Smart Devices for Industry 4.0

LAB ACTIVITY 2: THE INDUCTIVE SENSOR

Name	Class/Period	Date

1. Overview

In this lab activity, you will physically connect an inductive sensor to the IO-Link master and explore its capabilities.

2. Performance Objectives

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

- Physically connect an inductive sensor to the IO-Link master using the IO-Link M12 to M12 connection cable.
- Enable communication between the computer, the IO-Link master, and the inductive sensor.
- Describe the different outputs of the inductive sensor.
- Choose the best material for use with an inductive sensor.
- Change inductive sensor settings.

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3. Background

3.1. Inductive Sensor with IO-Link

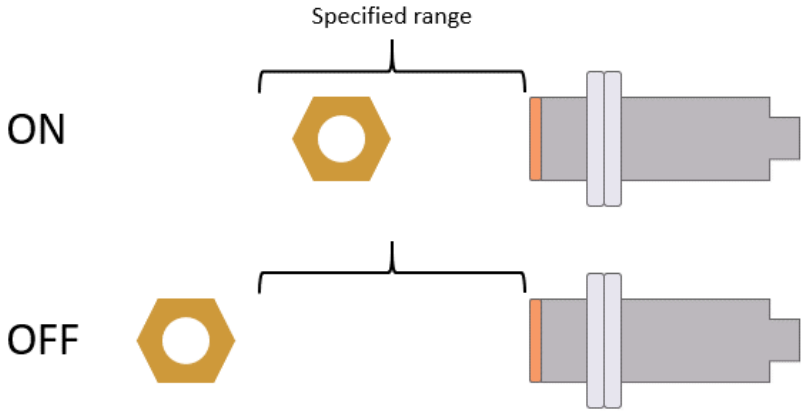
What is an inductive sensor?

An inductive sensor is a proximity sensor that uses the principle of electromagnetic induction.

In electromagnetic induction, a coil oscillator generates a magnetic field around the sensing surface. When a metallic object enters the specified range of the sensor there is a damping of oscillation amplitude which is read by a threshold circuit and changes the output.

This type of sensor is typically used as a binary (on/off) position sensor. An object is either detected, or no object is detected. For example:

- When an object is in close proximity (within a specified range) to the sensor, the “position” is considered to be “on.”
- When the object is not in close proximity (outside of the specified range) to the sensor, the “position” is considered to be “off.”



The reverse of the above statements may also be true, depending on the way the sensor has been configured. Also, there may also be more than one range. For example, the “position” may be considered “off” if the distance between the object and the sensor does not fall into one of these ranges.

Inductive sensors are suitable for noncontact detection of a wide range of different conductive materials. In industry, these sensors and similar proximity sensors are also sometimes known as proximity switches, initiators, or non-contact position sensors.

Characteristics of Inductive Sensor with IO-Link

The following are characteristics of your IO-Link inductive sensor:

- It connects to the IO-Link master via an IO-Link M12 to M12 connection cable.
- It sends the master analog and digital (binary) data.
- The analog data sent is the **P**rocess **D**ata **V**ariable (PDV) that contains the actual distance of the object from the sensor (proximity). Proximity is measured in micrometers (µm).
- The digital data sent are on/off signals via the switching signal channels (SSC). This is explained in detail in the next section

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Switching Signal Channel setting

The inductive sensor has two binary output channels called **S**witching **S**ignal **C**hannels (SSC). Each channel has 2 setpoints (SP) and three working modes:

- **Single point** – The system indicates when the distance of the object is lower than the value set on SP1.
- **Window** – The system indicates when the distance of the object is between the values of SP1 and SP2.
- **Two point** – The system indicates when the distance of the object is lower than the value set on SP2.

