Module I Test Project

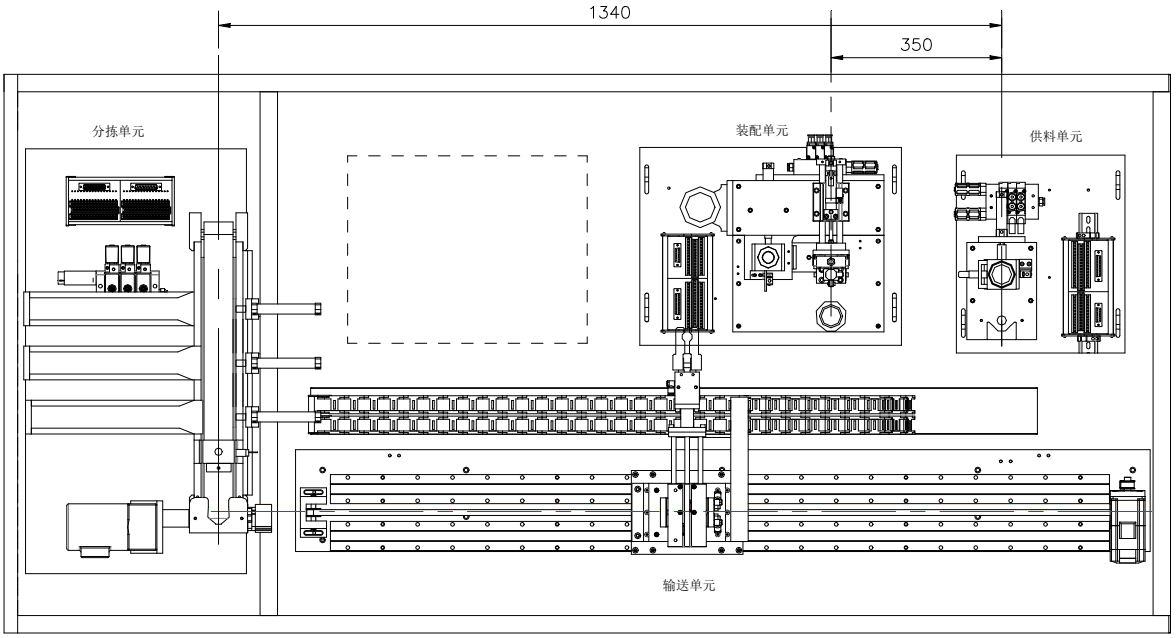
Design and implementation of intelligent production line

Score (point): 100

Time (minute): 180

Background:

In the context of intelligent manufacturing, the company is in urgent need of one intelligent production line to meet the requirements of new processes and new tasks and improve the company's core competitiveness. As the technicians of the company, you are asked to complete the equipment design, programming and debugging according to the relevant technical documents to realize automatic operation of the production line.



	Sorting unit
	Assembly unit
	Feed unit
	Conveying unit

Main tasks:

Based on the 2D drawing of the feed unit provided, build a device model and generate the assembly drawing.

Based on the assembly effect picture provided, complete the actual assembly of the feed unit.

Based on the I0 form provided, complete the wiring and air duct connection on device side and PLC side of the feed unit.

Based on the task requirements, complete the programming and debugging of feed unit and sorting unit.

The on-line program of HMI, conveying unit and assembly unit has been given and stored in the Skill Competition folder under the D drive of the computer.

The preconditions for completion of tasks are as follows:

1. The production line can operate correctly after mechanical assembly, circuit connection and air duct connection.

(On-site measurement for marking)

2. The system complies with the specification requirements.

(Consistent with the professional technical specification)

Task 1: Intelligent production line design

Create a three-dimensional digital model in the 3D software. Competitors are required to create some part and general assembly models of a unit of the product according to the working principle of the intelligent production line and generate the relevant design document.

1.) Documents provided:

Schematic diagram, parts drawing or part model;

Assembly diagram or assembly model;

2.) Tasks:

Create a 3D part model according to the parts drawing;

Create an equipment model, generate an assembly drawing, and edit the assembly drawing;

Render the 3D digital model and design the presentation graphics.

