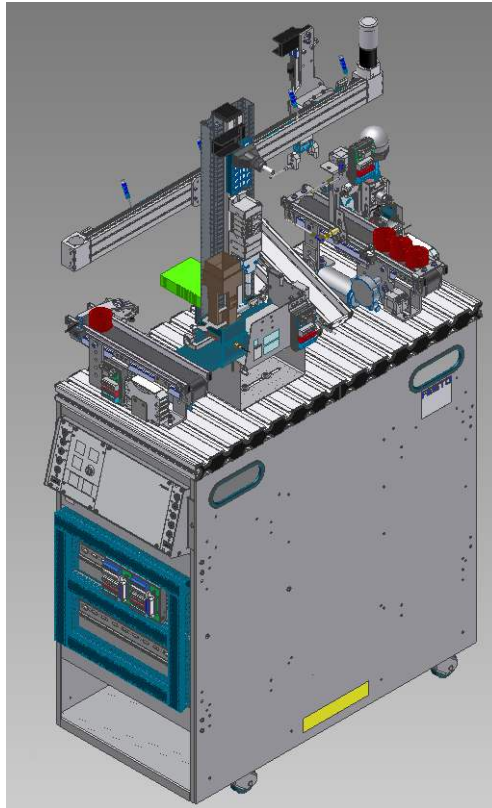**Skills** Compétences
Canada

2024 Task 2 Project

Mechatronics Trade 04

Introduction to the National Test Project

Disassembly, reassembly, programming, and commissioning of the Station

Maximum Time	Information
360 minutes	See additional documents

Scenario

- You work for a company and have been asked to reduce the footprint of the new line you received.
- You are tasked with disassembling some of the components to facilitate the move.
- You will also need to introduce a new inline distribution module.
- Your plant will need to ensure that all parts run the way they are designed 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 disassembled, approved for reassembly, 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.

