Smart Devices for Industry 4.0

LAB ACTIVITY 4: PHOTOELECTRIC SENSOR

Name	Class/Period	Date

1. Overview

In this lab activity, you will physically connect a photoelectric sensor to the IO-Link master and explore the sensor's capabilities and parameter settings.

2. Performance Objectives

After completing this lab activity, you will be able to:

- Physically connect a photoelectric sensor to the IO-Link master using the M12-to-M12 IO-Link connection cable.
- Enable communication between the computer, the IO-Link master, and the photoelectric sensor.
- Identify the different outputs of the photoelectric sensor.
- Choose the best object for use with the photoelectric sensor.
- Adjust photoelectric sensor settings.

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3. Background

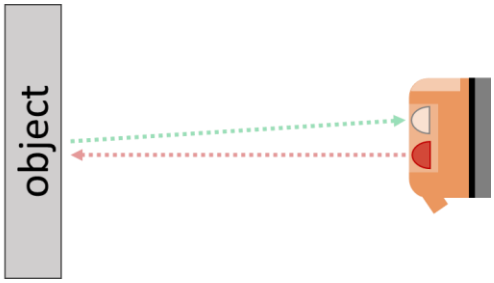
3.1. Photoelectric Sensor with IO-Link

What is a Photoelectric Sensor?

Photoelectric sensor is a proximity sensor that uses optical properties, usually infrared, to detect objects. There are three common operation method of a photoelectric sensor, and they all include a transmitter and a receiver. The three different methods are:

- The transmitter and the receiver are on different locations (hosts) and the object being detected interrupts the transmitted light beam.
- The transmitter and receiver are on the same host, and there is a second element, a reflector, that constantly reflects the light beam back to the sensor. When an object is present, it interrupts the reflected light beam.
- The transmitter and receiver are on the same host. The object reflects the light beam back to the receiver.

The photoelectric sensor we will use in this activity uses this third method, as shown in the diagram below.



Characteristics of your Photoelectric Sensor

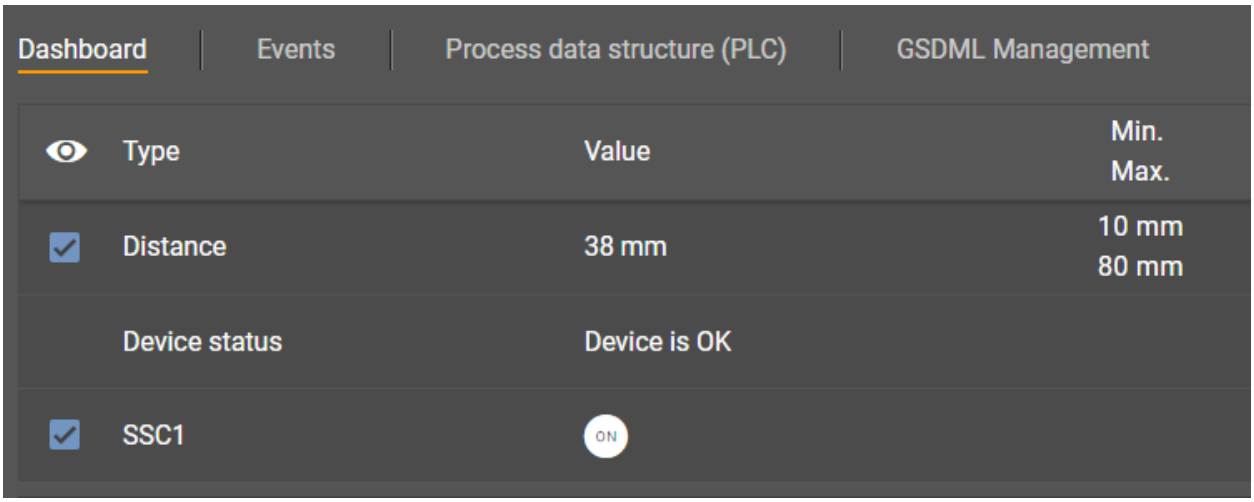
The following are characteristics of your photoelectric sensor:

