Polarized Retroreflective Photoelectric Switch

EXERCISE OBJECTIVE

- Introduce the Polarized Retroreflective Photoelectric Switch;
- Become familiar with its operation using the Reflective Block.

DISCUSSION

Retroreflective or retroflective sensing, is the most popular sensing mode. Retroreflective sensors can be used to detect most objects, including shiny objects. They contain both the emitter and receiver in the same housing. The light beam emitted by the light source is reflected by a special reflective surface and detected by the receiver, as shown in Figure 12. They are intended primarily for use in applications where an opaque target will completely block the light beam between the sensor and the reflective surface. Therefore, retroreflective sensors are not well suited to detect small and translucent objects.

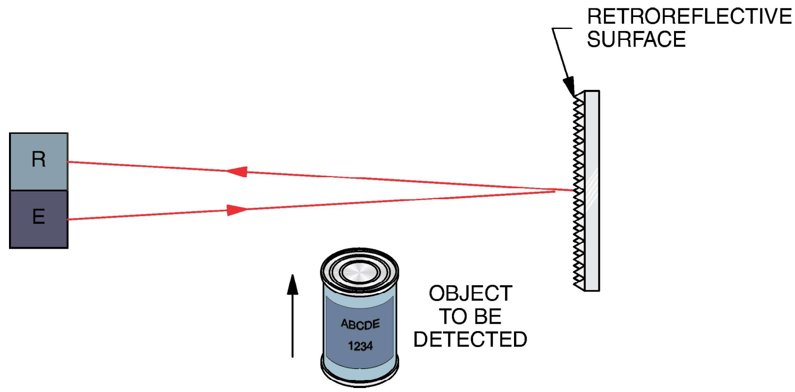

Figure 12. Retroreflective sensing.

Special reflectors or reflective tapes are used for retroreflective sensing. Unlike mirrors or other flat reflective surfaces, these reflective objects do not require perfect alignment. Misalignment of a reflector or reflective tape of up to 15° will typically not significantly reduce the operating margin of the sensing system. A wide selection of reflectors and reflective tapes is available. Some examples are shown in Figure 13.

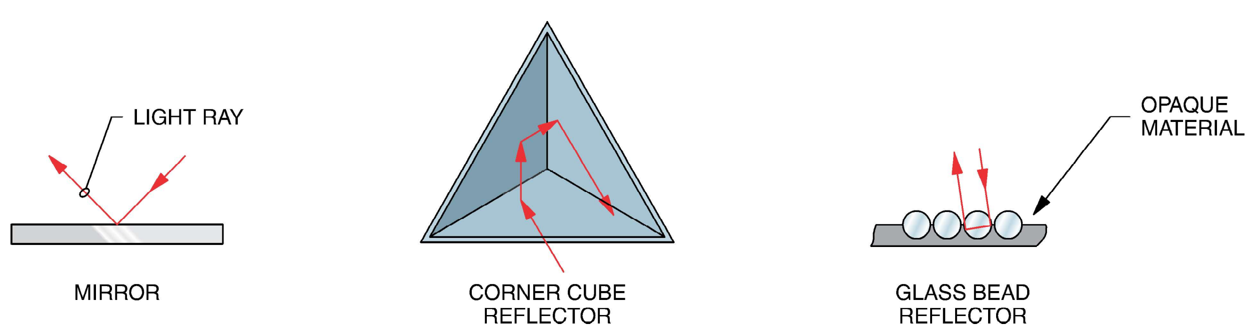

Figure 13. Retroreflective materials.

Occasionally, standard retroreflective sensors can be falsely triggered by reflections from shiny or highly reflective targets. To avoid this, polarized retroreflective sensing offers a better solution.

Polarized retroreflective sensors contain polarizing filters in front of the emitter and receiver. These filters are perpendicular, or 90° out of phase with each other, as shown in Figure 14. A depolarizing reflector is used to reflect the light.