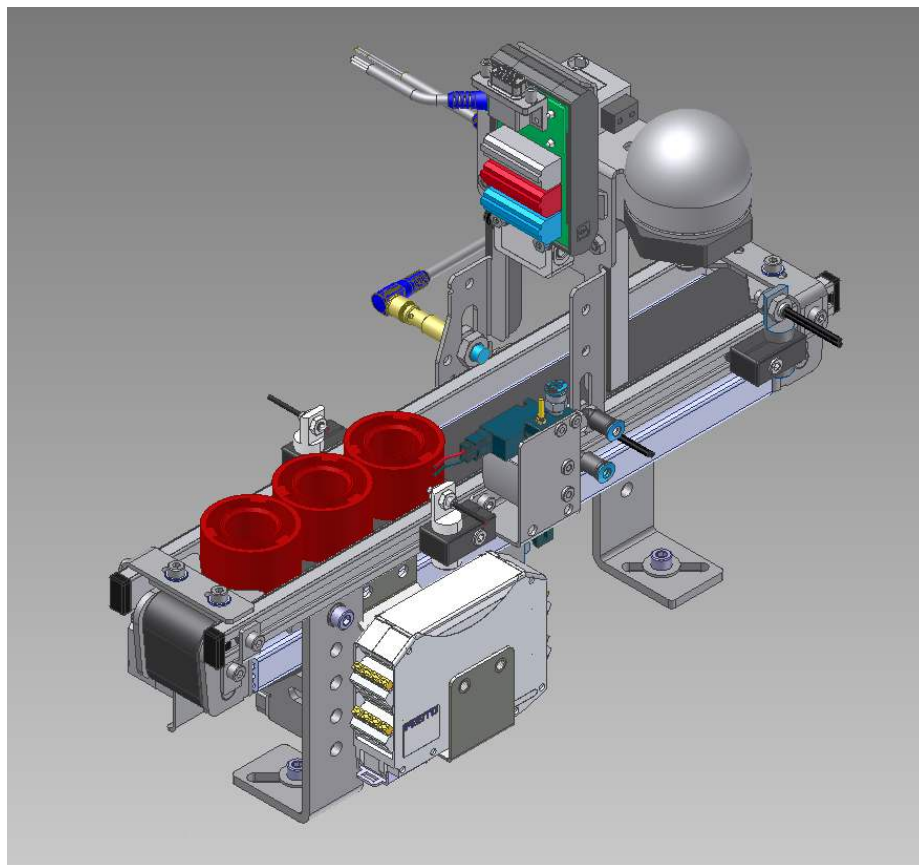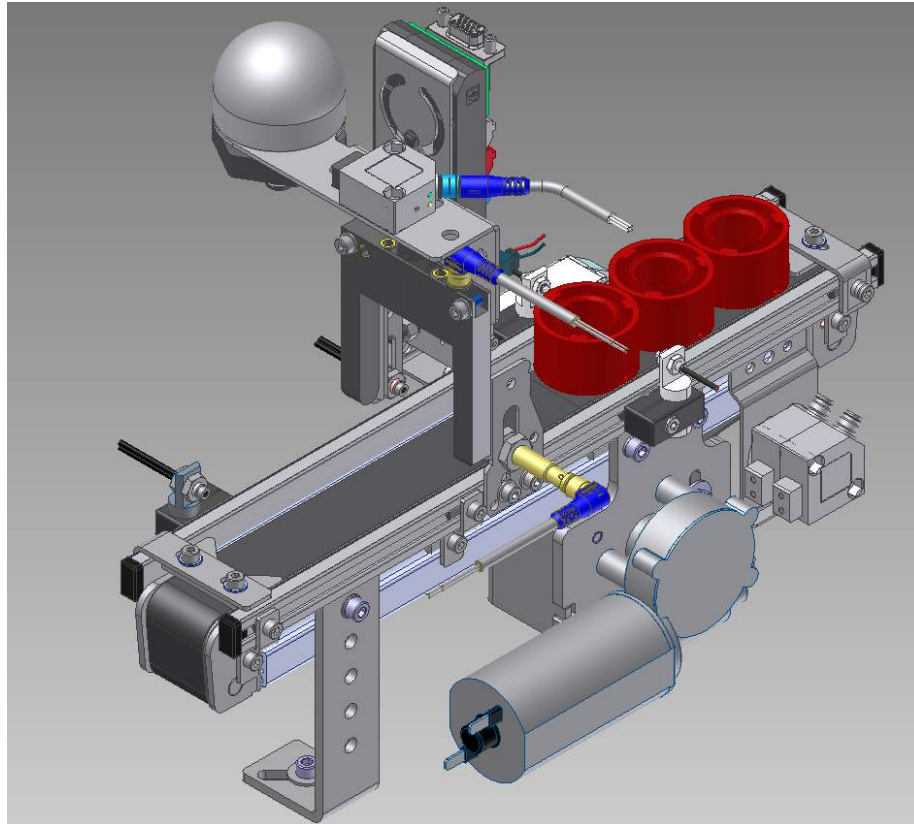## Mechanical Part
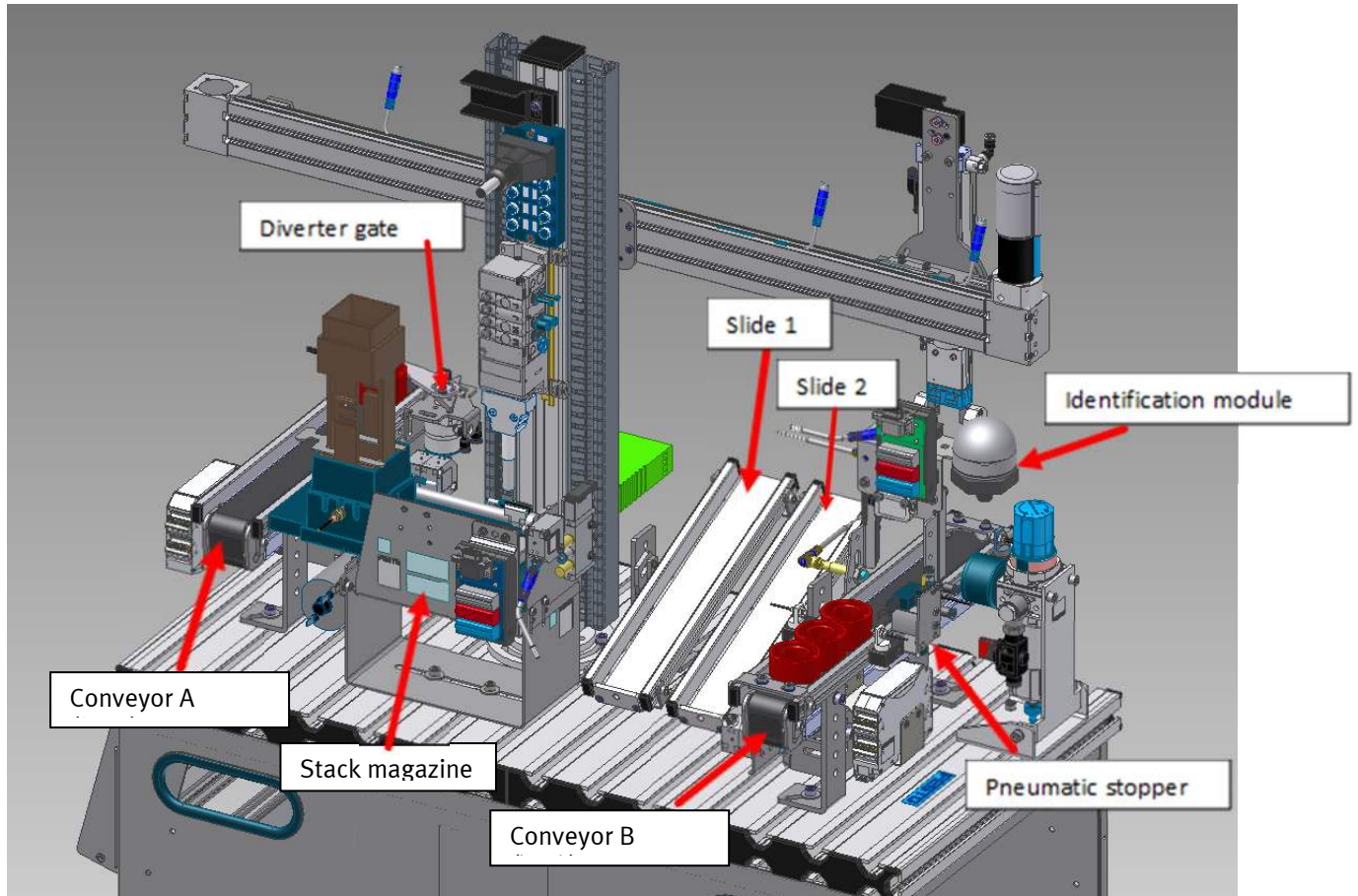