- It connects to the IO-Link master via an M12-to-M12 IO-Link connection cable.
- It sends the master one type of analog, one types of digital data, and one type of status data.
- The analog data is the **P**rocess **D**ata **V**ariable (PDV) that holds the actual proximity of the object as detected by the sensor. Proximity is measured in millimeters (mm).
- The digital data sent are on/off signals via the switching signal channels (SSC).
- It has two working modes: switching (on/off) and measuring. The default is switching.
- It has a yellow status LED that is activated when the switching output is ON.
- It has a green LED that is activated when an object is detected.

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The Dashboard

When the photoelectric sensor is connected to the master and selected on the **Device catalogue**, the components of the Dashboard indicators look like this:



The Distance indicator displays the actual distance of the object from the sensor (in millimeters).

- When the distance exceeds the upper limit, **OL** (Over Limit) is displayed.
- When the distance is less than the lower limit, **UL** (Under Limit) is displayed.

The Device status indicates the status of the device.

SSC1 (Switching signal channel) is the digital output indicator. The indicator changes status according to the setup.

4. Required Materials

You need these materials to complete the lab activity:

- IO-Link master (“the master”)
- Computer connected to the Internet.
- Ethernet switch (optional)
- Photoelectric sensor
- IO-Link master power cable
- IO-Link master Ethernet cable
- IO-Link M12 to M12 connection cable
- Small wrench
- Objects of different materials: Plate steel, brass rod, marked aluminum cylinder, blue plastic square, plexiglass block, magnet.
- Ruler

5. Required Software

The following software is required for this lab activity:

- Moneo Configure
- Ethernet Configuration Tool (Hilscher)

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6. Inventory and Safety

Before beginning the lab activity, review this checklist and mark off each item as you complete it.

- ☐ All hardware components are available for this lab activity.
- ☐ Hands, hair, and clothing are securely away from the work area.
- ☐ The work area is clean and devoid of food or drink.
- ☐ All required software is installed in your computer.

7. Lab Activity

7.1. Connections

In this task, you will physically connect the photoelectric sensor to the master using an M12-to-M12 connection cable. You will also connect the master to the Moneo application. Perform these steps:

1. Connect the power cable to the master's 24 power input port. Connect the other end to a power source.
2. Connect the M12 end of the M12-Ethernet cable to the IoT port of the master. Connect the Ethernet end of the cable to your computer or Ethernet switch. Observe the LEDs to ensure that a connection has been made.
3. Connect one end of the IO-Link connection cable to the sensor. Ensure that the slit on the connection cable aligns with the protrusion. Manually tighten the screw on the power cable to secure the connection. Connect the other end of the IO-Link cable to one of the master's free IO-Link input ports.

