Instrumentation and Measurement

Lab 5

Position Detection and Displacement Measurement

Date the Lab was performed (mm-dd-yy): 02/09/2024

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Submission Instruction:

Review the lab report before submitting and put a check mark (√) in the appropriate check box on the left if the item has been duly completed in your lab report. The bracket on the right side will be filled out by your instructor with your gained mark.

1. Scan and create .pdf of all pages.
2. Combine ALL pages of your lab report into a SINGLE .pdf file. Meaning, do not submit each Page of your lab report as a separate file
3. The lab report file must be named in the following manner: "Your First Name_YourLast Name.pdf",
4. Upload and submit the pdf of your lab report in Blackboard.

Marking:

- [x] Section 1 [ ] / 30
- [ ] Section 2 [ ] / 30
- [ ] Assignment [ ] / 40

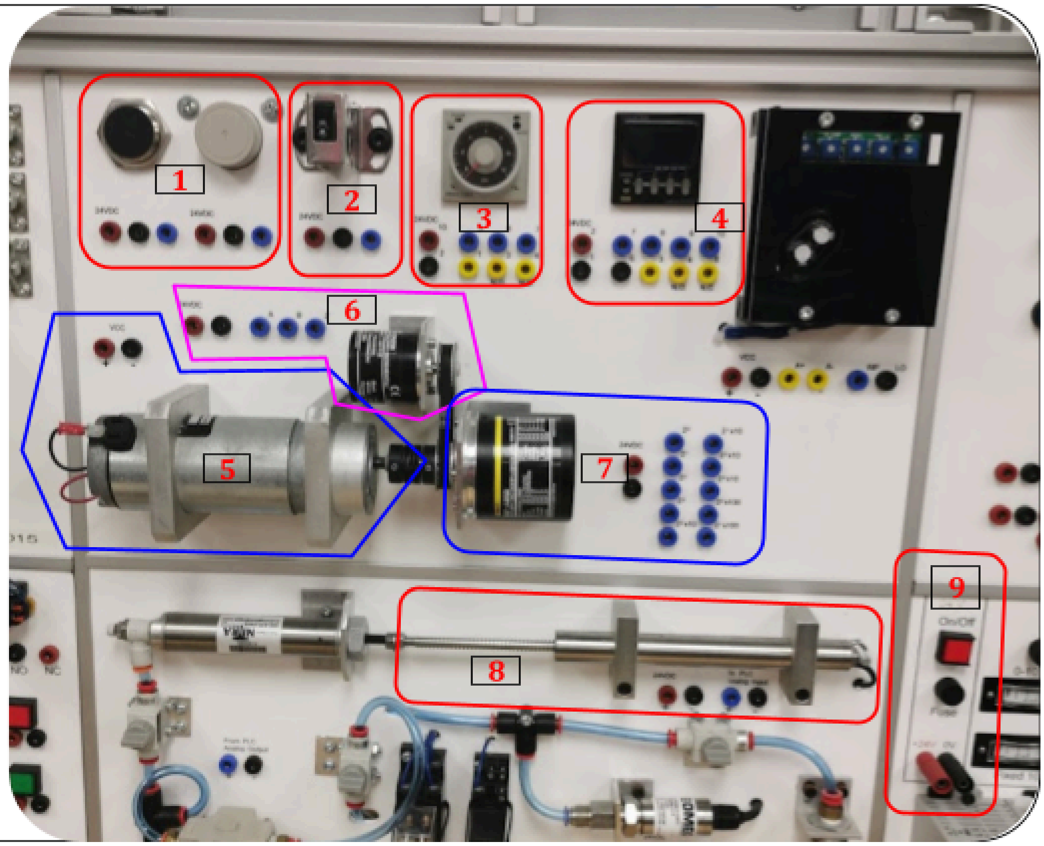
Every 20 minutes late is subjected to 10 marks deduction from attendance.