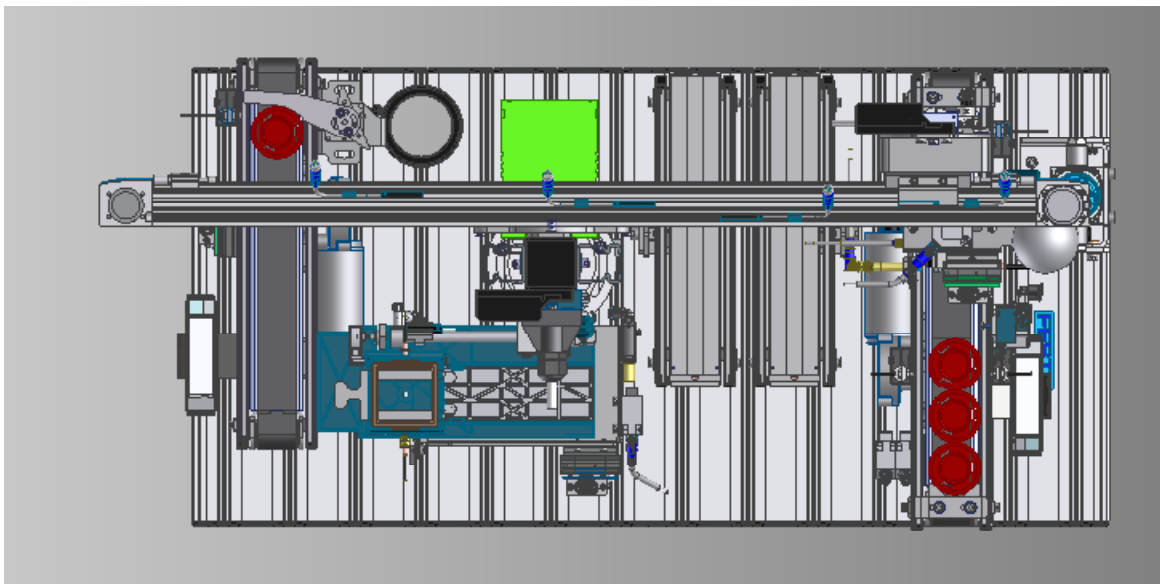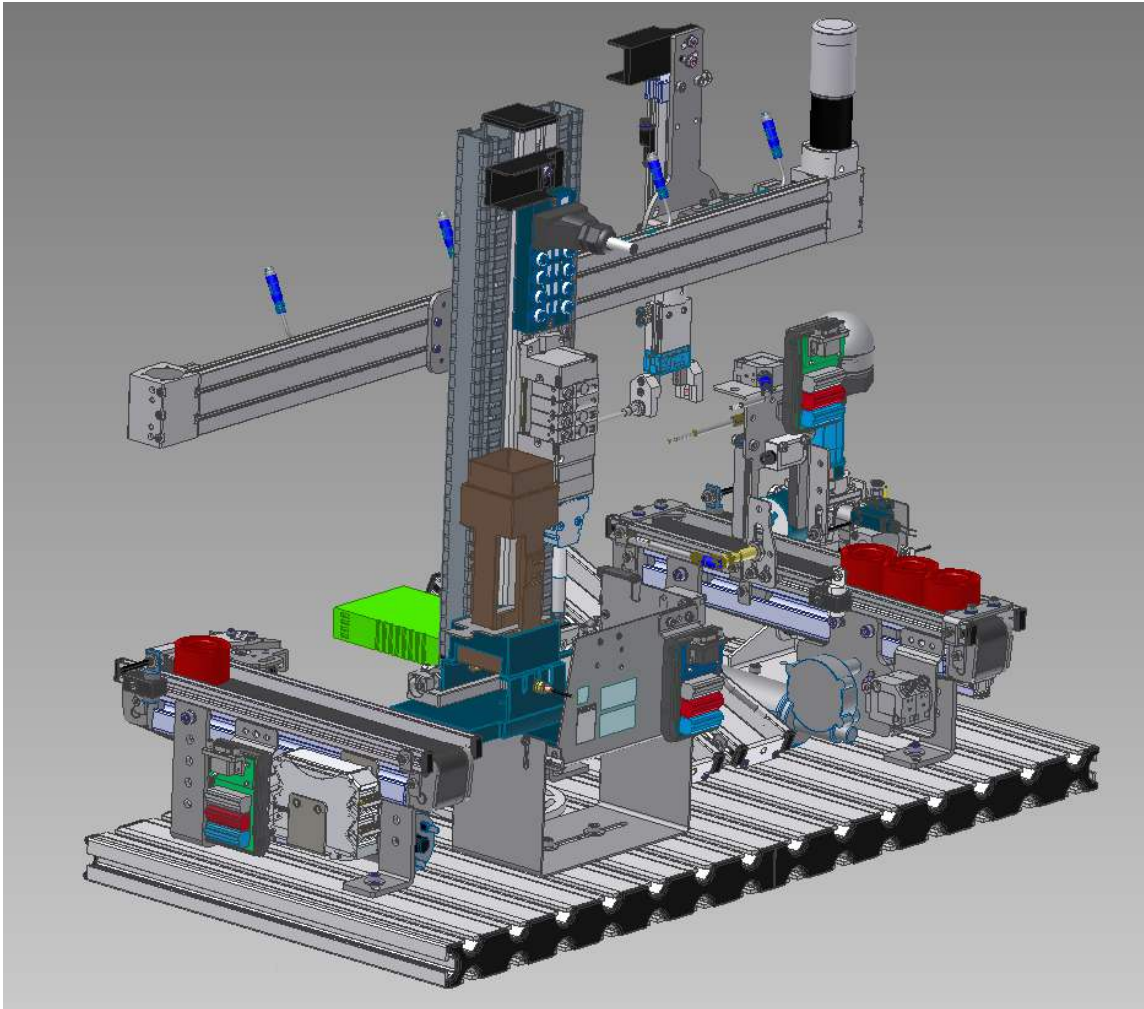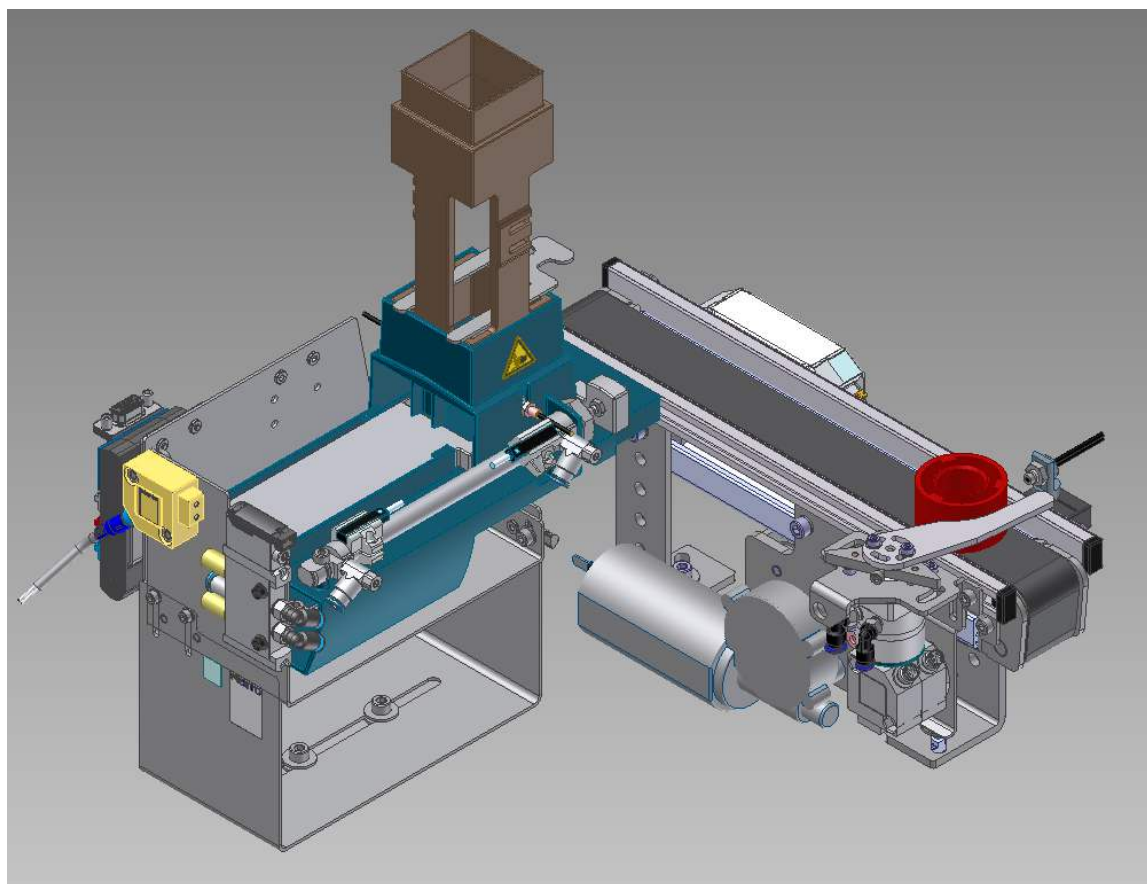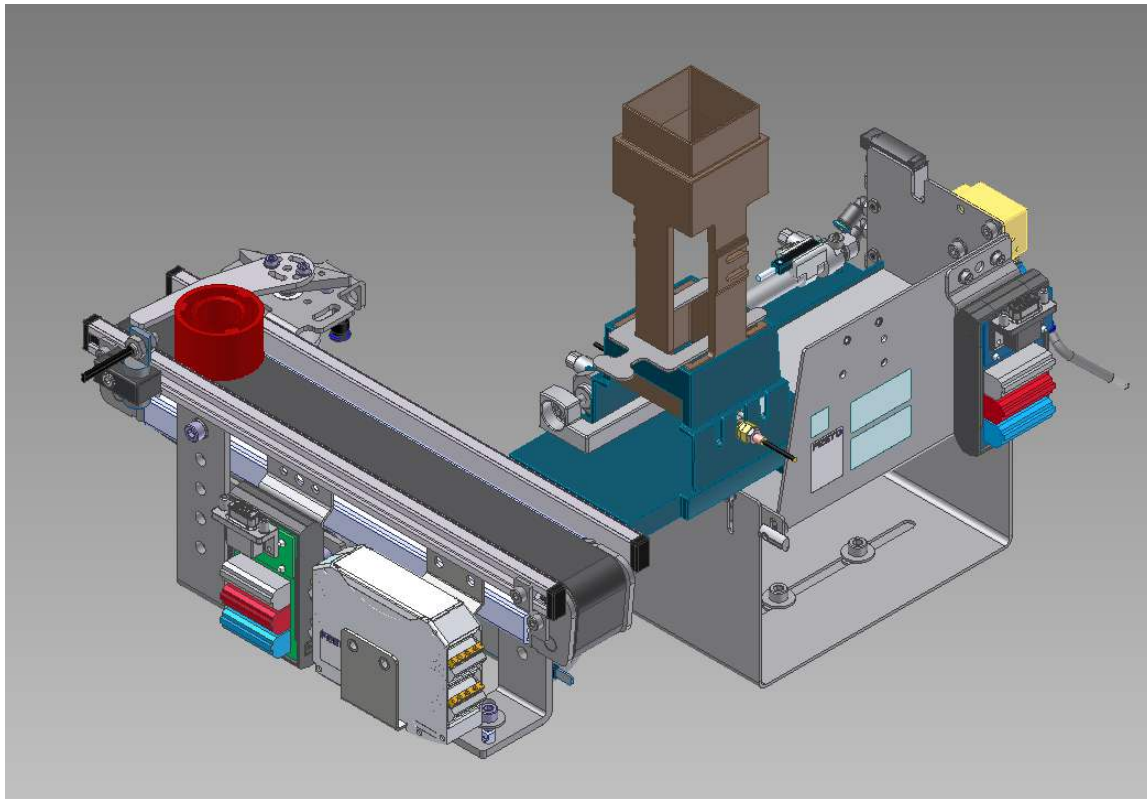
Electrical Part