In the absence of a target, the light emitted from the sensor is depolarized and reflected from the depolarizing reflector. Some of the reflected light passes through the polarizing filter in front of the receiver and is detected by the sensor, as shown in Figure 14 (a).

However, the light reflected by most targets is returned to the sensor with the same polarity, and cannot pass through the polarizing filter in front of the receiver, as shown in Figure 14 (b).

Polarized retroreflective sensors offer shorter sensing range than standard retroreflective sensors. Instead of infrared LEDs, they must use a less efficient visible red LED. They also have additional light losses caused by the polarizing filters.

Many standard reflectors depolarize light and are suitable for polarized retroreflective sensing. However, corner cube retroreflectors provide the highest signal return to the sensor. They have 2000 to 3000 times the reflectivity of white paper. For this reason, they are used to make safety reflectors for bicycles, cars, and signs.

As Figure 13 shows, corner cube reflectors consist of three adjoining sides arranged at right angles. When a light ray hits one of the adjoining sides, it is reflected to the second side, then to the third, and then back to its source in a direction parallel to its original course. You can experiment with the corner cube reflection by throwing a tennis ball into the corner of a room. The ball will return to you after bouncing off the three surfaces. Because of their high level of reflectivity, corner cube reflectors were placed on the moon by the Apollo astronauts and are still used today to measure the distance to the moon by timing laser light pulses reflected from Earth.

Polarized retroreflective sensors are often used to detect shiny objects. However, because the light may be depolarized as it passes through plastic film or stretch wrap, shiny objects may create detectable reflections (depolarized light) by the receiver if they are wrapped in clear plastic film.

