Inductive Proximity Switch

EXERCISE OBJECTIVE

- Introduce the Inductive Proximity Switch;
- Become familiar with its operation using the Reflective Block.

DISCUSSION

Inductive proximity switches are designed to detect the presence of metallic objects. They detect their presence by generating an electromagnetic field and detecting changes in this field caused by an approaching metallic object. Inductive proximity switches consist of a coil, oscillator, rectifier (detector circuit), and output circuit, as shown in Figure 23.

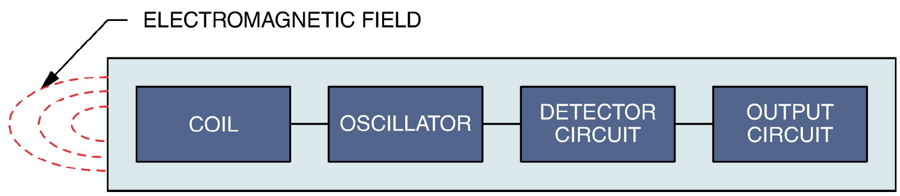

Figure 23. Inductive proximity sensor.

The oscillator produces a high frequency voltage applied to the coil to produce an electromagnetic field. As Figure 24 shows, when a metallic object enters the magnetic field, eddy currents are induced in the object. This causes a loss in energy and a reduction in the magnitude of the oscillations. When the energy loss becomes important enough, the oscillator stops functioning.

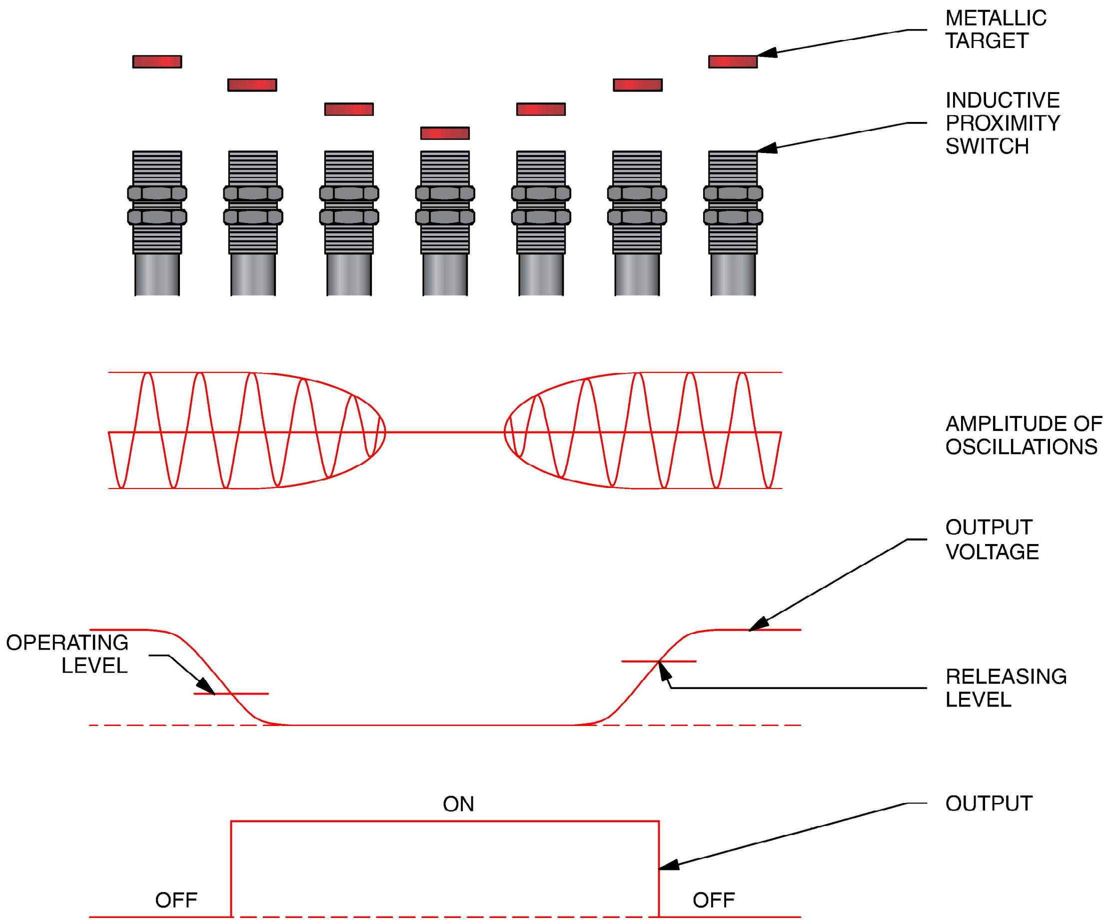

Figure 24. Operation of an inductive proximity switch.