Module information: Conveyor A (front)

Conveyor module wiring allocation (Mini IO Terminal)

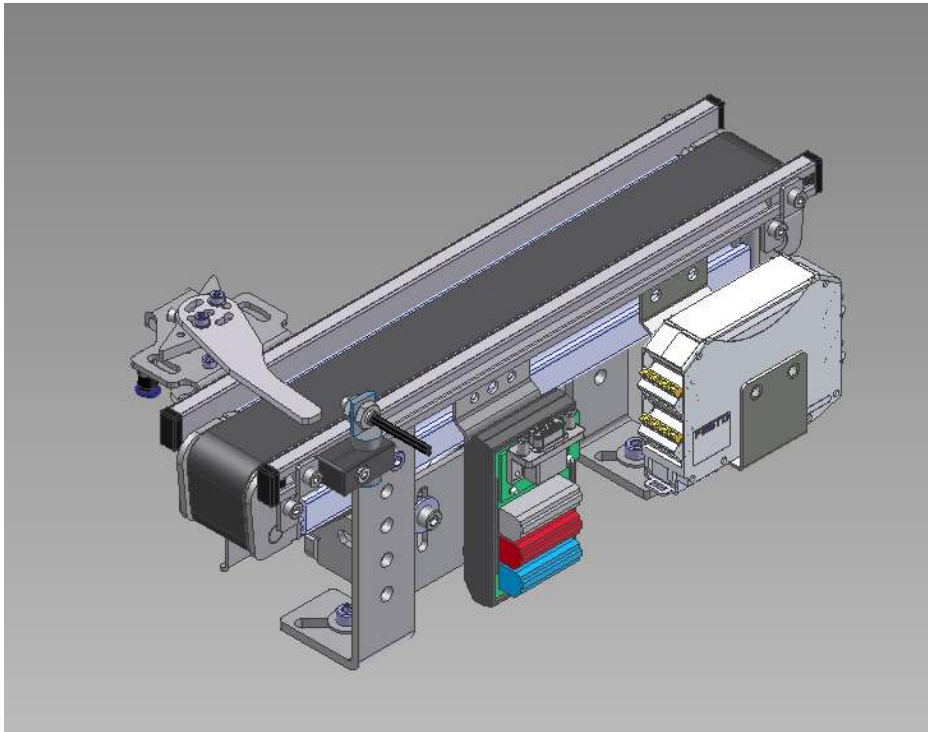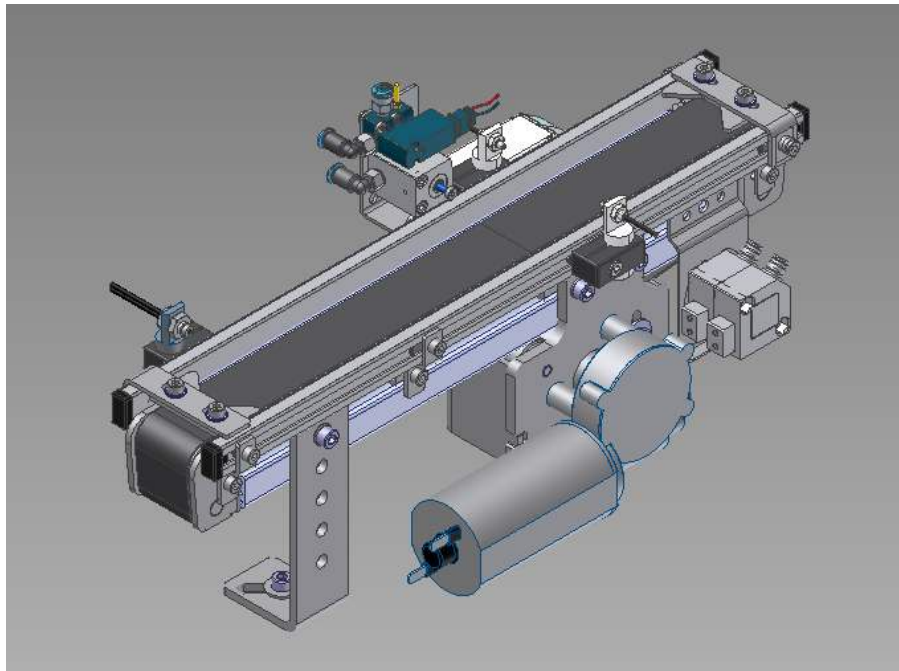| Function	D-Sub HD	Terminal	Description
I0	1	1	Not used
I1	3	2	Not used
I2	5	3	Not used
I3	7	4	Workpiece at distribution point (Diffuse)
AI0	9	5	Not used
AI1	10	6	Not used
Q0	2	7	Not used
Q1	4	8	Not used
Q2	6	9	Conveyor backward
Q3	8	10	Conveyor forward
AQ0	11	11/12	Not used
24 V A	12	24 V A	24 V power 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: Conveyor B (back)