ⓘ ***Note:*** *The value of SP1 can't be less than the value of SP2.*

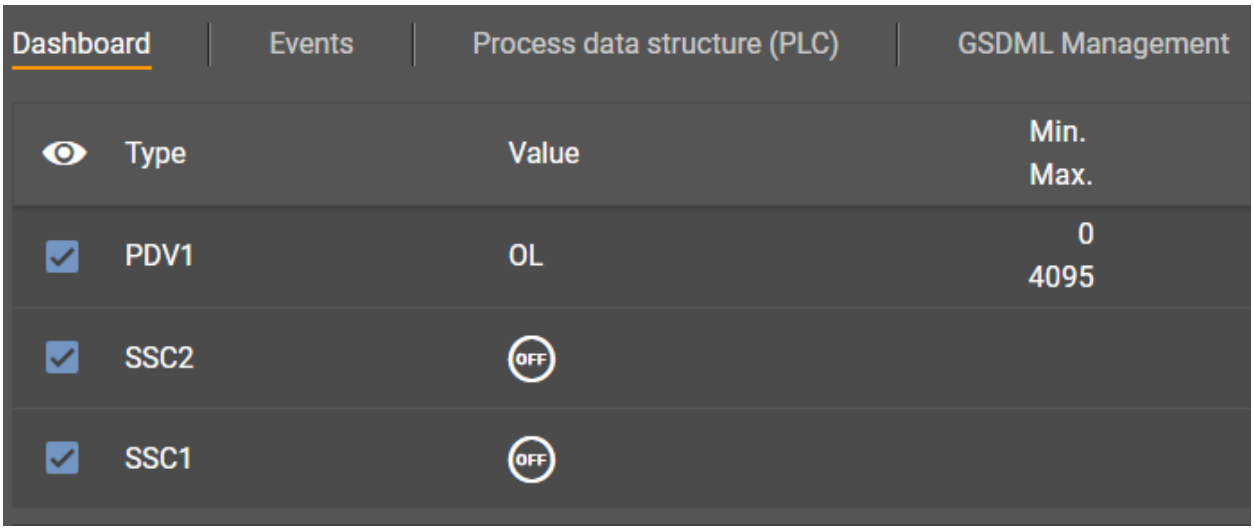
The SSC output can be set as High active (normally close) and Low active (normally open).

- **High active** means that the indicator returns an OFF signal when an object is not detected. Once detected, the system returns an ON signal. This is the default setting.
- **Low active** means that the indicator returns an ON signal to until it detects an object, and then it changes to OFF.

Another setting option is to set an On-delay and Off-delay (in milliseconds). This creates a delay between the detection of the object and the indicator output.

The Dashboard

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



PDV1 (Process Data Variable) shows the actual distance of the object from the sensor (in micrometers).

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

SSC1 and SSC2 (Switching signal channel) are the binary inputs. They change status according to the setup.

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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)
- IO-Link Inductive sensor
- IO-Link master power cable
- IO-Link Ethernet to M12 cable
- IO-Link M12 to M12 connection cable
- Objects of different materials: Steel plate, brass rod, marked aluminum cylinder, blue prism, plexiglass block, magnet.
- Ruler

5. Required Software

The following software is required for this lab activity:

- Moneo Configure
- Ethernet Configuration Tool (Hilscher)

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

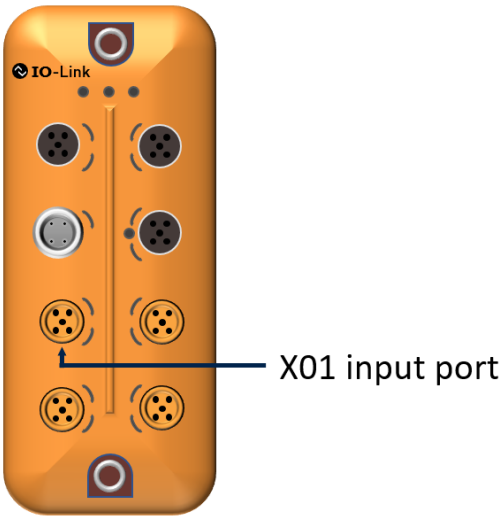
7.1. Connections

In this task, you will physically connect the inductive sensor to the master using the 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 an 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.

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4. Connect the other end of the cable to one ofthe master's free IO-Link ports. An example is shown here:

