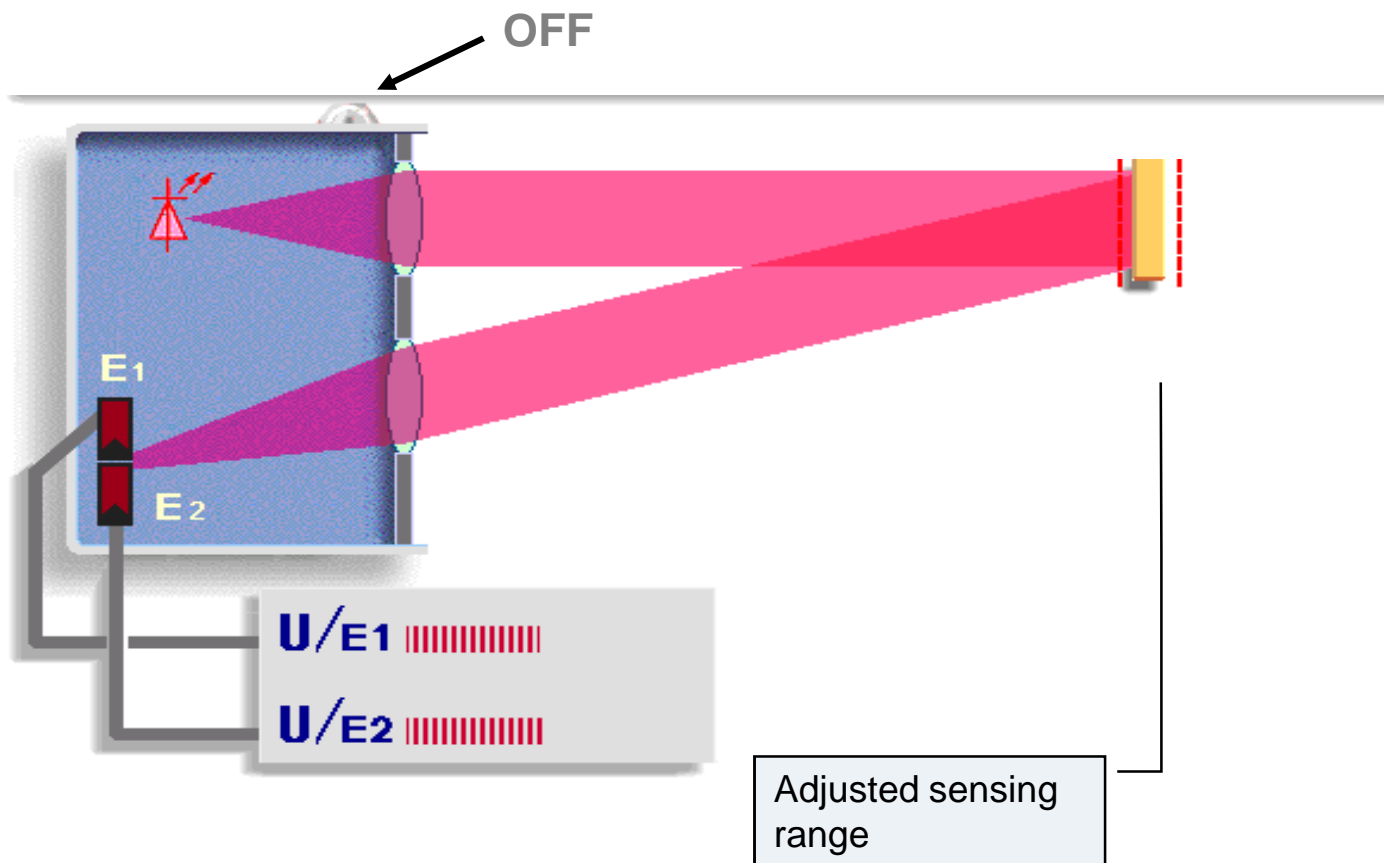
- No background or foreground suppression
- Range is color dependent
- Problems with dark objects in front of bright backgrounds
- Shorter range than both through-beam and reflex photoelectric sensors