Conveyor module wiring allocation (Mini IO Terminal)

Function	D-Sub HD	Terminal	Description
I0	1	1	Not used
I1	3	2	Workpiece at pick/drop-off point (Diffuse)
I2	5	3	Not used
I3	7	4	Reject area not full (Through-beam)
AI0	9	5	Not used
AI1	10	6	Not used
Q0	2	7	Conveyor backward
Q1	4	8	Conveyor forward
Q2	6	9	Not used
Q3	8	10	Retract stopper
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
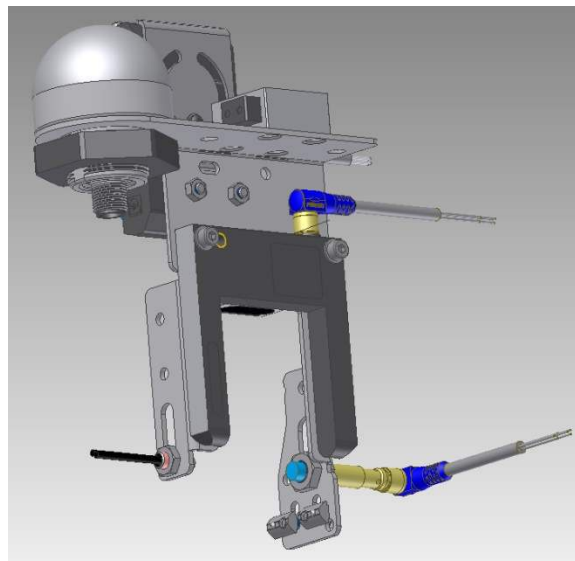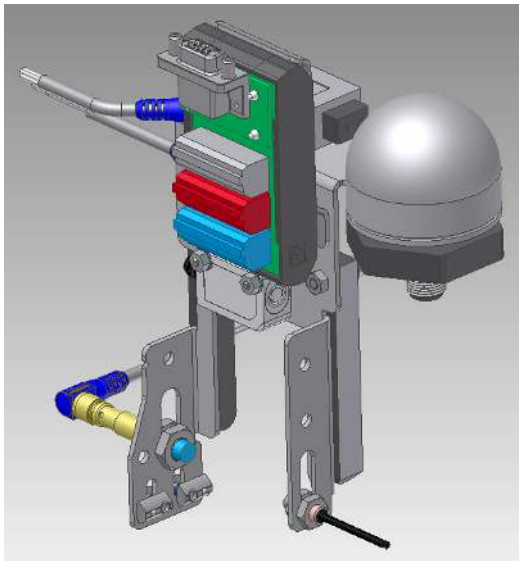
Identification module wiring allocation (Mini IO Terminal)

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 1
Q1	4	8	Light Indicator: Input 3
Q2	6	9	Light Indicator: Input 2
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: Distribution module
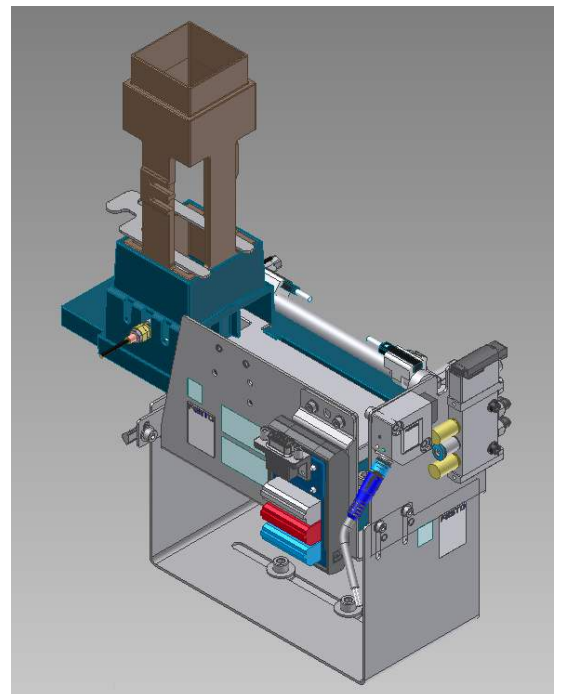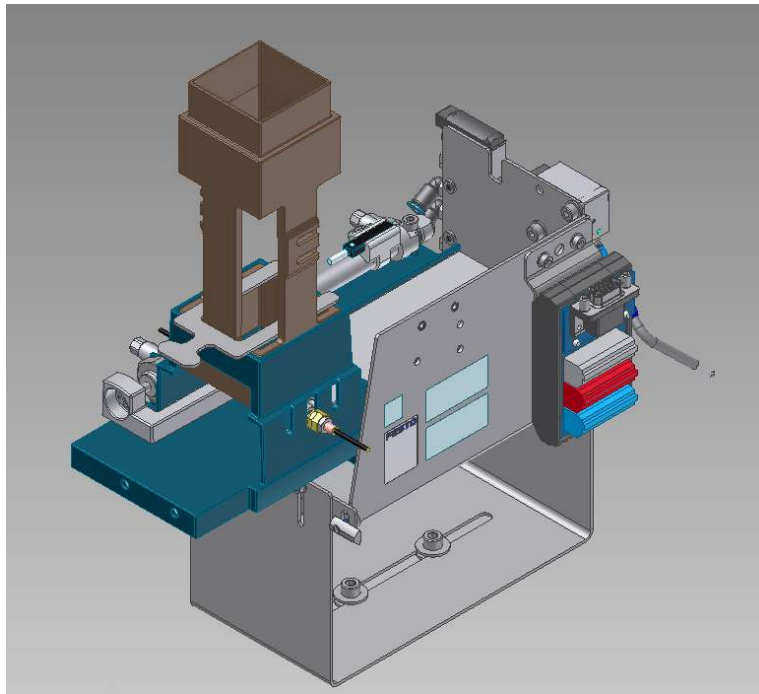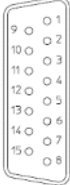
Distribution module wiring allocation (Mini IO Terminal)