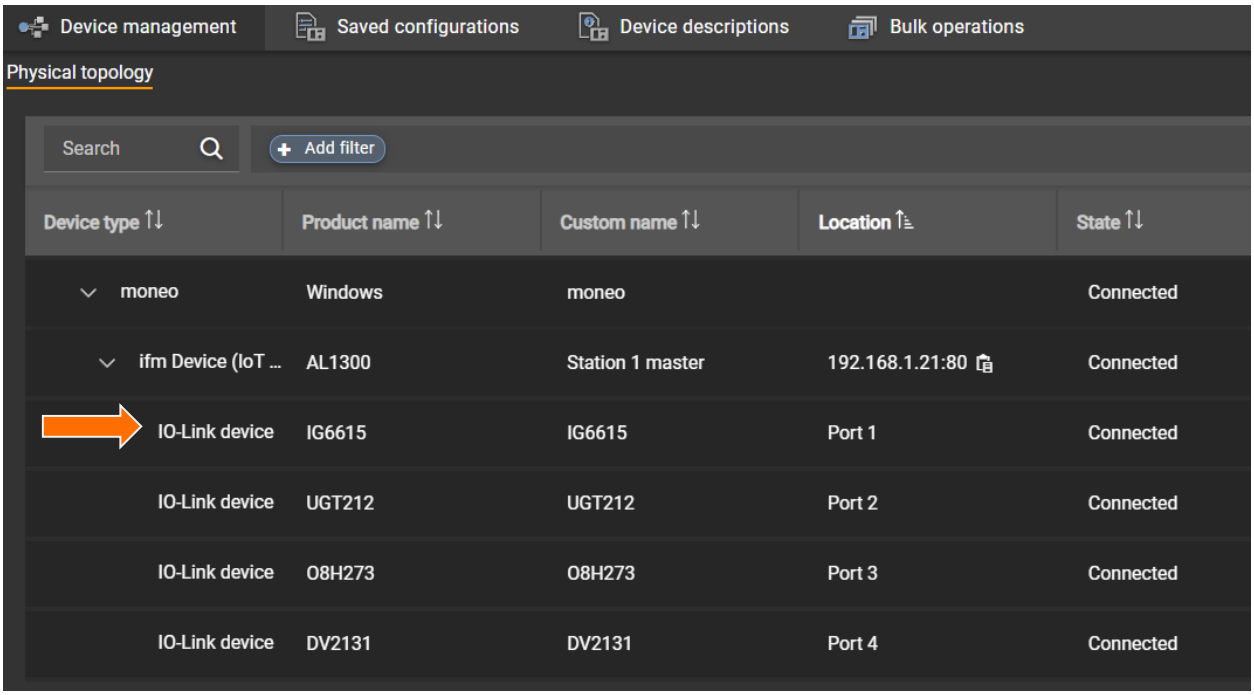




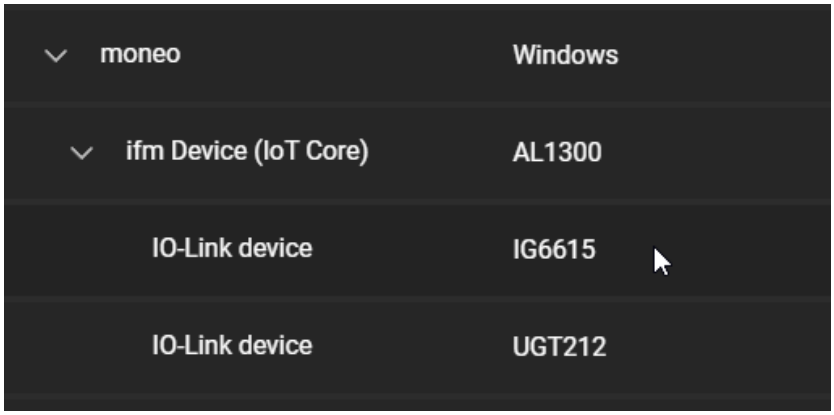
5. Enable communication between the master and your computer using the Moneo Configure application and, if necessary, the Ethernet Configuration Tool.

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Once connected, the master's parameters are displayed in Moneo Configure. The inductive sensor is indicated in the image below.