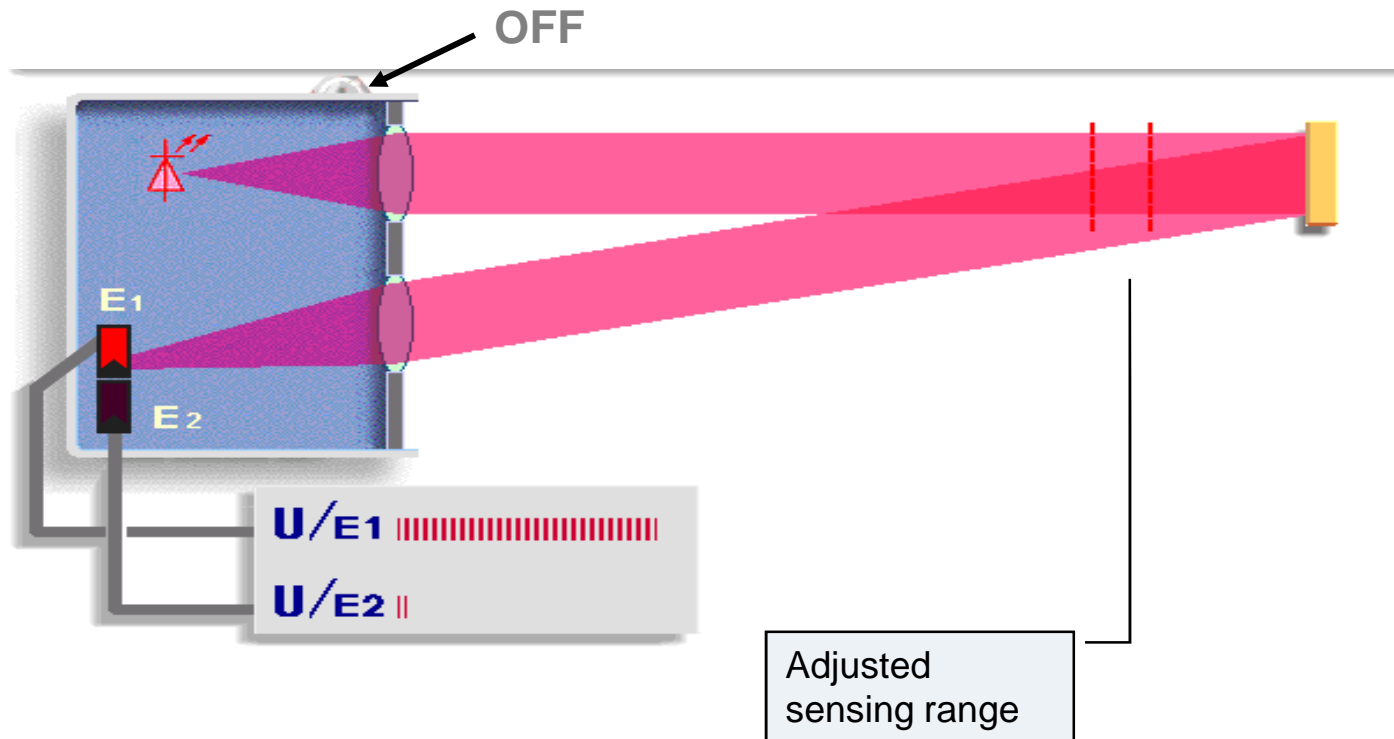
- Background suppression is a specialized form of proximity photoelectric sensor that is accomplished by means of light triangulation in which a focal distance is defined by the adjustment of the sensor
- Background suppression suppress objects occurring outside the adjusted sensing range
- Object distance, not returned light intensity, determines ON-OFF state



Target Object at Adjusted Distance



Target Object Beyond Adjusted Range



: Advantages

- No reflector needed
- Objects in background will not be detected
- Detection of small objects with high repeatability
- Small distance difference can be detected
- Color of objects has little influence on sensing distance

: Limitations

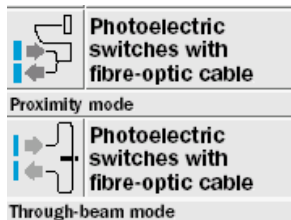
- Operating distance is limited (maximum about 2 meters)
- Care needs to be exercised in the case of shiny changing backgrounds
- Slightly higher cost in comparison to photoelectric reflex switches



