



2024 Task 1 Project

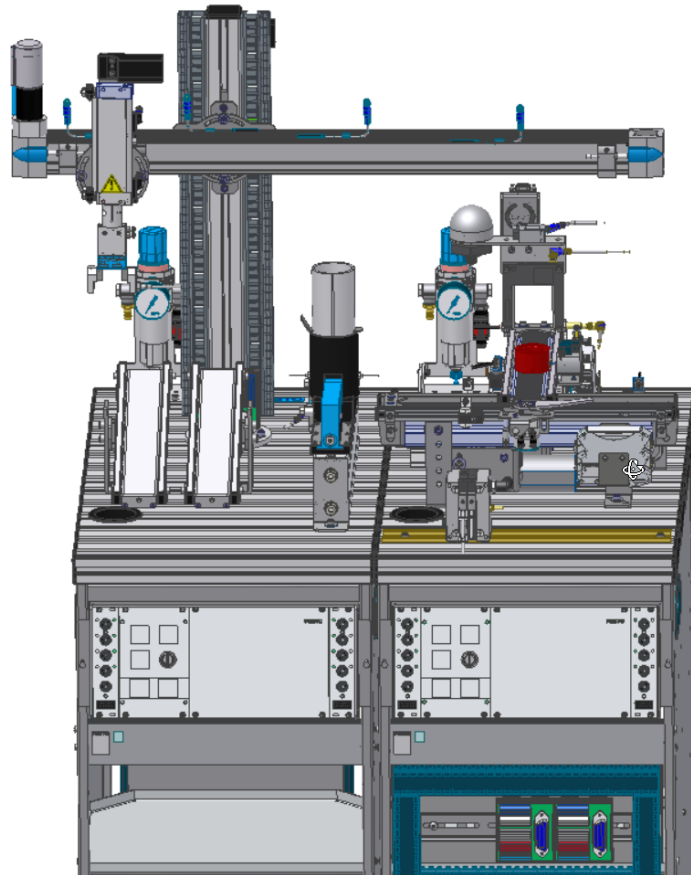
Mechatronics Trade 04

Introduction to the National Test Project

Reassembly, programming, and commissioning of the Handling and Separating Stations

Maximum Time	Information
360 minutes	See additional documents

Scenario



- You work for a company and are receiving an old system from one of your other locations.
- You are tasked with reassembling the station as per the original design specifications.
- Your plant will need to ensure that all parts run the way they are designed to and will be testing the proper build sequences along with testing the rejection process.