6. Click the sensor to view its settings.



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

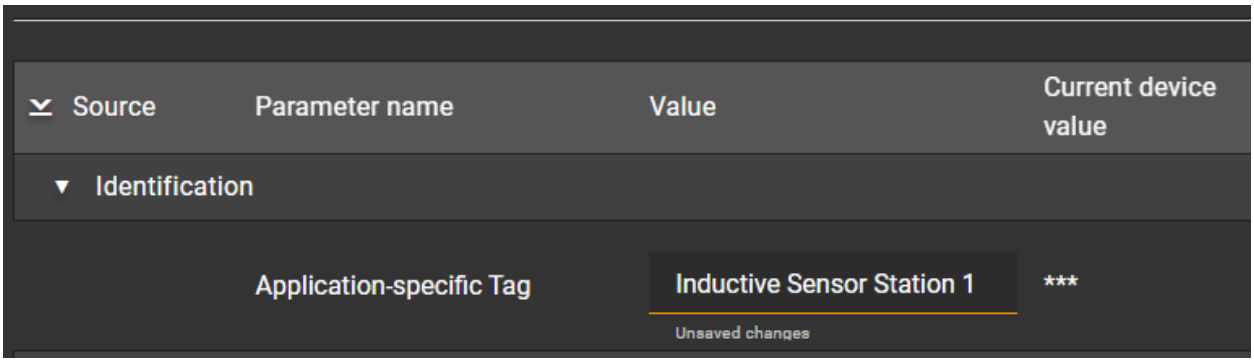


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7.2. Writing to the Sensor

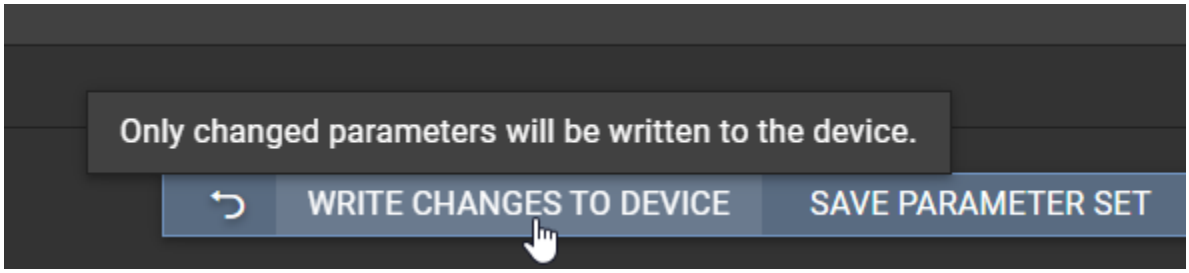
In this next task, you will change the sensor's **application-specific tag**. The application-specific tag is a name given to the sensor to make it more identifiable in the field or factory floor where many of these devices may be present.

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

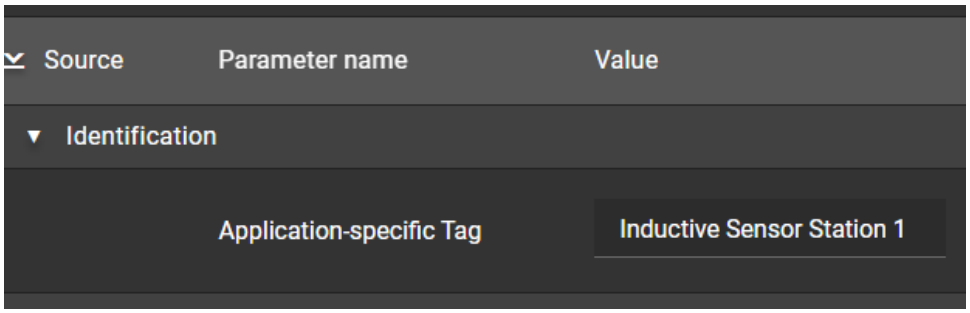


ⓘ ***Note:*** *The changes are unsaved until the settings are written to the device.*

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.



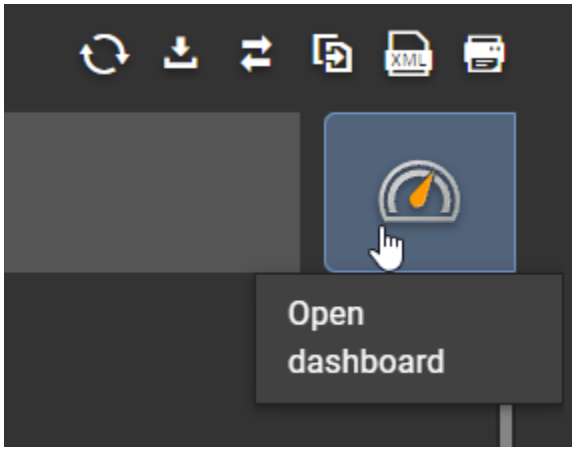
3. Show the new application tag to your instructor.