Position Detection and Displacement Measurement

Objective:

1) Proximity Sensor
2) Absolute encoder
3) Instrument Data Sheet and Manual reading

1) Proximity Sensors
2) Photoelectric sensor
3) Timer
4) Counter+Indicator
5) DC Motor
6) Rotary Encoder
7) Absolute Encoder
8) LVDT
9) 24VDC Power Supply



Experiment Panel

Figure (L5-1)

1) Proximity Sensor:

1-1) In Figure L5-1, you see the layout of the experimental panel on your station. Item-1 is two proximity sensors, black and gray. The manufacturer of the sensor is Omron and the model number for the black one is E2A-M30KS15-WP-B1.

1-2) Open the web browser and go to the manufacturer (Omron) website in https://www.ia.omron.com/ and search for the model number of the sensor. When the product page is opened, click on the catalog tab and download the data sheet (Figure L5-2).

1-3) On page 3 of the data sheet you can see the model number legend. Based on the model number and page 3 information decode the model number of sensor and find the following specification of the black sensor:

1-3-a) Sensor Body Material: Brass or Steel?

1-3-b) Sensor Diameter (Housing Size): 30 mm

1-3-c) Sensor Shielded or not Shielded?

1-3-d) Sensing Distance: 15.0 mm

1-3-e) Sensor Output Type : Sourcing or Sinking? (PNP or NPN) ?

1-3-f) Output Type: NO or NC

1-3-g) What could be the power supply voltage range for this sensor?

0-24V

1-4) Look at the experiment panel (Figure L5-1), below the sensor you can see three sockets, Red, Black and Blue. Red and Black are for sensors' power supply and the Blue is the sensor output.

1-5) The item 9 in Figure L5-1 is a 24 VDC power supply. Take connector wires and connect the power supply to the black sensor.

1-6) Figure L5-3 shows the testing light on the panel. The red sockets are for the positive head and the blacks are for the negative head of the lights.

1-7) Connect the sensor output to one of the test lights. (The sample drawing is provided in page 8 of data sheet)

1-8) Press the red button of the power supply (Item 9) to turn on the power supply. The power supply red light will turn on.

1-9) Take a piece of metal close to the head of the sensor, the test light should turn on. If not, troubleshoot your wiring for light and the sensor.

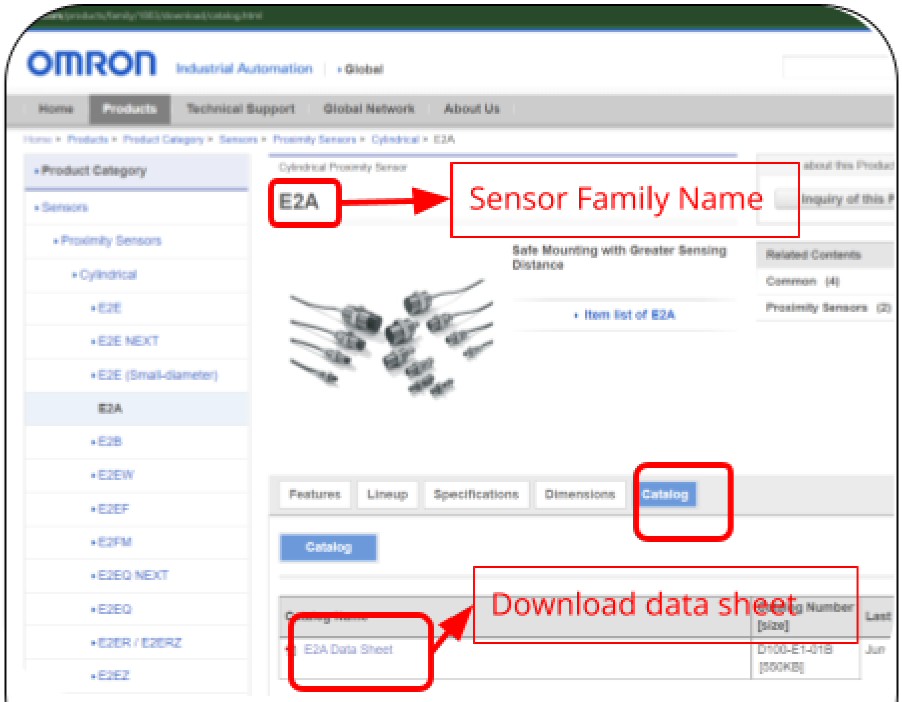


Figure (L5-2) - Web page for E2A sensor Family

1-10) Verify the sensing distance of the sensor by moving the metal piece back and forth and measuring the maximum sensing distance.