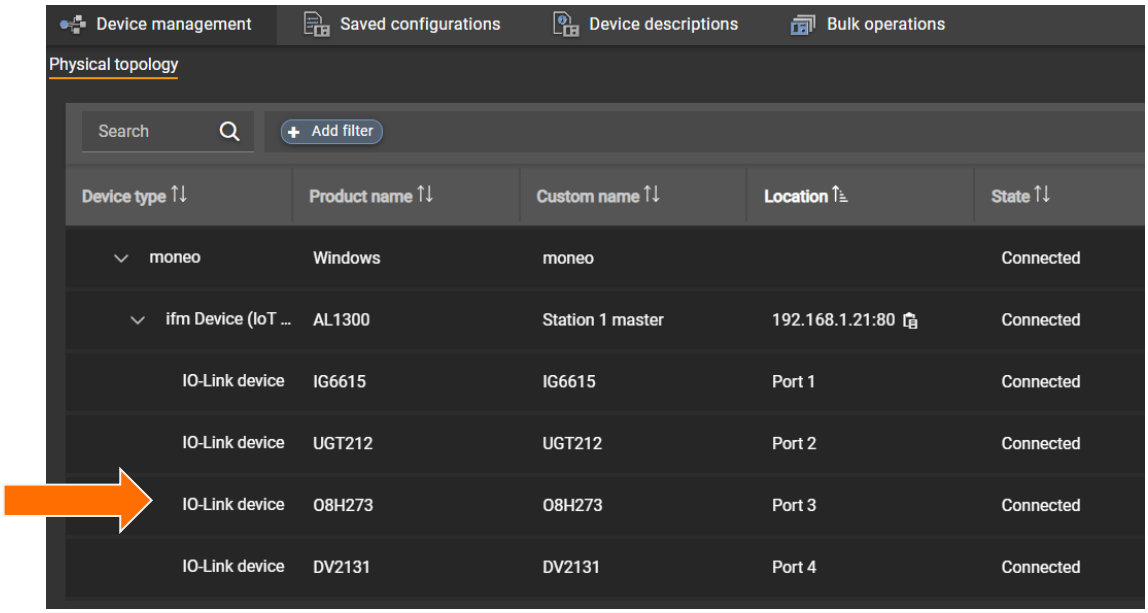


The photoelectric sensor connected to the master.

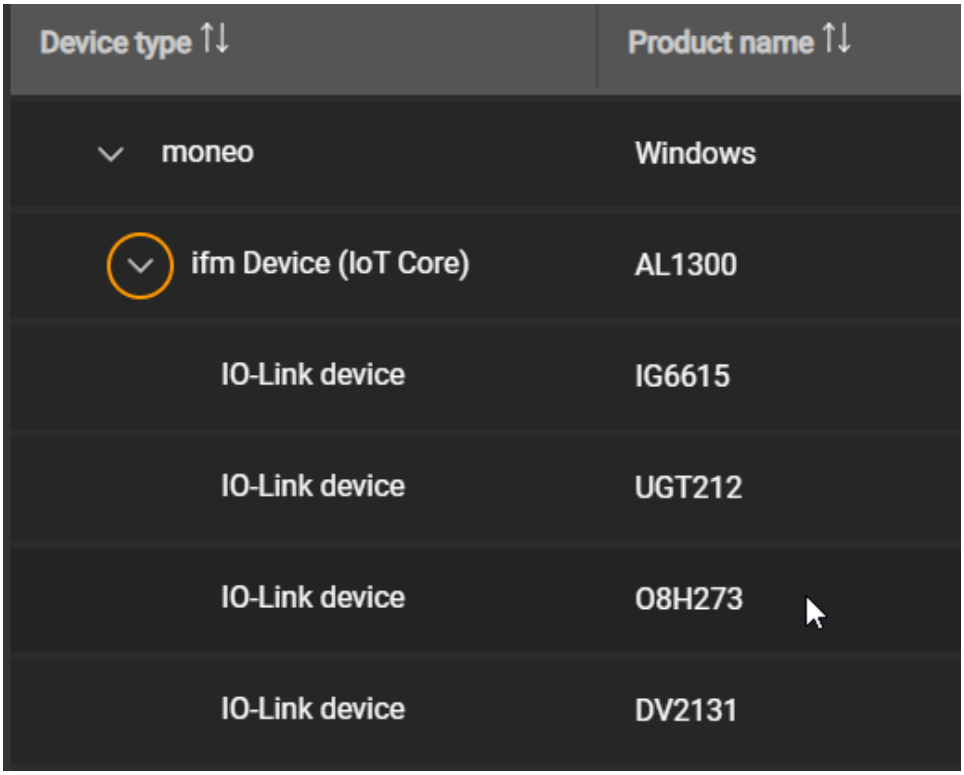
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4. Enable communication between the master and your computer using the Moneo Configure application and, if necessary, the Ethernet Configuration Tool.

Once connected, the master's parameters are displayed in Moneo Configure. The photoelectric sensor is indicated in the image below. Based on the image, the sensor is connected to Port 3.