3.) Documents submitted by competitors:

All electronic data;

A4~A1 drawings signed by competitors

Three-dimensional parts drawing in Par format and element 3D assembly model in asm or STEP format.

Project 1. Documents provided

Provide all part numbers of the feed unit and their drawings, 17 special parts (drawings are underlined), and 3 assemblies. Store the related documents in the "Feed Unit" folder under the root directory of the “D drive” on the computer, titled as follows:

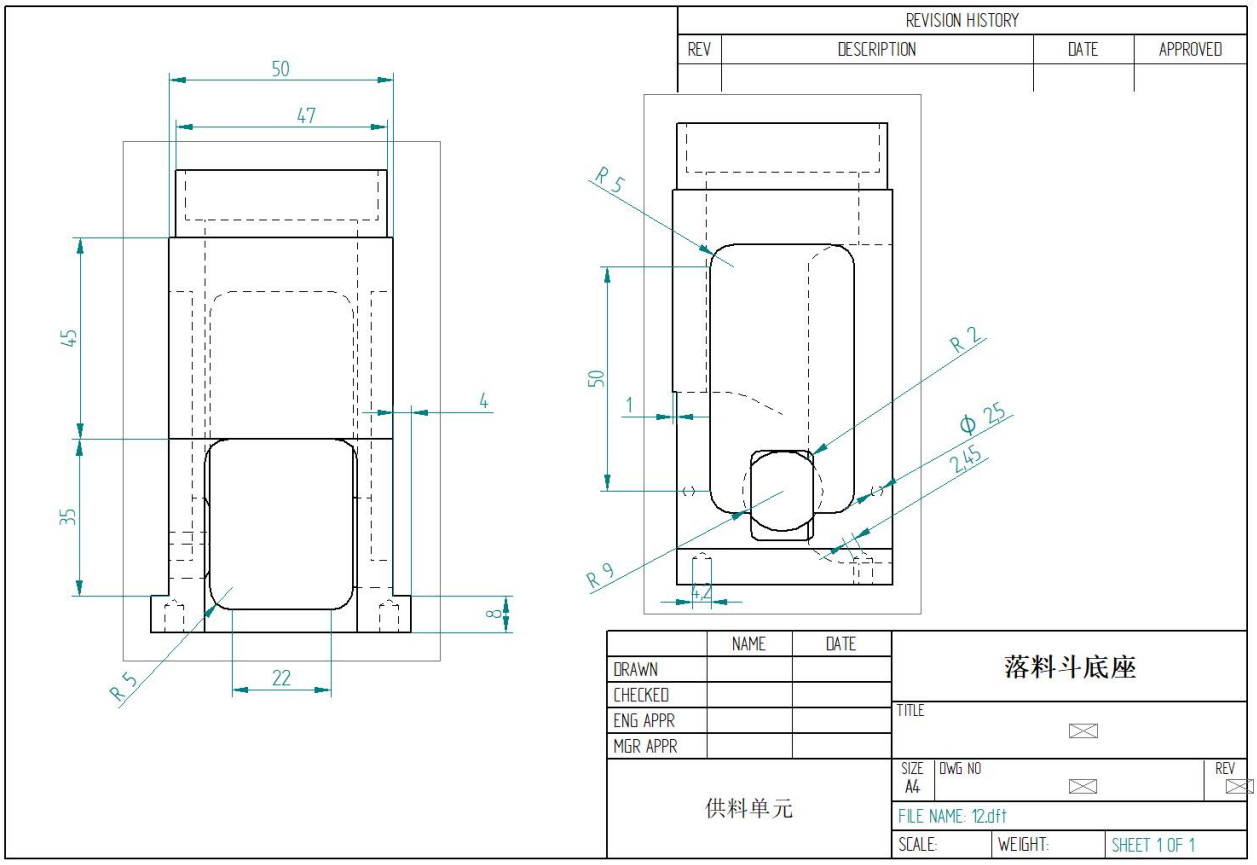
S/N	Name	Remarks
1.	Main baseplate of the feed unit	Part
2.	Upper and lower horizontal columns on the left and right sides of the support	Part
3.	Charging tube of large workpieces	Part
4.	Decorative ring on top of the charging tube of large workpieces	Part
5.	End cover of ejection cylinder rod of workpieces	Part
6.	Workpiece ejection position block	Drawing in PDF format
7.	End cover of the linear cylinder stem for workpiece ejection	Part
8.	Sensor support of workpiece grabbing position	Part
9.	Fixed tripod of feed support frame	Part
10.	Hopper sensor support	Part
11.	Metal sensor support	Part
12.	Falling hopper base	Drawing in PDF format
13.	Falling hopper support plate	Part
14.	Cylinder support	Part
15.	Support column	Part
16.	Upper horizontal column in front of and behind the support	Part
17.	Large material workpiece	Part
18.	Trunking	Part
19.	Connection terminal	Part
20.	Fixing support for wiring	Part
21.	Solenoid valve group	The folder contains assemblies and parts.
22.	Ejection cylinder assembly	The folder contains assemblies and parts.
23.	Push-rod cylinder assembly	The folder contains assemblies and parts.