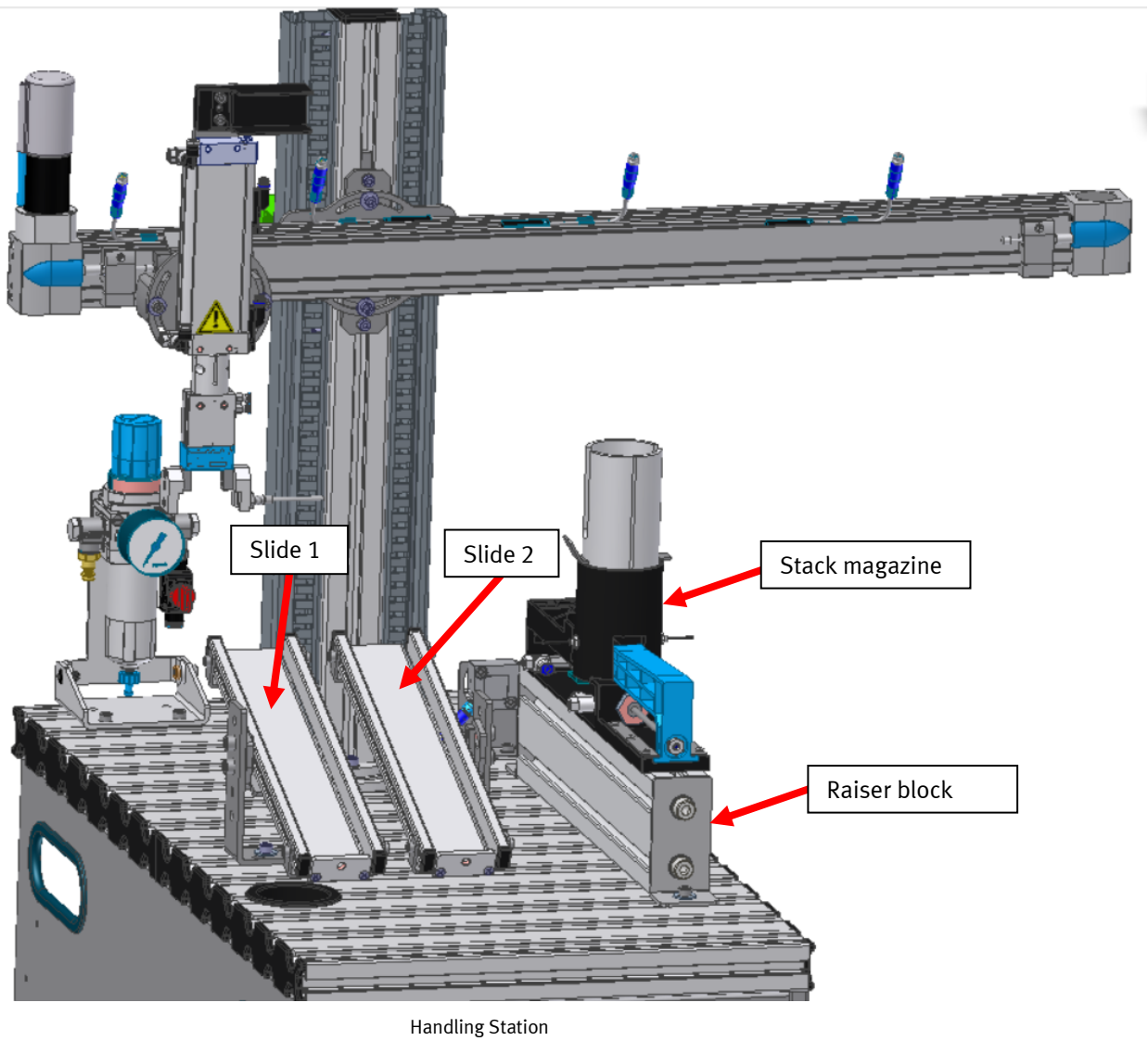
Task

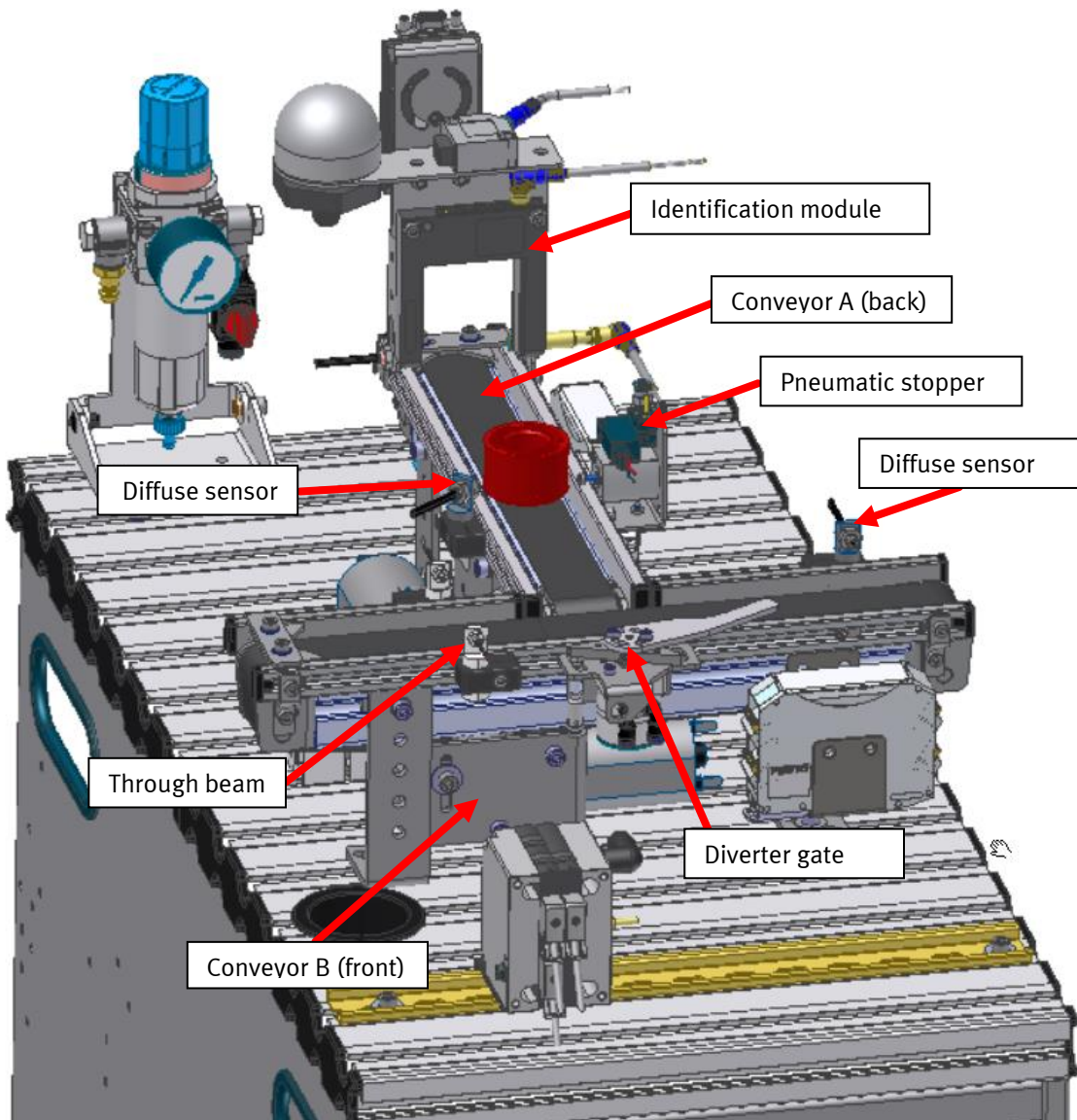
According to your company, your task is complete when:

1. The station has been mechanically assembled, correctly wired, connected and its correct operation is guaranteed (based on the *Simulation Box* evaluation).
2. Correct execution of the program with PLC activation is guaranteed (see the *PLC Board Evaluation*).
3. The system meets the specifications (in accordance with the *Professional Practice Document*).

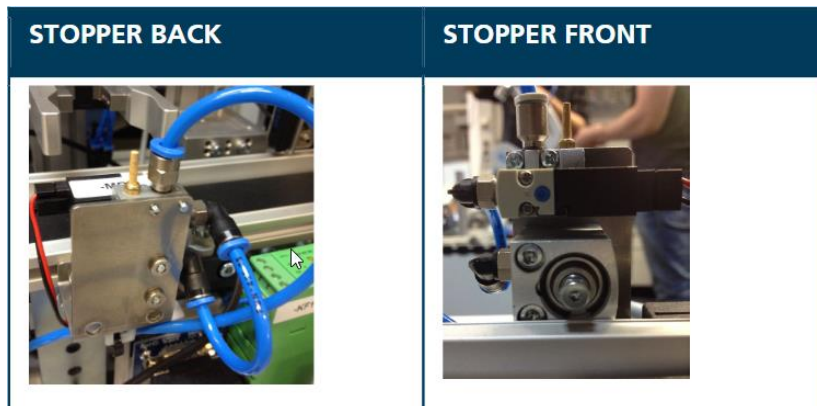
The system is needed in production as soon as you are finished. You will have no opportunity to make improvements later.

