**Department of Electrical Engineering and   
Computer Science**

**Faculty Member:** Dr. Shahzad Younis  **Dated:** 28/09/2022

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**EE-383:** **Instrumentation and Measurements**

Lab 3: Introduction to Photoelectric Sensors

Lab Instructor: Mr. Ali

Group Members

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Reg. No** | **Viva + Lab Performance (Individual)** | | **Analysis of data in Lab Report** | **Teamwork** | **Total** |
|  |  | **5+5 Marks** | | **5 Marks** | **5 Marks** | **20 Marks** |
| Danial Ahmad | 331388 |  |  |  |  |  |
| Muhammad Umer | 345834 |  |  |  |  |  |
| Tariq Umar | 334943 |  |  |  |  |  |
|  |  |  |  |  |  |  |

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# Introduction to Photoelectric Sensors

## Objectives

* To introduce students to photoelectric, capacitive, and inductive sensors
* To understand terms commonly used in the sensor field
* To familiarize with the components of your Sensors Training System

## Equipment

Hardware

* LabVolt Proprietary Sensor Training System



## Introduction

Photoelectric sensors can detect the presence or absence of virtually any type of object without any physical contact. Therefore, they can satisfy a wide range of control needs: they can count, sense height or size, position, monitor operating speeds, and much more. Moreover, there are three types of photoelectric sensing modes: diffuse-reflective, through-beam, and retroreflective.

## Lab Instructions

All questions should be answered precisely to get maximum credit. Lab report must ensure following items:

* Lab objectives
* Results (Graphs/Tables/Pictures) duly commented and discussed
* Conclusion

# Lab Procedure

## Photoelectric Sensor Light Sources

Determine if the sensor you are observing uses a visible red or infrared light beam by passing a finger at a distance of 25 mm (1 in) in front of the sensor.

Table 4.1‑1 Visible Red and Infrared Light Beams

|  |  |  |  |
| --- | --- | --- | --- |
| ID | Description | Visible Red | Infrared |
| 6377 | Diffuse Reflective Photoelectric Switch Model | ✅ |  |
| 6373 | Background Suppression Photoelectric Switch Model |  | ✅ |
| 6378 | Fiber-Optic Photoelectric Switch Model | ✅ |  |
| 6374 | Polarized Retroreflective Photoelectric Switch Model | ✅ |  |

## Characteristics of Reflective Block

The Reflective Block has five different types of surfaces that will be used to determine the characteristics of the sensors.

Associate the four following surface types to the surfaces shown in Figure 4.2.a Reflective Block Surfaces.

**MATTE BLACK METALLIC**

**BLACK SURFACE**

**WHITE SURFACE**

**SHINY METALLIC**

Diagram

Description automatically generated

Figure 4.2.a Reflective Block Surfaces

## Switch Operation

Diagram

Description automatically generated

Figure 4.3.a Connection Diagram (Left), Ladder Diagram (Right)

*Note: There should not be any objects within 100 mm (4 in) in front of the sensor.*

1. Is lamp L1 turned off, suggesting the output transistor of the Capacitor Proximity Switch is not activated?

**Answer:** Yes, as L1 is connected to NO (Normally Open) contact of the relay coil. Without the Capacitive Proximity Switch detecting any object, it will remain turned off.

1. Move a finger back and forth about 6 mm (0.25 in) in front of the sensor. Does the lamp L1 light? Explain why?

**Answer:** Yes, the lamp L1 lights up. Moving a finger within the maximum range of the Capacitor Proximity Switch, that is 25mm (1 in), causes the output transistor to activate and allows the current from the source to pass to lamp L1.

1. What happens to lamp L2 when lamp L1 turns on? Explain why.

**Answer:** As a consequence of lamp L1 turning on, lamp L2 is now treated as the component connected to the NO (Normally Open) contact of the relay coil. Hence, lamp L2 turns off.

# Questions

1. How do photoelectric sensors detect the presence of objects?

**Answer:** Photoelectric sensors use a light beam to sense the presence or motion of an object; they consist of a light emitter and a light receiver to perform either *light sensing* or *dark sensing* (depending on the use case) to detect objects. To achieve maximum efficiency from photoelectric sensors, one must spectrally match the emitter and receiver.

1. What is the difference between light sensing and dark sensing?

**Answer:** Light sensing means the receiver detects the presence of the light beam; no output signal is provided until the receiver detects the light beam. Whereas dark sensing is the converse of light sensing; the receiver detects the absence of the light beam.

1. What are the three types of photoelectric sensing modes?

**Answer:** There are three types of photoelectric sensing modes:

**Diffuse-reflective:** Emitter and receiver are contained in the same housing; emitter projects a light beam and activates upon the detection of light (reflected off of an object).

**Through-beam:** Emitter and receiver are contained in separate housings; emitter projects a light beam directly toward the receiver and activates on the absence of light.

**Retroreflective:** Emitter and receiver are contained in the same housing; emitter projects a light beam toward a reflector, which directs the beam back to the receiver and activates on the absence of light.

1. What is meant by excess gain ratio when describing photoelectric switches?

**Answer:** The excess gain ratio, also called operating margin or margin, is the ratio of light intensity available at a given distance of a sensor to the light intensity needed to trigger the sensor.

*Gain Ratio =*

In real-life cases, it can be expressed as the extra light energy available to overcome attenuation caused by distortions (gas, smoke, etc.) in the sensor’s environment.

1. What is meant by hysteresis when describing proximity switches?

**Answer:** Hysteresis is the difference between the operation point (excess gain ratio of 1) and the maximum range (release point, when the sensor deactivates). It serves as a basis to prevent chattering (turning on and off rapidly) when the sensor is subjected to shocks and vibrations, or when the target is stationary at the nominal sensing distance.

# Conclusion

In this exercise, you were introduced to sensors. You learned about the terms commonly used in the sensor field, and you familiarized yourself with the components of your Sensors Training System. You determined which photoelectric switches, of your training system, use visible red light and infrared light as a light source. You observed the different surfaces that characterize the Reflective Block. You also observed how the normally closed contacts of a switch become normally open contacts when the sensor output switches to the activated mode.