The rectifier converts the AC output signal from the oscillator to a DC voltage. When the DC voltage drops below the "operating level," the sensor switches the output transistor to the activated mode. When the DC voltage raises to the "releasing level," the sensor switches the output transistor to the deactivated mode.

Because the magnetic field associated with the induced eddy currents is quite small, the maximum sensing distance of an inductive proximity switch is also quite small. Typical sensing distances are from 1 to 15 mm (0.04 to 0.6 in).

These distances are standardized against a mild steel target, 1 mm (0.04 in) thick, with side lengths equal to the diameter of the active face or three times the nominal switching distance, whichever is greater. Objects smaller than the standard target will lessen the maximum sensing distance, and objects larger than the standard target may increase the sensing distance.

Sensing distance for capacitive proximity sensors depends on the size of the probe and the target. With inductive proximity sensors, the sensing distance depends on the size of the coil and the composition of the target object. The chart in Table 9 shows the effect of target composition on the sensing distance.

Table 9. Sensing distance

Type of metal	Correction factor
Mild steel	1.0
Stainless Steel	0.7 – 0.8
Brass	0.4 – 0.5
Aluminum	0.3 – 0.4
Copper	0.2 – 0.3

For example, an inductive proximity switch detects copper at approximately 25% of the standard sensing distance, and stainless steel at approximately 75%. Nonmetallic objects are very poor conductors and will not be detected at all.

Because nearby metallic objects affect the operation of inductive proximity switches, they must be spaced from surrounding metallic objects and/or other sensors, as shown in Figure 25. The distances shown in Figure 25 apply to the Inductive Proximity Switch of your training system.

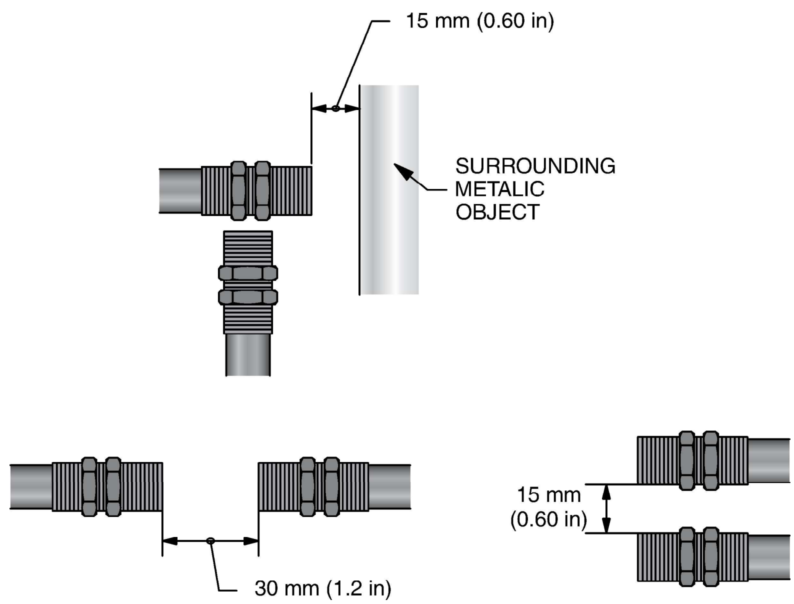

Figure 25. Minimum mounting distances.

Inductive proximity sensors can be shielded or unshielded. Shielded sensors are constructed with a metallic band surrounding the coil. This helps to direct the electromagnetic field to the front of the sensor and results in a more concentrated field.

Figure 26 (a) shows an inductive proximity switch checking bottles for bottle caps. Bottles without caps are rejected. Inductive proximity switches work better than other proximity switches in this application because they are not affected by high humidity. In Figure 26 (b) an inductive proximity switch counts the rivets on a finished work piece.