Mechanical Part





Separating station



Initial position

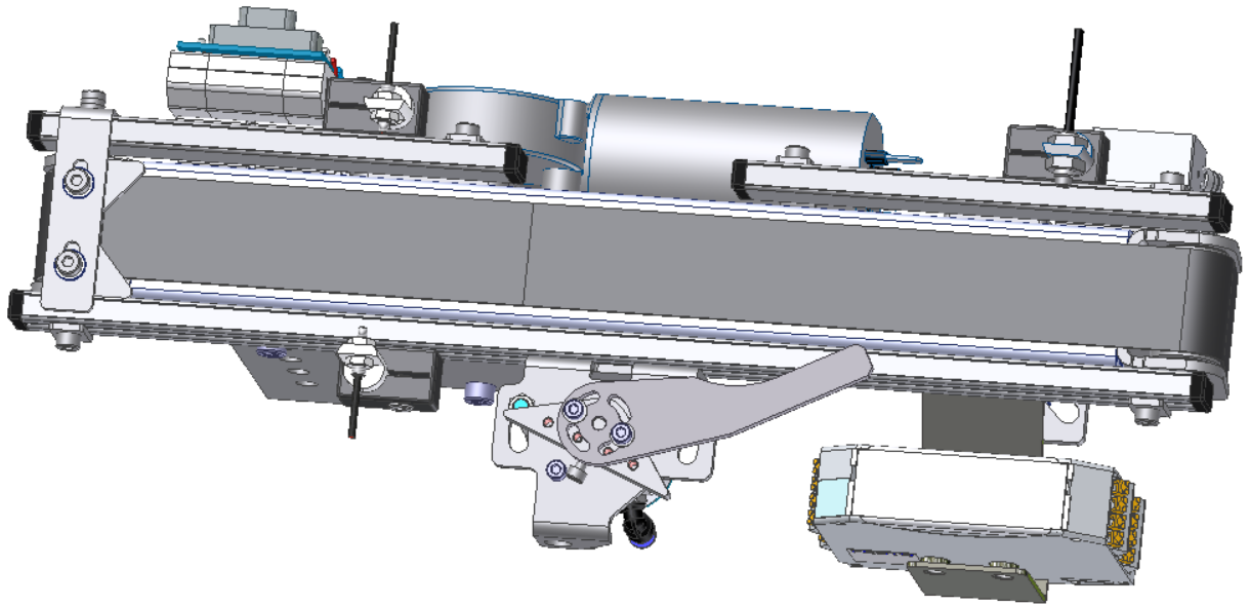
Electrical Handling Module
Electrical handling axis at Pick position (distribution module)
Gripper is open
Gripper arm up (retracted)

Conveyor A
Conveyor empty
Motor off
Gate extended

Conveyor B
Conveyor empty
Motor off
Stopper extended

Electrical Part

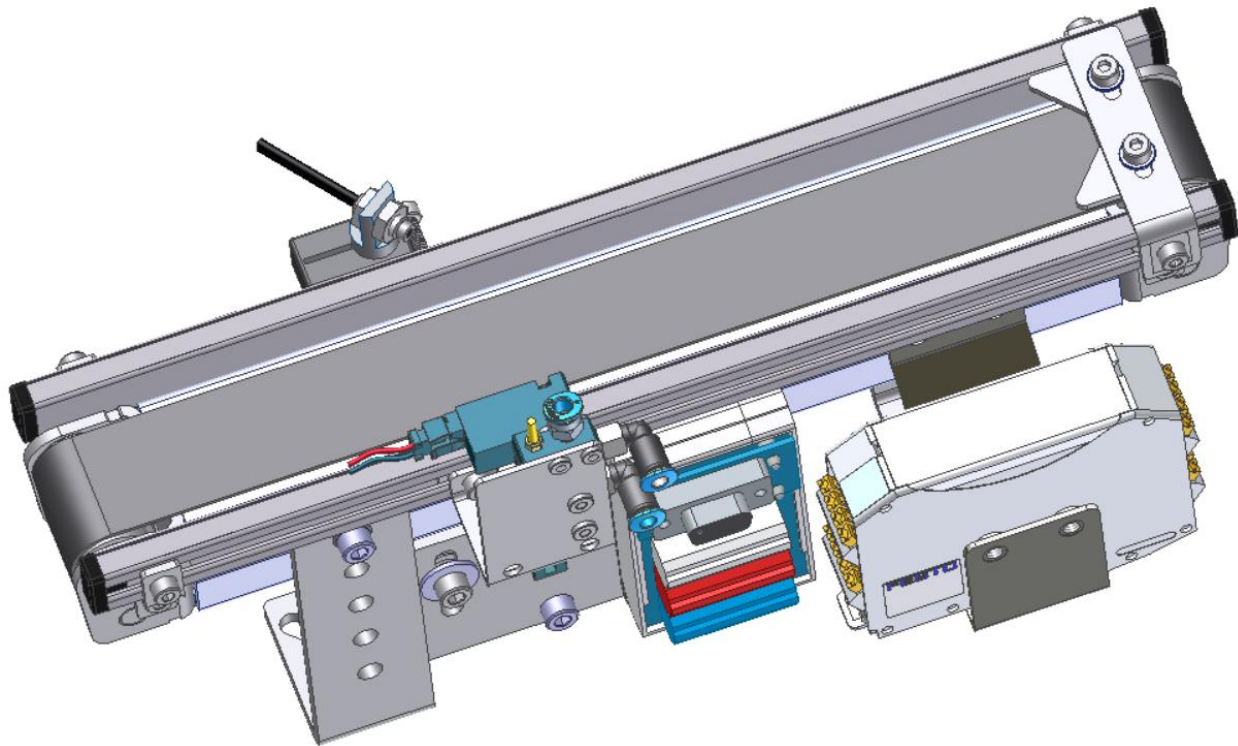
Module information: Conveyor B (front)