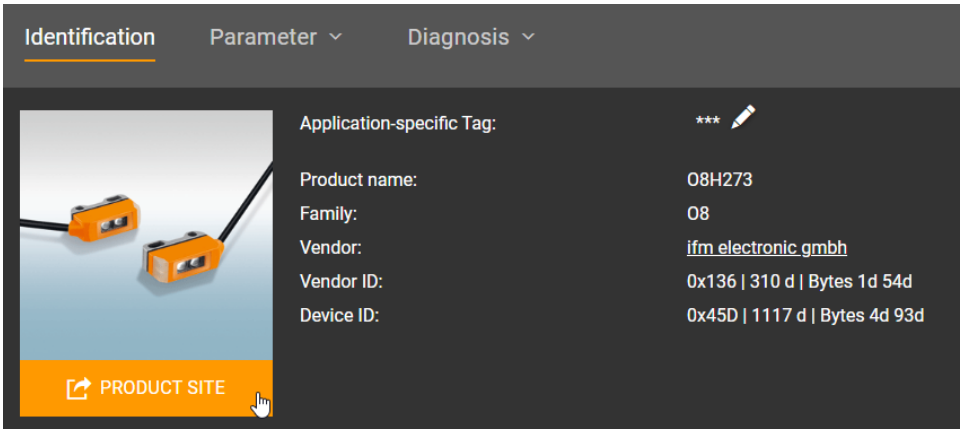


5. Click the sensor to view its settings.



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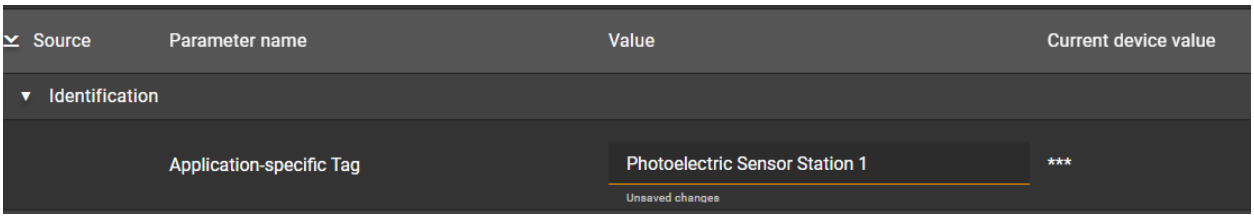
6. If you have an internet connection, take some time to review the device on the product site.



7.2. Writing to the IO-Link Master

In this next task, you will change the sensor's **application-specific tag**. The application-specific tag is a name given to the sensor to make it more identifiable in the field or factory floor where many of these devices may be present.

1. In the **Application-specific Tag** field, add a word or phrase such as "Photoelectric Sensor Station 1" that will make the sensor more easily identifiable. If such a tag already exists, make a small change to the text.



2. In the menu at the bottom right, click **Write Changes to device**. The application tag is written to the master, and the *Unsaved changes* indicator is no longer present.

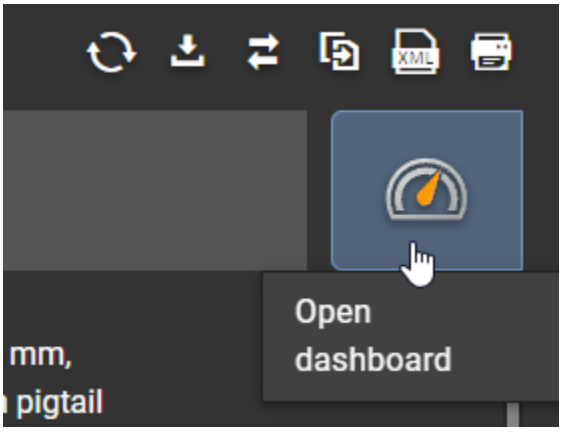
3. Show the new application tag to your instructor.

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7.3. The Dashboard

In this next task, you will learn how to read the inputs from the photoelectric sensor using the Dashboard display.

1. On the right side of the application window, click the **Open dashboard** button.



2. Observe the components of the Dashboard. There are three data types that the sensor sends to the master: Distance, device status, and SSC1.