Function	D-Sub HD	Terminal	Description
I0	1	1	Feeder retracted
I1	3	2	Not used
I2	5	3	Magazine empty
I3	7	4	Feeder extended
AI0	9	5	Not used
AI1	10	6	Not used
Q0	2	7	Not used
Q1	4	8	Not used
Q2	6	9	Extend feeder
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
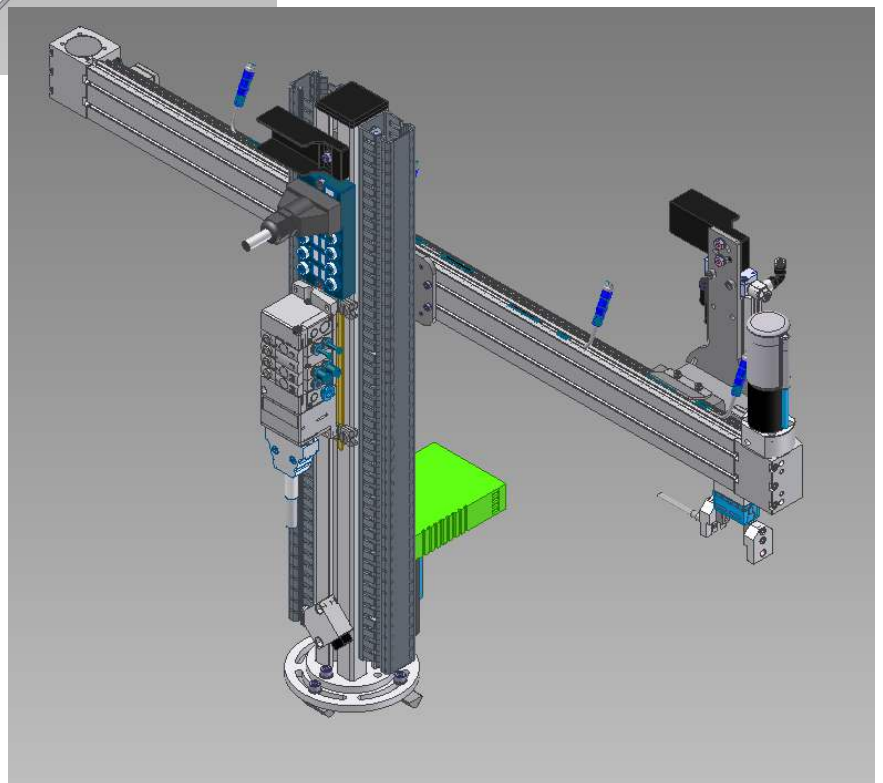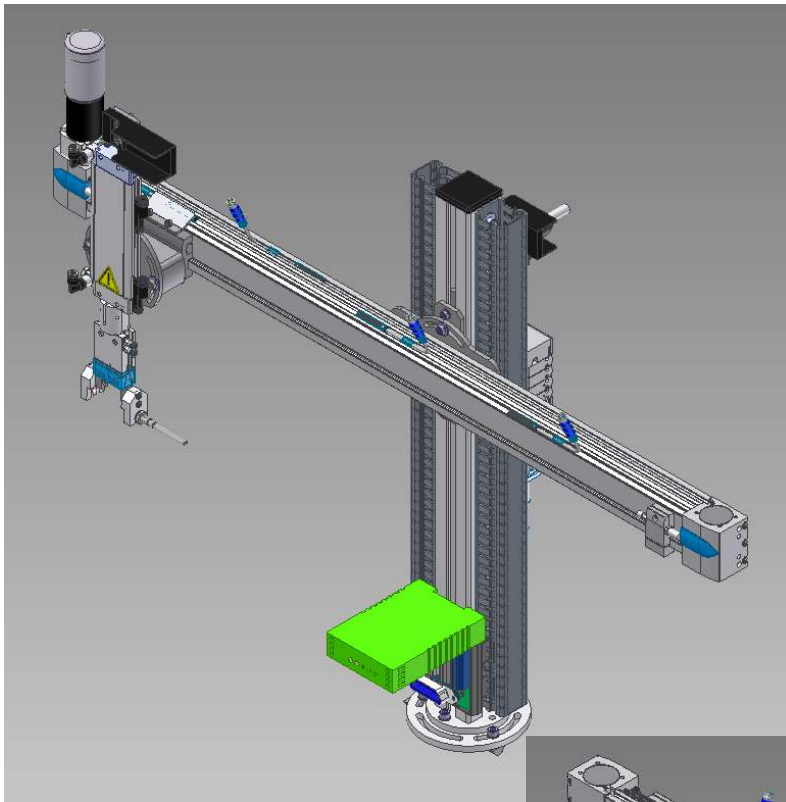
Pin Allocation for Valve terminal and Distributed I/O Block

PIN	Core Colour	Coil		Function
1	White	0	O1	Gripper arm retracts (up)
2	Brown	1	O3	Gripper arm extends (down)
3	Green	2	O5	Gripper opens
4	Yellow	3	O7	Diverter gate extends (open)
5-13	-	-	-	Not used
14	Brown-green	0 V		
15	White-yellow	0V		