Practical Sensing Distance: 7.5.....mm

1-11) The gray sensor in Item 1 of Figure L5-1 is also a proximity sensor. The manufacturer is Omron and the model number is E2K-C25ME1. Search in the Omron web site provided in step 2 to find the sensor data sheet and find the following information. (On the sensor web page click on catalog to download the data sheet).

1-12-a) Sensor Type: Inductive or Capacitive?

1-12-b) Sensor Diameter: 34..mm

1-12-c) Sensor Shielded or not Shielded?

1-12-d) Sensing Distance: 2.5.....mm

1-12-e) Sensor Output Type : Sourcing or Sinking? (PNP or NPN) ?

1-12-f) Output Operation Type: NO or NC

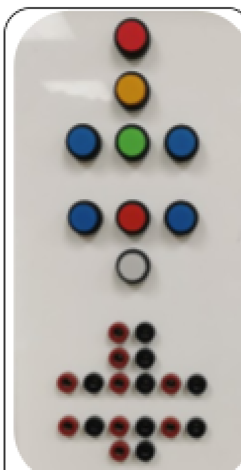


Figure L5-3 - Test Light

1-12) Connect the panel power supply to the sensor and connect the output to a test light and test the sensor functionality. *(The general sensor wiring diagram is on page 5 of the data sheet).*

Instructor Signature for section 1 ....

1-13) Press the button on the panel power supply to turn it off.

2) Rotary Encoder:

2-1) In Figure L5-1, Item 5 is a DC motor. Wire the panel power supply (Item 8) to the motor. Press the power button on the panel power supply, the motor should start running.

2-2) Pull out the motor power wire to stop it.

2-3) Look up the motor label on the body of the motor and you will be able to find the manufacturer and the model number of the motor. Fill out the area in below:

Manufacturer: Hansen Corporation Model Number: 121-42432-192

2-4) Look at the label of the encoder (Item 7) and find below information:

[E6F-A Absolute 60-mm-dia. Rotary Encoder/Specifications | OMRON Industrial Automation]

[CSM_E6F-A_DS_E_7_5 (omron.com)]

Manufacturer: Omeron **Model Number:** E6F-AB5B **Encoder type:** Incremental or absolute and Single or multi turn

Type of encoder outputs: Sourcing or Sinking **Output Code:** BCD **Positive Direction:** Clockwise

Maximum Permissible Speed: 5000 r/min **Resolution:** 360

2-5) Connect the panel power supply to the encoder (Item 7) .

2-6) Wire one of the test lights in Figure L5-3 to the outputs of the encoder and write down each output value in format of 1 and 0 below. then convert the current reading to integer number and obtain the current angle of the shaft.

	$2^1 \times 100$	$2^0 \times 100$	$2^3 \times 10$	$2^2 \times 10$	$2^1 \times 10$	$2^0 \times 10$	2^3	2^2	2^1	2^0
	1	0	0	0	1	0	0	0	1	1
Digits	100+0=200		0+0+20+0 = 20				0+0+2+1 = 3			

Current Angle: 223

2-7) Turn off the panel power supply.

2-8) Item 3 in Figure L5-1 is a timer. Now we want to set up the timer to run the motor for 2 seconds. The timer starts timing when it is powered up. There is a normally closed contact between pin 1 and pin 4 and a normally open contact between pin 1 and pin 3. When timing is done the NC contact will open and the NO will close. In next steps we use the NC contact to stop the motor when timing is done.