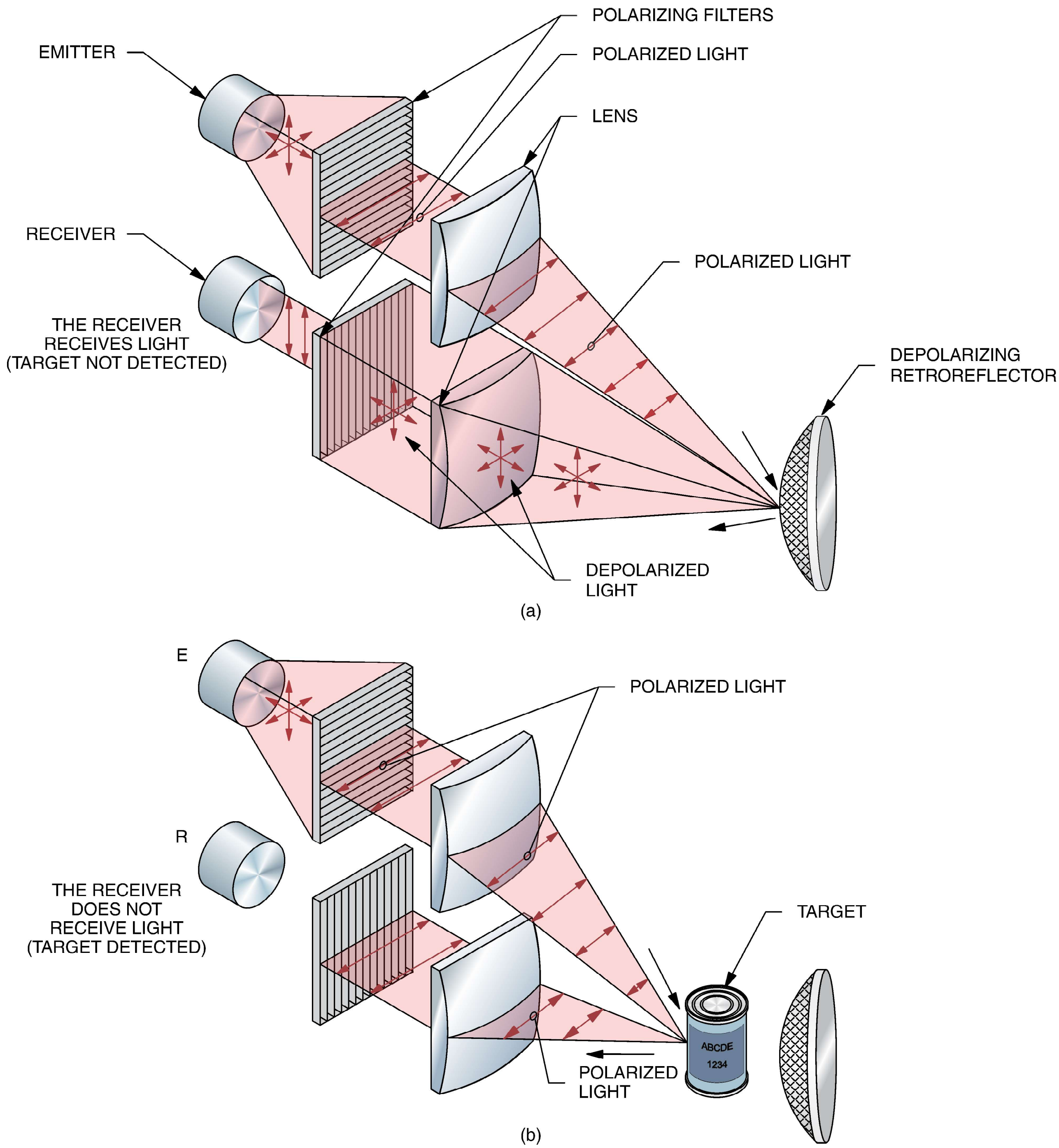

Figure 14. Polarized retroreflective sensing.

Most reflective tapes, like glass bead retroreflectors, do not depolarize light and are suitable only for use with standard retroreflective sensors.

The Polarized Retroflective Photoelectric Switch of your training system is shown in Figure 15. The sensor has a power indicator (green LED), an output indicator (yellow LED) that lights when the output is activated, and a stability indicator (orange LED) that lights when the excess gain exceeds 2.5. There is no sensitivity adjustment on this sensor. Other characteristics of the Polarized Retroflective Photoelectric Switch are shown in Table 4.

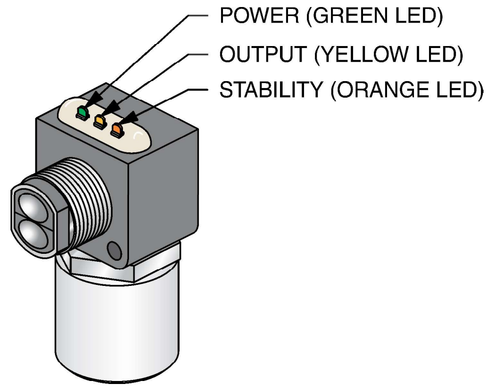

Figure 15. Polarized Retroflective Photoelectric Switch.

Table 4. Characteristics of the Polarized Retroflective Photoelectric Switch.

Characteristics of the polarized retroflective photoelectric switch		
Type		Polarized retroretlective
Transistor output type		Sourcing (PNP)
Sensing distance	Maximum	3 m (9.8 ft)
Light source	Type Wavelength	Visible red 660 nm (26.0 micro-inch)
Response time (sensor only)		1 ms
Light beam detection modes		Light operate/Dark operate (1)
Sensor output type		Relay output

(1) The sensor has light operate and dark operate outputs. The output relay coil is connected to the light operate output. The dark operate output is not used.

PROCEDURE OUTLINE

The Procedure is divided into the following sections:

- Set up and connections
- Equipment required
- Setup
- Characteristics
- Detection of various objects

PROCEDURE

Set up and connections

In the first part of the exercise, you will observe the ability of the Polarized Retroflective Photoelectric Switch to detect each surface of the Reflective Block.