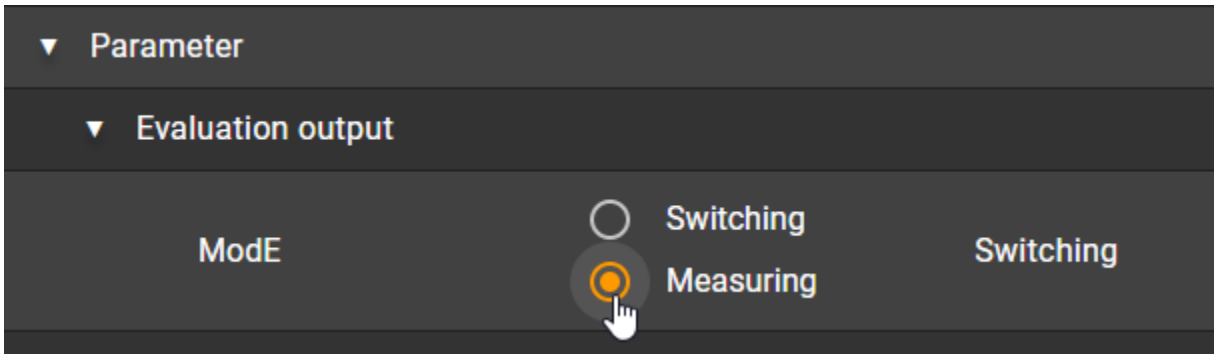
3. Take the brass rod and place it near the photoelectric sensor. Try to detect the distance where SSC1 changes status. Also observe the statuses of the LED indicators on the actual smart sensor. Note that, by default, distance values are not measured.

7.4. Changing the Default Settings

In this next task, you will adjust several photoelectric sensor settings and observe how the changes affect the reading on the Dashboard display.

Operating mode

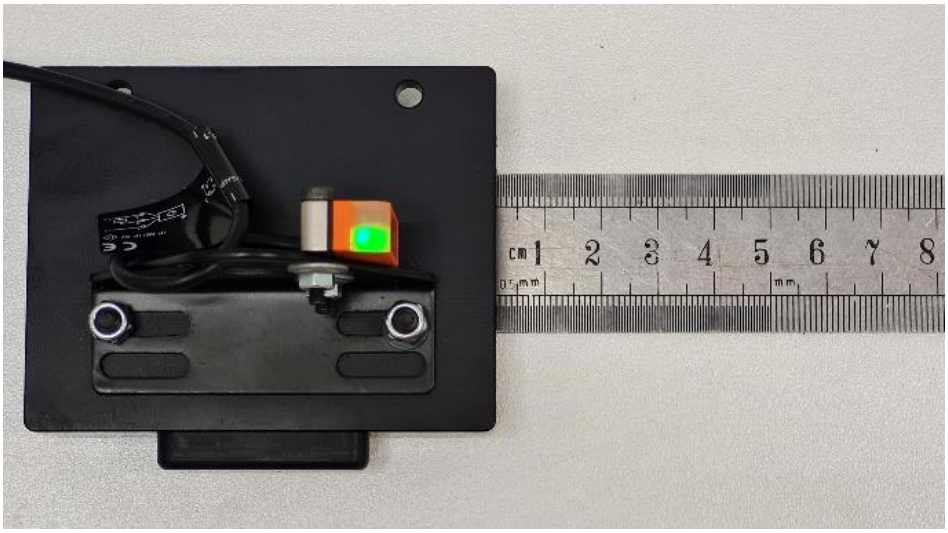
1. In the Device parameters menu, scroll down to **Evaluation output**. In the **ModE** row, select **Measuring**.



2. In the menu at the bottom-right, click the **Write changes to device** button.

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3. Place a ruler on a flat surface (close enough to the sensor) and place the photoelectric sensor at the zero-mark of the ruler.