Remarks: Parts are in par format and assemblies are in asm format.

Project 2. Task

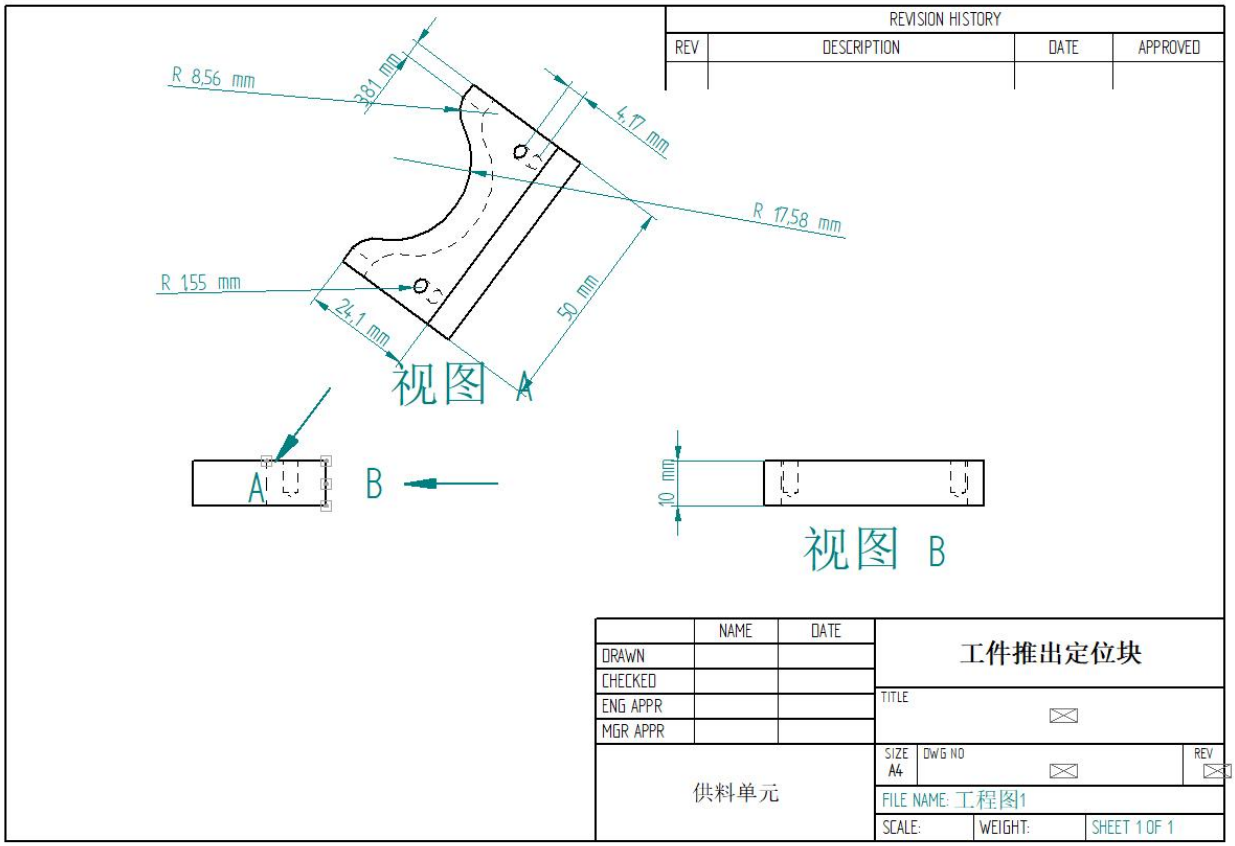
1.) Create the 3D models of No. 6 and No. 12 parts, and then conduct assembly modeling according to the working principle of the feed unit of equipment in the intelligent production line and the parts printing drawing provided. For any technical information not shown in drawings or models, such as standard parts (GB or ISO is available), thread or some dimensions, competitors can judge or select such information by themselves.