- : Reasons for fiber optic sensors
 - Application requires small size
 - Application requires low inertia or weight
 - Extreme vibration
 - Extreme shock
 - High ambient temperature
 - High magnetic fields
 - Hazardous application
 - Highly corrosive application
 - Need for special shape light spot
 - Detection of small objects



All Kinds of Shapes and Mounting



LL3-TR01



LL3 - TR02



LL3 - TR03



LL3 - TR03-2



LL3 - TB03



LL3-TB02



LL3-TS07



LL3-TB01



LL3-TB01-10



LL3 - TT01



LL3 - TV01



LL3 - TV02



LL3 - TV04



LL3 - TS08



LL3 - TS12



LL3 - TS10



LL3 - TY02



LL3 - TM02



LVISAA 16900



LL3 - DS06



LL3 - DB01



LL3 - DB02



LL3 - DV02



LBSA 32900



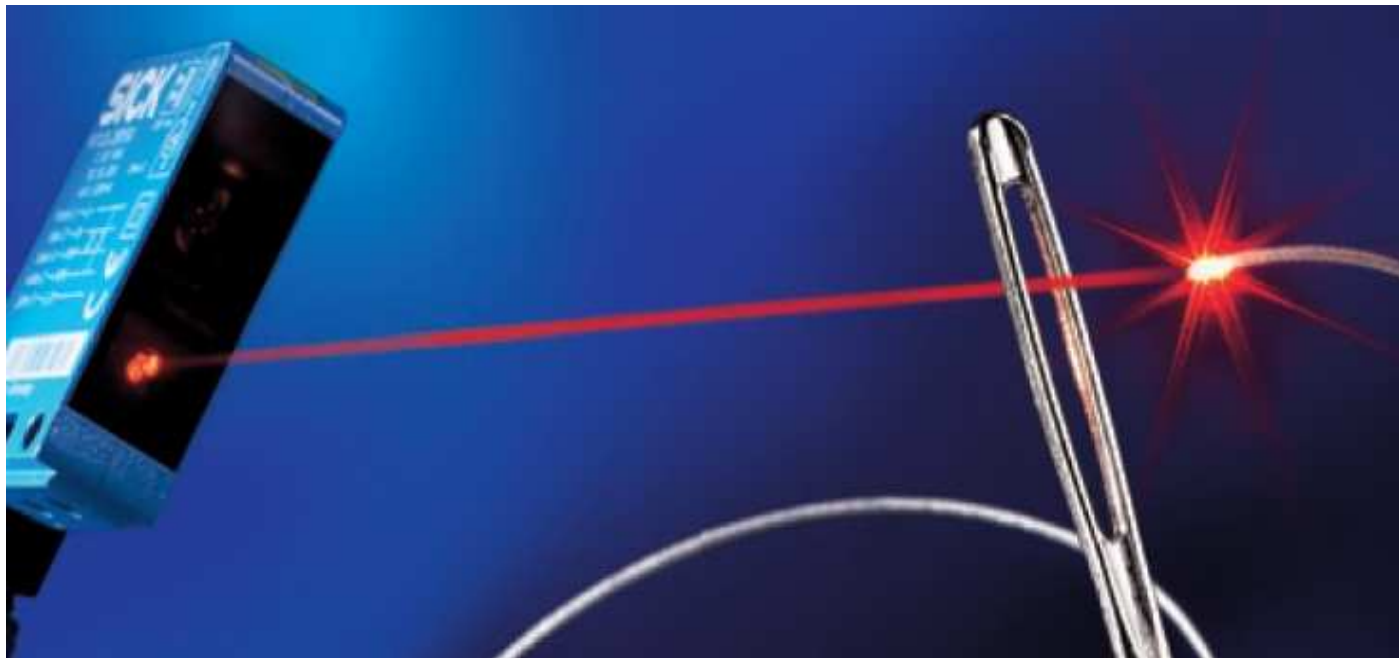
7 020 040
LISR 40900



7 020 051



- : Thanks to their compact laser beam, laser photoelectric switches are ideally suited for the precise detection of small objects, features or edges, and for applications where the laser beam must be aimed through small openings or holes
- : Laser light provides an easily visible light spot – simplifying alignment and offering longer ranges with reflex and through-beam photoelectric switch variations