In the second part, you will observe the ability of the Polarized Retroflective Photoelectric Switch to detect the presence of opaque, transparent, and small objects.

Equipment required

Refer to the Equipment Utilization Chart in Appendix A to obtain the list of equipment required to perform this exercise.

Setup

1. Set up the circuit shown in Figure 16.

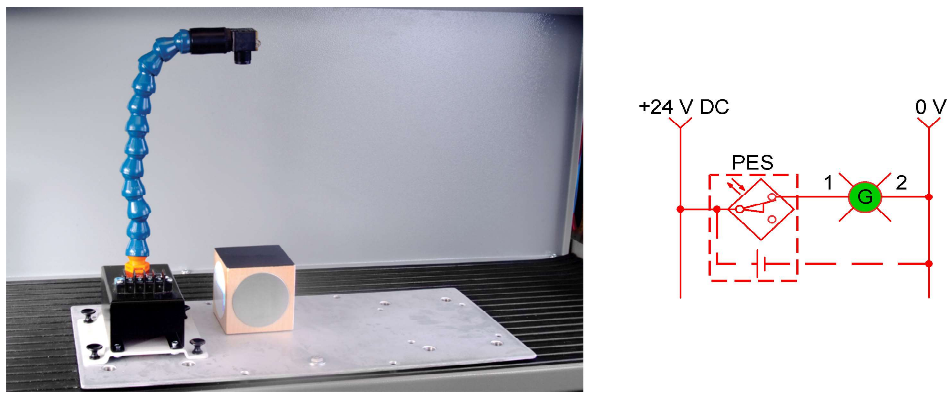

Figure 16. Circuit using the Polarized Retroflective Photoelectric Switch.

2. Perform the Energizing procedure.

3. Position the Reflective Block so the black plastic surface is parallel to the sensor sensing face at a distance of 200 mm (8 in), as shown in Figure 16.

Characteristics

4. Determine which surfaces are detected by the sensor. Note your observations in Table 5.

Table 5. Surfaces detected by the Polarized Retroreflective Photoelectric Switch.

Surface	Detected	Not detected
Black plastic surface		
White plastic surface		
Matte black metallic surface		
Shiny metallic surface		
Depolarizing retroreflective surface		

5. What can you conclude from your observations? Try with other distances between the sensor sensing face and the Reflective Block surfaces.

Detection of various objects

6. Position the Reflective Block so the depolarizing retroreflective surface is on top.

7. Is the green pilot light lit when an object is inserted between the sensing face and the depolarizing retroreflective surface? Explain why.

8. Pass a transparent object (plastic film) between the sensor and the Reflective Block. Does the photoelectric switch detect its presence? What does this mean?

9. Pass a small object like an electrical lead between the sensor and the Reflective Block. Does the photoelectric switch detect its presence? What does this mean?

10. Without modifying the sensor position, take the Reflective Block in your hand and hold the depolarizing retroreflective surface in front of the sensing face with an angle of approximately 45°. Does the photoelectric switch detect its presence in this position? What does this indicate?

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11. Turn the individual power switch of the AC Power Supply off, disconnect the circuit, and return the equipment to the storage location.

Conclusion

In this exercise, you were introduced to the Polarized Retroreflective Photoelectric Switch.

You observed how the Polarized Retroflective Photoelectric Switch detects the presence of various objects placed between the sensor and the depolarizing retroreflective surface of the Reflective Block. You saw that this sensor does not detect transparent objects. You also observed that it does not detect objects smaller than the light beam.

Review Questions

1. For which applications are the retroreflective photoelectric sensors designed?

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2. Name two reasons why polarized retroreflective sensors offer a shorter detection distance than standard retroreflective sensors.

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3. What are the purposes of the filters in a polarized retroreflective sensor?

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4. Name the type of retroreflector that provides the highest signal return.

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5. Explain why retroreflective sensors are not well suited to detect small objects.

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