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7.3. The Dashboard

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

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



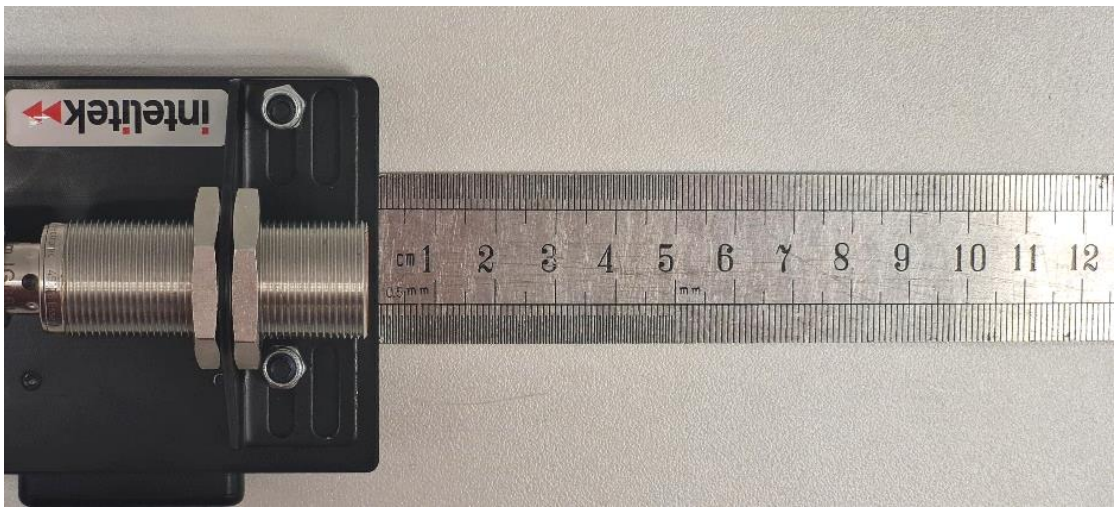
2. Observe the components of the dashboard. There are three outputs signals that sensor sends to the master.

3. Take the magnet and place it near the inductive sensor and look at the value on the Dashboard. Try to detect the distances where SSC1 and SSC2 change their statuses. Also observe the statuses of the LED indicators on the actual smart sensor.

7.4. Sensing Objects of Different Materials

In this next task, you will explore the inductive sensor's ability to sense objects made from different materials.

1. Place a ruler on a flat surface next to the inductive sensor as shown.

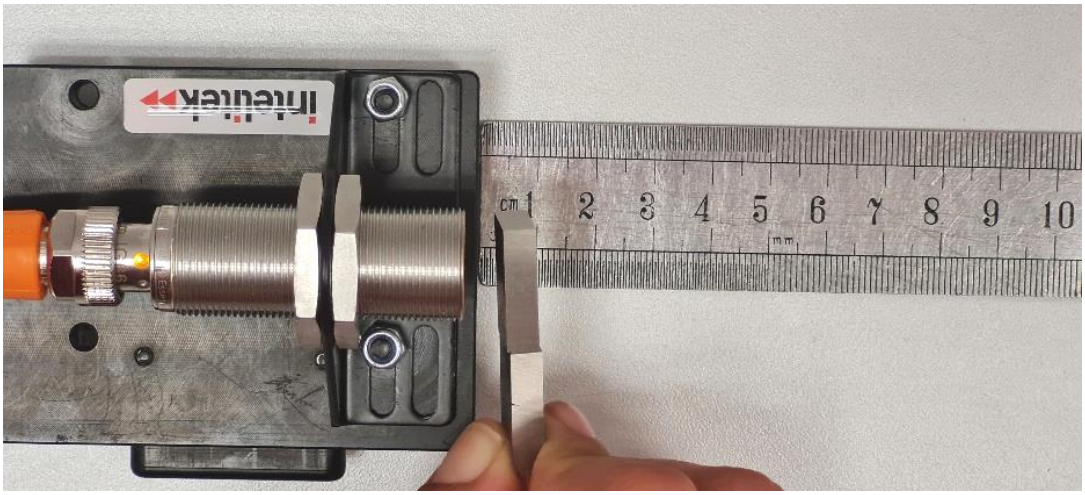


2. Go to the Dashboard screen.

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3. Take the magnet and place it near the inductive sensor, look at the value on the Dashboard. Note that SSC1 and SSC2 are ON when the PDV1 value is less than 3800 µm.