- ⋮ Lasers with small light spots can provide consistent edge switching
- ⋮ Some sensors provide analog output for measurement or control
- ⋮ For high speed applications use WFL laser fork sensors



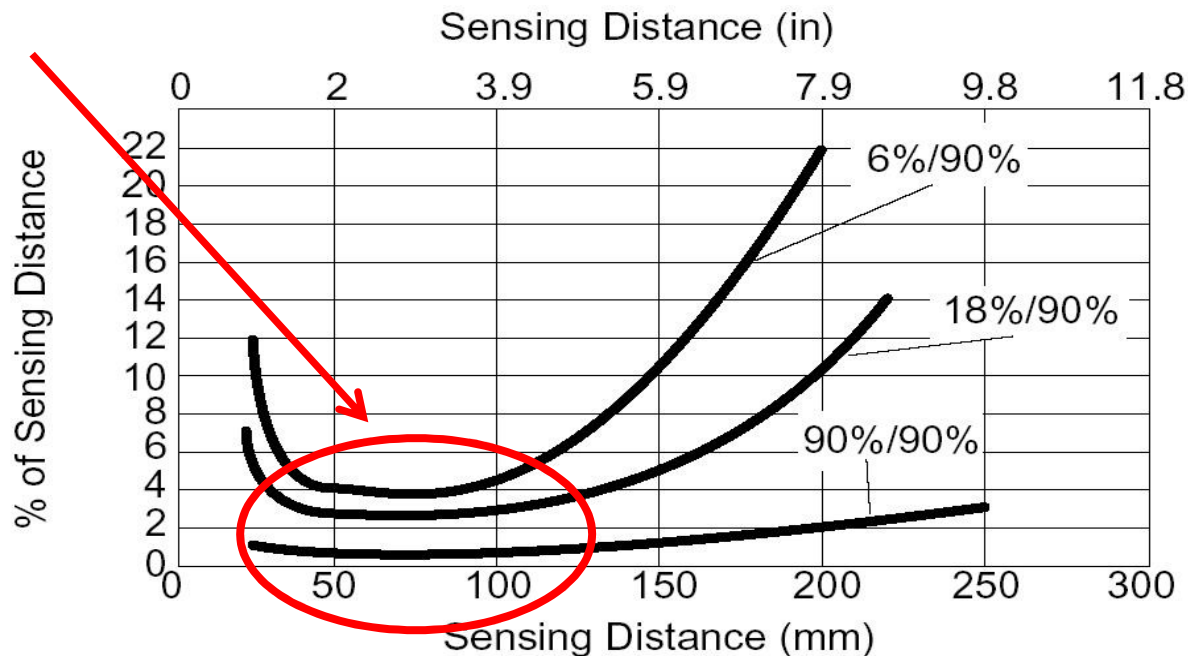
Step 4: Sensor Size/Shape

- What sort of physical size/shape best fits my application?
 - In our example using an inductive sensor, space is adequate for a tubular shaped inductive switch
 - Inductive switches are available in both short and long versions
 - Use a short version if space is limited
 - Use a long version if more adjustment is needed.
 - If space didn't allow for a tubular shaped inductive, use a rectangular or flat shaped product



Step 4: Sensor Size/Shape

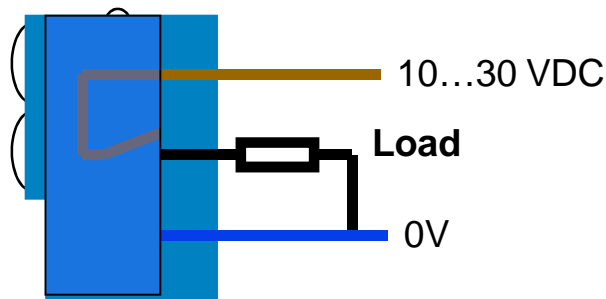
- With photoelectric sensors, size matters (a lot!)
 - Lens size, focal distance and separation distance influence sensing distance and light spot size
 - Choose a sensor model to provide sensing distance required
 - Choose a light spot size to match target object to maximize returned light difference
 - For best performance when selecting a background suppression photoelectric sensor examine sensor curves and choose a sensor having its best BGS performance (“sweet spot”) at the distance required for the application