PIN	Core Colour	M8 Socket		Function
1	White	0	I0	Conveyor A (front) position
2	Brown	1	I1	Conveyor B (back) position
3	Green	2	I2	Slide 2 position
4	Yellow	3	I3	Slide 1 position
5	Grey	4	I4	Gripper arm extended (Down)
6	Pink	5	I5	Gripper arm retracted (Up)
7	Blue	6	I6	Part in Gripper
8	Red	7	I7	Not used
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	Conveyor A (front) position
I1	14	2	Conveyor B (back) position
I2	15	3	Slide 2 position
I3	16	4	Slide 1 position
I4	17	5	Gripper arm extended (Down)
I5	18	6	Gripper arm retracted (Up)
I6	19	7	Part in Gripper
I7	20	8	Not used
Q0	1	9	Handler moves to the upstream position
Q1	2	10	Gripper arm retracts (up)
Q2	3	11	Handler moves to the downstream position
Q3	4	12	Gripper arm extends (down)
Q4	5	13	Not used
Q5	6	14	Open gripper
Q6	7	15	Not used
Q7	8	16	Extend the diverter gate
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
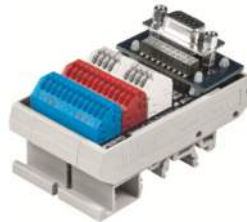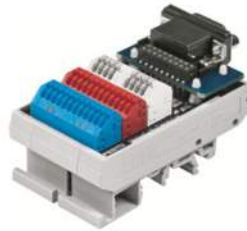
Sub-D-15-HD connecting cable with an open end
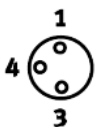
	PIN	Core Color	Function
	1	White	Input I0
	2	Brown	Output Q0
	3	Green	Input I1
	4	Yellow	Output Q1
	5	Grey	Input I2
	6	Pink	Output Q2
	7	Blue	Input I3
	8	Red	Output Q3
	9	Black	Analogue Input AI0
	10	Violet	Analogue Input AI1
	11	Gray-Pink	Analogue Output AQ0
	12	Red-Blue	Power Supply Inputs 24 V B
	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.
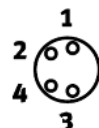
Contact allocation table of the digital I/O terminal

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
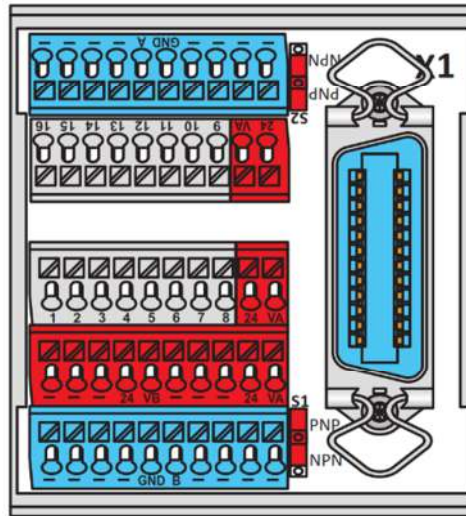
Wiring allocation for sensors

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

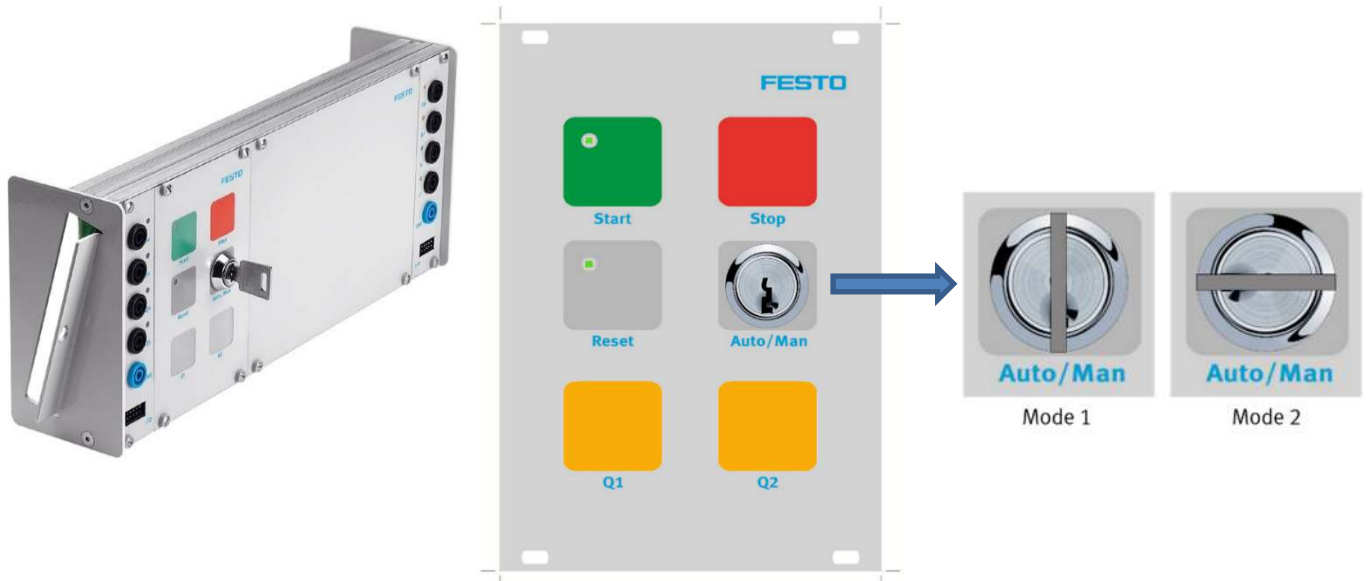| PIN	Core Colour	Function
1	Brown	24 VDC
2	White	Output
3	Blue	0 VDC
4	Black	Output

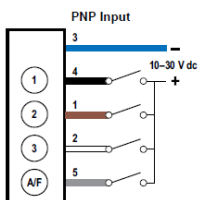# Additional Information

Workpieces

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

Control console

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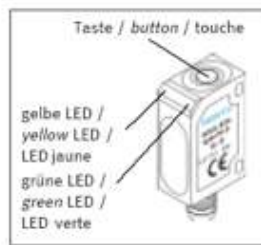
- Analogue output 0 ... 10 V
- Adjustable screening function
- Adjustable foreground and background suppression
- Measuring range 20 ... 80 mm adjustable
- Teach in
- Red light 660 nm
- Contamination indicator
- N.O. - N.C. selectable
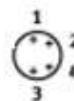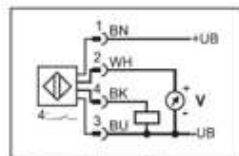
Anschluss / wiring / Raccordement

Bild 1 / fig. 1 / figure 1

+U$_B$:	15 ... 30 V DC
Out:	PNP Out max. 100 mA
Analog:	0 ... 10 V DC max. 3 mA
-U$_B$:	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.

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.