4. Observe the ruler, you can see that the magnet is in about 3 mm (3000 µm) from the sensor.



5. Repeat steps 3 and 4 with the other materials and note how they activate the sensor, but from different distances.

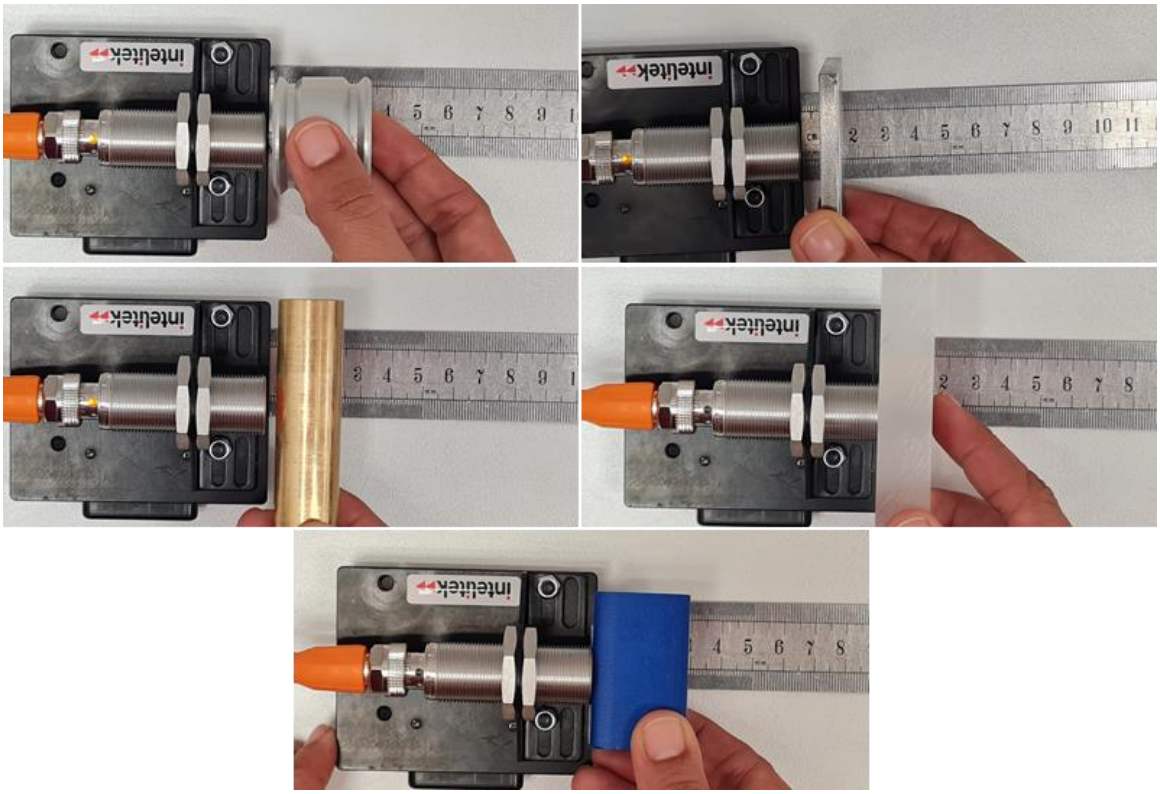


Figure 1. Top view of the inductive sensor, the ruler, and other materials.

This demonstrates that the best material to use with an inductive sensor is a magnet.

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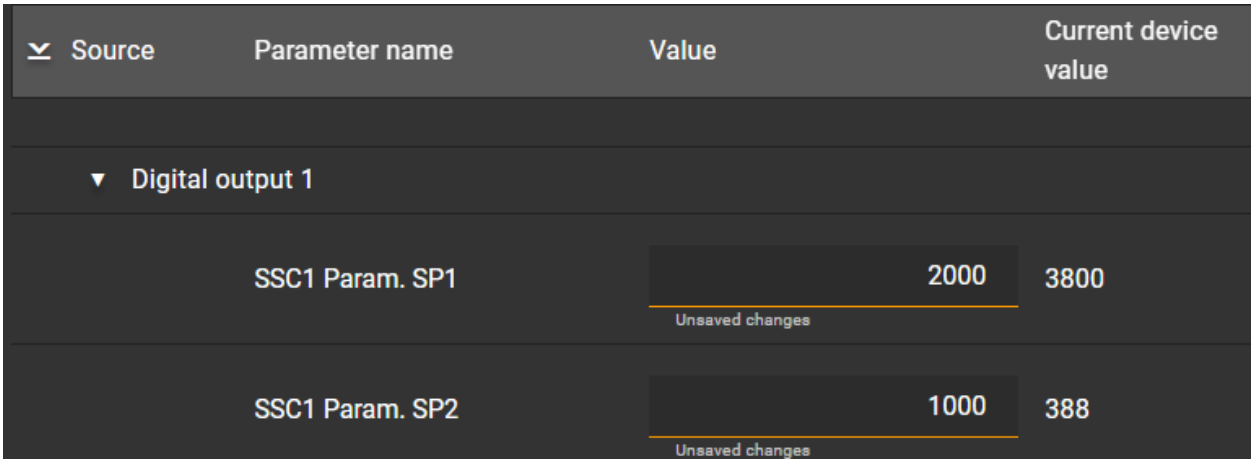
7.5. Changing the Default settings