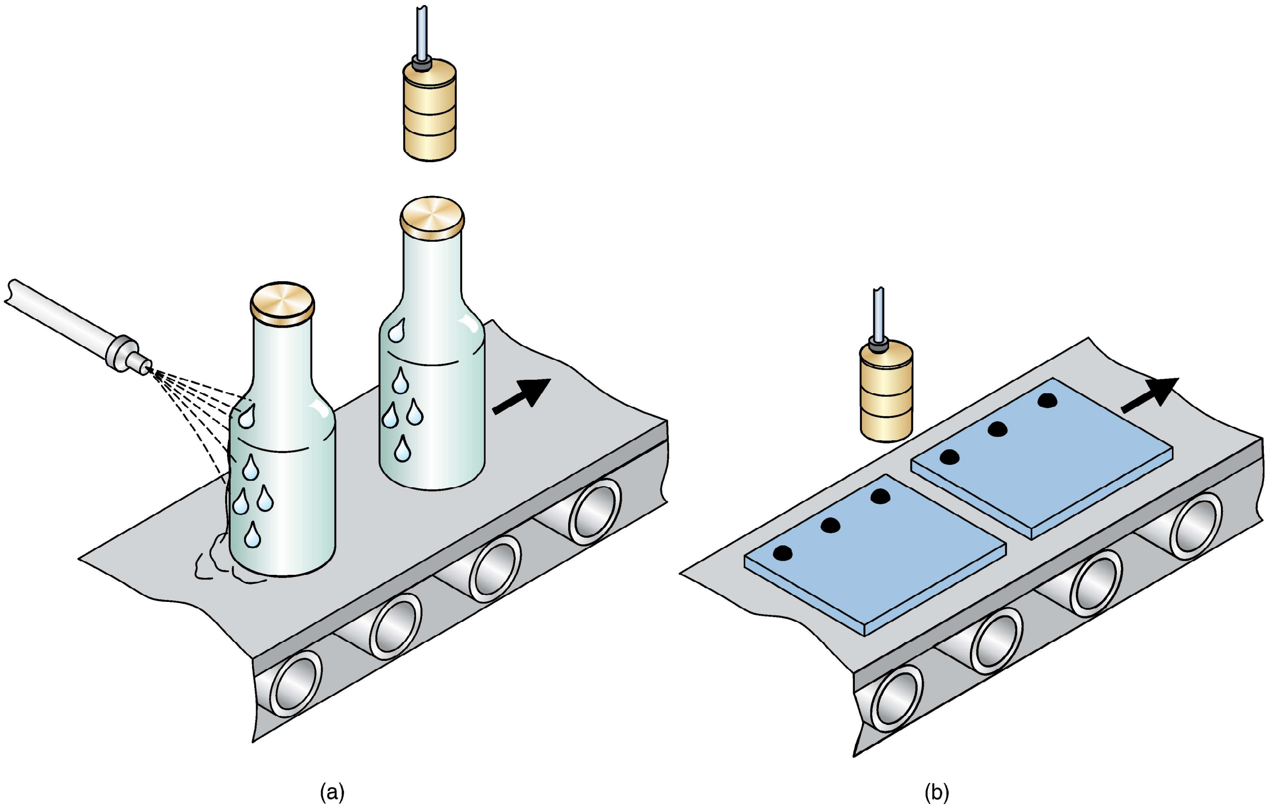

Figure 26. Inductive proximity switch applications.

The Inductive Proximity Switch of your training system is shown in Figure 27. The sensor has an output indicator (red LED) that lights when the output is activated, and there is no sensitivity adjustment. Other characteristics of the Inductive Proximity Switch are shown in Table 10.