2.) Determine the height of falling hopper base and mark the values on the drawing. (Meet the working requirements of the feed unit)



	Feed unit
	Falling hopper base

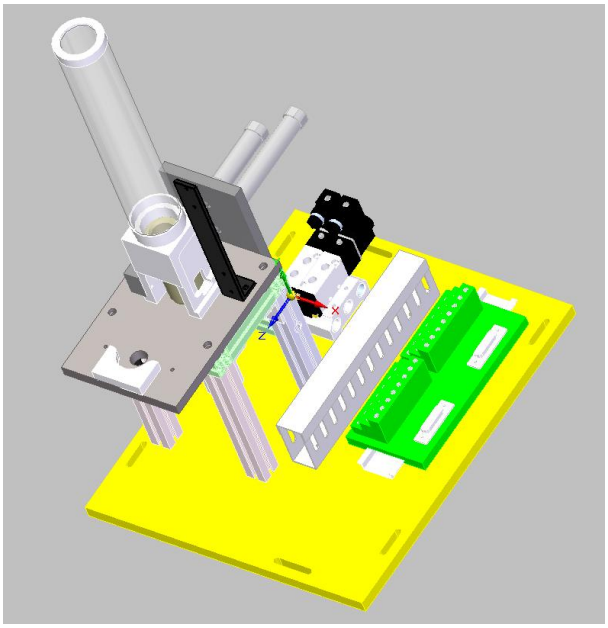
(No. 12 Part - Drawing)



	View A
	View B
	Feed unit
	Workpiece ejection position block
	Engineering drawing 1

(No. 6 Part - Drawing)

3.) Generate the assemblies of the feed unit and export them in STEP format.

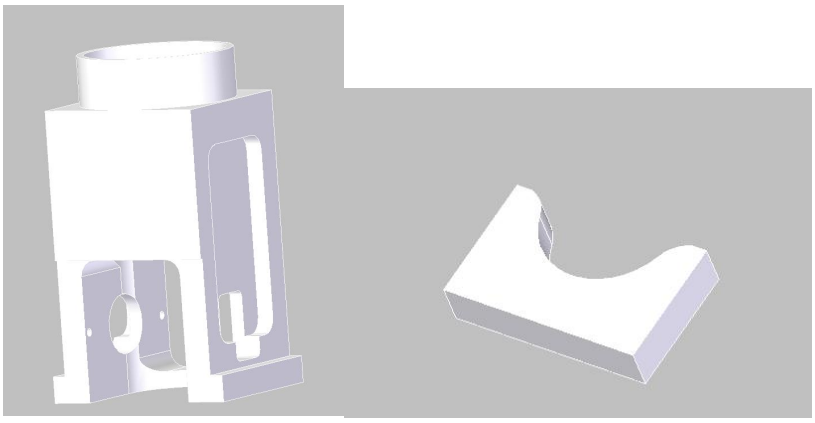


Project 3. Documents submitted by competitors

1.) Store all data to the "D Drive: \ Workstation Number \ M1\". It is not allowed to create separate folders for different types of documents.