1. In this next task, you adjust several inductive sensor SSC indicator settings and observe how the changes affect the reading on the Dashboard display.

ⓘ ***Note:*** *In this task you will change the SSC1 indicator settings. The same procedure is applicable for the SSC2 indicator.*

Setpoint 1 and Setpoint 2

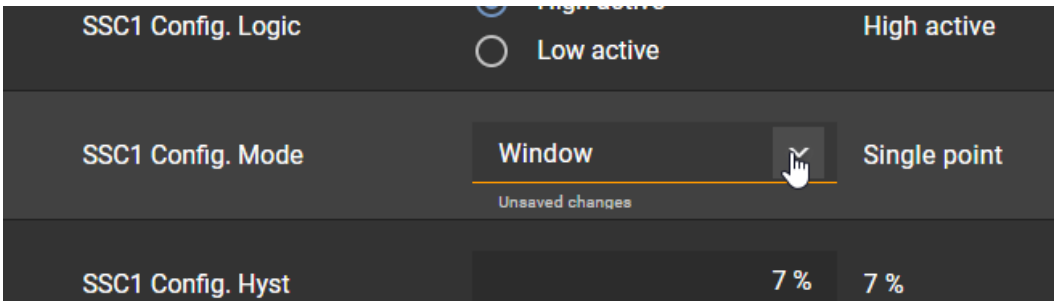
2. Scroll down to the **Digital Output 1** area.
3. In the **SSC1 Param. SP1** field, change the value to **2000**.
4. In the **SSC1 Param. SP1** field, change the value to **1000**.



5. In the menu at the bottom-right, click **Write Changes to device**.
6. Observe the Dashboard screen. Reopen it if you closed it beforehand.
7. Take the magnet and place it near the inductive 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.
8. Return to the **Setup** screen.

Mode

9. Scroll down to the **SSC1 Config. Mode** dropdown menu and select **Window**.



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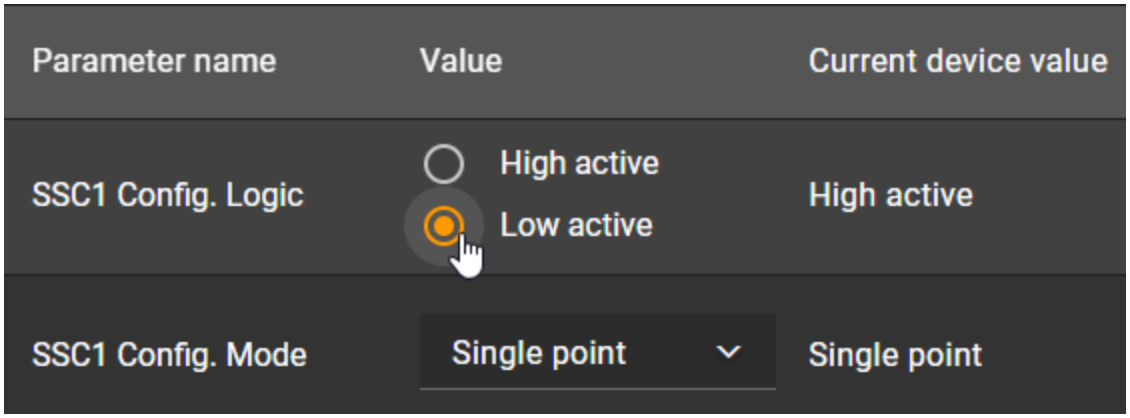
10. In the menu at the bottom-right, click **Write Changes to device**.
11. Return to the **Dashboard** screen.
12. Take the magnet and place it near the inductive sensor. Observe the PDV1 value and note when the SSC1 indicator changes to ON.
13. Return to the setup window. Change **SSC1 Config. Mode** to **Two point**.