2-9) Set the timer dial to 2 sec. Connect the panel power supply to the timer. Then connect the timer pin 1 to 24 volt, pin 4 to the motor + VCC, pin 6 to 0 volt and the motor -Vcc to 0 volt. Then turn on the panel power supply, the motor starts running and the timer light starts blinking which means the timer is timing. When the timer is timed out the red light turns on and normally closed contact between pin 1 and pin 4 opens and the motor stops. In case any mistakes have happened, it would be necessary to start over from step 2-6.

2-10) Then read the encoder outputs again.

	$2^1 \times 100$	$2^0 \times 100$	$2^3 \times 10$	$2^2 \times 10$	$2^1 \times 10$	$2^0 \times 10$	2^3	2^2	2^1	2^0
	1	1	0	1	0	1	0	1	0	0
Digits	200+100 = 300		0+40+0+10 = 50				0+4+0+0 = 4			

New Angle: 354

2-11) To determine the direction of rotation, toggle the panel power supply. (Turn off then turn on). The motor will start running, then look at the motor shaft direction. **Shaft direction:** CW or CCW

Instructor Signature for section 2 ....

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3) Assignments:

3-1) Compare the test light wiring for the black and gray proximity sensors and explain the differences? *(5 Marks)*

The test light wiring for the sensors are diffrant as Black sensor is NPN or a Sourcing Circuit where as the gray sensor is a PNP or a sinking Circuit.

The output types requir different circuits as PNP need you to sink some Voltage & NPN is the Opposite

3-2) Search on the internet for the manufacturer and model number of the motor recorded, in step (2-3) and find the motor data sheet. Look up the model number of the motor in data sheet to find its specification and then answer the below question:

Motor Speed: 3200 rpm Gear Ratio : 192 *(5 Marks)*

3-3) If the pulley diameter is 2.54 cm , based on the information in the previous step, calculate: (Show calculation in steps)

Shaft calculated speed: 16.7 rpm $\text{Shaft Speed} = \frac{RPM}{\text{Gear Ratio}} = \frac{3200}{192} = 16.7\ RPM$ *(10 Marks)*

Shaft speed: 0.28 rps (Revolution per second) $RPS = \frac{RPM}{60} = \frac{16.7}{60} = 0.28\ RPS$

Belt calculated Speed: 2.23 cm/s $V = 2\pi \cdot \frac{D}{2} \cdot RPS = 2\pi \cdot \frac{2.54}{2} \cdot 0.28 = 2.23\ cm/s$

Belt calculated Displacement in 2 seconds: 4.46 cm

$d = V \cdot S = 2.23 \cdot 2 = 4.46\ cm$

3-4) The encoder outputs in step 2-6 and step 2-10 present the shaft angle before and after running the motor for 2 seconds. Calculate the followings based on these two measurement: *(10 Marks)*

Shaft measured angular displacement in 2 seconds: 131 Deg $\frac{354 - 223}{2} = \frac{131}{2} = 65.5\ deg/s$

Shaft measured Angular speed: 65.5 Deg /sec $65.5 \cdot 60 = 3930\ deg/min$

Shaft measured: 10.92 rpm $RPM = \frac{3930}{360} = 10.92\ RPM$

Belt measured Displacement in 2 seconds: 2.9 cm $d = \frac{131}{360} \cdot 2\pi \cdot \frac{2.54}{2} = 2.9\ cm$

Belt measured Speed : 1.45 cm/s

$V = \frac{2.9}{2} = 1.45\ cm/s$

3-5) In assignment 3-3 the belt displacement and speed is calculated from data sheet information and in step 3-4 it is obtained from the encoder measurement. Do you see any differences? If Yes, what could be the sources of differences (name 3 factors which cause differences)?

Which data is more reliable and could be used in real application, measured or calculated data? *(10 Marks)*

Yes theres is a difference, some sources of difference would be:

The calculated values relies on assumption and rounds values off leading to inaccuracy, Enviromental Factors can Influence measured Values.

Real world systems are influenced by wear & tear, that lead to differences

The Calculated data can give a range of accuracy but for real world applications measured data is better.