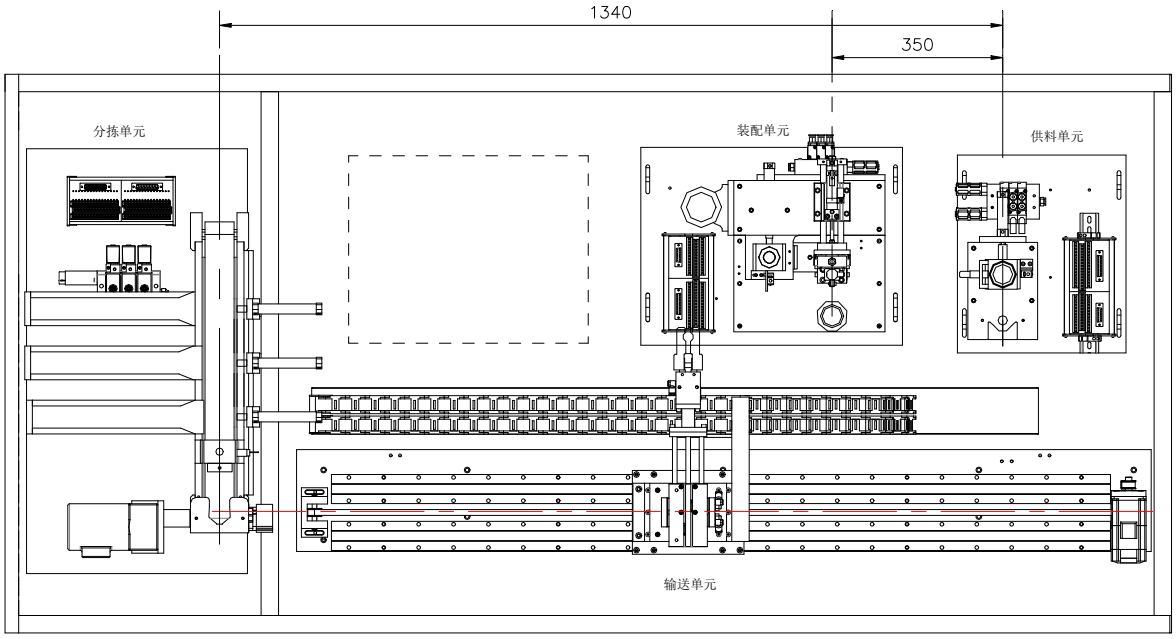
2.) A4~A1 drawings signed by competitors

3.) Three-dimensional parts drawings of workpiece ejection position block and falling hopper base (in Par format) and 3D assembly model of the feed unit (in STEP format).



Note: After the end of the Competition, competitors should back up the submittals in the USB flash drive as the judgment basis. If any competitor fails to store the submittals in the designated folder or USB flash drive, his/her results will be deemed invalid.

Task 2: Implementation of intelligent production line



	Sorting unit
	Assembly unit
	Feed unit
	Conveying unit

Schematic Diagram of Production Line Layout

Initial position of the production line

Initial position of the feed unit:	**Initial position of the sorting unit:**
1. The ejection cylinder is in the position of extension	1. Push-rod 1 cylinder is in the position of retraction
2. The pushing cylinder is in the position of retraction	2. Push-rod 2 cylinder is in the position of retraction
	3. Push-rod 3 cylinder is in the position of retraction
	4. The frequency converter stops operating

Description of unit installation and positioning:

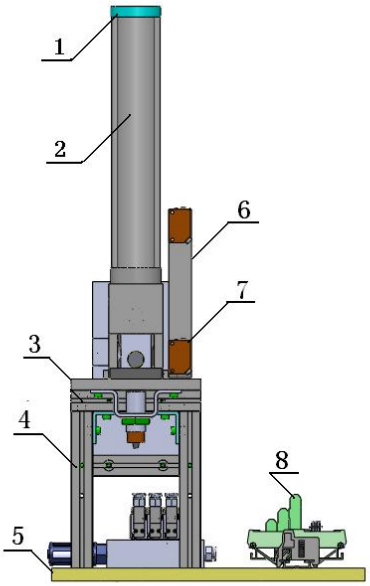
1. The sorting unit is the reference for positioning of various units, and movement is not allowed.