Conveyor module wiring allocation (Mini IO Terminal)

Function	D-Sub HD	Terminal	Description
I0	1	1	Workpiece at reject conveyor end (Diffuse)
I1	3	2	Not used
I2	5	3	Reject Area full (Through-beam)
I3	7	4	Diverter Gate Closed (Inductive)
AI0	9	5	Not used
AI1	10	6	Not used
Q0	2	7	Conveyor forward
Q1	4	8	Not used
Q2	6	9	Diverter gate extends
Q3	8	10	Conveyor backward
AQ0	11	11/12	Not used
24 V A	12	24 V A	24 V power supply to outputs
24 V B	13	24 V B	24 V power supply to inputs
GND A	15	GND A	0 V power supply to outputs
GND B	14	GND B	0 V power supply to inputs

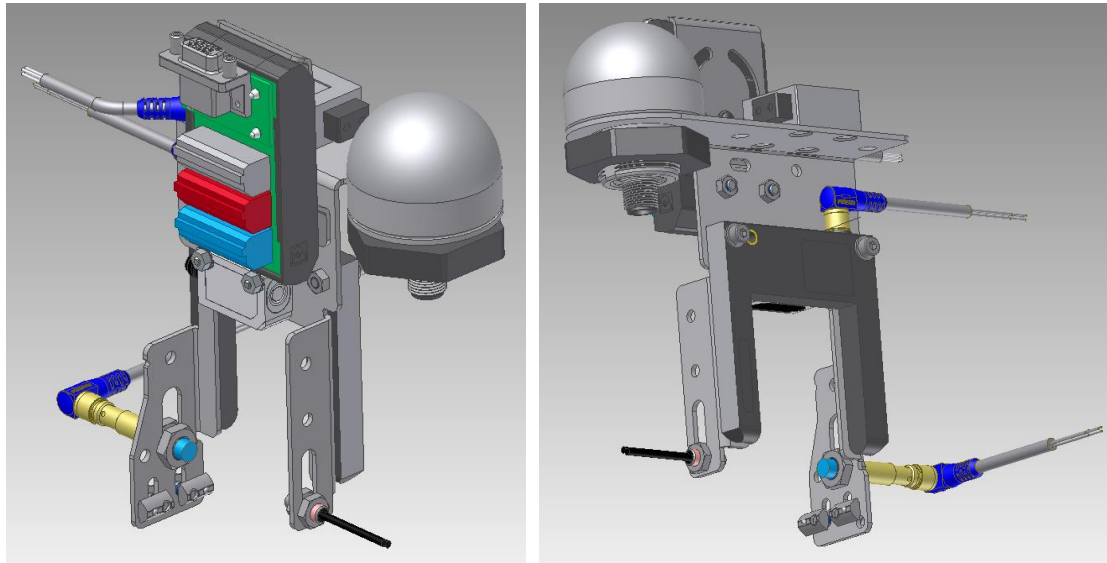
Module information: Conveyor A (back)



Conveyor module wiring allocation (Mini IO Terminal)

Function	D-Sub HD	Terminal	Description
I0	1	1	Workpiece at pick/drop location of conveyor (Diffuse)
I1	3	2	Not used
I2	5	3	Not used
I3	7	4	Not used
AI0	9	5	Not used
AI1	10	6	Not used
Q0	2	7	Retract stopper
Q1	4	8	Conveyor backward
Q2	6	9	Not used
Q3	8	10	Conveyor forward
AQ0	11	11/12	Not used
24 V A	12	24 V A	24 V power supply to outputs
24 V B	13	24 V B	24 V power supply to inputs
GND A	15	GND A	0 V power supply to outputs
GND B	14	GND B	0 V power supply to inputs