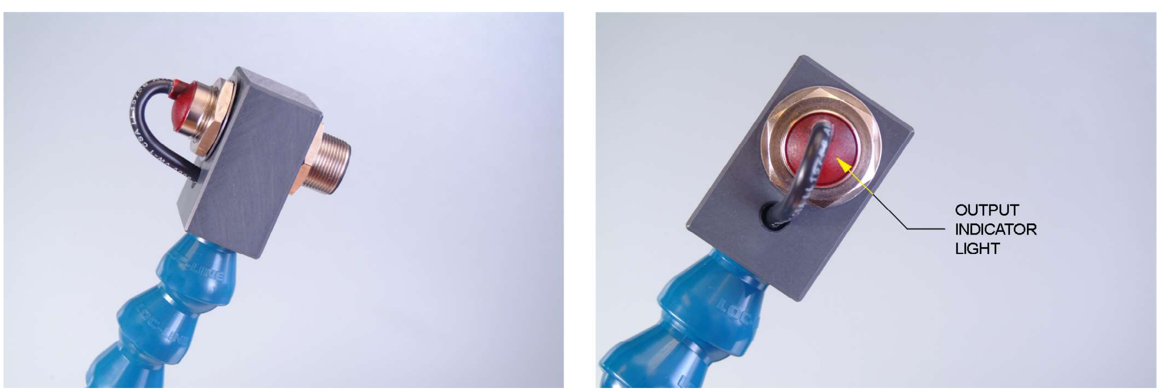

Figure 27. Inductive Proximity Switch.

Table 10. Characteristics of the Inductive Proximity Switch.

Characteristics of the Inductive Proximity Switch	
Type	Inductive shielded
Transistor output type	Sourcing (PNP)
Maximum sensing distance	5 mm (0.2 in)
Switching frequency (Hz)	1000

PROCEDURE OUTLINE

The Procedure is divided into the following sections:

- Set up and connections
- Equipment required
- Setup
- Characteristics
- Sensing distance

PROCEDURE

Set up and connections

In the first part of the exercise, you will observe the ability of the Inductive Proximity Switch to detect the presence of various objects.

In the second part, you will determine the maximum sensing distance of the Inductive Proximity Switch by using the Reflective Block.

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 28.

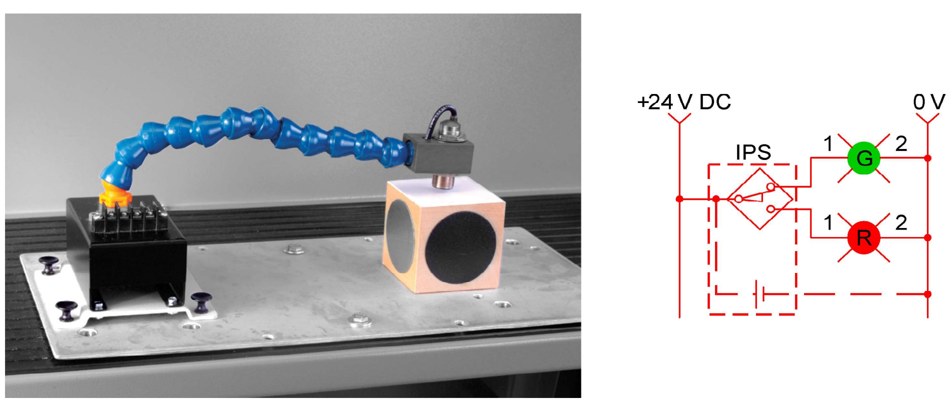

Figure 28. Circuit using the Inductive Proximity Switch.

2. Position the Reflective Block at a distance of 3 mm (0.125 in) from the sensor sensing face, as shown in Figure 28.

Characteristics

3. Perform the Energizing procedure.

4. Determine which surfaces are detected by the sensor. Note your observations in Table 11.

Table 11. Surfaces detected by the Inductive Proximity Switch.

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

5. Does the Inductive Proximity Switch detect all surfaces of the Reflective Block, whatever the surfaces covering the plastic block?

   ❑ Yes ❑ No

6. Place some objects of different materials (metallic and nonmetallic) against the sensor. Do your observations confirm that only metallic surfaces are detected by the Inductive Proximity Switch?

   ❑ Yes ❑ No

Sensing distance

7. Determine the maximum sensing distance of the Inductive Proximity Switch. To do so, place the shiny metallic surface of the Reflective Block against the sensor. Raise the sensor slowly away from the metallic surface until the red pilot light turns off. Determine the distance.

   Maximum sensing distance =___________

8. 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 Inductive Proximity Switch.

You observed the ability of the Inductive Proximity Switch to detect the presence of various objects.

In the last part of the exercise, you observed that the maximum sensing distance of this type of sensor is quite short.

REVIEW QUESTIONS

1. What type of material do inductive proximity switches detect?

2. What are the four main parts of an inductive proximity switch?

3. What causes the maximum sensing distance of an inductive proximity switch to be relatively short?

4. Explain why inductive proximity switches must be spaced from surrounding metallic surfaces and/or other sensors.

5. Name two parameters that affect the sensing distance of an inductive proximity switch.