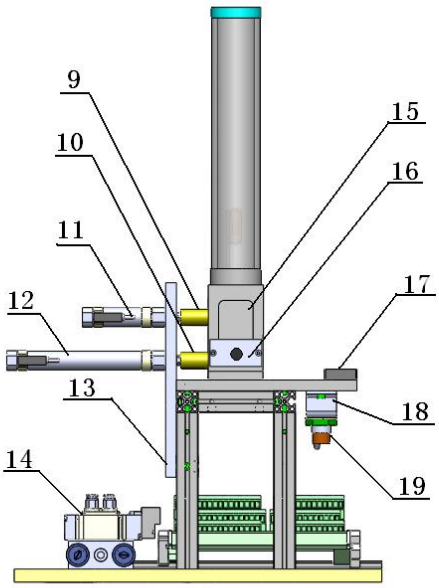
2. The positioning of the feed unit is determined by the position of the sorting unit.

Project 1. Feed unit

1) Mechanical assembly

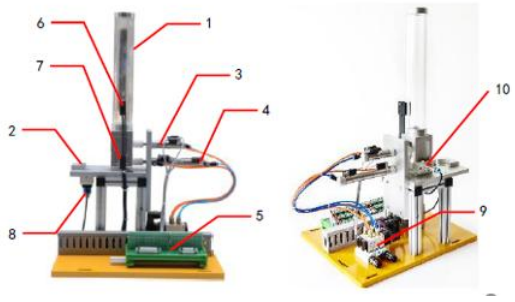
Based on the assembly renderings, complete the assembly of the feed unit.



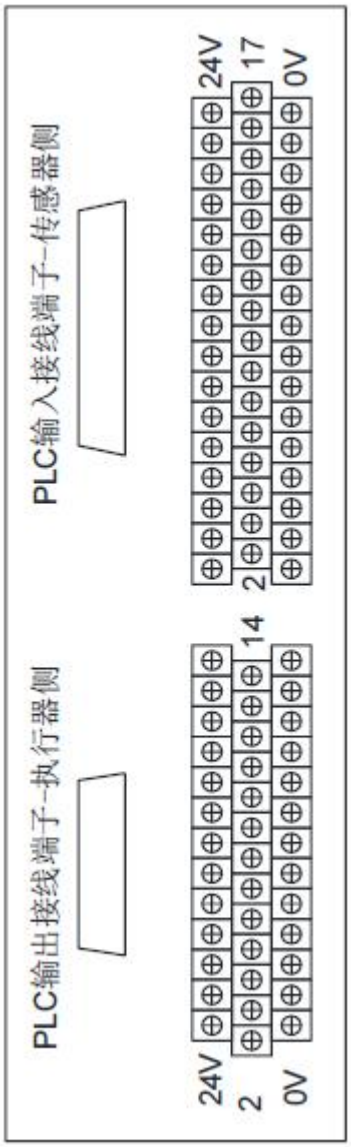


No.	Name	No.	Name
1	Decorative ring	11	Ejection cylinder
2	Charge pipe	12	Pushing cylinder
3	Base mounting plate	13	Cylinder mounting plate
4	Aluminium alloy support	14	Solenoid valve group
5	Module baseplate	15	Base
6	Sensor mounting support	16	Mounting kit of inductive sensor
7	Photoelectric sensor	17	Retention block
8	Terminal block	18	Sensor mounting support
9	Ejector head	19	Photoelectric sensor
10	Pusher head		

2) Electrical wiring



No.	Name	No.	Name
1	Silo	6	Underfeeding detection
2	Discharging platform	7	Starved feeding detection
3	Ejection cylinder	8	Workpiece existence detection
4	Pushing cylinder	9	Valve terminal
5	Connection terminal	10	Inductive sensor