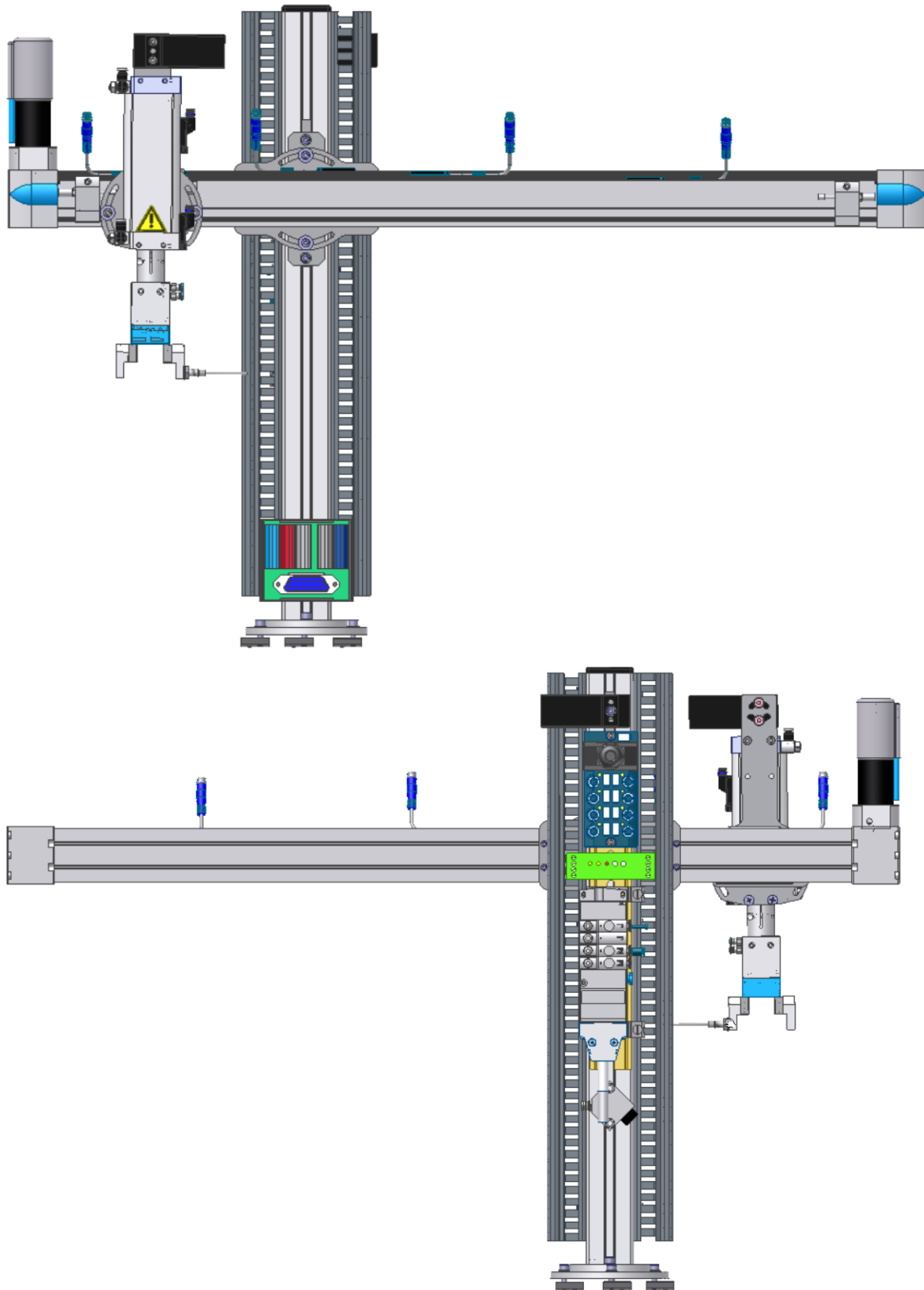
Module information: identification




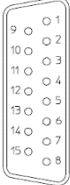
Identification module wiring allocation (Mini IO Terminal)


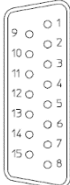
Function	D-Sub HD	Terminal	Description
I0	1	1	Height Sensor
I1	3	2	Inductive sensor (Metallic)
I2	5	3	Black/Non-black sensor (Diffuse)
I3	7	4	Workpiece detected (Light Barrier)
AI0	9	5	Not used
AI1	10	6	Not used
Q0	2	7	Light Indicator: Input 3
Q1	4	8	Light Indicator: Input 2
Q2	6	9	Light Indicator: Input 1
Q3	8	10	Not used
AQ0	11	11/12	Not used
24 V A	12	24 V A	24 V power supply to outputs
24 V B	13	24 V B	24 V power supply to inputs
GND A	15	GND A	0 V power supply to outputs
GND B	14	GND B	0 V power supply to inputs

Module information: electrical handling



Pin Allocation for Valve terminal and Distributed I/O Block

 	PIN	Core Colour	Coil	Function	
	1	White	0	Q1	Gripper arm extends (down)
	2	Brown	1	Q2	Gripper arm retracts (up)
	3	Green	2	Q5	Extend distribution magazine cylinder (retract feeder)
	4	Yellow	3	Q4	Gripper opens
	5-13	-	-	-	Not used
	14	Brown-green	0 V		
	15	White-yellow	0V		

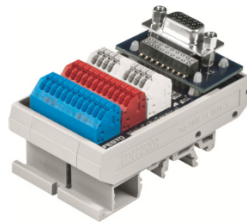
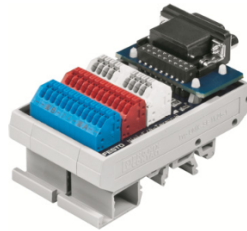
 	PIN	Core Colour	M8 Socket	Function	
	1	White	0	I0	Distribution position
	2	Brown	1	I1	Part in Gripper
	3	Green	2	I2	Gripper arm retracted (Up)
	4	Yellow	3	I3	Slide 1 position
	5	Grey	4	I4	Slide 2 position
	6	Pink	5	I5	Gripper arm extended (Down)
	7	Blue	6	I6	Not used
	8	Red	7	I7	Conveyor position
	9-12	-	-		Not Used
	13	White-green	0-7 / 1	24 VDC	
	14	Brown-green	0-7 / 3	0 V	
	15	White-yellow	0-7 / 3	0V	

Electrical Handling module wiring allocation (Digital IO Terminal)


Function	Syslink	Terminal	Description
I0	13	1	Distribution position
I1	14	2	Part in Gripper
I2	15	3	Gripper arm retracted (Up)
I3	16	4	Slide 1 position
I4	17	5	Slide 2 position
I5	18	6	Gripper arm extended (Down)
I6	19	7	(No) part in distribution magazine
I7	20	8	Conveyor position
Q0	1	9	Handler moves to the upstream position
Q1	2	10	Extend gripper arm (down)
Q2	3	11	Retract gripper arm (up)
Q3	4	12	Not used
Q4	5	13	Open gripper
Q5	6	14	Extend distribution magazine cylinder (retract feeder)
Q6	7	15	Not used
Q7	8	16	Handler moves to the downstream position
24 V A	9+10	24 V A	24 V power supply to outputs
24 V B	21+22	24 V B	24 V power supply to inputs
GND A	11+12	GND A	0 V power supply to outputs
GND B	23+24	GND B	0 V power supply to inputs