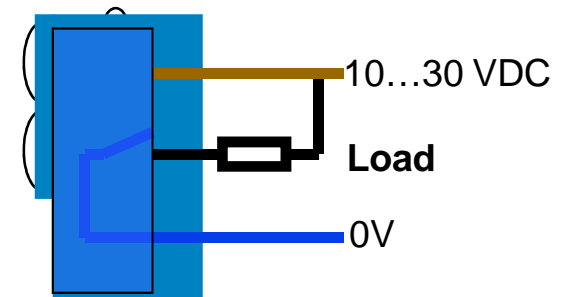
Step 5: Control Interface

- ⋮ What kind of controller interface and switching logic is required?
- ⋮ Most sensors are 3-wire DC types
- ⋮ Find out if PNP or NPN sensor outputs are needed for controller
 - In general, European and US PLCs favor PNP sensors and Oriental based PLCs have traditionally used NPN sensors. Many today have configurable inputs.
- ⋮ Determine if NO or NC and dark or light switching state is needed
 - Dark switching implies the sensor output is active when light is not received by the receiver (when a reflex sensor is blocked from reflector by target object)

PNP



NPN



- : How do I want to make the electrical connection?
- : Sensors are typically available with these electrical connections:
 - With flying leads (usually with 2 meter lengths, but others may be available)
 - Integrated quick-disconnect connector
 - M8 or M12 are most common
 - Pre-wired cable with a molded-on connector (often called a “pigtail” connector)
 - Terminal chamber (used often in larger, legacy sensors)

Most common connector types

M8 (DC ONLY)

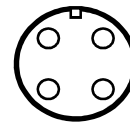


3-pin

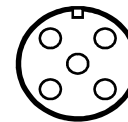


4-pin

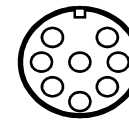
M12 (DC Versions)



4-pin



5-pin



8-pin



Step 7: Special Requirements

- : Are there any special application requirements?
- : High temperatures
 - More than 80° C
- : Nearby welding processes
 - May need WFI (Weld Field Immune) rating
- : High-pressure wash-down procedures
 - Will require IP69K rating



- Ready with all this useful information, one should now be able to visit a sensor manufacturer's website or catalog and select a functional sensor(s)
- If you're still not sure, sales people and technical support personnel are always ready to help you find the right sensor for your application
- Here are some useful addresses:
 - www.sickusa.com
 - sensorhelp@sick.com
 - safetyhelp@sick.com
 - autoidhelp@sick.com
 - visionhelp@sick.com
 - encoderhelp@sick.com
 - returns@sick.com
 - info@sick.com



Module Summary

Key Points

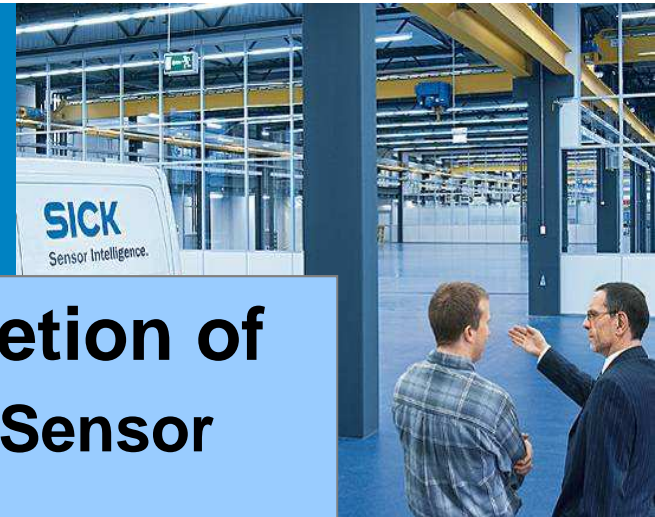
- : 1. Determine the type of sensing
- : 2. Determine the composition of target
- : 3. Determine the distance to the target
- : 4. Determine size of sensor needed
- : 5. Determine the control interface needed
- : 6. Determine wiring needs
- : 7. Determine any special requirements



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**: Congratulations on the Completion of
Choose the Right Object Detection Sensor**