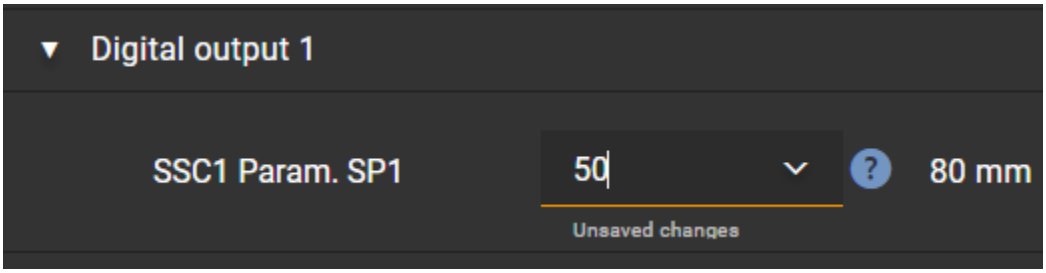


4. Take the brass rod and place it near the photoelectric sensor. Observe the output values. Note that when SSC1 is ON there is now a value for Distance.

Setpoint 1

In this task you will experiment with the setpoint settings.

1. In the Device parameters menu, scroll to **Digital output 1**.
2. In the **SSC1 Param. SP1** field, change the value to **50.**



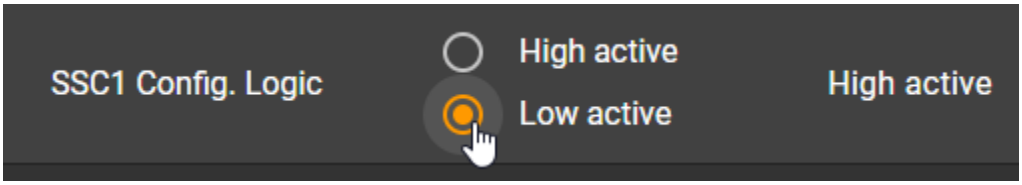
3. Write the changes to the device.
4. Take the blue plastic square and place it near the photoelectric sensor. Observe the output values. Note that SSC1 is ON only when the value of PDV1 is less than 2000 (SP1). This is because the SSC mode is *single point* by default.
5. Remove the blue square from sensor range.

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Normally ON/Normally OFF

In this task, you will experiment with the default on/off settings of the sensor.

1. In the **SSC1 Config. Logic** row, select **Low active**.



2. Write the changes to the device.
3. Observe the **Dashboard**. Note that the SS1 indicator is ON.
4. Take the brass rod and place it near the photoelectric sensor. Observe the distance value on the Dashboard and note when the SSC1 indicator changes to OFF.
5. Change **SSC1 Config. Logic** back to **High active**. Write the changes to the device.

Switch-On Delay and Switch-Off Delay

In this task, you will experiment with the sensor display-delay settings.

1. In the **SSC1 Switch-On delay** field, change the value to 1 seconds.
2. Write the changes to the device.
3. Observe the **Dashboard** screen.
4. Place the brass rod near the photoelectric sensor. Observe the distance values and note that the SSC1 indicator changes to ON *one second* after the Distance value becomes less than 50 mm.

7.5. Using Objects of Different Materials

In this next task, you will explore the photoelectric sensor sensibility when using objects from different materials.

1. Observe the **Dashboard** screen.
2. Take the different objects and place them, one at a time, near the photoelectric sensor, look at the value on the Dashboard. Note that SSC1 is ON when the Distance value is less than 80mm.
3. Observe the ruler and compare the onscreen distance values with those that you are observing on the ruler. Which material has the most precise readings? Which has the least precise readings? Compare your findings with at least two classmates.

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8. Authentic Skill Assessment

Have your instructor verify that your work meets the requirements in the performance objectives and sign below. Keep this lab activity sheet for future reference.

Instructor Signature	Date

9. Shutdown

Unless instructed otherwise by your instructor, review and complete each of the items on the checklist below.

- ☐ Restore the sensor's factory settings. To do so, navigate to **Setup > Restore Factory Settings > Execute command**.
- ☐ Close the Moneo Configure application and, if necessary, the Ethernet Device Configuration application.
- ☐ Disconnect and stow away the master, sensor and connecting cables.

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