Contact allocation table of the mini IO terminal

Terminal	D-Sub HD	Function	Description
1	1	I0	Digital input bit 0
2	3	I1	Digital input bit 1
3	5	I2	Digital input bit 2
4	7	I3	Digital input bit 3
5	9	AI0	Analogue input 0
6	10	AI1	Analogue input 1
7	2	Q0	Digital output bit 0
8	4	Q1	Digital output bit 1
9	6	Q2	Digital output bit 2
10	8	Q3	Digital output bit 3
11/12	11	AQ0	Analogue output 0
24 V A	12	24 V A	24 V power supply to outputs
24 V B	13	24 V B	24 V power supply to inputs
GND A	15	GND A	0 V power supply to outputs
GND B	14	GND B	0 V power supply to inputs

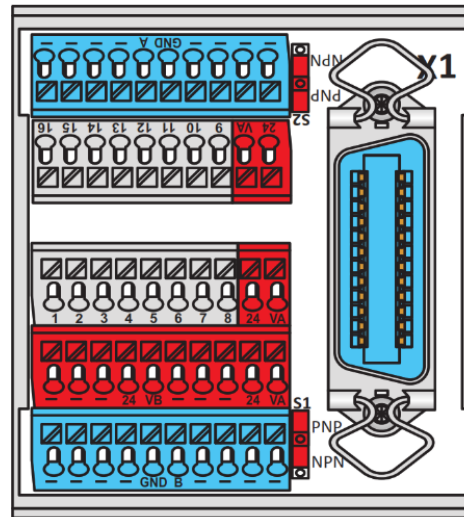


Sub-D-15-HD connecting cable with an open end


	PIN	Core Color	Function
	1	White	Input I0
	2	Brown	Output Q0
	3	Green	Input I1
	4	Yellow	Output Q1
	5	Grey	Input I2
	6	Pink	Output Q2
	7	Blue	Input I3
	8	Red	Output Q3
	9	Black	Analogue Input AI0
	10	Violet	Analogue Input AI1
	11	Gray-Pink	Analogue Output AQ0
	12	Red-Blue	Power Supply Inputs 24 V B
	13	White-Green	Power Supply Outputs 24 V A
	14	Brown-Green	Power Supply Inputs 0 V B
	15	White-Yellow	Power Supply Outputs 0 V A
		Yellow-Brown	N.C.


Contact allocation table of the digital I/O terminal

Terminal	SysLink	Function	Description
1	13	I0	Digital input bit 0
2	14	I1	Digital input bit 1
3	15	I2	Digital input bit 2
4	16	I3	Digital input bit 3
5	17	I4	Digital input bit 4
6	18	I5	Digital input bit 5
7	19	I6	Digital input bit 6
8	20	I7	Digital input bit 7
9	1	Q0	Digital output bit 0
10	2	Q1	Digital output bit 1
11	3	Q2	Digital output bit 2
12	4	Q3	Digital output bit 3
13	5	Q4	Digital output bit 4
14	6	Q5	Digital output bit 5
15	7	Q6	Digital output bit 6
16	8	Q7	Digital output bit 7
24 V A	9+10	24 V A	24 V power supply to outputs
24 V B	21+22	24 V B	24 V supply power to inputs
GND A	11+12	GND A	0 V power supply to outputs
GND B	23+24	GND B	0 V power supply to inputs



Wiring allocation for sensors

	PIN	Core Colour	Function
	1	Brown	24 VDC
	3	Blue	0 VDC
	4	Black	Output

	PIN	Core Colour	Function
	1	Brown	24 VDC
	2	White	Output
	3	Blue	0 VDC
	4	Black	Output

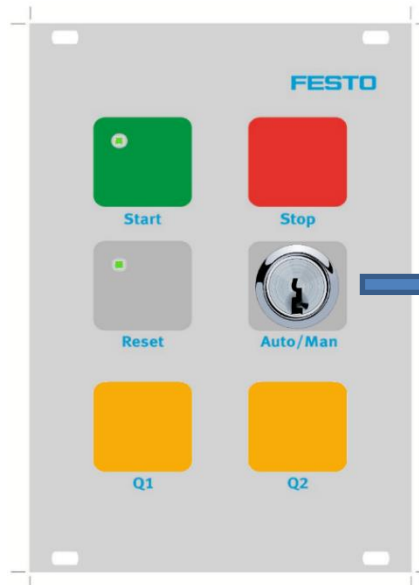
Additional Information

Workpieces

Workpieces come in three distinct colors: black, red, and silver.



Control console

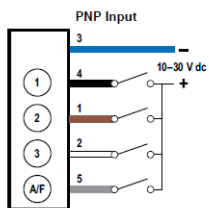


Mode 1



Mode 2

Light indicator specifications



	Red	Yellow	Green	Cyan	Blue	Magenta	White
Input 1	X	X				X	X
Input 2		X	X	X			X
Input 3				X	X	X	X

Motor controller

The motor controller is for use with DC brush motors with adjustable overcurrent monitoring. A status output indicates the states “ready for operation” and “error”. External speed selection is made possible by an analog input. If a voltage of greater than 11.5 V (24 V) is connected to the analog input, the motor controller’s internal speed setting function is used. See technical documentation for wiring and operation instructions.