14. Click **Write Changes to device** to write the data to the master.
15. Observe the **Dashboard** screen. Take the magnet and place it near the inductive sensor. Observe the PDV1 value and note when the SSC1 indicator changes to ON.
16. Return to the Setup window. Change **SSC1 Config. Mode** to **Single point** and write the data to the master.

Normally open/Normally closed

17. In the **SSC1 Config. Logic** dropdown menu, select **Low active**.

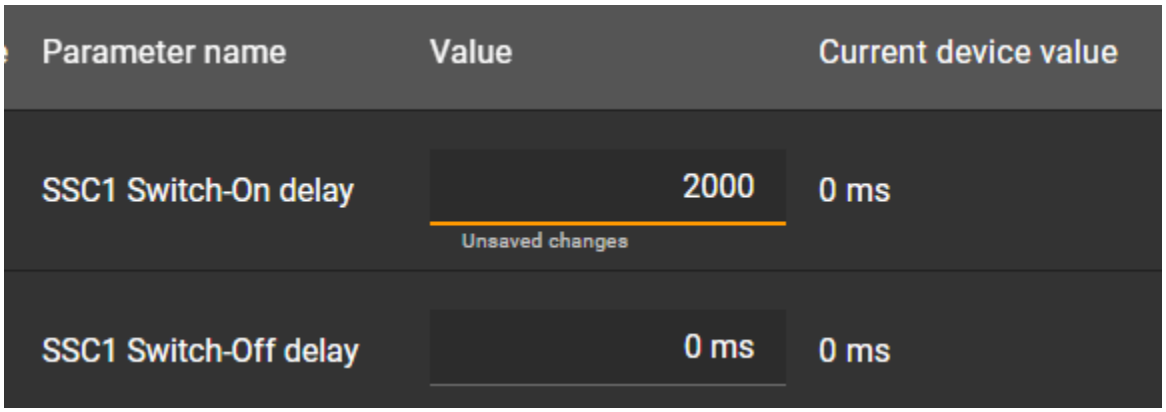


18. Write the changes to the master.
19. Observe the **Dashboard**. Note that the SS1 indicator is ON.
20. Take the magnet and place it near the inductive sensor. Observe the distance value on the Dashboard and note when the SSC1 indicator changes to OFF.
21. Return to the **Setup** screen.
22. Change **SSC1 Config. Logic** back to **High active** and write the changes to the master.

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Switch-On Delay and Switch-Off Delay

23. In the **SSC1 Switch-On delay** field, enter 2000 ms (2 seconds).



24. Click **Write changs to device** icon to save the changes.

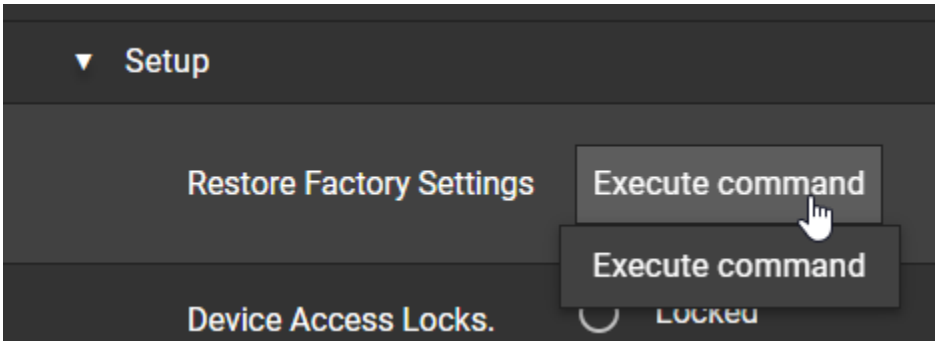
25. Observe the **Dashboard** screen. Take the magnet and place it near the inductive sensor. Observe the PDV1 values and notice that the SSC1 indicator changes to ON **two seconds** after the value on PDV1 becomes less than 2000 µm. Note also that this delay does not affect SSC2.

7.6. Resetting Factory Settings

In this activity-completing task, you will return all of the sensor's settings to their default values.

1. In the sensor's parameters menu scroll down to the **Setup** area.

2. In the Restore Factory Settings row, click **Execute command**.



3. In the confirmation window, select **Yes**. The settings return to factory defaults.

4. Close the Moneo Configure application and, if necessary, the Ethernet Device Configuration application.

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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.

- ☐ The IO-Link master is disconnected and stowed away.
- ☐ The connecting cables are stowed away.

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