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.
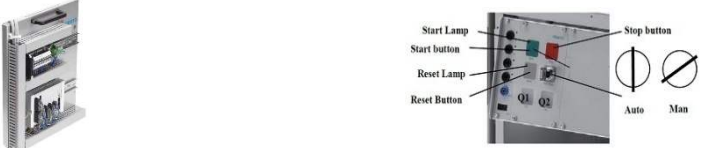
Evaluation sheet

Team : _____

Verification performed by : _____

Total time : _____ (maximum 360 minutes)

Final mark : _____

PLC board (operation)

Description	Evaluation	Maximum evaluation
Preparation: Connect the PLC board to the I/O terminal (PLC must be in RUN or Monitor mode). Put the key in MAN.	Done	Max. Points
1. After power-up the station remains static. The RESET light flashes at 1 Hz		
2. Nothing happens when a part is placed onto the conveyors.		0.75
3. Press the RESET button. The station returns to the home conditions: • Handler at Pick position on front conveyor • Gripper Arm Retracted • Gripper open • 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
4. Set the key to AUTO to execute the **_operation_** sequence or set the key to MAN to execute the **_teaching_** sequence and press START. RESET light turns OFF and START Light turns ON		0.75
5. **Teaching sequence (steps 5 to 8):** When entering the teaching mode Q2 is flashing at 1 Hz, indicating that we are selecting one of the possible 3 recipes for the slides. Q1 flashes 1 time in a 5 second window indicating that recipe 1 is selected (by default).		0.75
6. The START button is used to cycle between recipes 1, 2 and 3. Recipe 1: Q1 flashes 1 time in a 5 second window, repeated. Recipe 2: Q1 flashes 2 times in a 5 second window, repeated. Recipe 3 Q1 flashes 3 times in a 5 second window, repeated.		0.75
7. To validate the recipe choice, the STOP button is pressed. Q1 stops flashing and Q2 flashes the saved pattern in a 5 second window. 1 time for recipe 1, 2 times for recipe 2, 3 times for recipe 3.		0.75

8. The packaging sequence will look like this: **Recipe 1 (default)** | Pos	Slide 1	Slide 2
-----	---------	---------
1	Red	Black
2	Silver	Red
3	Red	Silver
4	Black	Black | **Recipe 2** | Pos	Slide 1	Slide 2
-----	---------	---------
1	Black	Silver
2	Silver	Black
3	Red	Silver
4	Silver	Black | **Recipe 3** | Pos	Slide 1	Slide 2
-----	---------	---------
1	Red	Silver
2	Red	Silver
3	Black	Black
4	Black	Black			
9. If the key is turned to AUTO and then returned to MAN, the teaching sequence should start over at the default		
10. Operation sequence: A workpiece is fed by the stacking magazine onto the front conveyor. When the part is detected on the conveyor, the part is moved to the handling module pick position.		0.75
11. When the part arrives at the pick position, the gripper moves down to grab it.		
12. When the part is picked from the front conveyor it is transferred to the back conveyor for identification. When the part is placed on the conveyor it is moved to the identification module for verification.		0.75
13. The system will then determine the next place for the part: packing (slide 1 or 2) or reject. If the part conforms to the packing recipe requirements, it needs to go to slide 1 or 2. If it is not in the proper sequence **OR** is in the wrong orientation (upside down), it must go to the rejection area. 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.		

14. If the part is needed for slide 1, the part will move from the identification module and wait for the handling module to pick the part. The handling module will move this part to slide 1 and release it, then move to the front pick position. ONLY proper parts will be placed here.		0.75
15. If the part is needed for slide 2, the part will move from the identification module and wait for the handling module to pick the part. The handling module will move this part to slide 2 and release it, then move to the front pick position. ONLY proper parts will be placed here.		0.75
16. If the part is rejected, the part will move from the identification module to the conveyor reject storage area (right of the rear conveyor). The stopper will open to allow access to the storage area.		1.50
17. When the reject area is full, the stopper will open and allow the parts to be rejected from the front conveyor. The parts must move one at a time from the reject area, through the handling module, to the front conveyor and be ejected left.		1.50
18. When both slides are completely full and ready for shipping, the System status light alternates at 2 Hz in the following sequence: Red, Yellow, Green, Cyan, Blue, Magenta, White, and continues to repeat in that order.		1.50
19. Empty the slides by hand and then hold the START button for 3 seconds. The status light stops flashing and the system allows packing a new batch with the same recipe.		0.75
20. During operation the Identification module shows the status of what is happening using the following standard: Stacking magazine or Handling module moving – Red Part being Identified – Yellow Front Conveyor moving – Green Back conveyor moving – Cyan Rejects being unloaded – White Flashing at 1 Hz While rejects are being unloaded, no other colours are displayed until the reject process is completed.		1.50
21. If the STOP button is pressed at any point during the operation sequence, the system should immediately return to home position to allow manual removal of the part that is in transition.		0.75
PLC board total		**15**

Simulation box (I/O allocation)

Conveyor A (front) and Distribution 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	Workpiece at distribution point (Diffuse)		0.50
I1	Feeder retracted		0.50
I2	Feeder extended		0.50
I3	Magazine empty		0.50
I4	Not used		-
I5	Not used		-
I6	Not used		-
I7	Not used		-
O0	Not used		-
O1	Not used		-
O2	Not used		-
O3	Not used		-
O4	Extend the feeder		0.50
O5	Conveyor backward		0.25
O6	Conveyor forward		0.25
O7	Not used		-
Simulation box total			**3**

Conveyor B (back) and Identification 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	Workpiece at pick/drop-off point (Diffuse)		0.50
I1	Height Sensor		0.50
I2	Reject area not full (Through-beam)		0.50
I3	Inductive sensor (metallic)		0.50
I4	Not used		-
I5	Black/non-black sensor (diffuse)		0.50
I6	Not used		-
I7	Workpiece detected (Light Barrier)		0.50
O0	Light Indicator: Input **1**		0.50
O1	Conveyor backward		0.25
O2	Light Indicator: Input **3**		0.50
O3	Conveyor forward		0.25
O4	Light Indicator: Input **2**		0.50
O5	Retract stopper		0.50
O6	Not used		-
O7	Not used		-
Simulation box total			**5.50**

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 Conveyor A (front) position		0.50
I1 Conveyor B (back) position		0.50
I2 Slide 2 position		0.50
I3 Slide 1 position		0.50
I4 Gripper arm extended (Down)		0.50
I5 Gripper arm retracted (Up)		0.50
I6 Part in Gripper		0.50
I7 Not used		-
O0 Handler moves to the upstream position		0.50
O1 Retract gripper arm (up)		0.50
O2 Handler moves to the downstream position		0.50
O3 Extend gripper arm (down)		0.50
O4 Not used		-
O5 Open gripper		0.50
O6 Not used		-
O7 Extend diverter gate		0.50
Simulation box total		**6.50**

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)		
• 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: $$\frac{RemainingTime}{MaxTime/3} * Max\ points$$ **See time evaluation calculation examples below**	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**