Terminal	Function
1	Digital input, “counterclockwise rotation” (switching to P potential)
2	Digital input, “clockwise rotation” (switching to P potential)
3	GND for external potentiometer, max. 0.5 A
4	Digital input, “creep speed” (switching to P potential)
5	Digital output, “ready for operation”, high active
6	Analog input, 0 ... 12 V, the speed specified by the internal potentiometer applies at greater than 11 V.
7	Auxiliary voltage output, +10 V / approx. 50 mA (PTC fuse)
8	Auxiliary voltage output, +24 V, max. 0.5 A
9	Motor connection –
10	Motor connection +
11	Digital input, “enable counterclockwise rotation / acknowledge” (switching to P potential)
12	Digital input, “enable clockwise rotation / acknowledge” (switching to P potential)
13	GND
14	+24 V DC (±10%) in
15	GND
16	+24 V out

Height sensor specifications



- Analogue output 0 ... 10 V
- Adjustable screening function
- Adjustable foreground and background suppression
- Measuring range 20 ... 80 mm adjustable
- Teach in
- Red light 660 nm
- Contamination indicator
- N.O. - N.C. selectable

Anschluss / wiring / Raccordement

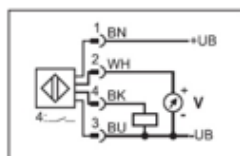
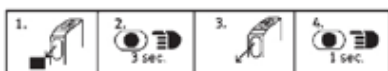


Bild 1 / fig. 1 / figure 1

+U_s: 15 ... 30 V DC
 Out: PNP Out max. 100 mA
 Analog: 0 ... 10 V DC max. 3 mA
 -U_s: Gnd



The Sensor has 2 outputs

a.) Analog output 0 ... 10 V (pin 3 – white)
 The analogue output is factory preset for a range of 20 ... 80 mm and can not be changed.

b.) Digital output PNP, 100 mA (pin 4 – black)
 The digital output can be used with a screening function. The detection limits (switching on and switching off) can be set by pressing a button.

N.O./N.C. setup

- 1.) Press the button for 13 s. Both LED's are flashing alternately.
- 2.) Release the button: the green LED is on.
- 3.) During the green LED is on, the output is inverted by pressing the button. If the button is not pressed during 10 s the present output function is saved, the sensor is ready to operate.

Screening range setting

- 1.) "Switching on" point:
 Line up the sensor to the "switching on" point.
 Press the button 3 s until both LED's are flashing synchronously.
 The "switching on" point is teached
- 2.) "Switching off" point:
 Move the object to the "switching off" point.
 Press the button 1 s.
 The "switching off" point is set.

Evaluation sheet

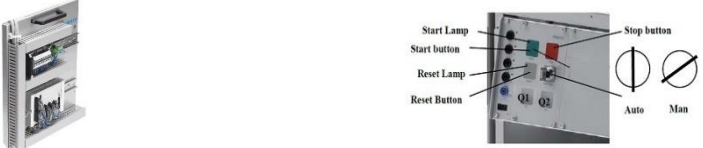
Team : _____

Verification performed by : _____

Total time : _____ (maximum 360 minutes)

Final mark : _____

PLC board (operation)


Description	Evaluation	Maximum evaluation
<p>Preparation: Connect the PLC boards to the I/O terminal (PLCs must be in RUN or Monitor mode). Put the key in AUTO mode.</p> 	Done	Max. Points
<p>1. After power-up the stations remain static. The RESET light flashes at 1 Hz when the key is set to MAN and both stations flash identically</p>		0.75
<p>2. Nothing happens when a part is placed onto the conveyors or the stacking magazine.</p>		0.75
<p>3. Press the RESET button. The handling station returns to the home conditions:</p> <ul style="list-style-type: none"> • Handler at Pick position (stacking magazine) • Gripper Arm Retracted • Gripper open • RESET light ON • START light flashes at 1 Hz • Q1 and Q2 lights are off • Stacking magazine feeder retracted 		0.75
<p>4. Press the RESET button. The separating station returns to the home conditions:</p> <ul style="list-style-type: none"> • Conveyor A off • Conveyor B off • Status light off • Stopper extended • Gate extended • RESET light ON • START light flashes at 1 Hz • Q1 and Q2 lights are off 		0.75
<p>5. When both stations meet their respective home conditions both reset lights turn off simultaneously.</p>		0.75
<p>6. On both stations: Set the key to AUTO the START lights begin to flash at 2 Hz.</p>		0.75
<p>7. On both stations: Press the START button, START light turns solid on each station as it is pressed.</p>		0.75
<p>8. On the Handling Station: A workpiece is fed by the stacking magazine. When the workpiece is pushed, the gripper moves down to grab it. Q1 (handling) flashes at 2 Hz indicating that the handling station is in operation.</p>		0.75

9.	<p>The Handling station then moves the part to the conveyor system and lowers to place the part on the conveyor.</p> <p>The handling unit then returns to the original pick position.</p>	0.75
10.	<p>When the part is detected, and the handling station is in pick position, the part moves to the identification area. Q1 (separating) flashes at 2 Hz indicating that the separating station is in operation.</p> <p>The identification area determines the proper part type: red, black, or silver.</p>	0.75
11.	<p>The system determines the next place for the part: packing (slide 1 or 2) or reject. If the part conforms to the packing requirements, it needs to go to the proper packaging area (slide 1 or 2), if it is not in the proper sequence, it must go to the rejection area.</p> <p>The packing recipe is as follows:</p> <p>Slide 1:</p> <p>Part 1 – Red</p> <p>Part 2 – Silver</p> <p>Part 3 – Black</p> <p>Part 4 – Silver</p> <p>Slide 2 :</p> <p>Part 1 – Black</p> <p>Part 2 – Red</p> <p>Part 3 – Silver</p> <p>Part 4 – Black</p> <p>The rejection system can only reject 3 parts at a time. This means that the conveyor will store 3 parts and when all three parts are in the rejection area, they will all be ejected together.</p>	
12.	<p>If the part is needed for slide 1 the part will move from the identification module to the conveyor pick and wait for the handling station to pick the part. The handling module will move this part to slide 1 and release it, then move to the pick position.</p>	1.50
13.	<p>If the part is needed for slide 2 the part will move from the identification module to the conveyor pick and wait for the handling station to pick the part. The handling module will move this part to slide 2 and release it, then move to the pick position.</p>	1.50
14.	<p>If the part is rejected the part will move from the identification module to the conveyor reject storage area (left of the front conveyor). The gate is closed and the stopper will open to allow access to the storage area.</p>	0.75
15.	<p>When the reject area is full, the gate will open and allow the parts to be rejected from the front conveyor.</p>	0.75
16.	<p>When any of the slides are completely full and ready for shipping, the Q2 light (handling) starts flashing.</p> <p>The slides are emptied by hand before the start button is held for 3 seconds. The Q2 light stops flashing to indicate that the system allows packing a new batch.</p>	0.75