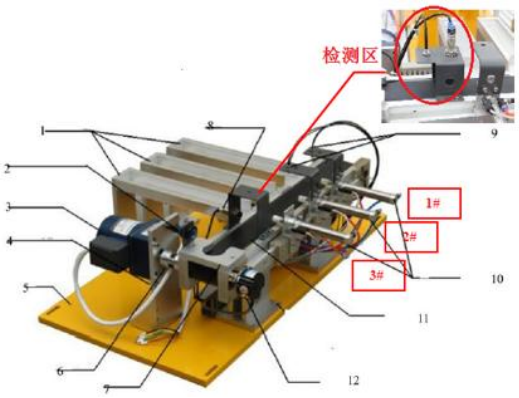
Terminal type		Terminal No.	Function
	PLC input signal terminal	2	Workpieces in the silo are insufficient
		3	The pushing cylinder is in the position of retraction
		4	The ejection cylinder is in the position of extension
		5	There is no workpiece in the silo
		6	The ejection cylinder is in the position of retraction
		7	The pushing cylinder is in the position of extension
		8	Workpieces exist on the discharging platform
		9	
		10	
		11	
		12	
		13	
		14	
		15	
		16	
		17	
		2	The ejection cylinder extends
		3	The pushing cylinder

	PLC input terminal - sensor side	PLC input signal terminal		extends
	PLC output terminal - effector side		4	
			5	
			6	
			7	
			8	
			9	
			10	
			11	
			12	
			13	
			14	

3) PLC end I0 allocation table

Description		**S**	
PLC input signal of the feed	**When the signal is 1**		
Workpieces in the silo are	I0.0		
The pushing cylinder is in the	I0.1		
The ejection cylinder is in the	I0.2		
There is no workpiece in the	I0.3		
The ejection cylinder is in the	I0.4		
The pushing cylinder is in the	I0.5		
Workpieces exist on the	I0.6		
Start (SB1)	I1.0		
Reset (SB2)	I1.1		
Manual/automatic switching	I1.2		
Emergency stop (SQ)	I1.3		
PLC output signal of the feed	**When the signal is 1**		
The ejection cylinder extends	Q0.1		
The pushing cylinder extends	Q0.2		
Reset light (HL1)	Q0.7		
Start light (HL2)	Q1.0		
Stop light (HL3)	Q1.1		
Total score			

Project 2. Sorting unit



	Detection area

No.	Name	No.	Name
1	Storage chute	7	Guider
2	Photoelectric sensor	8	Inductive sensor
3	Gear motor	9	Fiber optic sensor
4	Motor support	10	Push-rod cylinders 1-3#
5	Baseplate	11	Belt conveyor
6	Coupling	12	Encoder

Note: The picture is provided for reference only. Actual products may vary.

1) PLC end I0 allocation table

Sorting unit PLC input	**When the signal is 1**	**The I0 of the sorting unit is used for programming only and not used in marking**
Rotary encoder B-phase signal	I0.0	
Rotary encoder A-phase signal	I0.1	
Workpieces exist at the feed	I0.3	
The core is made of metal	I0.4	
Black and white detection for	I0.5	
Black and white detection for	I0.6	
Push rod 3# extends in place	I0.7	
Push rod 2# extends in place	I1.0	
Push rod 1# extends in place	I1.1	
SB2	I1.2	
SB1	I1.3	
Manual/automatic switching	I1.4	
Emergency stop (SQ	I1.5	
Sorting unit PLC output	**When the signal is 1**	
The frequency converter is under forward transfer	Q0.0	
Push-rod cylinder 3# is	Q0.4	
Push-rod cylinder 2# is	Q0.5	
Push-rod cylinder 1# is	Q0.6	
Reset light (HL1)	Q0.7	
Start light (HL2)	Q1.0	
Voltage output signal (frequency	AO	

Project 3. Control program of production line

Requirements:

Correctly write the program compliant with the operational function of production line according to the following control procedure description.