17. During operation the Identification station should show the status of what is happening using the following standard: Handling picking part – Yellow Part being Identified – Cyan Part moving to slide 1 – Green Part moving to slide 2 – Blue Part moving to reject – White Reject being unloaded – Magenta		1.50
18. At any point if the STOP button is pressed, the system should immediately return to home position. The operator needs to manually remove the part that is in transition.		0.75
PLC board total		15

Simulation box (I/O allocation)


Conveyor A (back) and Detection Module

Description		Evaluation	Maximum evaluation
Function to be checked using the simulation box 		Done	Max. points
Preparation: connect the simulation box to the I/O terminal			
I0	Height Sensor		0.50
I1	Inductive sensor (Metallic)		0.50
I2	Non-black sensor (Diffuse)		0.50
I3	Workpiece detected (Light Barrier)		0.50
I4	Workpiece at pick/drop location of conveyor (Diffuse)		0.50
I5	Not used		-
I6	Not used		-
I7	Not used		-
O0	Retract stopper		0.50
O1	Conveyor backward		0.50
O2	Not used		-
O3	Conveyor forward		0.50
O4	Light Indicator: Input 3		0.50
O5	Light Indicator: Input 2		0.50
O6	Light Indicator: Input 1		0.50
O7	Not used		-
Simulation box total			5.50


Conveyor B (front)

Description		Evaluation	Maximum evaluation
Function to be checked using the simulation box 		Done	Max. points
Preparation: connect the simulation box to the I/O terminal			
I0	Not used		-
I1	Not used		-
I2	Not used		-
I3	Not used		-
I4	Workpiece at reject conveyor end (Diffuse)		0.50
I5	Not used		-
I6	Reject Area full (Through-beam)		0.50
I7	Diverter gate extended (inductive)		0.50
O0	Conveyor forward		0.25
O1	Not used		-
O2	Extend diverter gate		0.50
O3	Conveyor backward		0.25
O4	Not used		-
O5	Not used		-
O6	Not used		-
O7	Not used		-
Simulation box total			2.50

Electrical Handling Module

Description		Evaluation	Maximum evaluation
Function to be checked using the simulation box 		Done	Max. points
Preparation: connect the simulation box to the I/O terminal			
I0	Distribution position		0.50
I1	Part in Gripper		0.50
I2	Gripper arm retracted (Up)		0.50
I3	Slide 1 position		0.50
I4	Slide 2 position		0.50
I5	Gripper arm extended (Down)		0.50
I6	(No) part in distribution magazine		0.50
I7	Conveyor position		0.50
O0	Handler moves to the upstream position		0.50
O1	Extend gripper arm (down)		0.50
O2	Retract gripper arm (up)		0.50
O3	Not used		-
O4	Open gripper		0.50
O5	Extend distribution magazine cylinder (retract the feeder)		0.50
O6	Not used		-
O7	Handler moves to the downstream position		0.50
Simulation box total			7

Professional practice

Description	Evaluation	Maximum evaluation
Professional practice 		
Criteria be determined:		
1-		2.5
2-		2.5
3-		2.5
4-		2.5
5-		2.5
6-		2.5
Professional practice total		15

Time evaluation

Description	Evaluation	Maximum evaluation
Time evaluation (only if 80% of points is achieved for both PLC board and simulation box operation and at least 60% for professional practice)		
<ul style="list-style-type: none"> If at least one team finishes with more than 1/3 of the time remaining, that team holds the reference time and the formula for determining the number of points is as follows: $\frac{MaxTime - TimeUsed}{MaxTime - ReferenceTime} * Max\ points$ If no team finishes with more than 1/3 of the time remaining, the formula for calculating the points is as follows: $\frac{RemainingTime}{MaxTime / 3} * Max\ points$ <p>See time evaluation calculation examples below</p>	Actual time =	5

Example 1:

The test lasts 300 minutes. The first team takes 180 minute and ends the event with 120 minutes remaining on the clock. The team obtains 100% of the points or 10 points since the remaining time is greater than 1/3 of the max time. The time of this team becomes the reference time. The score of the other teams will be determined according to the following formula:

$$\frac{MaxTime - TimeUsed}{MaxTime - ReferenceTime} * Max\ points = \frac{300 - TimeUsed}{300 - 180} * 10$$

Example 2:

The test lasts 300 minutes. The first team ends the event with 50 minutes remaining on the clock. The second formula must be used to calculate the points since the remaining time is less than 100 minutes (<1/3 of max time).

$$\frac{RemainingTime}{MaxTime / 3} * Max\ points = \frac{50}{300/3} * 10\ points = 5\ Points$$

The same formula will be used to determine the score of the following teams. In this scenario, the time of the first team that finishes does not have a direct influence on the scores of the other teams.

Total evaluation

Description	Evaluation	Maximum evaluation
Points for operation based on PLC board		15
Points for I/O allocation (simulation box)		15
Points for professional practice		15
Points for time evaluation		5
Total		50