Control procedure description	**Score**	**Max. score**
Use PLC to inspect the control procedure		
Preparation: Turn off the power of PLC, turn off the air supply, disconnect PLC from the programming equipment, remove all workpieces from the production line, put various unit modules in any position, and put all auto-manual switches of the production line in the manual position (anticlockwise). Start PLC, turn on the air pressure valve, and set the pressure of duplex part to be 5bar.		
I. Single-station test function (if the production line jams during		
1. Feed unit		
Turn off the air supply, put 5 workpieces in the silo and turn of the air		
Switch the auto-manual switch of the feed unit to the manual position to		
Press the Reset Button (SB2) to enable the Reset Light (HL1) to flash		
The feed unit returns to the original position: the ejection cylinder is in the position of extension and the pushing cylinder is in the position of		
The Reset Light (HL1) is normally on 3 seconds after the completion		
The Start Light (HL2) is normally on after pressing the Start Button		
A: The feed unit pushes workpieces to the discharging platform, and		
B: Press the Start Button (SB1) again to make the feed unit push		
Repeat A and B. If there is one workpiece left in the silo, the ejection		
Press the Start Button (SB1) again to make the pushing cylinder push		
If there is no workpiece in the silo, the Stop Light (HL3) will be		
2. Sorting unit		
Switch the auto-manual switch of the sorting unit to the manual position		
Press SB2 Button to enable the Reset Light (HL1) to flash (i.e. flash on		
The sorting unit returns to the original position: 3 pushing cylinders are		
A: Place workpieces manually at the inlet of the sorting unit. Then the Start Light (HL2) of the sorting unit flashes at 2Hz.		
B: Press SB1 Button. Then HL2 is normally on.		
C: The motor operates to the detection area at 15Hz.		
D: After the completion of detection, the motor runs to the pushing chute at 25Hz, and then the motor stops and pushes workpieces into the		

The sorting rules are as follows: Black metal-core workpiece + white black-core workpiece Push them into storage chute 1# Black black-core workpiece + black metal-core workpiece Push them into storage chute 2# Black white-core workpiece + white black-core workpiece Push them into storage chute 3#		
After the completion of pushing, return to Steps A-D.		
If the emergency stop button is pressed during the operation of motor,		
After the emergency stop button is reset, the equipment will continue to		
II. On-line test function (if the production line jams during the		
Preparation: Switch all auto-manual switches of the production line to the automatic position (clockwise), power the conveying unit off,		
Press the reset button on the touch screen. Then the yellow indicator light on the signal post flashes at 1Hz, and the manipulator of the		
Press the start button on the touch screen. Then the green indicator light		
A: The feed unit pushes workpieces to the feed platform.		
The manipulator of the conveying unit grabs workpieces from the feed platform.		
The servo motor runs to the assembly platform position of the assembly station at 300mm/s and sends an assembly request signal.		
The assembly station starts the workpiece assembly procedure after receiving this signal. After receiving the signal of assembly		
The servo motor runs to the assembly platform of the sorting station at 300mm/s and sends a sorting request signal.		
The sorting station starts the sorting procedure after receiving the sorting request signal, while the manipulator of conveying unit returns		
Sorting procedure		
The motor runs to the detection area at 15Hz.		
After the completion of detection, the motor operates to the pushing		
The sorting rules are as follows: Black metal-core workpiece + white black-core workpiece Push them into storage chute 1# Black black-core workpiece + black metal-core workpiece Push them into storage chute 2# Black white-core workpiece + white black-core workpiece Push them into storage chute 3#		
Abnormality handling		
If there are insufficient workpieces in the silos of feed unit and		
If there is no workpiece in the silos of feed unit and assembly unit, the red indicator light on the signal post will flash on for 1s and off for		

If the last workpiece is pushed from the silo of the feed unit, the equipment will continue to operate until the whole procedure ends, and		
When the manipulator of the conveying unit operates, the manipulator will stop immediately if the emergency stop button of the conveying		
After the emergency stop button of the conveying unit is reset, the		
Total score		